

A roadmap towards healthcare information systems interoperability in Greece

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Abstract— The advantages of the introduction of information and communication technologies (ICT) in the complex healthcare sector are already well known and well stated in the past. It is common knowledge that in order to install any type of information system in healthcare, six main groups of issues have to be dealt with: **organizational and cultural matters related to healthcare, technological gap between healthcare professionals and information science experts, legal requirements on the confidentiality of personal data, of patient related data and on data privacy, industrial and market position of healthcare informatics and interoperability complexity,** lack of vision and leadership of the health care managers and health authorities and user acceptability and usability of the proposed information systems. In order to meet these issues stated above, a special focus group (Z3) performed an assessment of the situation of healthcare informatics in Greece and of the main key points that would lead to success. In that sense it is now common knowledge that Greece is lagging information and communication technology progress in healthcare because almost none of the above mentioned issues were dealt with. This assessment is the result of the interaction of more than 150 decision makers, medical informaticians, healthcare practitioners and other individual involved in healthcare. As a conclusion, this focus group resulted in 4 major propositions that will lead to healthcare informatics introduction with better success chances: **focus on terminologies and standards, focus on interoperability and information systems sustainability, focus on clear goals and system metrics that can create a healthcare performance management cockpit, and focus on people and what they have to say, by creating a e-health forum.** These conclusions were taken into consideration by the Greek government and are incorporated the IASYS project, the national healthcare informatics framework for the next ten years.

Keywords— *interoperability, HL7, regional healthcare information system, medical informatics standards, medical codifications, information and communication technologies developments in the healthcare.*

1. Introduction

The advantages of the introduction of information and communication technologies (ICT) in the complex healthcare sector have already been depicted and analysed in the healthcare informatics bibliography [1–6]. It is nevertheless paradoxical that, although several major technological discoveries such as magnetic resonance imaging, nuclear medicine and digital radiology, which facilitate improve-

ment in patient care, have been satisfactorily embraced by the medical community, this has not been the case with healthcare informatics. Thus, it can be argued that issues such as data management, data modelling and knowledge management have a long way to go before reaching the maturity level that other technologies have achieved in the medical sector.

A variety of reasons could be proposed for this issue, though with a short analysis it becomes rather clear that modern ICT present integration problems within the healthcare sector because of the way the latter is organised. Healthcare is a strongly people-centred sector in which ICT has been considered more as an intruder, as a “spy” to the healthcare professionals’ way of doing things and as a competitor to this people-centred model. Thus, if ICT intend to prove its advantages towards establishing an information society, or even more a knowledge society, it has to focus on providing service-oriented solutions. In other words, it has to focus on people and this has not been the case in most of the circumstances. It is common knowledge that in order to install any type of information system in healthcare, six main groups of issues have to be dealt with [7, 8]:

1. The organizational and cultural matters related to healthcare. This issue is rather important, regardless of any information system, since organizational models and culture do endorse neither the continuity of care, nor any type of structured data collection. Issues such as mistrust between different specialists, between the different healthcare structures or between doctors and nurses prevent in many cases the effective sharing of information. Health reforms are currently under way in many countries stressing the will to deal with this problem.
2. The technological gap between healthcare professionals and information science experts. Doctors are often reluctant to use information systems which they believe are not designed for them. From another point of view, healthcare informatics have been introduced in healthcare institutions mostly on pilot-based projects aiming at addressing specific issues and have proposed solutions addressing a small number of healthcare practitioners, resulting in establishing a complex map of information niches. This approach is the consequence of applying information technology to procedures that were not designed for it, thus creating a panspermia of information models

which are neither compatible nor interoperable, even within a single institution's environment. Efforts in creating interoperability standards and protocols, such as health level seven (HL7), are proposing solutions to address this issue, thus enabling data manipulation and knowledge management.

3. The legal requirements on the confidentiality of personal and patient related data and on data privacy. It is clear that if this issue is not addressed at a managerial and procedural level by imposing suitable policies to meet these requirements, there is little chance that medical data will be kept digitally in a structured manner (thus allowing the transition from digital islands of clinical data towards a structured electronic healthcare record). The implementation of an information system, where the electronic healthcare record is considered to be the core of the system (patient-centred model), is the only way to drive data management towards creating new knowledge. The complexity of the problem can be explained if one just observes the course of implementation of both the *Health Information Privacy and Accountability Act* (HIPAA) in the US and *Directive 95/46/EC* in the European Union (EU). The issues seem to have been dealt with at the strategic level, but still a lot has to be done in the implementation and setup of those strategies.
4. The industrial and market position of healthcare informatics. In general the healthcare market is seen by the industry as large in size but not highly profitable, mainly due to the lack of standards in implementing and interoperating healthcare informatics products. As a consequence, the industry has focused on creating mostly small scale products (i.e., laboratory information systems – LIS, radiology information systems – RIS, clinical information systems) and not on evangelising the production of information systems that are dealing with healthcare as a whole. The lack of end-to-end solutions is dealt with by interconnecting heterogeneous information systems (a rather complex task with constant change management issues) and by introducing solutions from other business sectors (i.e., ERP, SCM, CRM) that have often been rejected by “key users” as non compliant with their job description. Nevertheless, the new web technology approaches (web services, XML, etc.) and the new information technology strategies (i.e., service oriented architecture) could be the drivers towards merging information technology and healthcare services and thus enabling the establishment of service oriented products.
5. The lack of vision and leadership of healthcare managers and health authorities, and the lack of willingness to re-engineer healthcare processes for the benefits of efficiency and quality of care delivery. Some

countries are in the process of introducing or implementing such business process reengineering projects in order to address healthcare delivery in a more information flow conformant way. This is a key point in reaching knowledge management, knowledge reuse and sharing, and finally proposing a solution for the knowledge-based society of tomorrow. This issue should be dealt with by proposing strategies that focus on processes and by establishing key performance indicators, balanced scorecards, or other metrics that are the upper level of a structured information flow-based model.

