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Developing an Enterprise Architecture proof of concept in a Portuguese hospital

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Abstract

A Portuguese hospital with 700 beds and assisting 600 000 inhabitants, in its strategic plan, claimed for the urgent need of using new management approaches for dealing with the complexity of their information systems (IS), the highly coupled Information Technology (IT) infrastructures, and the inefficiency in the communication. This paper describes a proof of concept development using the concepts of Enterprise Architecture (EA) to contribute for a solution for these needs. The work focuses on the improvement of the medical appointment and patients' customer service business processes. Based on key points of existing EA frameworks, we started by using a questionnaire to the top management, and defining a common vision for this specific area, followed by the elicitation of the business processes and the supporting IS and IT infrastructures. Finally, we selected the key performance indicators that will help the hospital to monitor the performance of these processes. With this information gathered we offer a tool for top management to communicate with the clinical and IT areas and, together, take decisions with a common mind map and with the possibility to simulate the impact in the organization of those decisions. Another result of this work is the lessons learned in this proof-of-concept that can be applied in other areas and business processes of the hospital.

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1. Introduction

Organizations with a great level of complexity struggle for obtaining value from their IT infrastructure, aligning it with the strategic goals, and improving the communication between the business people and the IT people[1]. Hospitals represent one of the most complex organization types, either by their critical service or by the numerous persons, materials, providers, and high skilled competencies to deliver that service[2]. This complexity can also be observed regarding hospitals' IS/IT infrastructures, their relationships with business processes and with overall hospital management. All aspects of an organization influence their efficiency and effectiveness, being IT a core asset in this context[3,4]. Applying the principles of Enterprise Architecture (EA) may help a hospital to overcome its challenges regarding this complexity.

EA comes from the nineties. Most of the conceptual and scientific works arise from the industry[5]. The main goal of the EA is to help an organization to share a common understanding of the different and possible views existing in the organization and create a common vision allowing the focus of all. Based on this it is possible to align the business area with the supporting areas, namely IT, to enable the creation of value[6].

Our attention is focused on a midsize Portuguese hospital with 700 beds and serving a geographical area with 600.000 inhabitants. The three year strategic plan of this hospital has the following priority: the urgent need to adopt new management mechanisms to deal with the IS/IT systems' complexity, the enormous interdependency of the systems and the ineffectiveness of the communication between IT departments and the remaining hospital's departments, including top management. The hospital presents a great number of systems that were historically developed over time for specific clinical and business areas. They behave as information islands leading to duplication of efforts to register data, gather information and enormous efforts to keep them working and evolving. Five years ago, the hospital took the decision to adopt an Enterprise Resource Planning (ERP) system for health from a provider with worldwide operations. From then, it has been doing a roadmap of migration of all the services for this ERP. Due to the financial crisis and the intervention of the International Monetary Fund (IMF) and European Central Bank (ECB) and the European Community (EC) in Portugal, in April 2011, all the public institutions had severe cut-offs in their budgets, demanding the re-organization of their priorities. In this context, the strategy has been rethought and the speed of the migration of the systems was reduced. In this way, and to continue to achieve the performance indicators with fewer resources, the hospital decided to give priority to reduce costs by the optimization of the operations and increase the profitability of the existing solutions. This demands an alignment of the clinical staff, the IT staff and the search, as a unique team, for solutions for subsequent implementation of those solutions. These actions must be performed based on a shared vision for the institution and with all the necessary data available. The present work intends to be a proof of concept of using an EA approach to meet these goals.

Next section introduces the concepts related with the EA approach with a brief presentation of some of the most existent relevant frameworks. Section 3 presents and justifies the methods used. The main results are presented in the fourth section. Finally, in the last section 5 we discuss the results, offer the main conclusions and derive future research works.

2. Concepts and related work

Tamm et al[5] expresses Enterprise Architecture (EA) as "the definition and representation of a high-level view of an enterprise's business processes and IT systems, their interrelationships, and the extent to which these processes and systems are shared by different parts of the enterprise". The main concept is to delineate a target architecture, based on a shared vision of the organization for the future. From here, strategic goals are defined and an outline of a roadmap to migrate from the existent architecture to the desired one can be conceived.

