Organizational factors affecting successful adoption of innovative eHealth services: A case study employing the FITT framework

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1. Introduction

Healthcare is a sector that currently experiences a number of pressures, both from inside and outside. The continuing innovation in medicine and technologies result in new methods and tools in healthcare. The demographic changes of an ageing European population, combined with citizen empowerment, stretch the limits of what countries can afford to offer as services of their national health systems. As a result, governments are confronted by the urgent need to find means to limit the rise in healthcare costs without compromising quality, equity and access. Consequently, new ways to organize and deliver health services are being investigated and experimented with. Citizens and patients are given more...
responsibility in the management of their own health and chronic illnesses, leading to the gradual creation of a more informed citizen.

As a consequence of this gradual re-organization of healthcare, hierarchies are giving way to partnerships; process-centered healthcare is becoming patient-centered care; and consumer healthcare is emerging as a significant driver in the sector [1]. In today’s challenging, dynamic, information and knowledge-intensive environment, it is not surprising that information and communication technologies (ICT) are viewed as central to any strategy aimed at raising productivity, controlling costs and improving care. In addition, integration of the various organizations delivering health and/or social care into Regional Health Information Networks (RHIN) is a central objective of many national and regional healthcare administrations. Central to these efforts is the provision of innovative eHealth services. Several studies and research efforts have documented eHealth “best practice” examples¹ and the adoption patterns.

However, little attention has been paid, in our view, to the considerable risk arising from not taking into account the organizational and social context of ICT implementations that often fail to reach initial objectives.

Effective technology adoption or diffusion requires adaptation of work practices, reorientation, and organizational change far beyond what is initially apparent [2] especially in the knowledge-intensive sector of medical practice. The various units of healthcare organizations have a substantial degree of autonomy, and established professional practice that are difficult and expensive to replace. In organizations that typically have strong central control, such as banking, IT is usually uniform and centralized. In healthcare organizations, where strong peripheral initiative is allowed or even encouraged, there is much less central control and a significant diversity of practice. Attempts to achieve common systems create tension between central interests in uniformity and local sensitivity to operational priorities.

The task of introducing or transferring information technology in large, complex organizations reliant on highly professional workers, such as doctors and nurses, requires an in depth analysis of organizational factors that influence implementation. Several theoretical models have been used to explain the factors that influence implementation of IT in organizations. However, frameworks, such as the Technology Acceptance Model [3] or the Technology-Task Fit [4] model often neglect to account for the interaction between user and task, failing to address a very important aspect of fit within organizations.

The “Fit between Individuals, Task and Technology” (FITT) [5] framework is based on the idea that IT adoption in a clinical environment depends on the fit between the attributes of the individual users (e.g. computer anxiety, motivation), attributes of the technology (e.g. usability, functionality, performance), and attributes of the clinical tasks and processes (e.g. organization, task complexity). The inclusion of the user-task dimension renders the FITT model as a useful framework to analyze technology adoption in organizations.

This paper applies the FITT model in the retrospective analysis of HYGEIAnet, a 15-year implementation effort of eHealth services in the RHIN on the island of Crete. The objectives of the case study are to (a) show the usefulness of the FITT framework in explaining the observed implementation successes and failures, and (b) the identification of factors that influence the adoption and diffusion of innovative ICT throughout a distributed health. The paper does not attempt an exhaustive review of either the technology evaluation or management literature or an in depth analysis of the medical informatics aspects of the systems implemented. It focuses on the analysis of success and failure in technology adoption and transfer using a specific conceptual framework as a way of gaining greater understanding of the complexity of the process.

2. Case description

The Regional Government of Crete has assigned a high priority to the development of the island as a model region of the emerging information society, with healthcare as an important application domain. The development of the RHIN of Crete, HYGEIAnet, an eEurope/eHealth award winner in 2003 [http://www.eipa.eu/eEurope_Awards/index.htm], was a conscious effort to provide an integrated environment for health monitoring, and healthcare delivery, as well as medical training and health education across the island. The objective was to put in place the people, the resources, the culture and the processes necessary to ensure that healthcare professionals and managers have the information needed to support the core purpose of the healthcare system: caring for individuals and improving public health. Technologically, implementation took advantage of the increasing capacity of terrestrial networks, wireless and mobile communications and the development of advanced eHealth services, to promote prevention of care, continuity of care and rehabilitation [6].

The healthcare system in Crete is geographically distributed across the island. Provision of hospital-based care is done in five district hospitals, a regional general hospital, a psychiatric hospital and a University Hospital. Primary care is provided by 16 Primary Healthcare Centers and their community medical offices. Emergency and ambulatory care is provided by the Pre-Hospital Emergency Service. The hospitals have the form of a professional bureaucracy in that clinical staff, especially medical staff, acts with a considerable level of autonomy. Services are normally provided free of charge. An extensive private healthcare system also exists alongside the public system.

The strategic objective of HYGEIAnet was to ensure that healthcare professionals have reliable, rapid and continuous access, to the relevant clinical information necessary to support patient care [7].

2.1. Clinical systems and eHealth services

The implementation effort of HYGEIAnet focused on various clinical sub-domains including a primary care information

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¹ Details of such European good-practices in ehealth can be found at http://www.good-ehealth.org/.
system, an emergency care information system, a hospital information system, an integrated electronic health record and eHealth collaborative services. These technologies are briefly described in the subsections below. The reader may find detailed descriptions of these technologies in the references provided.

