

Preliminary Assessment of the Interoperability Maturity of Healthcare Digital Services vs Public Services of Other Sectors

Angelina Kouroubali^a, Anastasia Papastilianou^b, Dimitrios G. Katehakis^a

^a Institute of Computer Science, Foundation for Research and Technology - Hellas, Heraklion, Greece,

^b National Centre for Public Administration and Local Government, Athens, Greece

Abstract

The development of electronic services for healthcare presents challenges related to the effective cooperation of systems and stakeholders in a highly regulated environment. Assessing the interoperability maturity of the provided services helps to identify interoperability issues in public administration. This paper presents a typical healthcare digital service: the inpatient admission in a public hospital in Greece. The Interoperability Maturity Model (IMM) is applied to assess its maturity, identify improvement priorities, and compare it with digital services of the healthcare sector. An analysis is also performed to compare a group of fourteen healthcare digital public services with sixty-seven public services of other sectors in the country. The IMM is a useful tool to facilitate awareness raising and priority setting concerning interoperability in public administration. What is discovered, through this preliminary assessment, is that healthcare digital services seem to have higher overall interoperability maturity than those of other sectors in Greece.

Keywords:

Health Information Interoperability, Health Information Systems, Public Health Administration

Introduction

Electronic Health or eHealth is a term incorporating different concepts, including health, technology, and business. Several definitions published include these concepts with varying degrees of emphasis. Health, as used in these definitions, usually refers explicitly to healthcare as a process, rather than to health as an outcome [1]. In eHealth, technology is portrayed as a means to expand, to assist, or to enhance human activities, rather than as a substitute for them. As such, eHealth can not only benefit citizens, patients and healthcare professionals, but also health organizations, businesses and public authorities [2]. Despite the opportunities and benefits, major barriers hamper the wider uptake of eHealth. One of the major ones is the lack of interoperability between eHealth solutions, which is far more than just data exchange. Interoperability in eHealth is about the delivery of contextually relevant understandings efficiently and securely to facilitate care coordination, irrespective of application, vendor or device [3,4]. It is about improving healthcare.

The healthcare sector has many digital services and tools that are interrelated with the Electronic Health Record (EHR) of the citizen, and several public services such as ones related to identification and authentication, health insurance validation, coordinated care and others. Interoperability in eHealth is

challenging for various reasons, including the fact that different products and solutions in the market do not follow well-known standards and interoperability guidelines [4-6]. It is important to create the necessary conditions and frameworks to guide the market towards interoperability solutions that follow specifications that facilitate interaction with existing healthcare services and necessary public services, integrated care pathways and shared workflows [7]. Healthcare digital services must interact not only with many other digital services offered by administrative bodies within the sector, but also across different sectors. In addition, the need arises for cross-border sharing and utilization of services, data, and business processes [8].

Although shared and reusable data are gradually being introduced to the healthcare domain through increasingly interoperable systems, measurement of the interoperability maturity of those services has not been common. Interoperability assessment methods involve the use of maturity models as a framework to describe the way a service is carried out within the same or across domains [9].

The Interoperability Solutions for Public Administrations, Businesses and Citizens programme (ISA²) (https://ec.europa.eu/isa2/isa2_en) in the European Union (EU) supports the development of digital solutions that enable public administrations, businesses and citizens to benefit from interoperable cross-border and cross-sector public services. In recognition of the importance of creating and promoting interoperable public digital services, IMM [10] was developed, as part of the ISA² programme in order to assess the interoperability readiness of the digital public services and raise awareness of the need for interoperable solutions. The IMM helps public service owners to evaluate, improve and consider all key interoperability aspects of the public service. As an evaluation tool, the IMM can be useful for national and cross-border services. The interoperability maturity of public services has been assessed for 17 Trans European systems and the Swedish and Cyprus public administrations to evaluate a number of public services provided at national and local levels [11]. Interoperability assessment models have been used also in the United States and Australia [12,13].

