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A Framework for Evaluation of Enterprise Architecture Implementation Methodologies

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***Abstract*—**Enterprise Architecture (EA) Implementation Methodologies have become an important part of EA projects. Several implementation methodologies have been proposed, as a theoretical and practical approach, to facilitate and support the development of EA within an enterprise. A significant question when facing the starting of EA implementation is deciding which methodology to utilize. In order to answer this question, a framework with several criteria is applied in this paper for the comparative analysis of existing EA implementation methodologies. Five EA implementation methodologies including: EAP, TOGAF, DODAF, Gartner, and FEA are selected in order to compare with proposed framework. The results of the comparison indicate that those methodologies have not reached a sufficient maturity as whole due to lack of consideration on requirement management, maintenance, continuum, and complexities in their process. The framework has also ability for the evaluation of any kind of EA implementation methodologies.

***Keywords*—**Enterprise Architecture, Enterprise Architecture Implementation Methodology. EAIM, Evaluating EAIM, Framework for evaluation.

I. Introduction

ENTERPRISE Architecture (EA) is employed by enterprises for providing integrated Information Systems (IS) in order to support alignment of their business and Information Technology (IT). EA implementation methodology can describe any structured approach in order to solve some or all of the problems related to EA implementation. Moreover, it can comprise some distinct methods for developing EA within enterprise. EA implementation process is a defined series of activities directed to the target of producing EA description [9], [14], [17].

For the first time EA was introduced by John Zachman in 1987. The purpose of the founder of EA was to use architecture like civil inside of enterprises to reduce complexity of developing IS. At first he presented the framework to create skeleton for his purpose. Zachman's Framework contains abstractions and perspectives [25]-[27].

In EA project, enterprise architect must select a framework and an implementation methodology. Although, there are some EA frameworks which represent a method for implementing EA, they are neither usable for all enterprises nor complete [9].

The aim of this study is to provide an appropriate framework for evaluating the Enterprise Architecture Implementation Methodology.

The remainder of this paper is organized as follows: Section II is introduced Enterprise Architecture Implementation, the proposed framework is represented in Section III. Selected EAIM for comparison, results, and conclusion are expressed in Sections IV, V, and VI respectively.

II. Enterprise Architecture Implementation

A Zackman's Framework (ZF) (as first EA framework) is limited to architecture and does not include a strategic planning methodology [25]. In 1992 Steve Spewak introduced the first methodology for implementing EA. Spewak presented the EA planning to complete EA lifecycle. In other words, EA methodology complement EA framework. EA contains three principal phases, As-Is architecture, To-Be architecture, and migration plan [22]. In As-Is architecture (also known as baseline, current, and initial architecture), EA will be defined current situation of business and IT of enterprise by means of set of definitions which illustrate the current state of the enterprise's mission, business processes and technology's infrastructure. The key role of this stage is vision of enterprise [9], [10].

In To-Be architecture (also known as desired, future, target architecture) EA will be represented the desired architecture including future of business and IT based on vision of enterprise. This type of architecture is the result of enterprise's long-term strategies and plans. The key role of this stage is to identify appropriate ISs [9], [10]. In EA migration plan (also known as transition plan) is the essential strategy that will be employed for Transition from the As-Is to the To-Be one. The key role of this stage is using the proper implementation method [9], [10].

The Enterprise Architecture Methodology supports advanced development techniques and technologies. It covers all aspects of the EA lifecycle- planning for enterprise understanding projects, the analysis of business requirements, the design of systems, the evolution of systems, and the ongoing enhancements of all of the above. The methodology is both complete and concise, serving as a coherent guide for practitioner professionals. It allows paths and pieces of content to be selected and extracted for application on specific projects [9], [21].

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Well implemented EA helps a company innovate and change by providing both stability and flexibility. Today's there are several EA methods which they are introduced to provide a plan for developing tailored IS. These IS must address existing enterprise's challenges and update business structure of enterprise by ISs integrity [14]. EA implementing method can be independent or dependent to a framework. While EA framework tries to capture information from enterprise's business and IT, and model them, EA method tries to utilize models for developing appropriate ISs and IT Infrastructure for enterprise [4], [10].