As mentioned earlier, this paper focuses on identifying the significant elements that led to success or failures of the adoption and/or diffusion of core systems. As a result our analysis focuses on the following systems:

- Primary care information system.
- Pre-hospital emergency management information system.
- Integrated Hospital Information System: Electronic health record and nursing information sub-systems concentrating on the modules related to CPOE.

2.1.1. Primary care information system
The primary healthcare centers (PHC) of the island were equipped with a modern telecommunication infrastructure and a range of ICT solutions including an electronic health record (EHR) application for primary care, a Laboratory Information System (LIS) and a miniPACS application. All systems were integrated into an institutional information system based on international standards [8] which was subsequently functionally extended with a technological platform to support synchronous and/or asynchronous eHealth services for second-opinion request, and remote patient management. Indicative such services and evaluation results are reported in [9,10].

2.1.2. Integrated system for pre-hospital emergency management
An integrated system was developed providing eHealth tools and services for the optimal planning, and response management of pre-hospital health emergencies [11]. The systems include an emergency health record, protocol based evaluation of the severity of emergencies, eHealth tools for remote monitoring of the emergency while on transfer and Geographic Information Systems (GIS) in combination with the Global Positioning System (GPS) for location based services enabling optimal resource management and routing [12].

2.1.3. Integrated hospital information system
The strategic objective for implementing an integrated hospital information system was to reduce cost, minimize medical errors, and improve care provision. Although concrete data is not available for the care setting in Crete, international evidence reveals the role of medical errors [13] in medical practice. Despite the controversy regarding the accuracy of the mortality estimates, general agreement exists that iatrogenic injuries are common, costly, and often preventable [14–16].

Reducing medical errors requires a multifaceted approach. Computerized physician order entry (CPOE) with clinical decision support systems (CDSS) is a promising intervention to improving medication safety [17]. In one study, CPOE reduced the serious medication error rate by 55% [18]. Other studies have also demonstrated reductions in medication errors [19,20]. Such published research results were extensively used by management in convincing the staff for the planned change. In addition, data analysis in the pilot hospital showed that approximately 20% of the results of paper-based orders to laboratories were never claimed by the requesting departments and in most cases these orders were re-ordered.

These findings were supported by available international evidence. Kaushal et al. [21] present an exemplary, thorough analysis of the financial impact of installing a CPOE system in a major academic hospital. As a result, hospital management expected significant cost savings in the long run.

In such a context, the RHIN of Crete included major investments towards the purchasing and/or development of sub-systems. Emphasis was put on their integration and/or interoperability based on open, established international standards [22] for the creation of an integrated hospital information system.

2.1.4. Integrated electronic health record
Health care providers are all too often faced with incomplete information to guide clinical decisions. Patient history is said to be 90% of the diagnosis, but patient mobility among providers inadvertently scatters clinical information across multiple sites out of a physician’s reach. Impaired access to clinical data outside a given healthcare enterprise has, also, significant financial implications, since this inability “…is at the heart of the duplicative medical procedures that represent 10–20% of all health care expenditure by public and private payers. It is estimated that for medical imaging, such duplication, in the US alone, represents $9–17B annually.”

Recognizing that healthcare professionals need to be able to reach information about a patient anytime, anywhere, a significant R&D effort focused on the creation of the required technical infrastructure to enable the delivery of an integrated electronic health record for all citizens. The effort involved the design, development and deployment of technologies along with the establishment of processes for the integrated electronic health record. The innovative technological approach adopted and the various challenges addressed are reported in detail in [23,24].

2.1.5. eHealth collaboration services
A technological platform for the provision of both synchronous and asynchronous broadband services for patient telemanagement and disease telemonitoring has been implemented [25]. The platform was successfully applied for the delivery and evaluation of a number of eHealth services, ranging from second-opinion request and collaboration among distant professionals to the management of asthmatic patients at home [26].

3. Research methodology
The central purpose of this paper is to demonstrate the applicability of the Fit between Individuals, Task and Technology (FITT) framework for explaining the observed patterns in the adoption, transfer and diffusion of IT systems and services in healthcare. A case analysis is therefore highly appropriate,
since a case can serve the purpose of exemplifying theory application. It has the further advantage of demonstrating why the theory is useful by making causal relationships transparent.

The motivating factor for this study was the fact that significantly different adoption patterns were observed across various organizational entities and departments. These patterns were documented based on statistical use-data drawn from the various systems themselves.

Both quantitative and qualitative methods were applied in seeking the answers to the research questions, including statistical data of system use, interviews, field observations and document review. The actions taken by the medical professionals working with the various systems were described through quantitative analyses of data stored in the systems. Furthermore, in-depth interviews were held with the majority of the staff of the various organizational units examined, in order to analyze the barriers and facilitators in a more qualitative manner. The field research was conducted over a period of 8 years, from 1998 to 2006, during the various implementation phases of a large regional initiative. It should be stated that one of the researchers was also heavily involved in the technical implementation of the various systems and services as the project manager of the technical team and that the second researcher was involved in various deployment related support activities and had a key role in the evaluation phase.