6. User acceptability and usability of the proposed information systems. This issue is the one most strongly related to the problem of dealing with the people-centred approach of the healthcare sector. This issue deals with information systems' user friendliness and attractiveness, with usability issues such as the time to reach a data entry point, the speed of information retrieval, the quality of information retrieval, the complex security procedures, etc. In order to implement information systems and knowledge management systems, education and training must be addressed with high priority since user acceptability is strongly related to them. Service oriented models and patient-centred information systems have a higher chance of passing the user acceptability test. A system that is not accepted by the user is often a system with poor data quality (or no data at all) and knowledge management, business intelligence or data warehousing solutions are consequently inoperable and unsuccessful.

Taking the above issues in mind, as well as the ongoing efforts of the Greek Ministry of Health, the Greek e-business forum¹ initiated a new focus group regarding e-health and interoperability, which took the codename Z3. This focus group gathered more than 150 decision makers, medical informaticians, healthcare practitioners and other individuals involved in healthcare. The focus group started working in September 2004 and ended in April 2005 with a one day event (workshop) to present publicly its findings and recommendations. The following paragraphs are depicting the result of that effort in Greece.

2. Defining the open issues

The focus group prepared an exhaustive questionnaire that was filled by the focus group members. The following list of issues was depicted from those questionnaires:

1. Political issues are strongly biasing the government's decision making strategy. In that sense, politics tend to change continuously, creating a lack of high level strategy.

¹ See <http://www.ebusinessforum.gr>

2. There is no national strategy for medical terminology, information systems security, disaster recovery, data interchange protocols, etc.
3. Greek medical institutions are understaffed regarding their need for the successful adaptation to new information and communication technologies.
4. As the public sector is concerned, the Focus Group noticed that procedures do not comply to the introduction of ICT, thus creating a draw-backing inertia of the national healthcare system.
5. High level leadership mostly focuses on day to day management than towards introducing the necessary structural changes to support ICT.
6. There is a strong lack of vision amongst leadership, starting top down from the high level administration.
7. The Greek medical ICT market is very small to enforce correct bottom up solutions, thus existing solutions simply follow the complex and bureaucratic way of doing things in the Greek public medical institutions.
8. The user requirements and technical specifications proposed to the implementers often lack of severity, clarity and business scope.
9. There is no follow up of other worldwide best practices, and visionaries are restricted to deploy strategies that never succeeded to overpass the design phase.
10. The proposed time management of the government ICT project is unrealistic and does not take into consideration the complexity of the healthcare sector.
11. Fund management and human resources management is not clear and are both mostly spent in unrealistic projects that do not promote ICT as success cases.
12. The high level leadership lacks of ICT knowledge and cannot focus correctly upon the benefit of the correct introduction of integrated information systems in Greek medical institutions. A large majority of questionnaire reported a techno phobic approach of the political and administrative leadership.
13. The Greek healthcare sector has four decision making groups (Ministry of Health, Ministry of Education, Ministry of Social Welfare and Ministry of Defence), thus making the business rules extremely bureaucratic, creating a business environment that lacks of homogeneity in matters of terminology and procedures.
14. The social security sector is also extremely complex and not homogenised in procedures, insurance coverage, and support to citizens. This is due to the separate route that each ministry has followed for its

institutions. Even today with the operation of a general secretariat for social security, the Greek government has not succeeded yet to create the correct environment for the citizen, despite the efforts of the last years.

15. The human factor lacks of expertise and training in ICT, thus making almost impossible to locate the correct amount of key users or early adopters to promote ICT.
16. It is extremely difficult to implement business reengineering projects in the public sector. Nevertheless, many efforts are in the process of implementation.
17. The reaction to change is quite large, since technophobia has passed from top management to a large number of employees, thus creating a hostile environment for ICT visionaries.

3. Interoperability roadmap prerequisites

In order to establish an interoperability roadmap, three prerequisites have to be met:

- selection of an interoperability architecture;
- pilot testing to establish possible open issues and implementation risks;
- defining an information systems sustainability scorecard.

3.1. *Proposing an interoperability architecture*

In 2001 a reform of the Greek national healthcare system [9] was introduced in order to enhance the performance and control of healthcare provision in Greece. One of the main changes was the division of the country in 17 autonomous healthcare regions where the regional healthcare authorities (RHA) are responsible for the regional healthcare strategy. In order to support this reform a series of ICT oriented interventions were introduced. After a period of analysis and design the Greek government started issuing a number of extremely detailed (more than 500 paged each) request for proposals (RFP) for each RHA [10]. The integration of existing and forthcoming information systems represents one of the most urgent priorities in order to meet the increasing clinical, organizational and managerial needs [11, 12]. In that context, the use of standards is essential since data processing needs vary widely in the complex regional healthcare environment. All RHA have a major concern in evaluating the existing operational hospital information systems and other information system infrastructure in order to make a decision on whether to maintain or replace them. In Greece, more than ten distinct vendors have installed healthcare IT related products (hospital information system, laboratory information system, radiology information system, etc.) that mostly work indepen-

