

Enterprise Architecture based Assessment of Healthcare Information System Strategic Alignment

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Abstract: Traditionally, most Information Technology (IT) implementations in healthcare are concerned primarily with improving the efficiency of operational tasks, without considering the effectiveness of the strategic management decision processes. This paper objective aims at filling this lack by presenting a new approach for Assessment of Healthcare Information Systems (HIS) Strategic Alignment. The underlined concepts are based on Enterprise Architecture (EA) related concepts, providing a clear and comprehensive view of the structure and operations of the healthcare system. This paper focus on how to carry out an internal EA analysis that aims at measuring HIS alignment via a set of metrics determining if the business processes, sub-processes, applications and databases are actually achieving their purpose. This will enable all parties involved in the HIS management process to stay abreast of what has been really attained, which goals are being met, and what needs to be changed.

1 INTRODUCTION

In today's highly automated business world, decisions made about the IT infrastructure influence the organization management, as well as its competitive position, and often dictate its ability to respond to beneficiaries' requirements. Failures, sub-optimum performance, misaligned solutions at the operational level, or even a poorly designed application can have immediate effects on the business level. Thus, it is not a surprise that aligning IT strategy with Healthcare organization objectives is one of the hot topics of both researchers and executives.

Indeed, over the last decade, the need to develop and organize new ways of providing efficient healthcare services has been accompanied by major advances in information technology, and particularly by the ability to record easily and inexpensively information about every health transaction and to access this information instantly no matter where it is stored. Nevertheless, traditionally most IT implementations in healthcare have not been considered on a strategic level. Nonstrategic IT systems are focused on information processing tasks such as patient data management systems, and customer relationship management systems.

The effectiveness of the strategic management decision processes requires an IT usage in a strategic and innovative manner to support the delivery of healthcare services. This objective represents a great challenge for all parties involved in the process: healthcare managers, care providers, as well as systems developers, and a complete alignment between Healthcare System and IT levels is hugely required. This paper discusses how Enterprise Architecture (EA) paradigms can provide an important measurement tool for evaluating HIS Strategic Alignment (SA) by checking if its layers' components (processes, applications, and IT infrastructure) truly collaborate to provide better solutions to meet the Healthcare system strategic needs.

The remainder of this paper is organized into five sections. Section 2 provides a literature review of related works to HIS Strategic Alignment. Section 3 describes the use of EA as a model to structure a HIS, where section 4 depicts how to use this structure to assess HIS Alignment. The proposed approach is illustrated by a study case evaluating strategic alignment of the IT system underlying to an automated process. This section also presents the platform developed in order to support the proposed approach. Finally, in section 5, we conclude and give

an idea about our future work.

2 RELATED WORKS

IT alignment can be defined as applying IT in an appropriate and timely way, in harmony with business strategies, goals and needs (Papp, 1998). The definition addresses both how IT is aligned with the business, and how the business should/could be aligned with IT. (Keen, 1996) suggests that IT architecture, integration, infrastructure, and standards should be defined from the organization's goals and that IT infrastructure should be an early consideration when defining business goals. Therefore, the degree of alignment among IT and business is facilitated by a complex interaction of management practices and strategic IT choices which an organization makes.

(Luftman, 2000) proposes the Strategic Alignment Maturity exhibiting these concepts and involving five conceptual levels of strategic alignment maturity (Initial/Ad Hoc Process, Committed Process, Established Focused Process, Improved/Managed Process, and Optimized Process). Each of the five levels of alignment maturity focuses on a set of six criteria (Sledgianowski et al., 2004): Communication, Competency/Value Measurement, Governance, Partnership, Scope and Architecture, and Skills. These approaches are management oriented, as they investigate management practices and strategic IT choices that facilitate IT-business alignment, and develop an instrument to measure the degree to which those practices are in place in an organisation.

Concerning HIS strategic alignment related works, (Sims, 1999) is one of the earliest approaches studying clinical information systems alignment with the overall business strategy of the healthcare organization, and proposing that these systems assessments to be based upon their ability to accomplish business objectives and solve problems for the patient care team.

