The Base Frame of the Algerian E-Health System: Methodology to Select the IHE Integration Profiles and the Standards to Control Interoperability

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Abstract. The use of standards and Integrating the Healthcare Enterprise (IHE) is a crucial technique for supporting, monitoring and controlling the integration profiles in healthcare organization systems. The risk of "no-interoperability" increases when several standards are used. Lack of experience in developing countries, particularly in Algeria, increases this risk. This article aims to suggest and present a methodology for selecting standards and IHE integration profiles in field of E-health in order to build a base-frame of the Algerian E-Health system. In fact, this base-frame must comply with international standards and perfectly adapted to medical processes, thru respecting IHE integration profiles.

Keywords. standards, IHE integration profiles, interoperability, Algerian E-Health system

1. Introduction

HIMSS[2] defines interoperability as "the ability of health information systems to work together, through the exchange of data, within and across organizational boundaries to improve health status and effective care for individuals and communities" [1]. Also means, "The ability of different information technology systems and software applications to communicate, exchange data and use the information exchanged" [2].

Data exchange systems and standards should allow data sharing between clinicians, laboratories, hospitals, pharmacies and patients, regardless of the application or application provider [3]. In order to achieve a high level of interoperability, in the context of well-identified business processes, IHE creates Integration Profiles [4] from relevant standards while limiting their use for referenced use cases. In addition , World Health Organization (WHO) organized two forums on the standardization and interoperability of eHealth in order to promote the interoperability of health information systems by adopting standards appropriate at national level [5] [6].

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[2] HIMSS: Healthcare Information and Management Systems Society.

As part of a central reference role in the world health organization, Algerian health organizations must evolve towards the standardization of their data and processes, hence the need to set up their own systems according to the international standards and IHE integration profiles. As a part of a CDTA[3] socio-economic project dealing with the "Base Frame of the Algerian E-Health System", a solution is currently being examine as a basic platform for integrating medical operations based on the automation part of the Health Users Medical File. Therefore, it is necessary to respect the international standards to improve this integration platform. It should be built on a standardized structure based decoupled modular architecture with perfectly suited for medical operations while respecting IHE integration profiles.

Hence, this article aims to suggest a methodology for selecting IHE profiles and standards that control and establish interoperability on this platform.

2. Methods

The methodology proposed in this work includes two phases; study and the process of developing IHE profiles as well as the standards appropriate to the integration platform. In the study, the classification of interoperability standards in e-Health has been identified, IHE integration profiles and the different methods of selecting E-Health Standards while respecting IHE integration profiles.

After the study phase, three steps were proposed in the process of developing IHE profiles as well as the appropriate standards for the integration platform. The first step consists of specifying the requirements that allow defining the base frame perimeter of the Algerian E-Health System and the required IHE profiles; an interoperability scheme to illustrate this perimeter was defined. The second step consists of the technical specification, which allows defining the use cases corresponding to this system whereby similarly can define the corresponding profiles and standards. Finally, the last step gives a roadmap for implementing the profiles and standards defined, these implementation details are the subject of another work.

3. Results

3.1. Study

Current bibliographic search is based on journals and conference posts primarily from Google Scholar Examination.

The study begins by defining the classification of the interoperability standards in e-Health and the IHE integration profiles. After that, study the different methods proposed in the literature-based E-Health Standards selection.

3.1.1. Classification of the Interoperability Standards in e-Health

Several studies have focused on interoperability standards in E-health [7, 8, 9, and 10]. The International Organization for Standardization (ISO) [7] gave the main classification,

[3] Centre de Développement des Technologies Avancées (www.cdta.dz).

which classified the interoperability standards, according to three aspects of interoperability aspects: semantic, technical and functional, as shown in Table 1:

Table 1. Classification of the Interoperability standards in e-Health.

