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Interoperability at healthcare institutions in Brazil: framework for identify maturity stages

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Abstract

There is a growing support from data management and analysis in the clinical and operational support at health services, impacting positively the patient outcome. Studies report that data management provides gains in productivity and raises the value of health services [1]. In this context, the interoperability of information systems (IS) at the environment of health services assumes an important role in spreading information and supporting different activities and procedures. The Brazilian government, through its Unified Health System (Sistema Único de Saúde – SUS), aimed to support and organize the growing use of data technology in the healthcare sector, formalizing protocols and concepts of interoperability used in both public and private health systems. Through applying this MF, it is expected to identify the state of interoperability at Brazilian healthcare institutions, defining a comparative scenario that allows the alignment of efforts in its strategic development in healthcare services, benefiting users and healthcare network.

Keywords: Interoperability; Framework; Healthcare

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1. Introduction

The complex hospital environment encompasses many processes, procedures, protocols, and other normative activities that are necessary for its operation. At such environment, there are professionals from diverse backgrounds working in different areas. Their common objective is to provide the best outcome to the patient, collaborating to the systemic support of the hospital management, which is determinant at this kind of environment held by a large spectrum of operational, clinical, and administrative processes that permeate the day-to-day operations [2]. The growing support of data management and analysis in healthcare services is positive, as far as it improves the service quality and the outcome of the patient, contributing to increase the operation efficiency and to reduce costs [1].

Health institutions, primarily hospitals, are living and self-governed organizations, even when operating within one common functioning complex [3]. They invest up to 5% of their budget [4] in information systems (IS) customized to their management model, according to the specialty they provide, generating its own IS protocols and structures, creating silos of data-generating services, and not exploiting the full analytical potential that an open data view would provide [5].

Interoperability plays an important role in enabling communication between IS transparently, uniformly, and efficiently across various organizations, allowing the exchange, addition, and/or editing of data [6] [7].

In 2010, the Brazilian government, through IS area, Data-SUS, presented protocols defined by the SOA-SUS interoperability project, which defined minimum standards assumptions, policies, and technical specifications, which must be followed by public health systems [8].

Although Data-SUS is proactive in coordinating interoperability in the Brazilian healthcare sector, the private institutions follow their individual schedules. No formal coordination between agents was identified amongst health providers or payers during surveys. The Brazilian National Association of Private Hospitals (Associação Nacional de Hospitais Privados – ANHAP), an association that covers most of the private reference hospitals in Brazil, does not have a clear view of the current stage of how its associates are adopting interoperability, which results in uncertainty about how to operationalize data available to patients and physicians [9].

The main goal of this work is to identify, through an MF that will be developed during this work, the maturity of the interoperability procedures applied at selected health institutions, taking as reference the concepts and protocols from Data-SUS.

2. Methods/design

The MF will be used as tool to evaluate the maturity stage of the pre-selected healthcare institutions, based on an exploratory research methodology. The content analyzed will be used to establish stages of maturity and, later, to structure the survey to be conducted. Subsequently, a double validation will be conducted using Delphi methodology in two stages.

The work will be carried out in four stages:

- Elaborating the maturity framework (MF)
- Developing and executing the research at selected institutions
- Compiling and stratificating results
- Validating the maturity framework (MF) using two-stages Delphi methodology

2.1. Elaborating the maturity framework (MF)

MFs help organizations to identify operational strengths and weaknesses and to define evolutionary stages of development, through standards and capacities, supporting the management in the continuous development and improvement of the organization [10] [11].

- The MF will be designed in an exploratory way, based upon a systematic literary review about interoperability, which aims to allow the exploration of the main concepts around the theme [12].

- It will be used as strategy to construct the MF the extraction of selected data from surveys and studies relevant to interoperability applied to the healthcare sector, technology applied to the segment, applicability, and possible restrictions, according to Table 1.
- The MF will be calibrated with Data-SUS protocols and concepts [8].

Table 1. Data extraction strategy.

Scope	Data to be extracted
Source	Author(s), title, citation, publication type, country of origin, aims/objectives, area of research, healthcare segment, public/private and social legacy
Layer 1	Concepts of interoperability in healthcare
Layer 2	Technology, structure, and protocols
Layer 3	Applicability, desire outcomes and limitations

2.2. Procedures and criteria

The MF structure elaboration process uses as reference the maturity model criteria of the Interoperability Maturity Model (IMM) [13], adjusted to the concepts of interoperability in healthcare, as highlighted in table 1.

Also, the IMM structure and criteria referenced, will be adapted to the context of the Brazilian healthcare segment and SUS policies for interoperability, according to technical and academic needs evidenced in the specific literature that are the basis for the construction of the MF.

The IMM evaluation criteria categorization used:

- Organizational: This criterion address policies and guidelines of the business involved.
- Informational: The criterion address aspects of interoperability linked to semantics exchanged between people, healthcare IS and devices, including possible constraints.
- Technical: The criterion related to protocols, syntax and information format within a message exchange.
- Security and Safety: The criterion address security policies, performance, and usability that will support the data exchange, reducing exposure.
- Operations and Performance: This criterion address quality, synchronicity and reliability requirements.