Interviews were conducted regularly, in most cases once a month, with staff from the relevant healthcare organizations, as well as with staff from IT vendor organizations who provided sub-systems of the integrated information system. Detailed field notes were taken during field observations. Whenever possible interviews were conducted by two researchers with a single interviewee; this was found to improve the comprehensiveness of the data collection, and to provide a validity check on interpretations. There were a few group interviews, and some telephone interviews for follow-up on important issues. The researchers maintained a consistent discipline of sharing the data collected from document review and interviews, holding 2 h meetings fortnightly during the data collection process and in between communicating new developments by e-mail. This enabled a continuing critical assessment of progress and permitted the researchers to conduct follow-up interviews where necessary.

Data collection and analysis was continuous throughout the duration of the project implementation. The quantitative items explored (see Table 4) were measured on a five-point Likert scale—strongly disagree to strongly agree. As particular themes emerged in time, they were integrated in subsequent interviews. As themes became more concrete, data analysis focused on similarities and/or differences in answers to particular issues. Conceptual analysis followed using the proposed FITT framework.

4. Conceptual framework

In general, models depicting the technology implementation process posit a number of system factors that jointly and/or independently predict the success of the implementation. Analysis of the factors influencing successful adoption or failures of IT systems in health care, has been an issue in research for many years. Based on the discussion in [4], we define IT adoption as follows: for voluntary used systems, IT adoption is reflected in the usage of the IT system; for mandatory used systems, IT adoption is reflected in the overall user acceptance. In the next paragraphs, we will present some research results on factors for IT adoption, focusing on general valid frameworks.

In our view, there are two major conceptual approaches to the study of technology adoption and transfer relevant to our case study: innovation/diffusion theory and configurational theories of IT-organizational fit. Innovation/diffusion theory was developed to explain the acceptance or otherwise of product innovations by consumers [27]. The central focus of diffusion of innovations theory is on the utility of the innovation to the individual consumer. While its findings are often transferable to organizational innovations, such as new health technologies and eHealth services, its analysis remains firmly rooted at the level of the individual user and hence only tells part of the story of technology adoption and diffusion.

Analyzing the concept of information system (IS) success, DeLone and McLean [28] developed an information success model for management information systems. This model proposes that the effects of IT on the user (the individual impact), and thus on the overall organization, depend on system use and user satisfaction. The strong focus on IT and information quality, however, as determinants of the overall impact, does not help explain why the same IT system can be adopted in different ways, and with different effects, in various settings. This was a fact that we met repeatedly in our case study.

The Technology Acceptance Model (TAM) [3] (Fig. 1) attempts to analyze why users adopt or reject a system. The Technology Acceptance Model [29,30] is a specific adaptation of the Theory of Reasoned Action (TRA) for studying Information Technology usage. The TRA and its successor, the Theory of Planned Behavior (TPB) [31], are well known, and help explain specific behaviors. In general, TRA and TAM state that a behavior is determined by the intention to perform the behavior. Intention and actual behavior have been found to be highly correlated [32].

Other researchers have further extended the TAM model [33–35]. One such extension has been the Information Technology Adoption Model (ITAM) developed by Dixon [34]. ITAM refines the “system design features” of the TAM model by describing how an IT system has features that must be matched with the knowledge and skills of the users and with the available technical infrastructure.

Such models have been extensively used in the literature in attempting to analyze the adoption patterns in the domain of healthcare IS and eHealth [35,36]. Despite their value, these models concentrate rather strongly on user and technology individual attributes, neglecting attributes of the clinical environment and of the supported clinical tasks. Clinical environment and tasks define the context of IT use, and therefore, are of high importance in understanding IT adoption processes and patterns.

To address these limitations, theories of IT-organizational fit have been developed to provide a better understanding of
Fig. 1 – The Technology Adoption Model (TAM) by Davis [3].

Fig. 2 – The Task-Technology Fit model (TTF) by Goodhue and Thompson [4].

the full range of organizational factors affecting the strategic application of IT [4]. These theories place IT as one key component within the wider organization. The idea of fit is comprehensively elaborated in the Task-Technology Fit model (TTF) of Goodhue et al. [37,38].

TTF takes into account technology and the user, as well as the complexity of the clinical tasks which have to be supported by an IT system. Goodhue et al. examines the influence of three factors – individual abilities, technology characteristics, and task requirements – on performance and on user evaluation of IT systems, highlighting the significance of the interaction (fit) of those three factors Fig. 2. He argues that TTF (Task-Technology Fit, or more correct task-individual-technology fit is the extent to which technology functionality matches task requirements and individual abilities).

The Task-Technology Fit model provides explicit inclusion of a task focus [39]. The ability of IT to support a task is expressed by the construct known as Task-Technology Fit, which implies matching of the capabilities of the technology to the demands of the task. Task-Technology Fit posits that IT is more likely to be used if the functions available support, and hence fit, the activities of the user. Users will choose those tools and methods that enable them to complete the task with the greatest net benefits. IT that does not offer sufficient advantage over competing systems will not be used.

Other researchers in IS/IT have extensively explored the bivariate fit of IT to its organizational context. Southon et al. [40] analyses the fit between organization, technology and user skills. Lundberg [41] examines the interaction between actors (staff), artefacts (technology) and working processes during a Picture Archiving and Communication System (PACS) installation.

In conclusion, the TTF extends the previously described models by concentrating on the fit incorporating aspects of the organizational context. However, TTF only focuses on the fit between user and technology, and between task and technology (Fig. 2). It does not consider the interaction of user and task—which is, in our opinion an important success factor for IT implementation projects. The fit between individuals, task and technology framework, described in the following section, further extends TTF to include fit between user and task, making it our preferred model for case analysis.