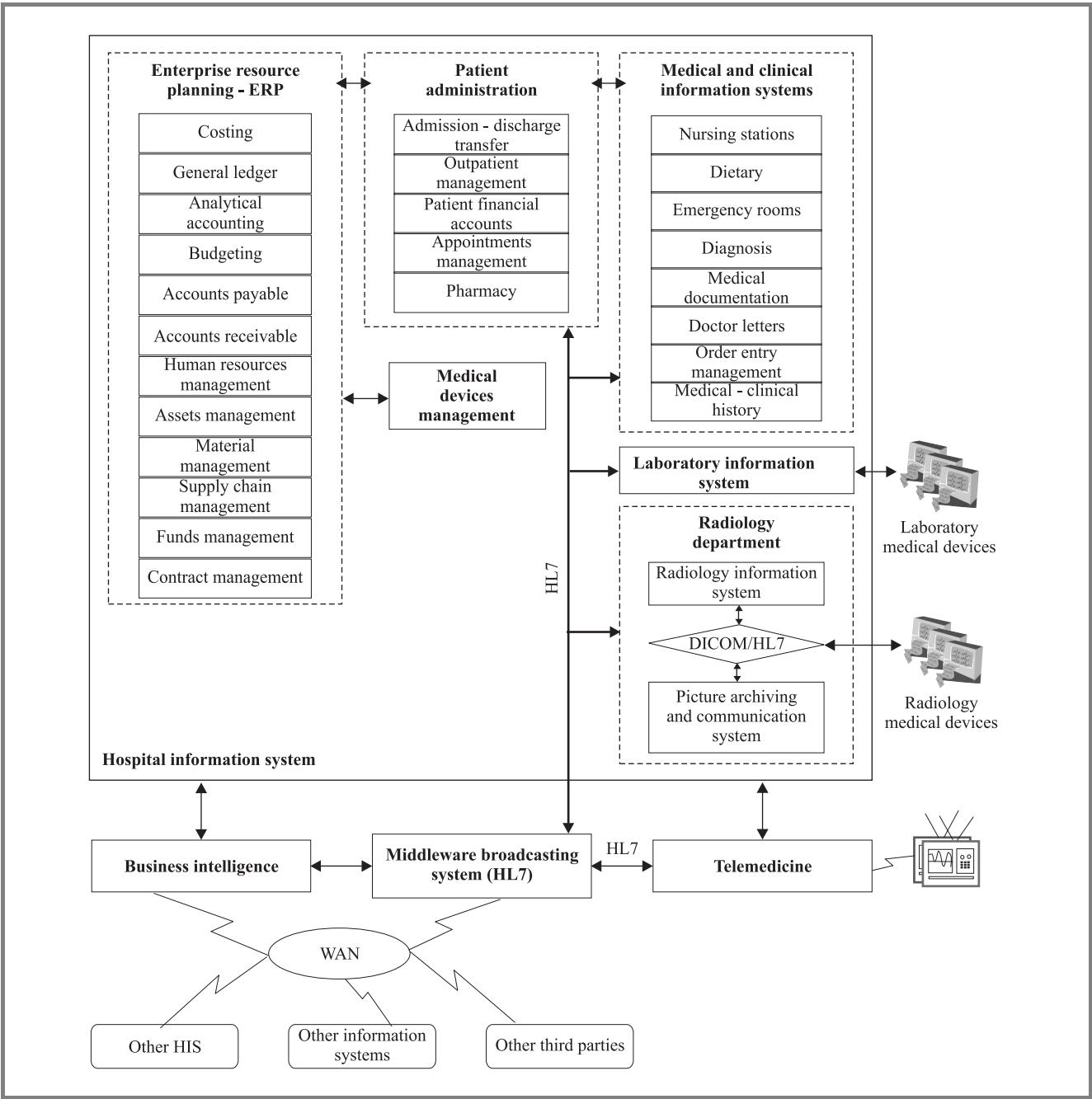


Fig. 1. Regional healthcare information system basic software components.

dently as IT niches. It is known that the lack of healthcare information standards is one barrier to the broad application of IT in health care units. The inability to share information across systems and between care organizations is just one of the major impediments in the health care business's progress toward efficiency and cost-effectiveness, as well as, the absence of a unique national or even regional patient identifier in Greece. Integration of these existing diverse systems with the future information systems to come remains problematic with a number of competing approaches, none of which alone represents the perfect solution. Current practice shows that the most promising approach to

achieve a regional healthcare information system is to use, where applicable, an HL7 message-based communication system implemented by an asynchronous common communication infrastructure between healthcare sites. The proposed information system in the RFP consists of a series of subsystems as depicted in Fig. 1, covering information management issues in a regional healthcare system. The system is innovative in the sense that it required the design and implementation of a complete and integrated information system at a regional level that comprises all types of healthcare levels (primary care, secondary care, home care, etc.), that includes interoperability issues, that covers

most of the needed components and that could be able to work efficiently in a secure wide area network (i.e., a VPN) to ensure data privacy and confidentiality.

Through the aforementioned RFPs, the need has arisen to make healthcare information systems in Greece to work together as the components of regional healthcare network (RHN), where newly introduced information systems must communicate with systems already present in various healthcare institutions. The proposed solution features the use of middleware broadcasting systems that are based on information exchange via messages utilizing some application protocol (ISO-OSI level 7).

The proposed architecture fulfils at least the following requirements:

1. Existing systems do not need to be altered.
2. No significant extra (hence unanticipated) load on existing systems is introduced.
3. Connecting existing systems is an economical viable activity.

The three requirements are met by an *asynchronous message* based information exchange infrastructure defining a uniform interface for any system that must send or receive information. All systems are connected, through a uniform interface, to an interoperability framework or more technically to a common communication infrastructure (CCI). In an asynchronous message based CCI, information is exchanged between two systems by breaking up the information into chunks. These “chunks” are called *application protocol data units* (APDU). An APDU has an explicit structure that is defined by the APDU (or message) *syntax*. Additional encoding and decoding rules help sending and receiving systems to construct and to analyze APDUs. Sending systems can insert information into APDUs and receiving systems can extract information from the APDUs.

APDUs are not transmitted directly; they are embedded in so called *protocol data units* (PDU). APDUs form the “payload” of PDUs. PDUs contain enough information for

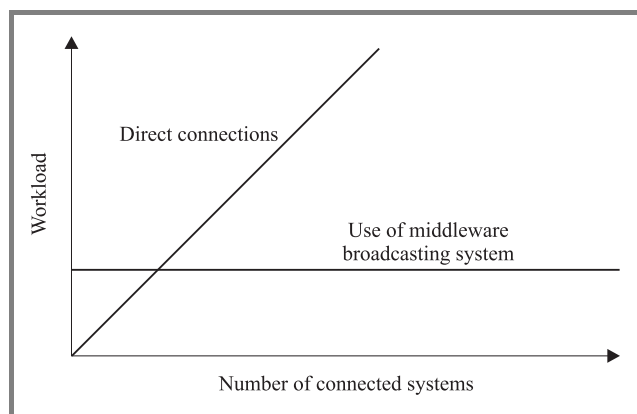


Fig. 2. Workload produced by connected systems.