EA seeks answering two main problems: 1) the complexity of the organizations; and 2) the value from the investment in Information and Communication Technologies (ICT). Midsize and big organizations share the difficulty in aligning their human resources with a common view of the organization, namely regarding strategic goals, the supporting processes, and the ICT infrastructures. Another problem is that organizations are spending more and more money building and maintaining these infrastructures without any visible return.

The first key work, Zachman's framework[7] is from 1987. Since then, significant scientific research could be observed regarding EA and its effective use in industry. We can distinguish for main contributes in the field: 1) the Zachman framework[7]; 2) The Open Group Architectural Framework (TOGAF)[8]; 3) The Federal Enterprise Architecture (FEA)[9]; and 4) the Gartner Methodology[10].

Zachman's framework focuses on building a strong taxonomy for the architecture. Some authors even do not consider it as an architecture, because it does not provide a framework in the strict sense of the framework definition. For instance it does not offer a method to reach to the taxonomy. In this way TOGAF is usually considered a process definition to obtain the architecture. FEA is the results of the efforts of the US Government to build a common organizational architecture for aligning the biggest public (and private) organizations in the world. It has both a comprehensive taxonomy, like Zachman's, and an architectural process, like TOGAF. Finally, the Gartner methodology is a very pragmatic practice, where the key are the results. It sees the architecture as an ongoing process and it is not very concerned about using either a rigid taxonomy or process, as long as it works (9).

The concepts and the need of EA is considerable obvious. It is, however, harder to demonstrate the real added value of this approach[5] and explaining why and how EA leads to the announced benefits. This work intends to explain in detail why and what exactly was performed in a concrete scenario. Next section explains in detail the methods adopted.

3. Methods

This work is an exploratory and empirical study to apply the principles of the EA architecture body of knowledge to the reality of a Portuguese Hospital.

In order to focus the work, the research team decided to centre the effort in the patients' medical appointment and customer service business processes. The reasons for this choice remain in the following arguments: a) the organization recognizes this area as a critical area; b) there are known problems, namely the time to schedule an appointment and the queue dimension for achieving a slot for such an appointment; c) the need of implementing the concept of a unique point for customer service; d) the need to monitor and achieve the performance indicators stipulated by the Portuguese Health Ministry; e) there is not a consensus about how to deal with these issues, despite the consensus about the urgency of finding ways to achieve solutions.

After this delimitation of the scope of the work, the second decision concerned about the methods to use. We decided to use an Enterprise Architecture approach due to the subsequent facts: a) there is no global view/description of the processes involved; b) different actors, even within the same department (such as the IT one), have different thoughts about the problems and how to solve them; c) the data involved is vast as also the number of data sources, disallowing an easy analysis either of the problem or the impact of possible solutions; d) there is not a way of monitoring the main key performance indicators in a consistent manner over time; e) there is no possibility to simulate scenarios, because it is not possible to estimate the full impacts of those scenarios.

The EA discipline offers a set of frameworks that may help in these situations, although there is no consensus about how those frameworks can deliver the benefits proclaimed[5]. In this way the research team decided to use elements, selectively, of several frameworks and define a walkthrough for the project after the definition of the tangible objectives for the project.

The identification of which elements of the existing frameworks were suitable and the priorities of the organization, 3 key elements of the hospital staff answered a questionnaire. This questionnaire is composed with 13 key areas and the respondent must select a value between 1 and 4 expressing is agreement/disagreement about the relevance of the area to solve the hospital challenges. Each area was presented with a short explanation and one example. For instance, the area of "Process completeness" was explained as "refers to how fully the methodology guides you through a step-by-step process for creating the enterprise architecture" and with the following example "Ex: Create a checklist or a model to build the EA". This questionnaire was adapted from[11] and is fully described in the Appendix A.