4.1. The FITT framework

The “Fit between Individuals, Task and Technology” framework (FITT) [5] has been introduced recently to better understand ICT adoption and diffusion. Central to the FITT model is the idea that IT adoption in a clinical environment depends on the fit between the attributes of the users (e.g. computer literacy, motivation), of the attributes of the technology (e.g. usability, performance), and of the attributes of the clinical tasks and processes (e.g. task complexity) [42].

In the context of the FITT framework, an “Individual” can either be an individual user or a user group. Individual attributes include computer skills, professional culture, motivation and interest. “Technology” includes all those tools, such as hardware, software and communications, needed to accomplish a given task. Technology attributes include availability, stability, usability and functionality of the applications, tools, and infrastructure. Finally, “Task” comprises all activities and working processes that have to be executed by the user (e.g. patient admission, order entry, etc.) and that are supported by the given technology (Fig. 3). Task attributes include work processes, complexity and interdependence of activities.

Insufficient fit between these attributes is often the reason for problems encountered during implementation and use.

We use the FITT framework in the retrospective analysis of the success and failure experiences of technology adoption and diffusion in the case study as described below.

Fig. 3 – The FITT framework (FITT) by Ammenwerth et al. [5]: IT adoption depends on the quality of the fit between individual, task and technology.
5. Results

5.1. Primary care information system

The development of the primary health care information system (PHC IS) has been a joint effort between the Biomedical Informatics Laboratory at FORTH, responsible for the technical development and implementation, the primary health care practitioners of the island and the Medical School of the University of Crete [43]. In 1998, a joint working group was formed with the participation of medical professionals from representative PHCs. Regular meetings were planned; requirements were analyzed, debated and elicited. A spiral requirements engineering process was adopted which, coupled with early prototyping, enabled early user evaluation and feedback. These development activities lasted for almost 2 years. In parallel, the networking infrastructures in all PHCs were developed, and extensive training of the doctors in all PHCs was organized.

Subsequently, in the fall of 1999 pilot implementation begun in four PHCs, and a hot line support was offered. During this initial piloting and validation effort, which lasted for 9 months, technological problems were identified, usability aspects were addressed, and updated versions of the applications were developed. Early in 2000, the systems were rolled-out to all PHCs of the island.

One important issue during this phase was the fact that doctors using the system required significantly more time to conclude and document a patient encounter, due to the fact that most were novice computer users. Doctors kept paper-based records as well as electronic versions. Some did data entry after the completion of their usual daily work.

A low fit between user and technology was obvious at this point in time. Whereas users required 10–15 min to complete and document a patient encounter, upon the introduction of the system, this time more than doubled. Benefits were observed once an adequate amount of information was entered in the system (at least four to five previous visits). The available information resulted in the shift from consulting paper-based files, to only consulting the electronic version of patient data.

Out of the 16 primary health care centers of the island, high adoption rates were observed in 5 of them. Another five showed moderate adoption rates (i.e. some system modules were used but others were not used at all), some employees did not use the technology, some aspects of the technology were not implemented. Finally, in the remaining six organizations, a critical mass of users was never achieved and system use gradually stopped.

5.2. Pre-hospital emergency management information system

The Pre-hospital Emergency Service (PES) of Crete holds an exemplary position as the most innovative emergency department throughout Greece. The reasons for its overall effectiveness include the establishment of the first training program for emergency care [44,45] as well as the use of information technologies for triaging, coordinating and managing episodes, and tracking ambulances.

The emergency sector deals with life threatening situations that require immediate and specialized response. Saving lives demands efficiency and effectiveness of operations. The response time of the ambulance, the medical care provided within the ambulance, the speed of transportation and the management of hospital resources contribute to the quality of pre-hospital services.

PES of Crete coordinates and manages the provision of emergency care services for the island of Crete, the largest island in Greece. Staff includes doctors trained in pre-hospital emergency care, 120 paramedics, 13 operators, 5 technicians, and 11 administrative personnel.

In 1998, in an effort to improve the quality of emergency services, PES Crete began a pilot project to computerize management of the incoming emergency calls at the coordination center of Heraklion. In 1999, following a successful pilot run, paper-based records were no longer used and all emergency incidents were managed with the support of the information system. In addition, the decision was taken to computerize triage protocols as part of the information system to assist the operator by providing decision support with respect to incident triage.

From January 2000, the system entered routine use. Transition to the new system did not occur without resistance. Using the information system not only required computer skills that most employees did not have, but also a new mentality for handling emergency incidents. The introduction of the new system required trained employees that could responsibly handle crisis situations and provide first aid. Resistance, however, did not last for long. The user-task fit as well as the technology-task fit proved very strong. Maintaining this strong fit required a range of measures, such as establishing a 24-h on-line technical support service and the provision of regular IT training courses to new personnel of the organization.

Employees were able to observe immediate benefits from using the system and therefore, IT use became an indispensable tool. The visionary leadership of the director of PES, the introduction of intensive training programs, as well as the continuous technical support of FORTH, proved instrumental in assisting the diffusion of the management system [46]. The results of using the system is shown throughout time in the measurements of ambulatory response rates in Fig. 4. The units along the vertical axis are in minutes.

In addition, given that the first 60 min (the Golden Hour) are the most critical regarding the long term patient outcome, the ability to remotely monitor the patient which would allow expert medical personnel at the coordination center to guide the on-board medical and (most importantly) paramedical staff in their management of patients was expected to assist in further increasing the quality of care delivered [47].