III. Comparison Framework

This section describes a framework for evaluation selected EAIM. It comprises a set of criteria that addresses both generic EA attributes and features that are uniquely found in EAIM. It covers three major aspects of each EAIM: Concepts, Modeling, and Process [13].

Concepts: EA concepts are importance for enterprises generally and for EAIMs particularly. According to literature research, a number of considerable EA concepts that are generally addressed, including: definition of EA, alignment between business and IT, importance of repository, the association and communication among artifacts and EAIM's strategy, governance, roles and process are identified [5], [9], [24].

Modeling: since EA concepts provide basis for EAIM, thus the modeling for portray designs regarding to those concepts is generally the main part of any EAIM. A typical modeling comprises of the following major components: notation, syntax and semantics. Modeling different perspectives of enterprise are significant part of modeling that need to utilize in EAIM. Consequently, by using an appropriate modeling the EAIM could reduce the complexities of current and desired architecture, and transition plan effectively [5], [9], [19], [24].

Process: As mentioned above, the modeling is considered as a compulsory part of any EAIM. However, EAIM emphasizes the set of process and parts performed as part of the EA life cycle. These activities and steps form the process, which guide enterprise architect and business analyzer in EA implementation. A useful EAIM should cover the following stages, enterprise modeling, current architecture analysis, desired architecture analysis, managing and providing detailed design of projects, describing controlled transition plan, and implementation. EAIM that covers all parts of the EA development by considering EA concepts is a consistent and complete methodology [5], [9], [19], [24].

IV. Selected EAIMs

This study selects the following EAIM as the examples in order to utilize the proposed framework for comparing with other EAIM:

- EAP
- TOGAF
- DODAF
- Gartner
- FEA

A. Enterprise Architecture Planning

Enterprise Architecture Planning (EAP) was introduced by Spewak in 1992. EAP contains activities and processes in order to achieve To-Be architecture by considering four EA architectures including: Business, Data, Application, and Infrastructure. It is also known as the Wedding Cake. It covers two first perspective of ZF [21].

EAP specifies a plan for subsequent design and implementation EA. The ZF prepares the broad description for architectural layers, while EAP concentrates on developing and managing the process for making alignment between business and IT. Moreover, EAP is planning that concentrates on the development of matrixes for comparison and analysis data, IS, and infrastructure. Significant part of EAP is an implementation plan [21]. EAP provides the process of using architectures for the utilizing IS in order to support business and the plan for implementing architectures. It comprises the following phases [20], [21]:

- Initiation Planning
- Preliminary business model
- Enterprise survey
- Current systems and technology architecture
- Data architecture
- Application architecture
- Technology architecture
- Implementation plan
- Planning conclusion
- Transition to implementation

In 2006, EAP has been changed and some items were added into the prior model. The intent of this change was to refresh one part of the EAP approach and update the model. One of the added items was governance. The reason for adding governance into the new edition of EAP model was: through effective governance possible to become a real portfolio of approved transition plan projects. The revised EAP Wedding Cake model is an important part of the refreshment of the EAP approach. This refreshment helps to strengthen and reconnect EAP to the continually evolving stream of EA methodologies that are in use globally. In EAP update, it has presented several significant changes that reflect updates in how and when to do EA that it felt was needed to advance and refresh the originally defined process. This will help make EAP more current and hopefully still very useful in understanding how to implement EA in the public and private sectors [22].

