Quality of Life through Quality of Information
J. Mantas et al. (Eds.)
IOS Press, 2012

doi:10.3233/978-1-61499-101-4-333

eHealth interoperability evaluation using a maturity model

Wded GUÉDRIA [a,1], Hanan BOUZID [a], Guido BOSH [a],
Yannick NAUDET [a] and David CHEN [b]
[a] *Public Research Center Henri Tudor, 29 Av. JFK, 1855, Luxembourg-Kirchberg*
[b] *IMS-LAPS/GRAI, University Bordeaux 1. 351, cours de la libération, 33405, Talence Cedex, France*

Abstract. To further improve individual health and well-being, access to high quality and safe services, eHealth interoperability is a fundamental prerequisite. A mature interoperability between health systems will support health services organization and delivery, and improve citizens' awareness of how to prevent disease and preserve good health. Within this context, health institutions have to solve interoperability problems or prevent them to appear, and if possible avoid them before they occur by adapting good practices toward interoperability. This paper proposes an evaluation of the potential health interoperability using the MMEI methodology (Maturity Model for Enterprise Interoperability). It discusses how the MMEI model can be used to help institutions to avoid interoperability problems. A use case for a particular hospital is more closely examined.

Keywords. eHealth interoperability, maturity model, improvement, assessment methodology, radiology

Introduction

Interoperability is recognized as the ability of two or more systems or components to exchange information and to use the information that has been exchanged (IEEE) [1]. In order to support healthcare institutions to better interoperate with their partners (government agencies, patients, practitioners, etc), interoperability requires being assessed and continuously improved. One of the assessment methods consists in using maturity models. A maturity model is a framework that describes, for a specific area of interest, a number of levels of sophistication at which activities in this area can be carried out [3]. In this paper, we present the application of a maturity model to evaluate the interoperability within an eHealth project. The objective is to assess and improve interoperability between healthcare institutions and the future e-Santé platform, designed to be a bridge between all healthcare Luxembourgish institutions.
The paper is structured as follows. After a presentation of the research context in section 1, we discuss, in section 2, how the interoperability assessment using MMEI (Maturity Model for Enterprise Interoperability) is applied to identify sources of interoperability problems and propose solutions. A use case study is detailed in section 3. Conclusion and perspectives are then presented in section 4.

[1] Corresponding Author.

1. Research context

Developing interoperability often requires solving many issues in order to achieve objectives targeted by enterprises. Solving interoperability problems is a long iterative procedure which can fail due to the lack of a consensus between partners, or because of the high cost of the applicable solution. Predicting and solving those problems before they occur is simpler, and usually less costly than developing corrective actions. Therefore, an *a priori* assessment deserves particular attention, in order to properly plan future health interoperations. For that, healthcare institutions need to plan and to be prepared for potential interoperations.

Based on investigations in factors influencing health interoperability's maturity and knowing the main relevant standards in the hospital operational environment, the MMEI [3] will be used to assess and improve potential interoperability within a health project: eSanté-Cara. This is a national Luxemburgish project which has been created within a program called eSanté [4]. The eSanté-CARA project is designed to study and establish the functional and technical requirements for an IT system to share medical radiology data between the main actors of the Luxemburgish public health system. The main aim of the eSanté platform is to form a bridge to communicate between the health institutions in Luxembourg. Within this context, it is very important that the different institutions assess their ability to connect to this platform, to avoid major interoperability problems and to deal in advance with any gap and/or barrier that can be detected. This can be tackled by measuring the degree of interoperability and proposing corrective actions. This is the purpose of the so-called maturity models, describing the stages through which systems should evolve to reach higher completeness in the realization of a given objective. In the main maturity models that exist [5], we have chosen to use the MMEI model because it is designed within a potential assessment perspective and is based on other existing maturity models. The MMEI deals with the *a priori* measurement of interoperability [3]. It defines three aspects [6]: i) Conceptual (i.e. semantic) interoperability, concerned with ensuring that the precise meaning of exchanged information is understandable by any other system that was not initially meant for this purpose, ii) Technical interoperability, concerned with the technical issues of linking systems and services, iii) Organizational interoperability, concerned with the definition of responsibility and authority so that interoperability can take place under good conditions [7]. MMEI defines five maturity levels: 1) Unprepared, means no capability for interoperation; 2) Defined, where there is a capability of properly modeling and describing systems to prepare interoperability; 3) Aligned, means a capability of making necessary changes to align to common formats or standards; 4) Organized, where there is a capability of meta modeling to achieve the mappings needed to interoperate with multiple heterogeneous partners; and 5) Adaptive, means capability of negotiating and dynamically accommodating with any heterogeneous partner. MMEI is intended to be used by assessors. They need to collect information through interviews. From the interviews, a rating is assigned based on validated data; a synthesis and conclusion is done after by the assessor team (for more details, see [3, 8]).