With the results from the questionnaire, we could derive the definition of the goals for the proof of concept, namely: a) modelling the business processes in an understandable way for all the stakeholders; b) identifying and representing all the ICT infrastructures directly or indirectly used by those business processes; c) making a clear association between the key performance indicators, the business processes, the systems and the persons that are

involved in the customer service and the medical appointment scheduling; d) registering all the information using a tool, allowing the simulation of possible strategies to solve the problems, namely, what must be changed in terms of the key performance indicators, and the impact of those changes regarding the processes, the persons involved and the ICT infrastructures used; e) collecting the lessons learned from this proof of concept and applying them to further areas in the hospital.

With these goals defined it was possible to state the relevant elements of the different frameworks (Zachman's, TOGAF, FEA, and Gartner), to use in the step by step walkthrough for obtaining the proof of concept. The results pointed out for a common priority: governance. In this way, according to Sessions[11] (2007), the most suitable frameworks are FEA and Gartner and the least suitable frameworks are Zachman's and TOGAF. According to the goals for a proof of concept, the research team decided to follow mainly aspects of the Gartner pragmatic approach: create a common vision among business owners, information specialists, and the technology implementer to driving profitability. Figure 1 presents the resulting approach.

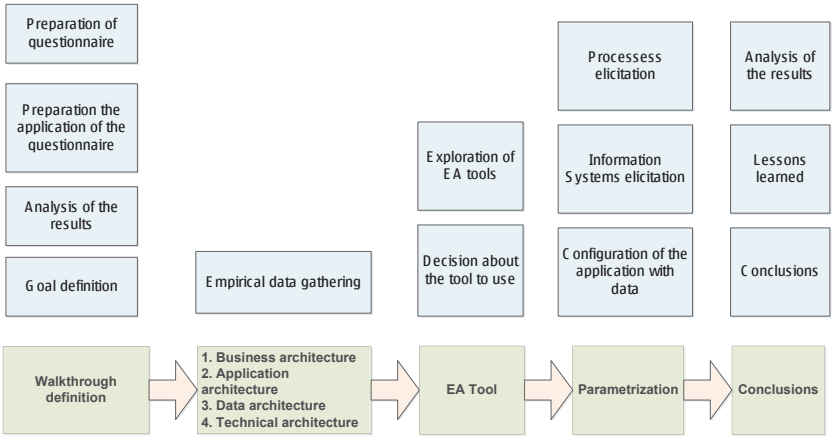

Fig. 1. Enterprise Architecture walkthrough for the proof of concept

The walkthrough starts with the empirical data gathering to build a first globally view for all the components of the EA, namely the business, application, data and technical perspectives. The following step was the exploration of EA tools to use. Two free, open source, cross-platform tools were under analysis: The Essential Project† and The Free ArchiMate Modelling Tool‡. The choice was for the The Essential Project tool due to the fact that ArchiMate is fully aligned with TOGAF making the use of this walkthrough more difficult. After the choice of the tool, the team started the business processes elicitation[12] and their respective supporting ICT. With this information it was possible to configure the opensource software tool provided by The Essential Project. The resulting configuration of the tool allowed the formalization of the organization, its processes and ICT infrastructure. With this formalization it was possible to make conclusions about the organization, its needs and register lessons learned about the process to use the EA in the hospital.

† http://www.enterprise-architecture.org
‡ http://www.archimatetool.com

4. Results

We can summarize the results of this research in the following items: the questionnaire, the results of the questionnaire, the walkthrough, the elicited business processes[12], the empirical data gathered, the formalization of that knowledge, the lessons learned about the walkthrough, and the conclusions allowed by this work.

The questionnaire intended to obtain the vision of the key elements of the organization and their priorities. This information was used to select which frameworks were more suitable. The questionnaire was adapted from Roger Sessions[11] work. He uses 13 criteria elements and classifies them using a scale from 1 to 4, where 1 means "Does a very poor job in this area" and 4 means "Does a very good job in this area". The full questionnaire can be accessed in the Appendix A. Figure 2 summarizes the results of the answers of the 3 key stakeholders of the Hospital.