(Cunningham, 2001) focuses on the challenges that are inherent in developing an IS strategy for a public healthcare system. It criticizes IS planning as being technology-lead and objective driven with the actual processes being ignored. In that respect, and in order to achieve alignment of strategy between entities, RISC (Role of Information Systems in Change) model is introduced as a way of describing where SISP (strategic information systems planning) fits in the process of organizational change. This continuous integration is one of the central

components of Earl's organizational approach (Earl, 2003).

(Vimarlund et al., 2003) proposed a framework classifying healthcare organizations into three types: (i) traditional (with a centralized management and information systems); (ii) developing, where IT operates in a distributed computing model and is used for coordinating the different parties throughout the organization, and (iii) flexible, designing the organization structure and the information system as a holistic, integrated process where the two are created in a simultaneous coordinated manner.

On the other hand, (Wager et al., 2005) proposes a normative approach to developing alignment and IT Strategy in HS, based on the fact that the process for developing IT strategy should be similar in approach and nature to the process used for overall strategic planning. However, it considers that organization strategy is often volatile and uncertain the ability of IT to support a strategy can be unclear and the trade-offs between IT options can be difficult to assess.

We propose in this paper an EA oriented approach consisting in 2 steps: (i) modelling HIS in compliance with EA structuring principles; and (ii) checking if HIS sub-architectures truly collaborate to provide better solutions to meet the Healthcare system strategic needs.

3 EA BASED HIS MODELING

3.1 EA Overview

The "2001 Practical Guide to the Federal Enterprise Architecture" defines an EA as "a strategic information asset base, which defines the mission, the information necessary to perform the mission, the technologies necessary to perform the mission, and the transitional processes for implementing new technologies in response to the changing mission needs. Enterprise architecture includes baseline architecture, target architecture, and a sequencing plan" (FCIO, 2001).

Since Zachman introduced his framework (Sowa and Zachman, 1992) providing a deeper, more detailed understanding of the enterprise architecture, a number of other frameworks have been proposed. The list includes well-known frameworks, such as the Federal Enterprise Architecture Framework (FCIO, 2001), the Open Group Architecture Framework TOGAF (TOGAF, 2003), And the DoDAF: DoD Architectural Framework (DoDAF)

(Stenbit, 2004).

EA is much more than just a list of IT standards to be followed by an enterprise. It covers the entire information system management process in order to provide a common basis for understanding and communicating how systems and internal layers (process, Application, Data and Technological Infrastructure) are structured to meet strategic objectives, and then to attain SA.

In this objective, we propose: (i) an EA based HIS standard structure; and (ii) a SA assessment approach consisting in evaluating the internal links existing between the modelled HIS layers.

3.2 EA based HIS Structure

The proposed EA based HIS is composed of four distinct layers: Healthcare process, Application, Data and Technological Infrastructure.

3.2.1 Healthcare Process Layer

This layer describes the “what” of the healthcare business model, activities, processes, functions, information and metrics. The overall healthcare processes and services are identified and hierarchical process decomposition is established as well as procedures, tasks and roles that characterize these processes and sub-processes.

3.2.2 Healthcare Application Layer

This layer encompasses the application components and services to be deployed in order to implement the Healthcare processes and their sub-process. Generally, HIS application layer is organized by speciality, loosely coupling the components but taking into account that there are common requirements that span all departments within the hospital – e.g. patient data.

According to the speciality based-system approach, the following Application components should compose this layer: Medical Records and Patients System, Managed Care System, Order/Request Management System, Pharmacy/Medication Management System, Practice Management System, Picture Archival and Imaging System (PACS) (Youngblood et al., 2008); (Zheng et al., 2008) and (MARKLE, 2003).

3.2.3 Healthcare Data Layer

This layer covers the persistent data used and updated by Healthcare processes and applications. This includes patient's records, pharmacy stock,

practices records and medical images. The main data is the patient's record, medical record or health record. It is a systematic documentation of a patient's individual medical history and care.

Although medical records are traditionally compiled and stored by health care providers, Personal Health Records (PHR) maintained by individual patients have become more popular in recent years (Baethmann et al., 1999).