2. Applying MMEI model within eSanté-Cara project

The eSanté-Cara project deals with the interoperations between healthcare institutions with the electronic radiological document exchange. Hence the focus is shifted towards electronic data exchange, which corresponds to data interoperability in MMEI model.

Within its framework, three kinds of problems need to be solved to ensure interoperability: technical, conceptual and organizational. The organizational aspects, including the management of responsibilities, authorities, etc. are dealt in another project within the eSanté program and therefore not tackled in this paper. Hence, the main objective here is to assess data interoperability with MMEI by identifying conceptual and technical issues to be solved by a healthcare institution in order to interoperate correctly with others via eSanté [4]. Within this context, we can define a simplified version of the MMEI for the eHealth interoperability domain (see table 1).
Table 1 depicts the practices and the systems states that need to be in place in order to reach a targeted maturity level of interoperability. For example, if the assessed institution has designed its data models and/or has the documentation and that simple electronic data exchange is possible; this means that the MMEI level 1 is reached. In order to enhance the interoperability, the quoted practices at the next level need to be considered. For our example, those related to the level 2 are: "use of standards for data models", "put in place rules and methods for data interoperability" and "identify rules and methods that can be modified and those which cannot". A maturity level can't be reached if the previous one is not. Level 4 is the highest level that can be reached.

Table 1. Simplified version of MMEI applied to the eHealth domain

	Conceptual	Technical
Level 0	Data models not explicitly modeled or documented	No or closed data storage devices, manual exchange
Level 1	Data models are modeled or documented	Data storage devices connectable, simple electronic exchange possible
Level 2	Use of standards and De Facto standards for alignment with other data models	Rules and methods for data interoperability in place and could be adjusted.
Level 3	Meta-modeling for multiple model mappings	Remote access to databases possible for applications, shared data
Level 4	Adaptive data models (both syntax and semantics)	Direct database exchanges capability and full data conversion tool

3. Use case application

In order to better understand the applicability of the MMEI methodology within the eSanté-Cara project, we present in this section a use case of one of the five Luxemburgish hospitals involved in the eSanté program.

A normal operational process starts when a patient asks for an appointment to do a radiological exam. His request is encoded in the Electronic Patient Record system, which includes the Hospital Information System (HIS) with an integrated Radiology Information System (RIS). The RIS manages the data generated by the exam, the radiology reports, etc. If a data modification is needed in the report fields, the request is directly sent to IT department which solves the problem in a short delay. Then the

exam images are produced, sent and stored in the Picture Archiving and Communication System (PACS) in the DICOM standard (Digital Imaging and Communication in Medicine) [10]. The RIS is connected to the PACS. It manages the storage and retrieval of digital images provided by the modalities (e.g. CT, MR) ; and the image data. In an emergency case, the remote access to the report and images recorded in the hospital's RIS/PACS is possible via a WebViewer, which communicates with the HIS system. The HIS, RIS/PACS interoperate via the HL7 standard [11]. Based on the collected information, we present in table 2 the evaluation sheet of the potential data interoperability of the hospital towards eSanté within eSanté-Cara project. We won't detail, here, the used metrics but we should say that behind this evaluation we use linguistic variables [8] then we aggregat the affected ratings using the OWA operator [12] (see [3] for more details). NA, PA, LA and FA stands respectively for "Not, Partially, Largely and Fully Achieved".