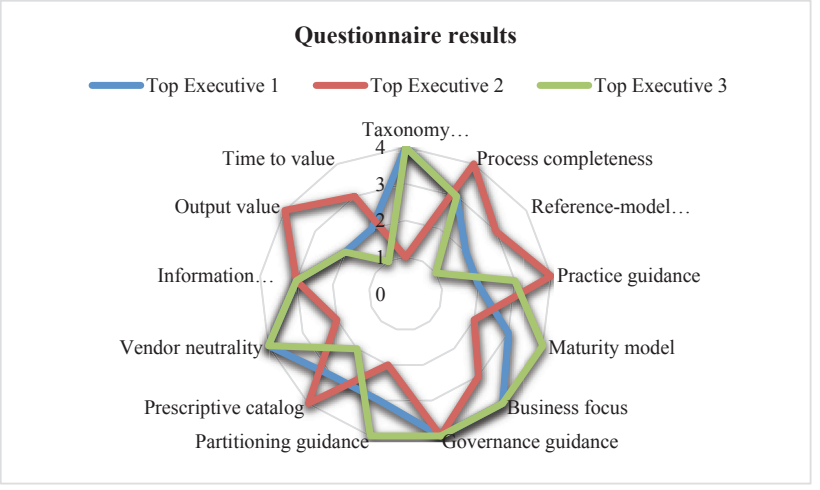

Fig. 2. The results of the questionnaire

Analyzing the results in Figure 2, it is possible to conclude: a) a disparity of the visions, demanding an urgent need of communication; b) a consensus about the importance and expected return of this Enterprise Architecture approach, namely on the governance field and on the possibility of having a taxonomy completeness. This also confirms the first point, i.e. the urgent need of communication across several distinct departments in the hospital; c) no consensus on the information availability, the practice guidance and the business focus. These main results lead to the choice of selecting the Gartner approach as the main driver for the work, resulting in the walkthrough definition explained in Figure 1. The empirical data gathering (the first step of the walkthrough), gathers the organic structure, strategic goals, the representation of the medical appointment business process and the main information flowing in that process. The organic structure consists in the departmental structure, the persons and their roles. For example, the women department manages all clinical services related to women, as well as the chirurgical department manage all chirurgical specialties. All the departments answer to a clinical board that answers to the administration board. The strategic goals come from the strategic plan and were refined for specific goals for each department; also it was necessary to specify key performance indicators to measure the progress of the strategic objectives, e.g., Monitoring and reduction of waiting list for medical appointments. Finally, the attention fell in the medical appointment process elicitation. Several iterations with operational and management actors result in process model[12] detailed in Figure 3.

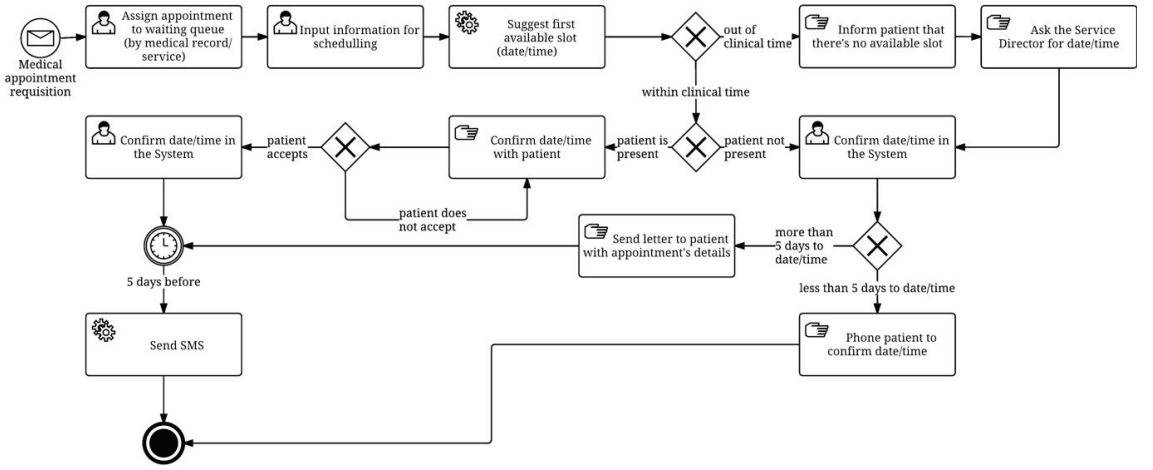

Fig. 3. Detail of medical appointment scheduling process (adapted from[12])