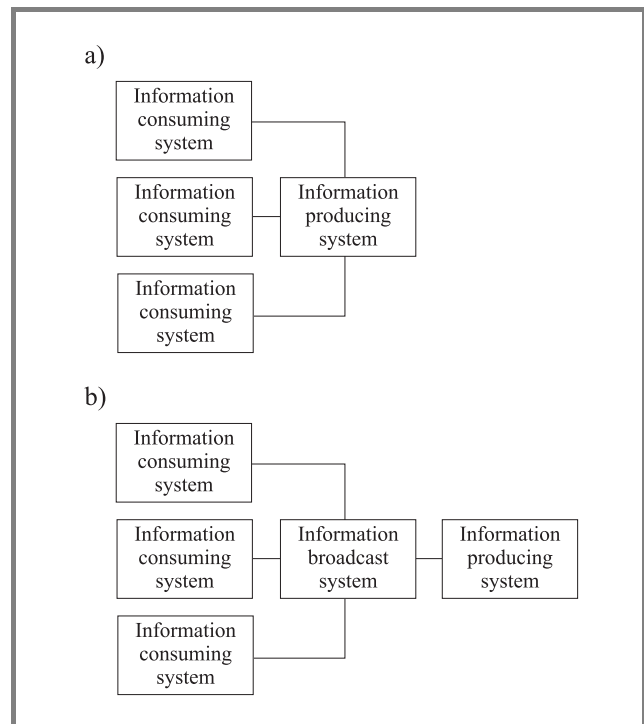


Fig. 3. Schematic representation: (a) direct connection; (b) use of middleware broadcasting system.

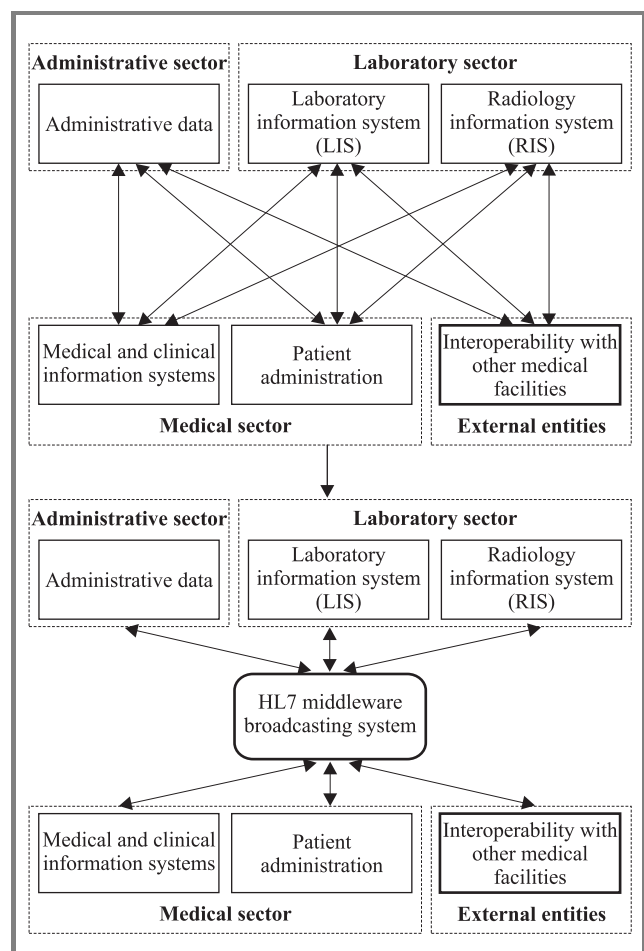


Fig. 4. Creating an interoperability framework.