The level of maturity applied in the MF:

- Initial: There is no specific approach to interoperability issues, they are addressed as they arise and achieving the objectives will require more time and customization.
- Managed: In this level, a situation can be managed by using project-specific processes and not having an ecosystem aligned on standards and integration processes.
- Defined: The "defined" level has standards and specifications in place, some level of compliance, supporting a coordinated effort and processes among ecosystem members. The efforts to improve the interoperability are more predictable and measurable.
- Planned: At this level, the ecosystem seeks to improve to a higher level of interoperability maturity through processes, requirements and/or technology, using appropriate tools, sharing best practices, within standards, all in an integrated manner.
  Optimized: Ecosystem members are actively working to improve the quality of interoperability, an ongoing process, they are addressing all needs to achieve the goals, certifications and standards planned for the interoperability ecosystem, resulting in better quality, more reliability, at a lower cost of integration.

Table 2. MF structure based on IMM.

Categories	Configuration & Evolution	Security and Safety	Operation and Performance	Organizational	Informational	Technical
Maturity level	Description of the criterion......					
Level 5 Optimized	Description that describes Level 5 maturity for this criterion					
Level 4 Planned	Description that describes Level 4 maturity for this criterion					
Level 3 Defined	Description that describes Level 3 maturity for this criterion					
Level 2 Managed	Description that describes Level 2 maturity for this criterion					
Level 1 Initial	Description that describes Level 1 maturity for this criterion					

2.3. Developing and executing the research at selected institutions

The survey will be conducted using descriptive research methodology, which is considered proper to work with the specific data to be collected. Through such method, is aimed to draw the distribution of phenomena in subgroups of a population [12].

- Eight Brazilian health institutions referenced as highlights in health management and technology adoption will be selected.
- The unit of analysis will be a group, in this case, institutions of healthcare providing and healthcare payers in the state of São Paulo.
- The survey will be designed and conducted at the selected institutions based upon the MF and with the help of electronic support, by using structured research aimed applications such as Survey Monkey, Google Forms and Mindminers. The questioning strategy and characterization will be defined after the MF design is completed.

2.4. Compilating and stratificating results

Data will be compiled according to the maturity structure by health institution consolidated in the MF.

- Compilating results according to MF.
- Presenting cartographically the state of each institution analyzed.
- Validating the MF using Delphi methodology in two steps. Such method is widely used in projects as it allows to gather a varied set of opinions on complex themes from experts separated geographically [14].

2.5. Validating the maturity framework (MF) using two-stages Delphi methodology

The method is widely used in projects, as it allows gathering a varied set of opinions on complex topics, carried out by geographically separated specialists.

- First stage: expert validation.

- Second stage: test to be held in real environment at institution to be defined during research.

3. Discussion

Under an IS development outlook, the adoption of an MF helps institutions to identify the operation's strengths and weaknesses and to define evolutionary stages of development through standards and capabilities, supporting the institution management [15].

When at a mature stage, a systems structure impact positively the control, planning and systemic formalization at healthcare organizations [10].

However, at complex institutions such as the healthcare ones, it is hard to structure an MF. In fact, there is a small number of examples within this field. Most of them are based on comprehensive models such as continuity of care maturity model (CMM) and capability maturity model integration (CMMI), ranging from three to nine stages, with superficial stage details in some cases, emphasizing MF of architectural design and healthcare learning [16].

In 2011, SUS provided a reference for interoperability standards and protocols for IS development in Brazil, aiming to coordinate the information generated by more than 6.000 healthcare providers [17] and to improve the network of service providers. In the other hand, private institutions invest in their own IS vision and concepts, which minimizes their contribution to the Brazilian health system [18].

The proposed MF will enable to increase the exchange of information and the convergence of goals and performance metrics, enhancing protocols and reducing costs. It is based on examples such as the NHS infrastructure maturity model (NIMM), from the United Kingdom, that supports the National Health Service (NHS) to coordinate the nation's technology infrastructure projects [16].

4. Final considerations

The proposed MF aims to foster the coordinated structuring of interoperable networks amongst the agents that make up the Brazilian healthcare network, which today counts more than six thousand health institutions between public and private. The MF will also provide a map of the current situation of interoperability at the healthcare sector in São Paulo, Brazil's main center at healthcare services. Secondarily, it aims to make possible to evaluate the understanding that these institutions have regarding interoperability concepts and protocols, in addition to gaps (if identified), compared to those promoted by SUS.

SUS, in addition to promote equal access to the public health system to all Brazilian citizens, coordinates the public and private healthcare networks for a large population (more than 200 million people), of which estimated 51 million are costumers of the private system.

The MF will offer open strategical support on interoperability to healthcare institutions and will help them to define objectives, to prioritize and to design their own technological map. It will facilitate the structuring of business plans and projects and its alignment with SUS guidelines.

To foster the coordination between public and private healthcare networks, it is important for the users to be able to navigate between both without impact on quality and cost. There are impacts also for the healthcare services providers and payers, who can improve their coverage and reduce waste at a national level.

This work has a few notable limitations that should be acknowledged. Firstly, the technological advancements of health institutions need to be considered. The findings and recommendations provided in this study may depend on the level of technological infrastructure available in different healthcare settings. Secondly, the generalizability of the study methods and outcomes may be limited when applied to institutions outside of Brazil.

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