As a result, a decision was taken to develop a telemedicine platform to enable real-time monitoring of patient vital signs at the scene of the accident and while in transfer, so as to assist ambulance personnel in better managing the emergency case. The system was piloted in two mobile intensive care units and the doctor’s office at the coordination center of PES. Design changes were introduced following initial user experiences; once usability evaluation was completed and all functional
changes requested were introduced, the system was installed in all mobile units.

Although strong managerial support was present for the use of the system, it was operationally used occasionally and gradually its use stopped altogether.

5.3. Integrated hospital information system

The strategic objective as defined by the management was to move towards the implementation of integrated hospital information systems. The technical approach adopted was to (a) use “best-of-breed” sub-systems for certain functional areas of the hospitals, (b) develop custom solutions for other such functional areas, and (c) mainly concentrate on their interoperability and/or integration based on international, de-facto medical informatics standards.

Most hospitals had operational systems to support their financial and administrative functions. The efforts, therefore, concentrated in the introduction of Laboratory Information Systems (LIS), and Clinical Information Systems supporting both medical and nursing personnel, i.e. Electronic Healthcare Record Functionality and Nursing Record. The PACS sub-system was left for a follow-up phase of the project.

The LIS system was installed by a commercial provider, market leader in the corresponding market segment in Greece. Although, considerable difficulty was observed in introducing the LIS system, eventually it was fairly extensively implemented and used.

Once the LIS systems were in production, the decision was taken to proceed with the implementation of clinical and nursing systems. The management priorities were focused on cost containment and productivity gains. As described earlier, significant cost saving were expected by the hospital management.

Technologically this choice implied that a variety of systems developed independently by different vendors had to be integrated. Several meetings were planned with the staff of the various departments, with management making clear its strong support for the planned change. During these meet-
Technology adoption is analyzed by using the elements of the systems into their diverse operational environments. Technology, which emerge from introducing the previously described applications defined by users, were successfully implemented in some primary healthcare centers but failed to be adopted in others? Also, why certain applications or system functionalities fail to be adopted in environments where otherwise, very high adoption rates are observed? To answer these questions we apply the fit dimensions as depicted by the FITT framework.

### 6.1. Primary care IS

The question that arises based on our experiences in developing and deploying ICT in primary care is why information systems that were “home grown” in accordance to specifications defined by users, were successfully implemented in some primary healthcare centers but failed to be adopted in others? Also, why certain applications or system functionalities fail to be adopted in environments where otherwise, very high adoption rates are observed? To answer these questions we apply the fit dimensions as depicted by the FITT framework.

#### 6.1.1. Individual-technology fit

The PHC information system required use of standardized terminologies for documenting the care process (e.g. reason for encounter or admission, diagnosis, etc.). However, standardized terminologies were mainly absent in the way healthcare professionals worked in the paper-based mode. The prevailing mode of operation was to simply use narrative text to document patient encounters. This fact resulted in the view that “the technology constrains work”. Perceived ease-of-use was identified as the key problem to begin with, which also resulted in a relative low perceived usefulness of the systems. In all organizations in which the implementation was not successful, problems of the fit between individual-technology were observed.

#### 6.1.2. Task-Technology Fit

Due to the geographical distribution of the PHC facilities and the fact that there was no internal IT support, the decision was taken to assign first level technical support of applications to a selected medical and/or nursing employee, which was appropriately trained for this task. In assisting these users a call center was established and hot-line support was offered 24 h a day. This model was used very successfully in many organizations, but in some cases resistance of medical professionals to undertake such “technical” or “administrative” responsibilities was observed. This resistance, coupled with the inability of the management to hire locally based technical support, resulted in occasional, but inevitable, technical problems of the IS infrastructures. In turn these created a low fit in the task-technology dimension.

#### 6.1.3. Individual-task fit

As discussed earlier, at the initial phases of the introduction of the systems, a patient encounter did require substantially more time on average (30–40 min) than what it was required in the paper-based mode (12–15 min). The reasons for this were two-fold: (a) slow data entry due to fact that health care providers were not expert computer users and (b) the fact that at the beginning doctors had to also consult their paper-based documents patient encounters. This fact resulted in the view that “the technology constrains work”. Perceived ease-of-use was identified as the key problem to begin with, which also resulted in a relative low perceived usefulness of the systems. In all organizations in which the implementation was not successful, problems of the fit between individual-technology were observed.

#### 6. Analysis

In this analysis, we concentrate on the organizational issues which emerge from introducing the previously described systems into their diverse operational environments. Technology adoption is analyzed by using the elements of the organizational-IT configurational framework described earlier. Diffusion of the technology is analyzed in terms of the problems of internal fit of the organizational configuration.

### 6.1. Primary care IS

In Tables 1–3, the statistical data of the CPOE related to three departments are presented, as representative cases of what was observed. The ICU and pediatric wards were among the four wards included in phase one of the effort. The Intensive Care Unit (ICU) was selected first because of the very large number of orders per patient. The internal medicine and pediatric departments have comparable numbers of daily orders, and as a result significant benefits were expected. The pediatric wards were part of phase I whereas the internal medicine and pediatrics was part of phase II.

