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Critical Success Factors for Adopting Enterprise Architecture Metamodels in the Health Sector: Literature Review

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Background and Purpose: Metamodels can be used as templates for describing models. In the context of the government enterprise architecture (GEA), the metamodels or metamodel-based reference models are primarily used to execute national strategic objectives in information systems. For example, if a National Health Insurance (NHI) service is to be delivered to approximately 400 government hospitals and 4000 clinics in South Africa, reference models (e.g. Business Information Reference Model for Health) will have to be seriously considered. This approach will require the proper definition of metamodels or metamodel-based reference models. The main purpose of this paper is to report the critical success factors (CSFs) for adopting enterprise architecture (EA) metamodels in the health sector.
Methods: The latest scientific literature based on the adoption of EA metamodels in the health sector was reviewed. The guidelines of the systematic literature review were partly adapted to organize the search.
Results: Queries made from the abstracts of eight digital libraries in September 2013 produced 31 hits. No papers were found on critical success factors for adopting EA metamodel in the health sector.
Conclusions: Governments are adopting EA for implementing their strategies and for improving production of services, especially in the health sector. However, there is little or no scientific research done on the adaptions of EA metamodels in the health sector.

Keywords: Enterprise Architecture (EA), Metamodel

1 Introduction

Within government services, healthcare has surfaced as the most critical services that need attention. The World Health Organisation (WHO) has recommended the expenditure of 5% of a country's gross domestic product (GDP) in health [1]. However, the United States, for example, is spending over 16% of GDP in health, and for South Africa the figure is 8.5% [2]. No wonder that healthcare is the biggest item of expenditure in governments around the world.

"To improve the health of populations and reduce the per capita cost of healthcare, all nations will need to go beyond improvements in the performance of their healthcare delivery systems to embrace the broader determinants of health" [3]. Therefore, governments are adopting EA for implementing their strategies and for improving production of services, especially in the health sector. This has been made possible because of EA's robustness in developing solutions that are holistic, coherent, and responsive to the need [4].

One precondition of holistic solutions is EA artifacts which are "tangible work products" [5]. It is important to understand how the solutions affect the EA artifacts (e.g. single models and model elements), discovering possible inconsistencies [6]. Another precondition is EA deliverables which "pre-

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define typical or recommended content in the form of work products that would be packaged for delivery" [5]. At the governmental level, it is important that the solutions take into consideration the EA deliverables (e.g. reference models) which usually contain constraints about interoperability.

We assume that there are one or more EA metamodels (the other forms of writing are meta-models or meta models) behind the GEA development. Therefore, we want to make the literature review of scientific researches around the adoptions of the EA metamodels (especially the GEA metamodels). We are familiar with the Government Wide Enterprise Architecture (GWEA) Framework — "the first [South African] public sector entity to formally adopt and adapt TOGAF® 9 for Enterprise Architecture (EA)" [7]. GWEA contains several artifacts and deliverables. The influence of the TOGAF content metamodel [8] is in the GWEA artifacts which are mainly entities of the TOGAF content metamodel. Furthermore, we are familiar with the Finnish governmental semantic assets repository (yhteentoimivuus.fi) [9]. In Finland, the EA development framework is called JHS 179 and is based on TOGAF [10]. However, the entities of the TOGAF content metamodel are implicitly mapped on the JHS 179 artifacts.

2 Materials and methods

A systematic literature review (SLR) is used as the method for identifying, assessing, and analysing published studies. Kitchenham & Charters [11] and later Okoli & Schabram [12] have suggested a well-defined protocol to undertake a SLR study. Kitchenham & Charters [11] view the SLR study method as an effective way of summarising the existing evidence, identifying gaps in the current literature, and providing the framework or background to position the new research. Okoli & Schabram [12] further suggest that the SLR process is more suitable for investigating information systems because of its nature to incorporate social sciences, business and computer science.