This paper introduces the IMM and applies it to a specific, typical healthcare scenario found in a Greek hospital, to assess its interoperability readiness as a digital service for shared activities. This scenario is subsequently compared to interoperability readiness of other digital healthcare services. In addition, further analysis identifies the maturity levels of healthcare digital services compared to other digital public services in Greece. Healthcare in Greece is provided by the National Health System (NHS). As a public service, it does not

exist in isolation but as part of the wider national public administration. The paper concludes with discussion of the key findings and ideas for future research.

Methods

Methods used for this work were based on the IMM. The IMM was used to evaluate the inpatient admission service delivered through applications developed by the Foundation of Research and Technology – Hellas (FORTH) at the NHS of Greece. In addition, an analysis was performed to aggregate the interoperability maturity of 14 healthcare services in total. The inpatient admission service results were compared to the results of the other (13) healthcare services. Finally, all healthcare services results were compared to the maturity evaluation of 67 digital public services of other sectors in Greece. The methodology is described in detail in the next paragraphs.

Interoperability Maturity Model

IMM has been designed to help public service owners at different government levels (i.e. local, regional, national, and cross-border) to evaluate the current interoperability maturity level of a public service and gain insight into the improvement priorities that are needed to reach the next level of interoperability maturity. A public service is a service that addresses the public interest and is delivered by a public administration to citizens (A2C), to business organizations (A2B) and/or to other public administrations (A2A). A *process trigger* initiates the public service that consists of several process steps. IMM measures the level of interaction of a public service with services of other organizations towards the realization of mutually beneficial and agreed common goals through the exchange of information and reuse of services [10]. Interoperability is distinguished in three domains: *service delivery* which refers to the way the public service delivers its outcome to the end-user, *service consumption* which looks at the services or data that are being reused from other public administrations and businesses where the assessed public service has the role of the consumer, and *service management* which refers to the coordination of all interactions with the internal and external environment. Each domain can receive a score from 1 to 5. Explanations of the scores are provided in table 1.

Table 1– Domain Scores for Interoperability Maturity

Score	Interoperability Maturity
1	<i>ad hoc: poor interoperability</i> - referred to a service that cannot be considered interoperable
2	<i>opportunistic: fair interoperability</i> - the digital public service implements some elements of interoperability best practices
3	<i>essential: essential interoperability</i> - the digital public service implements the essential best practices for interoperability
4	<i>sustainable: good interoperability</i> - all relevant interoperability best practices are implemented by the digital public service
5	<i>seamless: seamless interoperability</i> - the digital public service is a leading interoperability practice example for others

The healthcare digital service that is analyzed and presented in this paper refers to the admission of a patient in the clinic of a public hospital in Greece. The scenario is presented and its maturity model is assessed. The IMM questionnaire was filled

out to assess the interoperability readiness of the service for the three domains of interoperability: *service delivery*, *service consumption* and *service management*. The IMM was used vs the more lite version called Interoperability Maturity Assessment of a Public Service (IMAPS) which is a compact self-assessment online survey [11]. IMM was selected because it provides a comprehensive toolset for a detailed and in-depth analysis of the service landscaping. Based on the assessment a tailor-made set of recommendations is provided to the service owner. IMAPS has been introduced by ISA² at a later stage to support a faster self-assessment with easy to understand recommendations.

Assessment and Analysis

The IMM assessment took place as part of the work performed for the course *interoperability evaluation of digital public services* that was delivered by the National Centre for Public Administration and Local Government in Greece. The course introduced the IMM to public employees who were asked to apply it to a digital service and assess its maturity. The course was delivered 15 times through the years 2016-2018 and had overall 425 participants working in small teams. As part of the coursework, 81 different digital public services have been assessed. The quantitative analysis was performed on 81 public services, which were separated into two groups. One group had the digital services that were related to healthcare (14), and the other group had the rest of the public services (67). For the healthcare services, a comparison was made between the inpatient admission services and the rest (13). A descriptive analysis compared the services for the three domains of interoperability: *service delivery*, *service consumption* and *service management*.

Limitations of the Study

The study is considered as a preliminary assessment of healthcare services as the sample size is quite small. The interpretations of the analysis cannot be widely generalized but provide an indication of the interoperability maturity of the digital services of the public sector in the country. In addition, the IMM has an inherent limitation in that the assessment that occurs relies widely on self-reporting and interpretation of the questions. It is important to take into account that the results are based on qualitative critical evaluation. This limitation has been partly minimized with the intervention of experienced trainers during the assessment exercise of small groups of experts.