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In addressing these problems, various interventions were designed. In some organizations, data from the paper-based
Management used such evaluation data, to promote even more innovative, technology enabled re-structuring of the enterprise. Nevertheless, even in such a very innovative and forward-looking organization, the real-time patient telemonitoring module was not put into routine use. A series of interviews held with management and users revealed the reasons for this failure:

- Almost all mobile units are staffed with doctors rather than paramedics, which is the case in most other EU countries. Consequently, the need to remotely monitor the patient by an experience emergency care doctor was not necessary. Only in very few cases, when crew members were not assisted by medical staff, clear benefits from the use of telemonitoring were identified. As a result the perceived usefulness of the application was not very high.

- The system used 2.5/3 G mobile communications for the transfer of patient vital signs and all other data to the coordination center. Due to the fact that the geographical coverage of mobile communications in Crete is less than 100%, there was occasionally the case that the communication link was lost and it had to be re-established for patient telemonitoring to continue. This fact created confusion and delays within the ambulance and the coordination center.

In our view, a loose fit between individual and task and occasional problems in the fit between task-technology resulted in a very low perceived usefulness and the failure in adopting the specific module.

6.3. Adoption of CPOE system in a hospital environment

An analysis conducted by the management of the specific regional hospital had revealed that a large proportion of paper based orders and results were lost or never claimed. This fact together with political pressures for improvements of hospital resource utilization resulted in a management decision to pay particular attention to the introduction of a CPOE system.

Research on CPOE has shown that technology can reduce serious medication errors [50], preventable adverse drug events (ADEs), inappropriate doses, and inappropriate frequency, as well as improve the rate of corollary orders, medication turnaround times, radiology completion times and laboratory result reporting times [51,52]. The patient safety related benefits of CPOE have also been found in pediatric hospitals, as reported in [53,54]. At the same time, there is competing evidence in published research results indicating that a widely used CPOE system facilitated 22 types of medication error risks [55]. Other studies also report of an observed unexpected increase in mortality coincident with CPOE implementation [56].

Such published data regarding the expected cost-savings were used by the management in trying to create the appropriate climate and culture for technology adoption. Nevertheless, very different usage profiles emerged. The three departments reported in this article represent indicative cases of what has been observed throughout the organization.

patient records was input into the system. This fact increased the perceived usefulness of the system and quickly reduced the time per encounter required. As a result, as soon as users obtained a relative ease in using the electronic systems, productivity increased. Four to 5 months later, users achieved an even shorter time interval required per patient encounter (approximately 10 min). Thus, a tight fit in individual-task dimension was achieved and adoption increased steadily thereafter.

In other organizations with a higher number of daily patient visits, it was decided by users to adopt off-line data entry. Either the doctors themselves or appointed nursing staff had to extend their working day for data entry into the system. In parallel to such organizational interventions, extensive on-the-job training sessions were planned, with the objective of increasing IT skill level and familiarity with the business logic of the application. The facts that (a) in several organizations work responsibilities were not very clear, and (b) staff had to extend their daily work for data entry, soon created problems that were never really overcome.

An additional observation is the fact that the electronic storage of digital electrocardiograms (ECGs) or radiology images was not seen as an important functionality, since it did not relate to common service delivery. The additional capability offered, i.e. the ability to compare current and past ECGs [10], did not prove to be a sufficient motivation for the additional time and effort required to operate the digital ECG cart and to transfer and store of digital ECGs to the health record of the patient. This clearly indicates the absence of fit between individuals and task, and as a result the corresponding functionality/module was never really used in routine care.

6.2. Pre-hospital emergency management IS

The case of the PES Crete represents a homogeneous environment characterized by strong managerial commitment to change and innovation and visionary leadership capable of successful creation of a “sense of mission” to its employees.

IT was managed in a way that mirrors management of the business; instead of relying on planning processes which are only loosely coupled to performance, IT was strategically, structurally and managerially aligned to the business strategy, structure, and management processes. Therefore, alignment of business and IT strategy was observed, and a very tight fit of individual-technology task was achieved.

The transition from hand written cards to the use of computerized systems was a rapid one as the benefits of using the computerized system proved vastly superior to existing work practices and the observed inevitable resistance to change. Visionary leadership and extensive training were key factors in enabling change and establishing the information system within daily practice.

The evaluation of systems and services revealed significant benefits with respect to quality of care for two reasons [12]. These are: (i) the protocol based (triage) classification of emergency cases resulted in the dispatching of the most appropriate resources for each type of emergency and (ii) the level of training of the personnel increased, thus having a significant impact on the quality of care delivered.
we could not provide a convincing answer to the question “why is it that the technology is not actually used?”

As a result, it was decided to include in the interviews questions evaluating the extent to which the respondents thought they had enough training for their IT use and whether the support was adequate and explore other organizational issues that are possible affecting adoption.

With respect to training, responses were coded into three classes: sufficient, middle, and not sufficient. Approximately, 30% of all respondents reported the amount of IT training as sufficient. Almost half of the respondents thought it was not sufficient. The respondents were also asked how easy they perceived it to be to get help with their IT use (i.e. support). Responses were again grouped to three classes, easy, middle and not easy. Half of the respondents perceived it not to be easy, and 23% perceived it to be easy.

In addition organizational and cultural issues were explored. During the interviews it surfaced that: (a) medical staff were not used to high quality complete documentation, something that the system is now imposing (b) use of the system also introduced changes in daily activities and organizational roles, and (c) interpersonal and cultural issues arose, i.e. several staff members voiced concern to the fact that some of their colleagues were “rewarded” more than they did by been invited to speak about experiences in local conferences, etc. In our view there was a substantial absence of the required fit, mainly in the dimension between user and task.