We did not perform systematic literature review as "a form of secondary study that uses a well-defined methodology to identify, and interpret all available evidence related to a specific research question in a way that is unbiased and (to a degree) repeatable" [11]. Rather, we adapted SLR to explain the procedure explicitly and to collect evidence to establish the latest scientific research around the adoption of EA metamodels in GEA. Thus we set out to provide "a theoretical background for subsequent research", to learn "the breadth of research on a topic of interest", and to answer "practical questions by understanding what existing research has to say on the matter" [12]. Our review process had the following steps:

1. Specifying the search terms
2. Selecting the databases
3. Searching for the papers
4. Appraising the hits and selecting the papers
5. Citing the statements from the papers

3 Results

We appraised (

Table 1) the papers containing the terms "enterprise architecture" and metamodel (or meta-model or "meta model") in the abstracts. As a further requirement, the appraised papers had to be written in English and be peer-reviewed (i.e. proceedings or journal papers). Finally, the appraised papers must be available in full versions from the digital libraries (i.e. without request permissions). When we added "health" to refine the search we did not find any papers which satisfied the search requirements.

Alternative suggestion: Our study was limited to peer-reviewed (i.e. from proceedings or journals) papers written in English, and which must be available from the digital libraries without request permissions. Within these criteria we then extracted for appraisal (

Table 1) those papers containing the terms "enterprise architecture" and (metamodel or meta-model or "meta model") in their abstracts. When we added "health" to refine the search we did not find any papers which satisfied the search requirements.

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Table 1. Appraised hits

Digital library	Search query	Hits	Available full paper	Exclusions	Inclusions
ACM [13]	Abstract:"enterprise architecture" AND (Abstract:metamodel OR Abstract:"meta model")	21	2	2	-
IEEE [14]	"Abstract":"enterprise architecture" AND ("Abstract":metamodel OR "Abstract":"meta model") AND "Abstract":health	2	2	2	-
PubMed [15]	enterprise architecture"[Title/Abstract]) AND "meta"[Title/Abstract]	0	-	-	-
Wiley [16]	"enterprise architecture" in Abstract AND "meta" in Abstract.	1	0	-	-
EBSCO [17]	AB "enterprise architecture" AND AB "metadata"	1	0	-	-
Scorpus [18]	ABS("enterprise architecture" AND (metadata OR meta-data OR "meta data"))	6	0	-	-
ScienceDirect [19]	ABSTRACT("enterprise architecture" AND health) and ABSTRACT(metamodel OR meta-model OR "meta model")	0	-	-	-
Sage [20]	"enterprise architecture" and health in Abstract and meta in Abstract	0	-	-	-

Two papers from the ACM were excluded — one was presented in a workshop and the other was an invited talk. The net result is that, from eight digital libraries, the selection and extraction process yielded no papers that qualify for further analysis.

However, we did make the following observations:

- Some papers were extensions or modifications of the ArchiMate metamodel.
- Some papers were about analyzing or modeling the IT Impact on organizational structure.
- More than 10 papers discussed meta-database, metadata registry, intefaces, or interchange
- Metamodels are usually adapted for a smaller context than the (G)EA framework as, follows:
  - for automated enterprise architecture model maintenance
  - to make cost predictions and do risk analysis
  - to support service management in an enterprise context and to allow for service classification (an enterprise architecture metamodel for service-oriented architectures consisting of 39 entities)
  - for analyzing impacts of goal and requirement changes in EA goal models
  - a structure for the comprehensive capability meta-model
  - for the domain modelling of information systems
  - to propose Enterprise Architecture-based SBITA (Strategic Business and IT Alignment) assessment metamodels which have a limited set of 74 artifacts that can be modelled through 71 questions
  - to support enterprise system quality analysis
  - to support decision making on IT organization change scenarios
  - for enterprise service interoperability analysis
  - supporting organizational performance analysis
  - to propose a meta-model for Zachman Frameworks
  - to provide a suite or repository of various transformation elements made up of people, processes, and deliverables

Although we did not get any papers fulfilling our inclusion criteria, we did highlight some statements at the citing phase. These are quoted in the form of sentence snippets, where excluded parts are represented by three dots (...).

- How metamodels are important in the EA context:
  - "whether explicit or implicit in architecture frameworks, meta models play an important role in all EA efforts by providing a common language for the enterprise **...** Meta models are a core concept of EA, describing the fundamental artifacts of business and IT **...** the permissible entities and their connections are prescribed by the meta model, so that all models based upon it are coherent **...** the meta model enforces semantic rigor among the models subsequently created in its image. Such rigor is a precondition for successful communication and documentation **...** Analogously to the case of entity relations, a meta model can prescribe attribute relations." [21]