The elicitation of this medical appointment scheduling process consisted also in the analysis of its data flow, namely the input and output data required for each task and for the process in general[12]. All data were formalized using the The Essential Project EA opensource tool. The tool has a module to integrate with Protege™[§]. It allows the definition of an ontology and the mapping of the data elements in that ontology as instances of the concepts and relationships defined. The ontology should reflect the holistic shared vision of the organization. The tool offers a set of core ontologies that can be used as a starting point for the work.

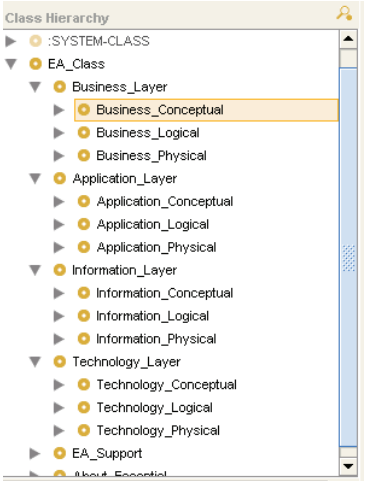

Fig. 4. The set of predefined ontologies offered by The Essential Project EA Tool.

Using the predefined ontology structure, the procedure was to map as much as possible the empirical data gathered into this structure, to benefit from the value of the tool. Where appropriated the structure was redefined. Figure 5 shows the mapping into the tool of one business objective.

[§] http://protege.stanford.edu

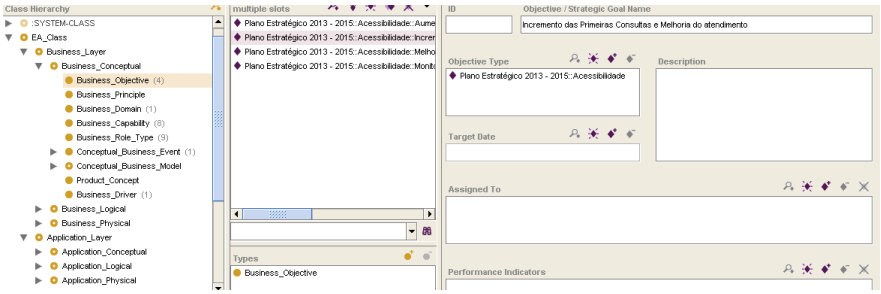

Fig. 5. Mapping a business objective in the The Essential Project EA Tool

In Figure 6 we illustrate four (numbered) screenshots of the The Essential Project tool web viewer, where users can see data from the hospital's enterprise architecture, previously populated through the Protege™ tool. This web viewer implements navigation features that map to the The Essential Project ontology, and users can easily drill down information to get acquainted with interconnected data.