PHRs enable individual patients and their designated caregivers to view and manage health information and play a greater role in their own health care.

3.2.4 Technology Layer

The objective of this layer is to describe the technologies required, as well as the software and hardware components necessary to run applications and to store any type of health data. All defined components would work together in order to implement an integrated HIS. In this vein, a HIS should as far as possible try to get standardized on the basis of one component technology, to be built following the most suited architectural template for distributed and heterogeneous environments, and to adopt sustainable standards for health-related data exchange, integration, conversion and storage.

4 HIS STRATEGIC ALIGNMENT ASSESSMENT

The proposed approach aims at evaluating the internal links existing between the modelled HIS layers. The goal consists of checking if HIS layers' components (processes, applications, and the IT infrastructure) truly collaborate to provide better solutions to meet the Healthcare system needs.

4.1 Internal EA Relationships Analysis

Alignment is not guaranteed by simply creating diagrams and models showing how a given strategy is supported by healthcare processes that are implemented by specific software applications, databases and technological infrastructure.

It is necessary to establish a set of relevant metrics with the aim to assess and measure HIS alignment following a breakdown structure, i.e. to determine if the processes, sub-processes, activities, applications and databases are actually achieving their purpose. Necessary Information for building such metrics system, are provided by the analysis of

the relationships and dependencies between these architecture layers (see Figure 1 below).

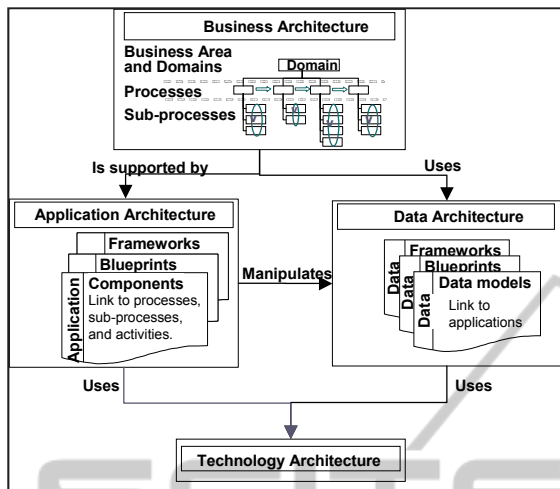


Figure 1: Internal Enterprise Architecture links.

Such inter-layers links are stressed by the EA meta-model shown in Figure 2, identifying numerous relevant metrics (Elhari and Bounabat, 2010) allowing organizations to locate their strategic alignment.

On the basis on this meta-model, a the S2AEA (Strategic Alignment Assessment based on Enterprise Architecture) platform is developed (Elhari and Bounabat, 2011). It supports the approach consisting in: (i) modeling the EA, (ii) detecting elements that harm HIS strategic alignment, and (iii) proposing solutions to the detected problems.

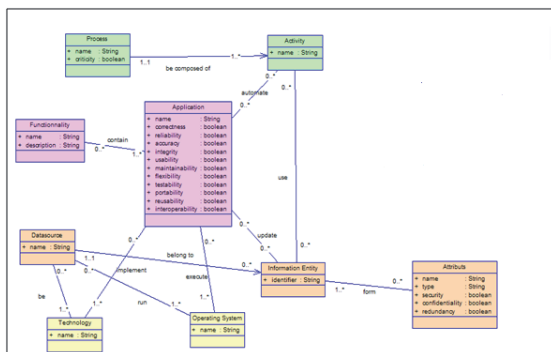


Figure 2: Enterprise architecture metamodel.

4.2 e-Health Case Study

The objective is to illustrate the proposed approach by assessing an automated e-Health process: “Pass a consultation in the neurology service in a hospital”, and identifying factors that affect the HIS strategic

alignment. The studied e-Health process consists of five activities:

- Scheduling an Appointment: Making an appointment is necessary to have a consultation with a doctor in the service.
- Receiving Patient: The patient goes to the reception desk to complete the formalities, and to provide some information: personal information, health insurance, etc.
- Receiving Patient in Neurological Service: In the neurology department, a file is opened containing the patient's personal information, a history of illness, specific allergies, etc.
- Passing Consultation: the sounding of the doctor is done through this activity. This consultation is assisted by computer.
- Charging Consultation: The consultation is estimated at a price depending on the nature of the examination carried out in the consultation.