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- "IS Strategic Planning and Enterprise Architecture are two major disciplines in IT Architecture and Governance **...** The main concept underlying both the process and the taxonomy is the metamodel to describe architecture elements and to produce architecture deliverables **...** it is necessary to define a rich and structured metamodel covering both architecture elements (processes, applications, data..) and transformation elements (programs, projects, budgets) **...** The metamodel is the backbone of architecture description and methodology. The metamodel guarantees the exhaustiveness of overall architecture work and the coherence and alignment of architecture layers **...** Many metamodels have been defined explicitly or implicitly by EA frameworks. They are of different natures and focus depending on their intent. Some of them are poor in term of business or IS content" [22]

– GEA metamodels define required information and their relationships [23]:
  - "A meta-modeling approach is used to design GEA database and to communicate with agencies regarding how they should manage agency-level EA information **...** the KGEA {Korean GEA} Meta-model is a set of standard EA deliverables required by agencies to create and report for the sake of the government-wide EA success. It is a backbone model used to construct an agency's EA, by defining required architectural information and their relationships. Agencies can develop their own EA by defining architecture models or meta-models aligned with the agency's EA objectives, however, agencies' models must include the information required by the KGEA Meta-model."
– There are different kinds of metamodels [24]:
  - "Metamodels are generally used in specifications or frameworks to describe models. For example, TOGAF 9 uses a metamodel in its Content Metamodel description to inform the generation of enterprise architecture content **...** the OMG (Object Management Group) uses metamodels in specifications such as SPEM (Software Process Engineering Metamodel) **...** and HL7 (Health Level Seven, Inc. - the global authority on standards for interoperability of health information technology) specified the HL7 RIM (Reference Information Model) as part of HL7 Version 3 **...** HL7 RIM specifies the grammar of HL7 V3 messages and specifically, the basic building blocks of the language (nouns, verbs etc.), their permitted relationships and data types."
– Probably, several metamodels and frameworks have to adopted in the health sector [25]:
  - "The Generic Component Model (GCM) is used as a framework for modelling any system to evaluate and harmonize state of the art architecture development approaches and standards for health information systems as well as to derive a coherent architecture development framework for sustainable, semantically interoperable HIS {health information system} and their components. The proposed methodology is based on the Rational Unified Process (RUP), taking advantage of its flexibility to be configured for integrating other architectural approaches such as Service-Oriented Architecture (SOA), Model-Driven Architecture (MDA), ISO 10746, and HL7 Development Framework (HDF) **...** tailoring the RUP best practice for large projects in order to provide a process configuration that supports the development of architectures for health information systems **...** the HL7 Message Development Framework (MDF), and offers models and artifacts for information modeling in healthcare."

4 Discussion

Is it an only critical success factor if the government formally adopts and adapts a certain EA framework, especially formally adopts and adapts a certain EA metamodel (e.g. TOGAF Content metamodel)? We know that there are difficulties in understanding the elements of the metamodels — i.e. entities, their attributes, and relationships between entities. Furthermore, some EA frameworks do not explain their elements explicitly. However, instances of the elements (e.g. actors, data, processes, and services) are mainly enterprise-specific. Therefore, GEA provides guidelines to collect those instances, and it usually suggests the set of allowable frameworks (standards, for example) and other constraints, like the implementations of the strategies (**Fig. 1**). We assume that it is difficult to discover or formulate special CSFs for adopting the EA metamodel in the health sector. However, it is a crucial part of our study and it will point out subjects for further research.

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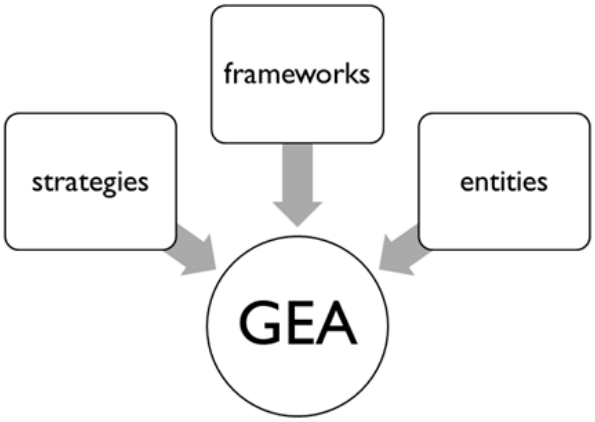

Fig. 1. GEA makes effects of the entities, frameworks and strategies transparent

In future, it might be reasonable to talk about concrete (critical) activities [26] instead of CSFs. For example, we can ask what activities have to be done if a service like a National Health Insurance (NHI) is going to be delivered to approximately 400 government hospitals and 4000 clinics in South African. It will not be enough to reply that the reference models (e.g. Business Information Reference Model for Health) have to be taken into consideration. We must control activities by setting performance indicators. Critical activities (critical success factors) drive the strategies forward and indicators enable the measurement of strategic performance (**Fig. 2**).