Results

Digital Healthcare Service in a Greek Public Hospital

The Patient Administration family of applications (ICS–A), is part of the FORTH Integrated Care Solutions (ICS) suite (https://www.ics.forth.gr/ceha/index_main.php?l=e&c=664). The ICS family of applications supports, among others, all patient management processes for both inpatients and outpatients in a healthcare unit, including all medical, nursing and administrative processes in the hospital. ICS applications support patient admission, transfer and discharge, hospitalization data logging, scheduling of appointments and surgeries, waiting lists, ordering and recording of medical acts, billing, payment collection, and electronic reimbursement [14]. ICS applications interact with digital services within and across the healthcare enterprise using interoperability services. They contribute to the improvement of organizational performance and cost savings by applying the *data entered-once* and *used-anywhere* key concepts.

The Inpatient Admission Service

The inpatient admission office application supports all the business processes related to inpatient admissions. It follows the movement of the patient during hospitalization, from admission to discharge. The *service process trigger* occurs when a patient or caregiver arrives at the patient admissions office for admission. The administrative staff searches for a patient record in the local hospital database and then in the regional central patient registry. If the patient record is not found, the administrative staff registers a new patient record. The patient demographic data, the patient insurance data and the insurance coverage validity are acquired online from the National Electronic Confirmation Service (ATLAS) [15], using the National Social Security Number (AMKA) as an identifier. The administrative staff fills out additional patient information and creates the patient record. If the patient record already exists in the Hospital Information System (HIS), the administrative staff checks for the validity of patient insurance coverage by retrieving data from ATLAS. Then the patient admission to the hospital is registered and the HIS sends a notification to the service of the National Organization for Health Care Services (EOPYY) [16]. Then, the ward management system at the clinic where the patient is admitted receives the corresponding patient admission notification and relevant data. The inpatient admissions office application also communicates directly or indirectly with third party systems including laboratory and radiology, pharmacy, enterprise resource planning, and business intelligence systems.

The family of applications described are based upon an open, scalable and evolvable architecture that integrates distributed information and knowledge in a flexible manner, focusing on the timely and effective delivery of the appropriate information to all authorized users. Being the outcome of applied research, it encompasses both state of the art trends and real-world requirements for effective use [14,17].

Interoperability Maturity Assessment

The assessment of the inpatient admission service scored 2.80 for the dimension *service delivery*, 4.30 for *service consumption*, and 4.45 for *service management*. The overall interoperability maturity score was 3.98. The results are presented in table 2.

Table 2– IMM Assessment of Inpatient Admission Service

Maturity Dimension	Score	Interoperability
Service Delivery	2.80	<i>essential</i>
Service Consumption	4.30	<i>sustainable</i>
Service Management	4.45	<i>sustainable</i>
Overall Maturity	3.98	<i>sustainable</i>

The inpatient admission service consumes the digital electronic confirmation services of ATLAS for demographics and insurance coverage, and the inpatient admission announcement service provided by EOPYY. The ATLAS service has been implemented as a base registry for AMKA and insurance coverage. The inpatient admission announcement has been implemented as a service for cost control within the NHS. Both services are consumed, when needed, by digital services of the public sector. The inpatient admission service maturity level for *service consumption* is considered *sustainable* as it consumes all available digital services that exist.

Interoperability Maturity of Healthcare Public Services

The evaluated services in the healthcare sector are provided by various health administration authorities and other organizations such as hospitals and pharmacies. The list in table 3 contains services that are related to the healthcare and social welfare of citizens as evaluated during the course work.