At this point of time, several measures were taken. A secretary was assigned to do initial data entry for a period of time. As a result users began to gradually observe the envisaged benefits of the system. At the same time “on-the-job-training” was provided by the technical persons positioned in the organization’s premises by the implementers. These interventions affected positively all three fit dimensions. The second quantitative evaluation 9 months afterwards indicated a clear improvement in both PEOU and PU as well as user satisfaction; this was reflecting, in our opinion, an improvement in the fit, a fact that was also supported in the interviews. This improvement was clearly reflected in the adoption rates and usage patterns observed (see Table 2).

### 6.3.3. Pediatric department

The data presented in Table 3 reveals the fact that adoption was very problematic in this department from the start of the effort. Once again the research question we were seeking an answer to is: “why is it that a technology successfully implemented and used in one organizational unit, fails to be adopted in another such unit?” A range of interviews were planned with department management, as well as the doctors and nursing staff. Based on the analysis of the recorded data, the major issues observed in this department relate to the following: Fit between individuals and technology.

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**Table 4 – The operationalization of the constructs**

<table>
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<tr>
<th>Construct</th>
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<th>Items measured</th>
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**Table 2**

<table>
<thead>
<tr>
<th>Major issues observed in this department relate to:</th>
<th>Demographic characteristics of the respondents</th>
<th>Clinical department</th>
<th>Impact on the staff</th>
<th>Impact on the patient</th>
<th>Impact on the workflow</th>
<th>Impact on the communication</th>
<th>Impact on the quality of care</th>
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<tr>
<td><strong>Fit between individuals and technology</strong></td>
<td><strong>Demographic characteristics of the respondents</strong></td>
<td>ICU</td>
<td>Internal medicine department</td>
<td>Pediatric department</td>
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<td><strong>6.3.1. ICU</strong></td>
<td><strong>Due to its nature, the functioning of the ICU department depends strongly on elaborate and regular documentation upon which clinical decisions are taken regarding the adherence to or modification of the patient management protocol. As a result, ICU staff members, both doctors and nurses, were used to high quality documentation prior to the introduction of the systems. In addition, ICU is a heavy user of clinical ordering, since twice or three times a day a complete laboratory order had to be performed for all patients. The fact that the electronic ordering system created observable benefits in time savings coupled with the fact that strong local management was present resulted in the quick adoption of the new systems. Although the process was not linear, and some resistance was present at times, the very good fit of all dimensions, user-technology, task-technology and also user-task, resulted quickly in high adoption rates.</strong></td>
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Interviews showed the existence of some initial problems handling the new hardware and software. Most users were initially unfamiliar with computers, due to the fact that most had not taken part in the training sessions organized. However, general attitudes towards computers were initially comparable to the other wards. The fit between individual-technology was slightly smaller compared to other departments. Fit between task and technology

Use of the system introduced required users to use standardized terminologies for documenting the care process (e.g., reason for encounter or admission, diagnosis, therapy plan, etc). This decision was based on the managerial strategy to employ ICD-10 as a uniform terminology standard throughout the hospital. That was not the way health professionals used to work in the paper-based mode. The prevailing method was to simply use narrative text to document patient encounters. In various group interviews, staff were voicing objections towards the ICD standard, or any other standard, claiming that “the technology is constraining their work”. As a result the perceived ease-of-use was identified as a problem, which in turn resulted in a relative low perceived usefulness of the systems. Overall, significantly greater problems in the fit on this dimension were observed, compared to other departments. Fit between individuals and task

In the Pediatric department, despite the fact that the responsibility for ordering examinations lies with the doctors, nursing staff used to execute the orders. The majority of orders were requested verbally by the doctors, and nursing staff had to do all the required documentation work, with the doctors simply signing the relevant documents later on. The introduction of CPOE and the implementation of a role-based access control security policy implied that the doctors had to log into the system and formulate the order request themselves.

This new organizational process was agreed and strongly supported by top-level management. It was well accepted by nursing staff, since for them it actually implied less work, but it created significant resistance from the doctors, who refused to change their established patterns of work.

The department asked for specific adaptations to the workflows supported by the system to better match the existing operational procedures of the ward. Elaborate attempts were made to convince the staff that the hospital needs to establish standardized operational procedures, and as a result they had to adapt to the system rather than the system adapting to their “specific needs” and “operational procedures”. The staff appeared to accept the rational of the management’s argument, and explored organizational alternatives.

It was decided to act along two directions. Firstly to provide additional IT training to staff, and secondly to ask nurses to undertake the responsibility of initiating the task in line with doctors wishes. At the same time, though, the ward was one of the mostly understaffed in nursing personnel. The nursing staff found this as an opportunity to voice their discomfort with their overall situation in the department; they reacted to this decision and practically boycotted the use of the system as it is often seen in similar cases [57].

The clear low fit between users and task coupled with unsuccessful interventions to resolve the observed problems resulted in a complete failure of the system in this department (see Table 3).

7. Discussion and conclusions

In this paper, we applied the FITT framework to discuss the interaction and fit between individual, technology and task, attributes in the retrospective analysis of the introduction of a range of clinical information systems and eHealth services in a Regional Health Information Network. The detailed analysis of the case study showed common features, but also differences of IT adoption within the various health organizations.