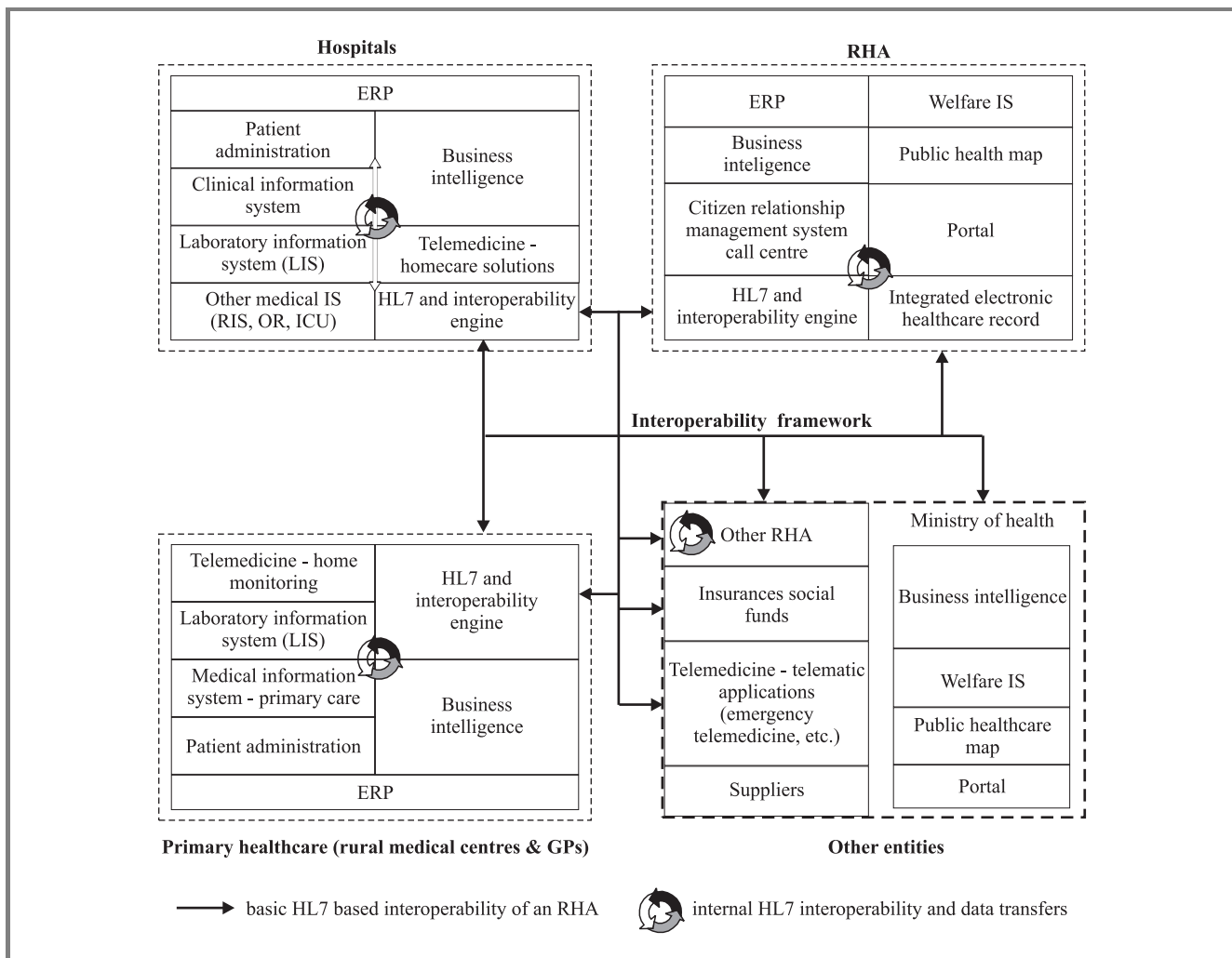


Fig. 5. Regional healthcare based interoperability framework.

the CCI to be able to “route” the information sent to the receiving application. Additional “meta” data help the receiving side to understand if the PDU has been received intact and contains the APDU anticipated.

Using (A)PDUs to exchange information between systems brings a number of distinct advantages:

1. All systems can be interfaced in a uniform way with each other.
2. There is decoupling between systems which allows information to be routed, stored and forwarded, and processed independently from the actual exchange.
3. Information exchanging does not need to reveal their internal structure to each other. This form of “information hiding” significantly improves the connectability of systems.

As depicted in Fig. 2, the use of a middleware broadcasting system is enabling the interconnection of information systems without creating extra workloads on existing information systems. When a system provides a uniform interface for sending and receiving information it can be

connected easily and even routing of information becomes feasible. The latter is very important to connect remote systems that cannot communicate directly. Clearly the third advantage is the most important. The fact that two information systems do not need to know each others database schemata or database connection technology, tremendously simplifies the task of interfacing these systems. Figure 3 depicts the change that occurs when introducing a middleware broadcasting system.

Another important feature of the proposed solution is that it creates an interoperability framework that can be replicated from one healthcare institution to another. In that sense, common interoperability messages can be used to interconnect heterogeneous information systems within a healthcare institution or even at a regional healthcare level if a centralized information system is in place, as depicted in Fig. 4.

The proposed interoperability framework greatly simplifies the data exchange issue in a regional healthcare information system since a lot less interoperability connections are required and messages used are homogenized between all involved healthcare institutions.

Health level seven [13–15] is by far the most widely used message based information exchange standard in the clinical environment. It is in use on all continents of the world. Also HL7 is clearly the most mature message based information exchange standard. As a consequence, HL7 was set as a mandatory requirement in the selection process for the implementation of the RHN for each RHA in Greece.

Figures 3 and 4 mostly deal with interoperability issues within a healthcare institution, where typically hospitals are mostly concerned since they produce the wider range of medical data. Figure 5 though is extending and describing the proposed interoperability framework and clearly depict the basic interoperability paths required at a regional healthcare level. As stated before, a regional healthcare system can be either an aggregation of interconnected distributed and variable information systems, either a totally centralized system based upon an application system provider's (ASP model) approach or a combination of the aforementioned architecture. In all cases information flows, patient journey data, electronic healthcare record data (data collected from various institutions, in various formats and appointed to each individual based upon a master patient index – MPI) are creating very important interoperability issues. It is without saying that data privacy issues are important when transferring or gathering data at a regional level and should be dealt with according to EU directives and additional national laws. Data privacy issues are addressed by the means of creating the proper patient consent mechanism, by creating and imposing strict and firm data manipulation and data storage procedures and by avoiding aggregation of sensible data when not strictly required.

Figure 5 depicts the interoperability point within a regional healthcare information system. The interoperability framework can be implemented either centrally with one middleware broadcasting system that interconnects all concerned information systems in a regional healthcare network (VPN based) setting or with an aggregation of interconnected and networked middleware broadcasting systems (one for each institution in the regional setting) that all communicate by an agreed numbers of HL7 based messages. In that sense, the cooperation of such middleware systems could be expanded nationwide, thus enabling patient mobility and data consistency within a nationwide electronic healthcare record.

3.2. Pilot testing

In order to test the proposed framework a small scale pilot project was conceived [16]. The pilot aimed at implementing interoperability among hospital information systems and the management information system (MIS) of a RHA. The implementation of an HL7 link requires fewer resources when HL7 middleware is deployed, and the data are stored in open architecture database management systems. The required human resources were

one software engineer with knowledge of HL7, database systems and HL7 middleware concepts, one project coordinator (part time employment), one system administrator per site/link (part time employment), one project manager from the RHA (part time employment) and one application/database administrator (part time employment).

The time consumed for the pilot project is described in Table 1.

Table 1
Duration of the phases of such project

Activity	Duration in hours
Defining the scenario	Depends on user requirements
Defining the events and the event data	60
Selecting the right message types	24
Extend selected message types (optional)	12
Define the protocol	12
Determine implementation parameters	12
Map message fields onto table columns	40
Mapping table columns onto message fields	40
Implement message sending	120
Implement incoming message processing	120
Verification and validation	60
Total	500 hours

Furthermore, the risk analysis for the implementation of such projects is summarized into three categories: *data quality, technical and organizational*. Table 2 presents an analysis of the risks.

3.3. Information systems sustainability scorecard

Defining existing information systems sustainability is not an easy task since most of the reasons for disinvesting or reinvesting in information systems is highly subjective, mostly based upon criteria such as user friendliness, cost effectiveness, etc.