Table 3– List of Assessed Healthcare Services

#	Service Description
1	Hematological examinations
2	Hospital patient admission ticket issue for outpatients
3	Hospital admission ticket submission to the Business Intelligence System of the Ministry of Health
4	Health insurance record
5	Registration of dependent family members for insurance eligibility assignment
6	Electronic submission of hospitalizations to EOPYY
7	Inpatient admission service
8	Issue of a European Health Insurance Card (EHIC)
9	Disability Certification
10	Registration of new members for the acquisition of AMKA
11	Electronic decision to grant Medicare benefit
12	Digital signatures for citizens
13	Updating of contact information for an insured citizen
14	Registration and information retrieval on insurance eligibility

Focusing on the assessment of evaluated healthcare services, the value of the overall interoperability maturity of healthcare services is 3.32 as shown in table 4, and is characterized in terms of IMM as interoperability level 3: *essential*.

Table 4– IMM Assessment of Healthcare Services

Maturity Dimension	Score	Interoperability
Service Delivery	2.69	<i>essential</i>
Service Consumption	3.55	<i>sustainable</i>
Service Management	3.49	<i>sustainable</i>
Overall Maturity	3.32	<i>essential</i>

The interoperability maturity level for the *service delivery* dimension was 2.69, for *service consumption* dimension was 3.55, and *service management* dimension was 3.49. Looking more closely at the internal dimensions of health services maturity level, it is noted that in healthcare, the highest level (3.55) is in *service consumption* versus the lowest in *service delivery* (2.69). The low score for *service delivery* can be attributed to the fact that healthcare digital public services are mostly delivered from administrative personnel on behalf of citizens. These services are usually applications within healthcare organizations. There are no multichannel options for the delivery of the services. In addition, the services are not part of a service catalogue. As a result, the score for *service delivery* in healthcare remains low. On the other hand, *service consumption* is high as there are specific digital services such as base registries and services for financial management that have to be consumed by the majority of healthcare services.

Interoperability Maturity of the Inpatient Admission Service vs Other Healthcare Services

The overall maturity level of the inpatient admission service is 3.98, which is *sustainable*. Analysis of the rest of the 13

healthcare services showed an overall interoperability maturity of 3.27 which is characterized as *essential* (figure 1).

It is seen from the interoperability assessment that the described scenario scores higher than other healthcare services examined.

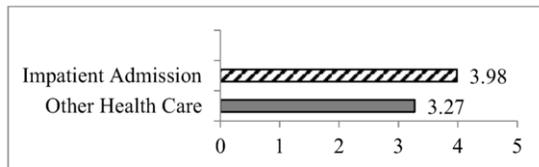


Figure 1 – Interoperability Maturity of Inpatient Admission vs Other Healthcare Services

Interoperability in Healthcare Services vs Public Services of Other Sectors

The average value of the interoperability maturity level of healthcare services is 3.32, which is not significantly higher than the interoperability maturity score of all other public services whose maturity is 3.29, as shown in Figure 2.

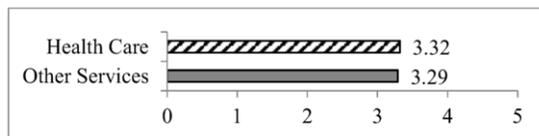


Figure 2 – Interoperability Maturity of Healthcare vs Public Services of Other Sectors

The healthcare services and public services of other sectors have, in terms of IMM, the same interoperability maturity at *essential* level. Looking more closely at the internal dimensions of healthcare services maturity versus those of all other services, as shown in Figure 3, it is noted that the *service delivery* dimension scores slight lower in healthcare than in other public services. This could be attributed to the fact that public services of other sectors could be used directly by citizens and are part of service catalogues.

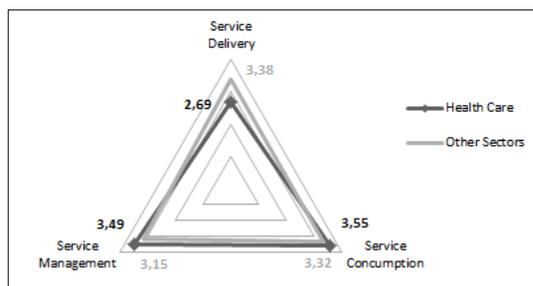


Figure 3 – Interoperability Maturity Dimensions of Healthcare Services vs Public Services of Other Sectors

Discussion

Based on the analysis of the real data generated during the conducted coursework, it has been shown that healthcare services score slightly higher in overall interoperability maturity to that of public services of other sectors. In the healthcare sector, several digital services have been implemented in the past years for the entire public sector. These implementations were reinforced through the economic crisis

and the need for better control of costs within the NHS. Base registries for the healthcare sector, such as the electronic confirmation service ATLAS, are supporting instruments for public administrations.