Fig. 2. GEA includes goals which are achieved by critical activities (CSFs) and key performance indicators (KPIs)

References

[1] Reinhardt UE, Hussey PS, Anderson GF. Cross-National Comparisons of Health Systems Using OECD Data; 1999. Health Aff May 2002 vol. 21 no. 3 169-181. doi: 10.1377/hlthaff.21.3.169
[2] Department of Health. National health insurance in South Africa; 2011.
[3] Shortell SM, Gillies R, Wu F. United States innovations in healthcare delivery. Public Health Reviews 2010;32:190-212.
[4] Saha P. Enterprise architecture as platform Understanding the Impact of Enterprise Architecture on Connected Government; 2010. http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan041801.pdf
[5] Object Management Group (OMG). Software & Systems Process Engineering Meta-Model Specification, version 2.0; 2008. http://www.omg.org/spec/SPEM/2.0/

 DOI: 10.12856/JHIA-2013-v1-i1-43

[6] Winter R, Fischer R. Essential Layers, Artifacts, and Dependencies of Enterprise Architecture, Enterprise Distributed Object Computing Conference Workshops, 2006. EDOCW '06. 10th IEEE International. doi: 10.1109/EDOCW.2006.33
[7] The Open Group South Africa. An overview of the GWEA Framework. http://opengroup.co.za/ea-forum/presentation/overview-gwea-framework
[8] The Open Group. Content metamodel. http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap34.html
[9] European Comission. Community of European Semantic Asset Repositories. https://joinup.ec.europa.eu/community/cesar/description
[10] JUHTA. JHS 179. Available from: http://www.jhs-suositukset.fi/web/guest/jhs/recommendations/179
[11] Kitchenham B. Procedures for performing systematic reviews. Keele, Technical Report, UK, Keele University, 2004.; http://tests-zingarelli.googlecode.com/svn-history/r336/trunk/2-Disciplinas/MetodPesquisa/kitchenham_2004.pdf
[12] Okoli C, Schabram K. A Guide to Conducting a Systematic Literature Review of Information Systems Research. SSRN Electronic Journal, 2012. http://dx.doi.org/10.2139/ssrn.1954824
[13] http://dl.acm.org/
[14] http://ieeexplore.ieee.org/Xplore/home.jsp
[15] http://www.ncbi.nlm.nih.gov/pubmed
[16] http://onlinelibrary.wiley.com/
[17] http://www.ebscohost.com/academic/academic-search-elit
[18] http://www.scopus.com
[19] http://www.sciencedirect.com/
[20] online.sagepub.com
[21] Saat J, Franke U, Lagerström R, Ekstedt M. Enterprise architecture meta models for IT/business alignment situations. Enterprise Distributed. 14th IEEE International Enterprise Distributed Object Computing Conference (EDOC); 2010. http://dx.doi.org/10.1109/EDOC.2010.17
[22] Lakhdiss M, Bounabat B. A new content framework and metamodel for Enterprise Architecture and IS Strategic Planning. International Journal of Computer Science Issues (IJCSI) 2012;9(2):253–8. http://ijcsi.org/papers/IJCSI-9-2-2-253-258.pdf
[23] Lee Y, Kwon Y, Shin S, Kim E. Advancing government-wide Enterprise Architecture - A meta-model approach. Advanced Communication Technology (ICACT) 2013;886–892. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6488323
[24] Gerber A, Kotzé P, van der Merwe A. Towards the formalisation of the TOGAF Content Metamodel using ontologies. In Proceedings of the 2011 IEEE 15th International Enterprise Distributed Object Computing Conference Workshops (EDOCW '11). Madeira, Portugal; 2010. p. 54–64. http://hdl.handle.net/10204/4075
[25] Lopez DM, Blobel BGME. A development framework for semantically interoperable health information systems. International journal of medical informatics 2009;78(2):83–103. http://www.ncbi.nlm.nih.gov/pubmed/18621574
[26] http://en.wikipedia.org/wiki/Critical_success_factor