The proposed scorecard is based upon some initial assumptions:

- There is no issue of sustainability concerning existing information systems that are to be replaced by technologically more advanced platforms.

Table 2
Risk analysis table

Risk	Description	Encountered during this pilot
Data quality risks		
Annotated database schema missing	There is no annotated database schema at all. Lack of a comprehensive database schema significantly reduces the likelihood of successfully reverse engineering the database schema.	No
Database schema contents not interpretable	The names used in the schema are unclear or ambiguous; also relations are not clearly defined.	No
Database tables not used as described in the database schema	Database table usage has drifted away from the logical or semantic design.	Yes
Free text fields used for structured data in an ad hoc fashion	Free text fields are using to store structured data. The database schema should be redesigned.	No
Inconsistent use of enumerable data types	In particular in reference tables like COUNTRY, CITY values like "GREECE", "Greece", "greece" all representing the country Greece.	Yes
Required data not present	Data that according to the database schema are required (NOT NULL) but are null in the tables. The database schema does not reflect the current structure of the database.	No
Semantic analysis of data	Data fields does not contain semantically valid data.	Yes
Character set encoding problems	There are problems with the character set encoding in the database.	No
Technical risks		
General interface to access database system	Access to information systems' databases through general interfaces that are independent from applications, must be available (and configured) in every (hospital) information system.	No
Proprietary operating system	The database system runs on a platform with proprietary operating system (e.g., Not Windows, Linux, Unix, or VMS).	No
Database not accessible	It is impossible to logon to the database.	No
Exotic communication protocol	The platform on which the database runs can only be connected through a non-TCP/IP communication protocol.	No
LAN not reachable	The LAN on which the pilot system is connected to cannot be reached from outside the LAN due to security matters and other reason.	Yes
Unstable or failing computing environment	The computing environment is unstable or failing causing the pilot system to malfunction.	No
Organizational risks		
Not enough competent staff	IT staff is not qualified or inadequate in quantity.	Yes
Lack of individual co-operation	Individuals in the organization are reluctant to co-operate.	No
Rules and procedures	Rules and procedures are becoming an obstacle or slow down progress especially in public services.	Yes
Lack of decision making	There are no decision makers that can put the project in progress.	No
Lack of software vender support	Software vendors that need to assist do not do this.	No
Software vendor sabotage	Software vendors are actually sabotaging the project out of commercial interests.	No

- A RHIS is an integration of specific oriented building blocks that are commonly acknowledged and agreed. Those are the enterprise resource planning (ERP), the HIS, the LIS, the RIS, the human resources management, the document management system, the interoperability middleware tool, the portal and the business intelligence tools.

As a consequence the following steps are required:

- defining the building blocks (BB) of RHIS (as above);
- proposing a scorecard for sustainability;
- defining the needs for interoperability between building blocks.

As a matter of scorecard the following criteria were proposed:

1. Technical and logical architectural conformity.
2. Recent technological platform (Windows or Unix GUI, Web GUI).
3. Interoperability capability with other BB (HL7, XML).
4. 80% coverage of ERP standard functionality.
5. 60% coverage of HIS standard functionality.
6. 100% coverage of HRM standard functionality.
7. 100% coverage of LIS or RIS standard functionality.
8. 80% coverage of the established Greek national healthcare systems procedures.
9. 100% coverage of required data exchange within BB modalities.
10. Vendor sustainability (ability to deliver and support the information systems for at least 3 years).
11. Fixed budgeting rules.

4. Medical terminology: a prerequisite for interoperability

4.1. The importance of codification

Healthcare institutions are creating a huge amount of data of any type (administrative, financial, medical, etc.) or format (reports, medical records, medical images, transcriptions, doctor letters, etc.), on a daily basis.

Despite the technological efforts and new proposed technologies of our times, a great deal of those data is still hand written or paper based, thus not enabling the exploitation of those rich information sources. Part of this delay

is due to a lack of codification, terminology and standard usage for recording, storing and interchanging data. The use of medical terminologies allows systemic and procedural reuse of information in order to assist medical staff, to fill the electronic patient record, to promote prompt and correct diagnosis and to enhance quality of care.

Furthermore coded data are more malleable concerning statistical analysis and public health monitoring, both at a national and international level. Both administrative management and medical staff are able to gather any type of data fitting their job descriptions.

The most common codifications are the classifications such as the International Classification of Diseases (ICD)² proposed by the World Health Organization (WHO), and the nomenclatures such as Systematized Nomenclature of Human and Veterinary Medicine (SNOMED)³. Other types of codifications are the thesauruses, the taxonomies and the formal terminologies. In Table 3 some of the most commonly proposed and used codifications are listed more as examples than a complete list. The oldest classification reported, the “London Bills of Mortality” was conceived in England for forensic purposes in 1662. WHO started ICD in 1901 with Version 1 and today we have reached Version 10, finalized in 1992. SNOMED started in 1928 (SNOMED RT) and is been continuously updated, now having more than 361 800 medical terms, 975 000 descriptions and 1 470 000 semantic correlations in SNOMED CT (2004).

Organizations as WHO, College of American Pathologists (CAP), Health Level Seven and the world organization of national colleges, academies and academic associations of family physicians and general practitioners (WONCA) are not the only bodies that have deployed successful coded data sets. It is rather common that national standardization bodies are either translating most commonly used international codifications or creating their own national subsets of any type and complexity.

Codifications by themselves are one of the most important steps toward public health monitoring, cost containment and better healthcare services to the citizens. Codifications are also extremely important as input or output of a healthcare information system of any range and penetration. The use of coded data results in having high quality structured data that enable better reuse of the knowledge created during the day to day process of patient treatment, thus enabling patient history keeping, diagnoses recording and better healthcare outcomes. Structured data enable statisticians and administrations to better monitor public health, disease prevention and strategic policy planning.