Interoperability Categories	Standards Categories	Examples
Semantic Interoperability (Content)	Data Standards	Vocabularies and terminologies (e.g. ICD[4], SNOMED[5], LOINC[6])
	Information Content Standards	Reference information models (RIMs), templates, and IT standards.
Technical Interoperability (Infrastructure)	Information Exchange Standards	Message-based, structured document-based, e-mail-based standards, IT standards.
	Identifiers Standards	National provider Identifier (NPI).
	Privacy and Security Standards	Access control, consent directives.
Functional Interoperability	Functional standards	Interoperability use cases, him practice standards
	Business standards	Business rules, guidelines, practice checklists
	Health information technology	Safety standards

The fact that there are many interoperability standards for exchanging data between healthcare applications is challenge to implement the project. Choosing the right standard is a complicated task. In order to achieve a high level of interoperability in the context of well-identified business processes, IHE creates integration profiles from relevant standards while limiting their use for the referenced use cases.

3.1.2. IHE Integration Profiles

IHE Profiles describe specific solutions to interoperability problems. Profiles specify how "Actors" use standards to address a specific healthcare use case. Each domain defines and publishes profiles to address interoperability issues related to its clinical and operational scope [4]. The IHE has classified these profiles into these categories: Cardiology, Dental, Endoscopy, Eye Care, IT Infrastructure, Pathology and Laboratory Medicine, Patient Care Coordination, Patient Care Device, Pharmacy, Quality, Research and Public Health, Radiation Oncology, Radiology. Before providing the development process of the IHE integration profiles, which will allow the selection of the suitable standards of the integration platform, the following section presents a summary of the existing methods adopted for e-health standards selection.

3.1.3. Methods to Select E-Health Standards

Given standards diversity, the choice to use a standard is a difficult task especially in a critical domain such as the E-health domain. Hence, several methods have been proposed to select the E-Health Standards. Intensive work has been achieved by developed countries (e.g. European Commission [11], Canada [12]), unlike developing countries, where we have found two remarkable works that have been proposed by two countries: Kenya [13], South Africa [14]. Briefly presentation of them given in the next sections:

3.1.3.1. Approach Recommended by the European Commission

This approach recommended through the project présented in [11], consists of seven phases:

[4] https://www.icd10data.com/ICD10CM/Codes
[5] http://www.snomed.org/
[6] https://loinc.org/

- Identify use cases from an end-user perspective, including the glossary, scenario, actors, and privacy requirements.
- Select profiles and standards that support the use case.
- Refine data content, including document templates, metadata, and terminology.
- Write interoperability specifications that describe the standards and profiles selected.
- Organize testing by preparing test cases and adopting a test environment for implementers to demonstrate component interoperability.
- Educate end-users on interoperability.
- Participate in communities of practice to promote sustainable standards-based implementation and offer feedback to standards and profiling organizations.

3.1.3.2. Approach Recommended by Pan-Canadian

Pan-Canadian promotes population-based development and planning policies. Therefore, the pan-Canadian standards product life cycle consists of four phases [12]:

- Needs identification: defines the specific business, clinical and technical requirements.
- Options research and analysis: gives candidate specifications, reviews these specifications and analyses gaps, risk and cost to determine the feasibility of the standards.
- Specification development: based on previous results, completed supporting material for the specification or new standards could be created.
- Maintenance: Specification is maintained through a structured maintenance and deployment model.

3.1.3.3. Kenya's Approach to Select E-Health Standards

The Kenyan Ministry of Health specifies six main functional areas that should be supported by any EMR system implemented in this country.

Any choice of a standard should be based on these six functional requirements [13]: Basic demographic and clinical health information, Clinical decision support, Order entry and prescribing, Health information and reporting, Security and confidentiality, Exchange of electronic information.

3.1.3.4. Selection Method for e-Health Interoperability (SMeHI) Recommend in South of Africa

The objective of this method is to guide the selection of e-health standards, particularly for developing countries, to support the interoperability of e-health systems.

The process outcome is a combined list of functions mapped to profiles and underlying base standards. SMeHI Method [14] consists of the following five phases:

- Determine interoperability objectives and priorities
- Develop business use case specifications
- Extract the key business functions from business use case specifications
- Identify the applicable implementation guidelines that support
- Extract the underlying standards from the implementation guidelines.

It was noted that the methods proposed by developed countries are useful when users have the technical expertise and test environment to assess the criteria considered. This type of experience and environment is not available in Algeria. On the other hand, the majority of methods proposed by developing countries are weak and do not provide

concrete examples to justify their choice. For these reasons, we suggest our development process for IHE profiles and appropriate standards for this integration platform. This process corresponds to the information acquired and the requirements of the platform described in the description of the socio-economic project [15].