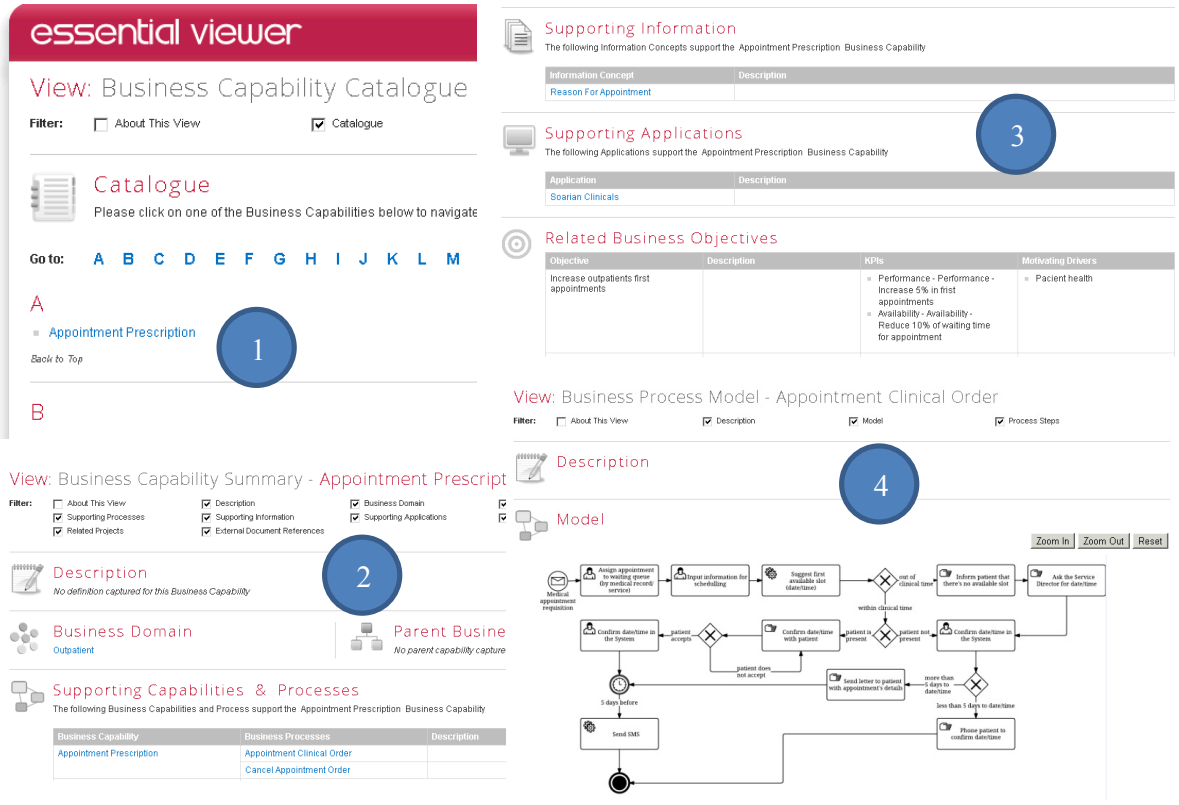

Fig. 6. The Essential Project web viewer tool populated with EA information on our case study hospital

The four screenshots in Figure 6 are an example of such navigation, where a user may start by choosing a Business Capability from a catalogue (screenshot 1) and navigate to its details (in this case, the medical Appointment Prescription capability – screenshot 2). Once there, s/he can pick one of the correlated business processes, and navigate to its details (screenshot 3). Here, several information about the business process is available, including correlated business objectives (such as key performance indicators), related information and

software applications. From there, s/he can see the model of the business process model in detail (screenshot 4). Similarly (not shown), picking up, for instance, a related software application, s/he can drill down to its details, including the services it executes, the hardware where it is installed, and the user input information needed to work with it. Furthermore, s/he could choose the hardware details, where another view would show her/him the associated technology, provider, location and main specifications.

The proper parametrization for our proof of concept was achieved by populating, at the Business level, the Objectives, the Business Domains, the Business Capability, the Roles, the Events, the Driver, and actors data. At the Application level, the data introduced involved the Architecture Objective, the Service, and the Functions. At the Information level it involved introducing data about the Architecture, the Principles, the Representation, the View, and the Data Representation. At the Technology level, the Domain, the Architecture Principles and objectives, the Capabilities, the Components, the Providers, the Protocols, the Instance and the Node data were filled up using this predefined ontology structure.

We address in the next section the lessons learned from the implementation of this EA proof of concept.