The EU, through the ISA² programme, encourages cross-border public administrations to develop integrated digital services for national administrations in support of the vision for the European single digital market. To work towards this direction a number of instruments need to be in place to support this work. Development, implementation and use of these instruments in the European public sectors can help administrations reach the next level of maturity in the digital services they provide. Some of these instruments are presented in the following paragraphs.

Health Interoperability Framework: The framework gives specific guidance on how to set up interoperable digital public services. A framework can integrate the fundamentals and set the standards of healthcare services. The new European Interoperability Framework (new EIF) in combination with the healthcare specific interoperability framework provide an appropriate guide for establishing a national interoperability framework for healthcare [7].

European eHealth Governance: The eHealth Network is the main decision body on eHealth at a European level. It gathers representatives of the Member States at a high level, on a voluntary basis, to define a common vision and strategy for eHealth across Europe [18]. The eHealth network was established by article 14 of Directive 2011/24/EU on patients' rights in cross-border healthcare. The eHealth Network identifies areas for cooperation and meets two times a year to agree on common priorities.

Health Quality Assessment: Certification of healthcare processes will allow continuous monitoring in healthcare organizations. As far as interoperability and conformance testing are concerned, it is very important that a compliance strategy is in place as well as a roadmap for the development and maintenance of national specifications and interoperability principles, standards-related rather than self-defined. The creation of a mechanism for compliance control and certification of relevant software is considered critical.

Service Catalogues: The general service catalogue for public administration services can also help the healthcare sector by considering all possible extensions.

Healthcare Process Modeling: It is important to incorporate process modeling in healthcare service delivery using international standards, such as the graphical representation for business process model and notation (BPMN), and templates of descriptions of high level use cases and realization scenarios [7]. Standardized process modeling will facilitate the unified description of digital services for easier consumption and sharing.

Healthcare Service Vocabulary: The process of providing cross-border healthcare services across EU Member States is complex, due to the heterogeneity of the actors, information and services of the different Member States. The complexity of exchanging data may lead to semantic interoperability conflicts. The core public service vocabularies can be extended and used, in healthcare as in all other areas, to reduce these semantic conflicts (<https://joinup.ec.europa.eu/solution/core-public-service-vocabulary>).

Healthcare Learning Programs: Education and training about interoperability, interoperability assessment, and sector specialized interoperability challenges for end users, policy makers and public employees, are essential. These learning

courses providing the basic and advance understanding of interoperability challenges, needs and issues in the public sector.

Conclusions

Assessment of interoperability maturity and specific measures for interoperability enhancement can contribute to cost reduction and greater integration through reuse of available services. Orchestration of services is an effective manner to maximize service outcomes and benefits for citizens and public administrations. IMM is a way to investigate deeply how a service performs and relates to other digital public services. It helps service owners to gain a better understanding of the interoperability maturity of a digital public service. An evaluation strategy needs to be closely linked with specific policies to support the continuation of the assessment, governance and implementation of digital public services nationally.

The maturity of healthcare digital public services show a higher maturity in service consumption and service management, as well as to the overall interoperability maturity, compared to other public services. This indicates that the healthcare sector has made improvements towards harmonizing with relevant EU directives for integrated public services. Future work will involve the application of IMM in a wider range of public services as well as the tracking of interoperability maturity of public services across time.

There is significant space for improvements towards the development and implementation of seamless interoperable services for citizens, administrations and businesses in the public sector across Europe. Further work is necessary to validate the results amongst a larger number of services. In addition, further research can be conducted to evaluate similar public services across countries in Europe.

Acknowledgements

This work has been funded, in part, from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688095 (SlideWiki (<https://slidewiki.eu/>), and by the Center for eHealth Applications and Services (<https://www.ics.forth.gr/ceha>) of the Institute of Computer Science, of FORTH. The authors would like to acknowledge Fokion Logothetidis, Ioannis Petrakis, and Nikolaos Stathiakis for their contribution in the definition and assessment of the hospital scenario presented.