3.2. Development Process of the IHE Profiles and the Appropriate Standards

To simplify the implementation of the IHE profiles development process, we propose three stages similar to that proposed for the simple software development process, as shown in Figure 1 and show described in below:

Figure 1. Development process phases of the IHE profiles and the appropriate standards.

3.2.1. Overview of the Interoperability Schema and the Requirements Specification

As illustrated in Figure 2, defined the perimeter according to the requirements of the platform described in the description of the socio-economic project, as follows:

- The system consists of three-sub systems: Patient Administrative Management System, Medical Laboratory Management System and the Radiology Information Management System. It must implement the IHE Profiles below:
    1. PAM[7]: coordinates the exchange of information relating to the patient.
    2. SWF [8] : supports the prescription and completion of radiology examinations and the provision of the resulting images and reports.
    3. XDS.b [9]: facilitates the registration, distribution and access across health facilities of patient electronic health records.
    4. PIX[10]: allows providing the identities of the local domain, obtaining the patient identifier in another domain and managing reconciliations of inter-domain patient identities.
    5. XD-LAB[11]: allows sharing biologic report in the form of a structured electronic document.

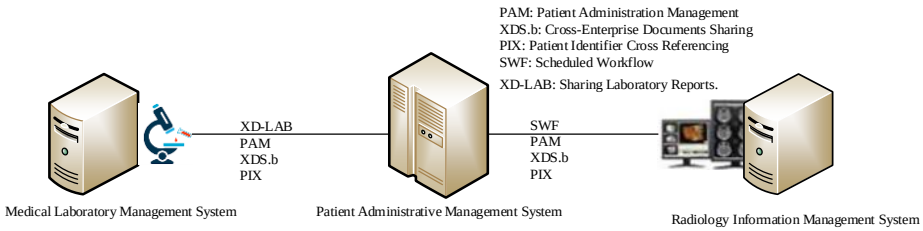

Figure 2. Perimeter of the base frame of the Algerian e-Health system and the associated IHE profiles.

[7] https://wiki.ihe.net/index.php/Patient_Administration_Management
[8] https://wiki.ihe.net/index.php/Scheduled_Workflow
[9] https://wiki.ihe.net/index.php/Cross-Enterprise_Document_Sharing
[10] https://wiki.ihe.net/index.php/Patient_Identifier_Cross-Referencing
[11] https://wiki.ihe.net/index.php/Sharing_Laboratory_Reports

3.2.2. Technique Specifications

According to the interoperability schema and the requirements specification, presented above, we can extract the use cases of our system and thereafter deduce the profiles and standards corresponding with each use case as shown in Table 2.

Table 2. Use cases, profiles and standards corresponding.

Use Cases	Profiles Corresponding	Standards Corresponding
Patient Administrative Management	Patient Administration Management (PAM)	- HL7 v 2[12]/ Fhir[13]
Document Sharing	Cross-Enterprise Documents Sharing (XDS.b)	- Formatted text (e.g., HL7 CDA release 1), Images (e.g., DICOM [14]). Structured and vocabulary coded clinical information (e.g., CDA release 2, DICOM sr). - ebMS OASIS/ebXML Messaging services specifications v3.0. - ebRIM OASIS/ebXML Registry Information Model v3.0. - ebRS OASIS/ebXML Registry Services Specifications v3.0. - HTTP HyperText Transfer Protocol (IETF RFC2616). - ISO/IEC 9075 Database Language SQL.
Identifiers management	Patient Identifier Cross Referencing (PIX)	- HL7 v2/ Fhir
Radiology management.	Scheduled Workflow (SWF)	- HL7 messaging - DICOM Storage Commitment Service
Laboratory management.	Sharing Laboratory Reports (XD-LAB)	- HL7 CDA Release 2 - LOINC (Logical Observation Identifiers Names and Codes) - The Unified Code for Units of Measure (UCUM), RFC 2397.

These standards must be applied in compliance with Algerian law, for example, the national nomenclature of pharmaceutical products for the use of human medicine [16] has been defined by the Ministry of Health. We find drugs that are banned in Algeria for different reasons: commercial, political, etc. For example RISPERDAL CONSTA LP 50MG / 2ML, the withdrawal of this drug by the holder due to a variation in the country of origin introducing a device of Israeli origin. DOXORUBICIN HCL, withdrawal by the holder for commercial reasons. The details of these constraints are the subject of another work.