5. Conclusions and future work

With this work, there is a number of lessons learned and conclusions that can be used in future works. The first lesson is the importance of defining the walkthrough process and the elicitation of the data without being influenced by the software tool. Due to the completeness and complexity of the existing tools, and namely the one used in this work, it is easy to the organization to fall in the temptation of adapt itself to the tool instead of using critically the tool to achieve the strategic goals of the organization. The second lesson learned is the importance of making, in the beginning of the walkthrough, a separate assessment of the different views of the organization followed of separated sessions to achieve a more unified vision. In the proof of concept it was possible to realize different, and sometimes, opposite views of the organization. It is possible to find the missing parts to obtain a complete knowledge about a certain business process. Another lesson learned is the value of sharing the vision and observing small, but concrete, indications of the people aligning their behavior and decisions according to the shared vision. It is also important to observe the connection of the strategic goals to the operations, through the key performance indicators, allowing the measure of the efficacy of the decisions. The tool allows the drill-down and the drill-up of the information and the configuration of specific views for the different users. It could also be observed a considerable difficulty in loading the data as well as obtaining real-time feedback. There is no automatic tool to load data and feeding up the used tool with existent data from several data sources of the organization must be programmed.

As future work, the research team intends to extend this approach to other areas of the hospital. Another future work is to implement a real time data feed add-on for the open source tool. The tool provides an integration module for external data, e.g., datasheets or databases. This module demands the development of "wrappers" using the script libraries provided by the application programming interface (API).

Appendix A. Questionnaire

Within the scope of the research work of applying the principles of Enterprise Architecture for your Hospital, we would like to count on your availability to answer a quick questionnaire which intends to rate the aspects that are most important to represent, i.e., in which area the hospital will take more advantage to build a representative model of its enterprise architecture. We propose a numerical rating ordered by importance, where 1 means less important and 4 means most important. This classification is subjective and serves to identify the most important areas where this project can bring more benefits to your Hospital. This will be a key contribute for the choice of the most suitable framework to adopt for the field work.

1. Taxonomy completeness refers to how well you can use the methodology to classify the various architectural artefacts. Example: A diagram seen by different people could have different meanings. Try to end ambiguities.

2. Process completeness refers to how fully the methodology guides you through a step-by-step process for creating enterprise architecture. Example: Create a checklist or a model to build the EA.

3. Reference-model guidance refers to how useful the methodology is in helping you build a relevant set of reference models. Example: Existence of reference models that help builds the EA.

4. Practice guidance refers to how much the methodology helps you assimilate the mind set of enterprise architecture into your organization and develop a culture in which it is valued and used. Example: Identify methods and routines for the change management.

5. Maturity model refers to how much guidance the methodology gives you in assessing the effectiveness and maturity of different organizations within your enterprise in using enterprise architecture. Example: Identify the inefficient or the break points in the institution.

6. Business focus refers to whether the methodology will focus on using technology to drive business value, in which business value is specifically defined as either reduced expenses and/or increased income. Example: Find inefficient business areas; Or possible critical areas in a project.

7. Governance guidance refers to how much help the methodology will be in understanding and creating an effective governance model for enterprise architecture. Example: The generated models help in the vertical communication of the organization. Find decision reason.

8. Partitioning guidance refers to how well the methodology will guide you into effective autonomous partitions of the enterprise, which is an important approach to managing complexity. Example: All areas area important and rule adjusted. Same roles executed by different departments.

9. Prescriptive catalogue refers to how well the methodology guides you in setting up a catalogue of architectural assets that can be reused in future activities. Example: Understand how business works and the goals. Is the investment adequate for the business goals?

10. Vendor neutrality refers to how likely you are to get locked-in to a specific consulting organization by adopting this methodology. A high rating here indicates low vendor lock-in. Example: Independent configuration and adaptations.

11. Information availability refers to the amount and quality of free or inexpensive information about this methodology. Example: Open Source; communities; Manuals;

12. Output value refers to the quality and effectiveness of the objects output by the tool. Example: type of outputs: documents; diagrams; models; tables?

13. Time to value refers to the length of time you will likely be using this methodology before you start using it to build solutions that deliver high business value. Example: Time needed for build and maintain the EA.

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