The FITT framework focuses on the significance of the optimal interaction (fit) of individual user, technology, and task. The fit between the attributes is more important than the attributes themselves. For example, IT skills of the users are not sufficient for the success of an introduction – rather, they must match the requirements by the IT software (e.g., software complexity). The clear structure of the model of three objects and three fit dimensions was very useful to understand and reflect upon the observed differences of technology adoption within the various healthcare organizations and clinical departments. The model provided a structured way to identify and understand the problems encountered and explain the reasons for the success or failure of ICT implementation. It is worth noting that the FITT framework helped explain the majority of aspects observed in our case study.

The introduction of the dimension of fit between user and task is in our view very important as it sheds light to the organizational aspects involved in implementations. This dimension is often overlooked. In many cases, IT introduction is accompanied by organizational changes, often leading to low user satisfaction or even user boycott [58]. Resistance to change is often attributed to the IT system, suspecting a low fit between IT and user or between IT and task. But in fact, resistance is mostly due to the limited acceptance of new tasks, thus reflecting a low fit between user and task.

The experiences collected during the implementation of all reported systems, reveal that fit management can be regarded as a system with a feedback loop. Fit between dimensions is never in equilibrium but ever changing based on influences from external factors or deliberate interventions. Thus, fit management becomes a constant and complex task for the whole life cycle of ICT implementations.

The healthcare environment is one of the most versatile industries and remains in constant flux. Within such an environment change is continuous. Training of staff, implementation of new terminology standards, software updates, documentation and process restructuring are some of the changes that require continuous management and optimization amongst the FITT dimensions. Our analysis highlights with specific examples the importance of organizational structures in managing the introduction, transfer or diffusion of technology. Tight organizational fit of strategy, management, roles, skills and technology greatly facilitates the adoption or diffusion of ICT in healthcare.

Several factors influencing the three fit dimensions of the FITT framework emerged from our case study. In agreement with reported research [59,60], these factors included quality, compatibility, and customizability of the system, training and technical support, managerial commitment and strategies of organizational change.
Successful implementation of ICT in healthcare is accompanied by organizational changes, often leading to low user satisfaction or even user boycott. These problems are then often attributed to the IT system, suspecting a low fit between IT and user or between IT and task.

Theories of IT-organizational fit have been developed to provide a better understanding of the full range of organizational factors affecting the strategic application of IT.

What this study added to the knowledge:

- The analysis of the case study provides a better understanding for IT adoption successes or failures in the domain of healthcare and therefore should enable better prepared and more successful such implementation initiatives.
- The introduction of the dimension of fit between user and task in understanding IT adoption patterns is in our view very important. In many cases, IT introduction is accompanied by organizational changes, often leading to low user satisfaction or even user boycott.
- The work presented in this paper, proves the applicability of the FITT framework in explaining the totality of aspects observed in our case study.
- We noticed that the picture that emerges is a complex nexus of contributing factors to IT adoption, as well as a rich context for the application of multi-level interventional strategies to promote IT use.
- Based on this case study, we derived facilitators and barriers to IT adoption of clinical information systems and eHealth services.

The two most influential for the success of ICT implementations were training and organizational support. The amount and type of training as well as the level of leadership and management were direct and/or indirect predictors of success. In every organization where implementation was successful a local champion could be identified. These local champions acted as change agents who actively promoted innovation, adoption and diffusion of information systems. Also, these local champions were, in each of our successful cases, in a position to influence the strategy and decision making of the organization.

The FITT framework presents, in our view, a straightforward analytic framework to describe and analyze IT adoption efforts. Compared to other models, FITT is innovative in that it clearly describes the objects and interactions affecting individual, technology and task fit while introducing fit management as a loop-back system.

It is our belief that the framework could be utilized in an a priori assessment of the goodness of fit of the three fit dimensions, prior to the initiation of a deployment effort as a predictive tool of success and as a tool for identifying missing success conditions. As a result, interventional measures could be designed to take place before the implementation effort begins, so as to better prepare the organization and its users. However, more detailed research is required to further establish the utility of the framework as a success prediction tool.

Our experience with a 15 years long implementation effort of ICT in healthcare leads us to conclude that implementation success is not guaranteed following a specific model, method or guide. To our view, ICT implementation, adoption, use and diffusion is a complex nexus of multi-level intervention strategies and contributing factors within the rich context of healthcare organizations, decision bodies and technology providers [61]. Thus, in agreement with Liker et al. [62], we believe that narrow models, such as those that focus on only one or two kinds of predictors of success, are oversimplifying the complexity of organizational settings into which IT is introduced.

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Author contributions: Dr. Tsiknakis has been the technical coordinator of the effort for the implementation of the RHIN of Crete. He directed the deployment group and the person collaborating with the Management of the various Healthcare Organizations and other stakeholders. He has been directly involved in the data gathering processes for the study reported in this paper, and coordinated many of the data collection interviews. Dr. Tsiknakis drafted the original version of the paper which has been subsequently discussed, debated and improved jointly with Dr. Kouroubali, and was responsible for responding to review comments and the production of the final version.

Dr. Kouroubali has been involved in the effort to implement the RHIN of Crete since 2001. She has focused her research activities on aspects related to evaluation and adoption issues. She has been in direct contact with a number of organization in the primary healthcare sector and the emergency services. She participated or conducted many of the data gathering activities (interviews, questionnaires) and played an important role in the production of the final version of the paper.
REFERENCES