The use of coded data is also the cornerstone of cost analysis of a well designed healthcare system, making it possible to foresee procurement requirements, institution deployment and other important decision regarding healthcare management. It is important to state that EU has a strong

²See <http://www.who.int/whosis/icd10/>

³See <http://www.snomed.org>

Table 3
Most common existing codifications (*copyright: A. Berler*)

National and European data sets	Financial and administrative data sets
Master patient index Social security number (SSN) National and EU statistical codification sets Patient record: OpenEHR/HL7-RIM	Greek GL prerequisites (PD 146/2003) DRGs NCDP (e-claiming) ECRI
	Data interfacing protocols
Medical terminology	HL7 (Version 2.x/Version 3)
ICD 10 – WHO SNOMED – CAP ICPC 2- WONCA	HL7/CDA DICOM 3.0
	Other codifications
Diseases and procedures	ATC/DDD η NCD (Drugs)
ICD-10-PCS/CPT CCI – CCAM HCPCS, CPT, OPCS-4	GMDN
	Research
	Arden syntax (HL7), OWL, GELLO (HL7), semantic web, GLIF, XML topic maps

focus towards structured medical and clinical data and has proposed a series of white papers, green papers, communications and directives [17–22]. Codifications are also critical for the dissemination of medical knowledge and information systems interoperability. It is not possible to design any type of interoperability roadmap without taking into consideration the strategic need at a national or European level for structured data. Initially medical terminologies, clinical classifications, medical procedures and clinical guidelines were proposed as a solution to calculate and restrict the number of medical errors or adverse drug events.

A large number of studies in the US [23, 24], Australia [25], Canada, Denmark, Italy, The Netherlands, Sweden and New Zealand, all report that a large number of adverse drugs events and medical errors have resulted in damages of the health of patients. In the UK, statistics report that about 10% of inpatients have been involved in episodes of care where wrong dose or other medication was given with minor or important consequences in patient's health status. The financial costs of those events are estimated at £3 billion only for the extra bed days. As a consequence the use of e-prescribing, bar coding and/or computer based order entry systems are of critical importance and have proven to reduce dramatically the number of medical errors.

In Italy more than 14 000 patients die every year due to medical errors whilst this number reaches each year 44 000 up to 98 000 in the US, surpassing death tolls that are accredited to traffic accidents, breast cancer, AIDS, etc. [24]. All studies state that those errors could be prevented or at least a large number of them, if medical data collected had the proper quality rate. Medical terminologies and codifications have a lot to offer in that sector:

- In 1992 at LDS Hospital of Salt Lake City (US) the establishment of an adverse drug reaction monitoring system recorded 569 cases, saved many extra bed days and \$1 000 000 of the hospital's budget.
- The drug “Seldane” was approved by the Federal Drug Administration (FDA) in 1985, presented the first adverse reactions with erythromycin (cardiac arrhythmia) in 1992 and was only withdrawn in 1998 due to lack of decisive data.

The use of codified data into information systems in healthcare provides the ability to those systems to interoperate and exchange important medical knowledge in order to establish a unique electronic healthcare record (EHR) for each citizen by collecting all important data from each patient encounter with the healthcare system. EHRs cannot be created with medical codifications since they are the base for any type of semantic interoperability. This issue is not new since Florence Nightingale stated in 1893:

“In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purposes of comparison. If they could be obtained, they would enable us to decide many other questions... They would show subscribers how their money was being spent [and] what amount of good was really being done with it...”

4.2. Medical terminology and codifications: the cornerstones of e-health

Figure 6 depicts the workflows both external and internal that have to be met within a healthcare system of any range (from a single institution to a national healthcare system). From that figure it is clear that three major structural re-

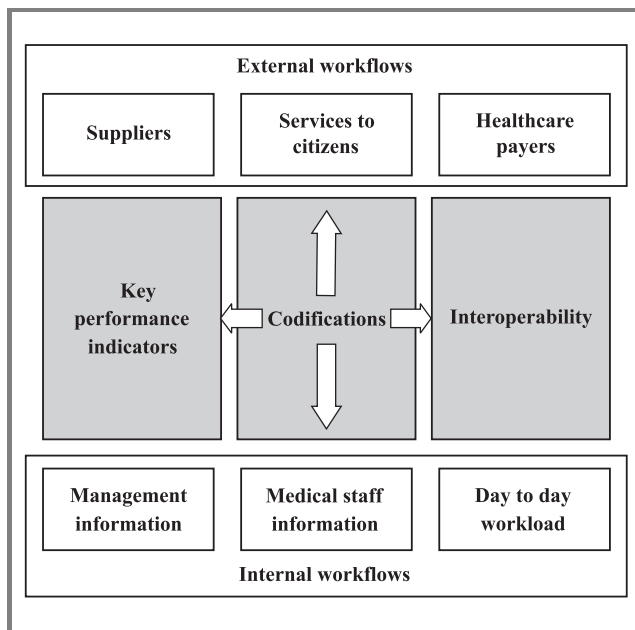


Fig. 6. Healthcare workflows (copyright: A. Berler).

quirements have to be met to reach a satisfactory level of coverage of the healthcare workflows with the use of ICT in healthcare:

1. The deployment of key performance indicators and public health indicators, which is one of the key recommendations and directives of the European Union [26, 27].
2. The design and implementation of an interoperability framework based upon commonly adopted and agreed international standards such as HL7 (already adopted nationally in the US, Canada, New Zealand, Australia, The Netherlands, Germany and UK, while other States such as France, Croatia, Ireland, Italy, etc., are moving towards that direction). EU is also in favour of such strategic policies [28–30].
3. The implementation and maintenance of national medical terminologies as described in the previous paragraphs.

5. Focus group suggestions

Taking all the above mentioned issues the focus group reached a consensus that is described below as a set of recommendations for the Greek medical informatics market, the establishment of medical codifications and for the establishment of an interoperability roadmap.