The elements of the enterprise architecture are represented by the following stereotypes (see Table 1).

Table 1: Symbols and stereotypes used in the S2AEA platform.

Symbol	Name
	Process
	Activity
	User
	Application
	Functionality
	Data source
	Information entity
	Operating system
	Technology

4.3 SA Assessment of the Process Implementation

As shown in Figure 3 S2AEA is used to the description of the “Passing a consultation” process in the EA based HIS model, by defining the components belonging to each layer and supporting the process (5 activities, 4 applications, 3 data sources and 2 operating systems).

Once the e-Health process implementation (existing or targeted) is defined, the Strategic Alignment Assessment can start (“SA Assessment” item in “Figure 4”), following 3 metrics presented and validated in (McCall et al., 1977); (Wegmann et al., 2005) and (Sousa et al., 2005):

- m1: Number of not automated activities
- m2: Number of applications supporting the same business process activity, evaluating severity of certain deficiencies as redundancy in data insertion, multiple logins, etc.
- m3: Number of operating systems on which turn an application, assessing the applications portability and technical interoperability capacities.

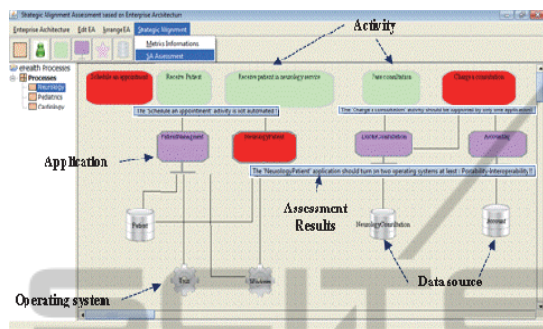


Figure 3: EA Description and Strategic Alignment Assessment using the S2AEA Platform.

After the 3 metrics are evaluated, the S2AEA platform identifies, via adequate messages (commentaries, recommendations, etc.), the changes to be made in order to attain a higher SA level:

- The "Schedule an appointment" activity harms the alignment in the sense that it is not automated (identified by the red colour in Figure 3). It can be a real deficiency to deal with in order to reach SA, since non automated activities require more human resources and more time.
- The "Charge a consultation" activity harms the alignment because it is supported by two different applications (Accounting, Doctor Consultation). Indeed, an activity should be supported by a minimum number of applications: this can facilitate modification in case of business process activity change and can reduce the need for distributed transactions across applications (Bounabat, 2006) and (Vasconcelos, 2007).
- The application "neurology Patient" turns on only one operating system. This harms alignment because the application is neither portable nor interoperable. This generates problems if we want to interoperate two applications to reach a business goal (Sousa et al., 2005) and (Vasconcelos, 2007).

As this study case demonstrates, the proposed HIS strategic alignment assessment approach contribute to the efforts aiming at changing the view of healthcare delivery to a business process oriented approach. This evolution will permit the setting-up of a more appropriate and efficient organizational

and information infrastructures to support the clinical and business processes of the organization.

5 CONCLUSIONS

The IT expansion applies to all the healthcare stakeholders to take inevitable steps to align and assess the HIS development to their business strategies. In this respect, this paper presents a novel approach to use EA in HIS strategic alignment evaluation. It depicts, analyzes and assesses the relationships between the various informational architecture components and how the architecture serves as a strategic asset for the healthcare organisation.

Such IT alignment assessment is useful to help a Healthcare organisation to estimate the gaps for each component of the HIS Architecture to be strategically aligned, and to evaluate the necessary efforts to attain this objective.

Our research efforts are currently focusing on two main objectives. The first consists in improving S2AEA by adding more interesting assessment metrics and by developing other platform functionalities. On the other hand, EA is a really promising discipline aimed at capturing the as-is architecture of an enterprise, defining the target and the roadmap to get from existing to desired state. Therefore, the second objective aims at setting up a new methodology for IT Strategic Planning based on Enterprise Architecture and applying it in Healthcare domain.

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