Table 2. Evaluation sheet of a Luxemburgish hospital using MMEI

Activities to evaluate	Findings	Team Rating NA PA LA FA
Data models are modeled or documented	Use of HIS data models for the demographic data and RIS/PACS for radiological data.	☐ ☐ ☐ ☒
Data storage devices connectable, simple electronic exchange possible	Access to medical data is possible via a WebViewer.	☐ ☐ ☐ ☒
Use of standards for alignment with other data models	Use of HL7 v2. A variation of CCAM [9] codes is used.	☐ ☐ ☐ ☒
Rules and methods for data interoperability in place and can be adjusted	Data are produced jointly by the hospital and the Health Ministry.	☐ ☐ ☒ ☐
Meta-modelling for multiple model mappings	----.----	☒ ☐ ☐ ☐
Remote access to databases possible for applications, shared data	No, only for the radiologists via a WebViewer, the security is ensured via https protocol.	☐ ☒ ☐ ☐
Adaptive data models (both syntax and semantics)	In case of modification, the problem is solved by the IT department or the IT vendor	☐ ☒ ☐ ☐
Direct database exchanges capability and full data conversion tool	----------	☒ ☐ ☐ ☐

The level reached is 2. It means the studied hospital is open to interoperability and can adjust its data and technical assets to solve interoperability problems. Based on the levels' specifications, two guidelines are given in order to make the enterprise aware of next steps to be undertaken for interoperability improvement: a) design meta-models to facilitate multiple model mappings and b) secure data sharing and ensure remote access to databases and applications.

4. Discussion

The MMEI bring out the problems of interoperability and to focus on the solution to resolve them before they occur. This model is also a way to define what improvement means for the organization. In our case study, the maturity level 2 means that the hospital is prepared for making changes to align common formats or standards. We can observe, in terms of interoperability and following the eSanté requirements, that this

hospital can still improve their systems to better interoperate and avoid possible problems in the future. This target is reachable by following guidelines in higher levels. These are merely suggestions for "what a hospital should do to optimize its systems", but not how to implement it. An enterprise has then to associate the necessary means to reach its objective, e.g. migrate to the next maturity level. Although, it is a missing in maturity models, adopting this approach consists in providing a sufficiently concrete support for the evaluator (i.e. generic questionnaires, assessment organization) and provides a methodology to determine the maturity level. This support is a valuable basis to: a) select processes and systems to be evaluated; b) assess the results in a comprehensive and objective manner; and c) propose guidelines for improvement.

5. Conclusion and Perspectives

In this paper we have presented the use of the MMEI methodology within a healthcare domain. We have given a brief description of this model and the context of its application: the eSanté-Cara project. MMEI can be very helpful for identifying *a priori* interoperability problems and setting up guidelines to solve them before they occur. A fully automatization of this maturity model will form a good basis for the decision support for heatlthcare institution interoperability. This requires a formal modeling of the healthcare interoperability, domain as well as related problems and solutions. The use of ontologies gives us a possible approach that we have started to explore, as shown in [2], and will carry on by integrating exploiting MMEI in a reasoning system.

References

[1] IEEE (Institute of Electrical and Electronics Engineers).: Standard computer dictionary a compilation of IEEE standard computer glossaries;1990.

[2] Naudet Y, Latour L, Guédria W, Chen D. Towards a systemic formalization of interoperability. Computers in Industry, Special issue on Integration and Information in Networked Enterprises, Vol. 61, Issue 2, pp. 176-185; 2010.

[3] Guédria, W., Naudet, Y., Chen, D.: A Maturity Model assessing Interoperability Potential. In: 12th International series of working conferences on Business Process Modeling, Development and Support (BPMDS) in conjunction with CAiSE. LNBIP 81, pp.276-283, London (2011)

[4] http://www.santec.lu/project/esante/start

[5] Guedria W, Yannick Naudet, Chen D. Interoperability maturity models – Survey and Comparison. Proc. of the 3rd IFAC/IFIP, OTM workshop, EI2N'08 (Enterprise Integration, Interoperability and Networking), Monterrey, Mexico; 2008.

[6] ISO 14258, Industrial Automation Systems. Concepts and Rules for Enterprise Models, ISO TC184/SC5/WG1, (1999)

[7] CEN/ISO 11354-1, Part 1.: Framework for enterprise interoperability, Draft International Standard ISO/DIS 11354-1. (2009)

[8] Wided Guédria, Yannick Naudet, and David Chen: Enterprise Interoperability Maturity: A Model using Fuzzy Metrics. In CAiSE 2011 workshops, LNBIP 83, pp. 69-80, London 2011

[9] www.ccam.sante.fr

[10] Pianykh O.Digital Imaging and Communications in Medicine (DICOM): A Practical Introduction and Survival Guide. Springer-Verlag Berlin and Heidelberg GmbH & Co. K;2008.

[11] www.hl7.org

[12] Yager R.R. Aggregation operators and fuzzy systems modeling. In Fuzzy sets and systems, 67. 129-145; 1994.