References

- [1] Pagliari, C., Sloan, D., Gregor, P., Sullivan, F., Detmer, D., Kahan, J. P., Oortwijn, W., and MacGillivray, S. (2005). What is eHealth (4): a scoping exercise to map the field. *J Med Internet Res*, 7(1).
- [2] Cunningham, S. G., Wake, D. J., Waller, A., & Morris, A. D. (2014). Definitions of eHealth in *eHealth, Care and Quality of Life*, Springer, Milano, 15-30.
- [3] Stroetmann, K. A. (2014). Health System Efficiency and eHealth Interoperability—How Much Interoperability Do We Need? *New Perspectives in Information Systems and Technologies*, 2, 395-406.
- [4] Kouroubali, A., Starren, J., Barrows, R. C., & Clayton, P. D. (1997). Practical lessons in remote connectivity. Proceedings : a conference of the American Medical Informatics Association. *AMIA Fall Symposium*, 335–339.
- [5] Katehakis, D. G., Kondylakis, H., Koumakis, L., Kouroubali, A., & Marias, K. (2017). Integrated Care Solutions for the Citizen: Personal Health Record Functional Models to Support Interoperability. *EJBI*, 13(1), 41-56.
- [6] Hammond, W. E. (2017). A New World for Better Health. *EJBI*, 13(1), 3-8.
- [7] Katehakis, D. G., Kouroubali, A., & Fundulaki, I. (2018) Towards the Development of a National eHealth Interoperability Framework to Address Public Health Challenges in Greece. Semantic Web Technologies for Health Data Management, <http://ceur-ws.org/Vol-2164/paper6.pdf> [accessed on April 01, 2019].
- [8] Katehakis, D. G., Masi, M., Wisniewski, F., & Bittins, S. (2016). Towards a Cross-domain Infrastructure to Support Electronic Identification and Capability Lookup for Cross-border ePrescription/Patient Summary Services. *pHealth proceedings*. 152-157.
- [9] Leal, G. D. S. S., Guédria, W., & Panetto, H. (2019). Interoperability assessment: A systematic literature review. *Computers in Industry*, 106, 111-132.
- [10] Interoperability Maturity Model, <https://joinup.ec.europa.eu/document/interoperability-maturity-model> [accessed on April 01, 2019].
- [11] ISA2 Interoperability Maturity Assessment of a Public Service https://ec.europa.eu/isa2/solutions/imaps_en [accessed on April 01, 2019].
- [12] Carvalho, J. V., Rocha, Á., & Abreu, A. (2019). Maturity Assessment Methodology for HISMM-Hospital Information System Maturity Model. *Journal of medical systems*, 43(2), 35.
- [13] Interoperability Framework - Interoperability Maturity Model v1.0 in Australia <https://developer.digitalhealth.gov.au/specifications/ehealth-foundations/ep-1143-2006/nehta-0062-2007> [accessed on April 01, 2019].
- [14] Katehakis, D. G., Halkiotis, S., & Kouroubali, A. (2011). Materialization of Regional Health Information Networks in Greece: Electronic Health Record Barriers & Enablers. *J Healthc Eng*, 2(3), 389-403.
- [15] Hellenic National Insurance Registry, ATLAS, <https://www.atlas.gov.gr/ATLAS/Pages/Home.aspx> [accessed on April 01, 2019].
- [16] National Organization for Health Care Services Homepage, <http://www.eopyv.gov.gr> [accessed on April 01, 2019].
- [17] Katehakis, D. G. (2018). Electronic Medical Record Implementation Challenges for the National Health System in Greece. *IJRQEH*, 7(1), 16-30.
- [18] eHealth Network: https://ec.europa.eu/health/ehealth/policy/network_en [accessed on April 01, 2019].

Address for correspondence

Angelina Kouroubali, FORTH-ICS, N. Plastira 100, Vassilika Vouton, GR 700 13 Heraklion, Crete, Greece, kouroub@ics.forth.gr, +302810391680.