3.2.3. Implementation of the IHE Profiles

According to the technical specifications, presented below, as well as the technical framework called "Technical Framework" [17] prepared by IHE, developers can implement the profiles defined above. Therefore, we have three choices:

- The use of libraries: Java, .Net, HTTP, allows the implementation from scratch, which will complicate our task.
- The IHE profiles are implemented in various open source tools such as: OHF[15], Mediboard [16], etc. We have tried to reuse Mediboard, but the lack of documentation as well as some source files led us to abandon this idea.

[12] http://www.hl7.eu/refactored/hl7.html
[13] https://www.hl7.org/fhir/overview.html
[14] https://www.dicomstandard.org/
[15] http://oht.squarespace.com/
[16] https://mediboard.org/

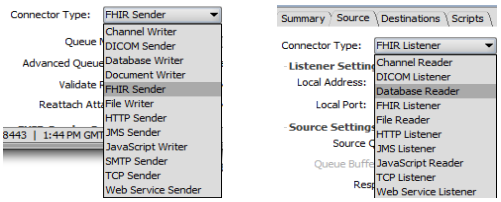

Figure 3. Connectors added to Mirth Connect.

- This led us to the use of the Mirth Connect tool, which is an open-source tool, allows the creation of channels that facilitates the implementation of the transactions of IHE profiles. This tool natively integrates most health connectors, which allow creating these Channels. To use this tool, we must:
  1. Download, install and configure Mirth connect according to its tutorial [18].
  2. Create a database named Mirthdb on a database server (e.g., Microsoft SQL Server) to record all the information and data produced after the creation of the different channels.
  3. Add connectors (e.g., Hl7 v2, Dicom, Fhir) that correspond to the standards to be used for the integration of subsystems, as shown in Figure 3.
  4. Create all the channels necessary for the integration of the different subsystems by exploiting the added connectors. Figure 4 shows an example of two connectors (send_idt, idt1) created under Mirth connect, the implementation details of our system is the subject of another work.

4. Discussion and Conclusion

In this article, a methodology based on two phases was proposed based on the selection of IHE integration profiles and standards to control and establish interoperability on this integration platform. The first one which is the study phase, allows us to identify the different aspects related to the selection methods based on integration profiles and the corresponding standards. It was noted that the methods proposed by developed countries are useful when users have the technical expertise and test environment to assess the criteria considered. This type of experience and environment is not available in Algeria. On the other hand, the majority of methods proposed by developing countries are weak and do not give concrete and good examples to justify their choice. Therefore, to simplify the implementation of the IHE profile development process and the choice of standards, the authors proposed the second phase of the methodology, which simplifies the implementation of the IHE profile. The standards chosen must comply with Algerian law, as for example, the drugs banned in Algeria. More details on this can be subjected to another research work. Despite the efforts towards the use of standards in the information systems of the Algerian health facilities, the following challenges are identified as:

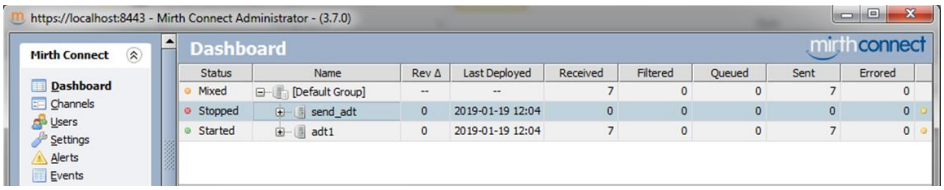

Figure 4. Channels that we created under Mirth Connect.

Lack of formalization of the various business processes at the level of health facilities. Insufficient human resources especially the well-formed ones and the instability of existing skills. No standards extension to support Algerian law (e.g. civil status (polygamy), artificial insemination, organ transplants). To overcoming these challenges, we recommend: Formalize the business processes of healthcare facilities. Lay down a national strategy, which will allow the construction of well-trained personnel in the e-health domain, particularly in interoperability standards. Establish standard extensions, which respect Algerian law, by collaborating with international committees such as that of HL7 standards.

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