5.1. Ten recommendations for the Greek medical informatics market

The recommendations are as follows:

1. Urgent involvement of the leadership in favour of projects related to the introduction of ICT in healthcare.

2. Urgent involvement of key users in the design process of ICT projects instead of simple top down decision based projects.
3. Incorporation of knowledge experts such as the Greek affiliate of HL7 international.
4. Continuous ICT dissemination training programmes.
5. Top down design should be restricted to business planning and strategic objectives clarifications in order to make the national business rules crystal clear.
6. Strategic business planning continuity from the Greek Ministry of Health regardless from any political or governmental change. This should be made possible by employing a number of business experts focused towards ICT implementation in healthcare which is at least a ten years plan.
7. Strategic cooperation with other decision makers in healthcare such as the Ministry of Social Security and the Ministry of National Economy.
8. The establishment of an information authority monitored by the Ministry of Health that will be responsible for the implementation of ICT strategies, maintenance of medical terminologies and the management of the interoperability framework.
9. The creation of national public health indicators that will be in accordance to the EU guidelines and requirements.
10. Establishment of an e-health forum in order to create a constant interaction framework between all key players in the healthcare sector (government, medical institutions, industry, medical informatics implementers, etc.). This forum will be responsible for the public concertation of regulations, terminologies, strategies and other policy papers so that the maximum consensus can be reached before the implementation of new strategies and regulations.

5.2. Ten recommendations for medical codifications

The following recommendations were drawn up:

1. Greece has to fully participate in the creation of international standards and protocols by assigning national delegates to all forums and standard development organizations related to healthcare.
2. The “one size fits all” codification scheme is not efficient as medical specificities are regarded. Some clinicians prefer nomenclatures (i.e., pathologists) while others prefer simple classifications (i.e., internists).

3. There is an urgent need to select and implement the Greek set of codifications since the existing scheme of “any code is good” is a major draw back for any national data quality strategy and national ICT deployment for better health and cost containment. This should be made clear to all decision makers and administrative leadership.
4. The deployment of medical terminology could be assigned to the healthcare market itself through scientific societies and international standardization bodies.
5. EU directives should be taken into immediate consideration regarding medication related errors, the creation of access-free libraries of codes, the creation of workflow models based upon adopted standards (OpenEHR, HL7-RIM) and abstinence from the creation of national standards where international or European standards are already in place.
6. For the successful implementation and use of medical terminologies it is required that medical personnel is immediately involved in the design and proposition process, constant dissemination and training strategies are followed, consensus based decision making is adopted, job descriptions are refined and incentives are proposed.
7. Each selected codification should be selected for the specific requirements that need to be covered. All codifications should be maintainable and upgradeable and have the possibility to interrelate with other terminologies.
8. Codifications and terminologies should be selected as integrated parts of a wider interoperability platform so that all type of internal or external workflows can be completed with the use of ICT.
9. A constant dialogue framework must be established regardless of any political matters and governmental changes. The proposed e-health forum is an optimum solution for this clause. A five to ten years consensus is absolutely necessary.
10. Greece has separated the strategic planning of healthcare and social security, thus cutting the correlation of healthcare providers from payers. This has created a duplication of standardization efforts not always pointing to the same direction; Best practices in interoperability and standardization in health have often started from the payers rather than from the providers. Payers, providers and patients should be put all together under the same strategic umbrella as soon as possible to create the needed economies of scale.

5.3. *Ten recommendations towards interoperability: creating the roadmap*

There are the following recommendations:

1. Deployment of an interoperability framework based upon common communication interfaces.
2. Assessment and sustainability of existing information systems in medical institutions, based upon a specific scorecard methodology.
3. The healthcare informatics market should strongly focus towards standards conformance and standards maintenance. Consensus based processes for the deployment of the basic standards functionality are of critical importance (i.e., implementing integration labs).
4. HL7 is mature enough to solve most of the interoperability issues in Greek and many more than simple data interchange.
5. HL7 standards should be refined to meet peculiarities of the Greek healthcare system if such issues exist.
6. HL7 Hellas can assist the Greek ministry of health in the required standardization process that is needed to implement a national interoperability platform (terminologies, processes, workflows, performance indicators, etc.).
7. Specific task forces and standardization teams should be established immediately, under the umbrella of an information authority or of an independent scientific society, such as HL7.
8. National interoperability conformance statements must be implemented based upon the work done by integrating the healthcare enterprise (IHE) with the use of HL7 and DICOM conformance statement templates and methodologies.
9. Greece should follow the work done by international task force created by standardization bodies such as ISO, CEN/TC 251, HL7, openEHR, etc. This is especially valuable as the creation of a national EHR is regarded.
10. Immediate involvement of Greek experts and knowledge workers in international standardization processes.

6. Conclusions

The result of the focus group was publicly presented during a one day workshop with the involvement of all key players of ICT in healthcare in Greece. It was not expected that those recommendations would change the situation in Greece overnight. Nevertheless the situation

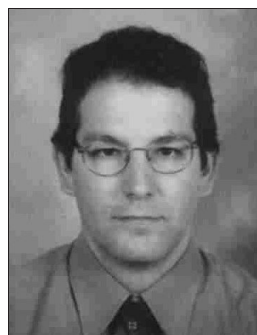
of ICT introduction in Greece is blooming of activity with more than 15 high level ICT projects in the implementation process, with the initiation of consensus based efforts in order to reach a national framework regarding uniform workflows and processes, medical terminologies and an interoperability roadmap. Concerning the latter, HL7 has been largely adopted by the project implementers and the sustainability scorecards is expected to integrate information niches wherever this is plausible, both technically and financially.

Finally, the Greek government has made tremendous efforts into proposing a complete strategy regarding ICT in Greece, by proposing the IASYS project to be gradually implemented in the forthcoming years. All projects under way at this moment will be integrated into this national strategy from a technical and procedural point of view. The proposed interoperability roadmap will permit information systems to cooperate efficiently and work together as one. In order for this important strategic project to succeed an information authority is to be established to manage centrally all ICT projects in Greece and in parallel to create the required coded data structure, procedures, workflows and quality rules for these information systems. In addition, the Ministry of Health is about to announce the operation of an e-health forum covering most of the proposed recommendations of focus group Z3.

In that sense most of the focus group recommendations have been considered by the Greek Ministry of Health. The process of the successful introduction of ICT in the Greek healthcare system should nevertheless take more than ten years to be completed.

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