B. TOGAF

The TOGAF Architecture Development Method (ADM) provides a tested and iterative process for developing EA. It comprises instituting an architectural framework, transitioning, developing architecture contents, and governing the comprehension of architectures. Mentioned activities are fulfilled by employing an iterative cycle of continuous architecture description and comprehension that permits enterprises to transform themselves in a managed manner in

accordance with business targets. TOGAF ADM is a methodology that describes an iterative method for EA development. Enterprise architect must be determined some features of TOGAF methodology such as: level of details, breadth of coverage, and extent of time horizon due to ADM does not provide prescription on those. The ADM phases are [23]:

Preliminary: It clarified the current architecture in an organization by way of using framework and concepts of EA.

ADM Cycle: It consists of the following phases: Architecture Vision consists of description of current architecture and desired architecture of business and IT views. Business Architecture depicts the current architecture of business and analyzes gaps between it and desired one. IS Architecture specifies the desired data and IS architecture by analyzing the requirements of them. Technology Architecture is employed to build up the basis implementation. It comprises eight sub-phases comprising: formation of current, considering perspectives, selecting services, creating architecture model, determining criteria, verifying business targets, conducting gap analysis, and defining architecture. Opportunities and Solutions comprises of assessment and choice of implementing options. Migration Planning concerns on prioritizing implementing projects in accordance with their dependencies. Implementation Governance concerns on governing of EA project particularly on implementing and deploying. Architecture Change Management concerns on future changes by using repeated surveillance process in business and IT which can cause new deployments.

Requirements Management provides the place for identifying and keeping requirements for other ADM Cycle phases.

TOGAF specifies a Technical Reference Model (TRM) for Enterprise Continuum (EC). TRM model base on Application, Application Platform and Communication Infrastructure and their interconnectivity depicts a system. Moreover, it describes quality of services that organized by the system and the Standard Information Base in the EC provides integrated information, management and IS standards for architecture development [23]. TOGAF ADM supports evolution of EA by way of EC as its knowledge base. Although, processes of each ADM phase are defined appropriately, ADM leaves flexibility of implementation to EA architects to decide needed activities for EA project from distinct set of possible results. In order to trace designing and deciding on architecture ADM suggests documenting of design rationale [23].

C. DODAF

The Department of Defense Architecture Framework (DODAF) is the holistic framework and conceptual model for enabling the development of EA particularly for DOD agencies. As conceptually DODAF is an EAF-in-practice like FEAF, but it was developed for a specific domain and enterprises, and was not designed to be used beyond those bounds. In contrast to more abstract methodology like Gartner, and TOGAF which were designed to solve general issue with EA development across a wide array of enterprises, DODAF was designed to solve a wide array of specific issues within a singular organizational context, the DOD. The DODAF method is Model-driven, that is specific templates of data that are used to aggregate and communicate data on a specific architectural issue. When these models are complete they become a “View” of a facet of the current DOD architecture. In DODAF 2.0, there are eight prescribed perspectives [7]:

- All
- Capability
- Data and Information
- Operational
- Project
- Services
- Standards
- Systems

DODAF, by using given perspectives focuses on the supporting decision makers guide the development of EA within the DOD whether the effort is on a strategic or tactical level.

D. Gartner

Gartner methodology believes that EA is about bringing together three constituents: business owners, information specialists, and the technology implementers. Bringing given groups together and merge them into the one vision based on values of business, cause project has succeeded; otherwise project has failed. In Gartner point of view success could be measured by pragmatic term [12].

According to Gartner point of view EA project must be started with understanding enterprise direction on business, not with finding its current position. This activity needs to listen to the enterprise strategic plan and understanding how it response to this plan. In order to obtain pure and concise information about enterprise, Gartner tries to achieve them in simple words, without concerning about recommended standard document, or technical babbling. The result of this method is providing common understanding about enterprise situation and strategic plan [12].

E. FEA

The Federal Enterprise Architecture (FEA) method is mainly concentrated on creating architectural method for governmental agency and is described in the FEA Practice Guidance. The segment-architecture development process consists of four steps including [1], [8]:

- Architectural Analysis- describes explicit vision of enterprise, and related to the organizational plan.
- Architectural Definition provides the To-Be architecture of the enterprise, considering design alternatives, documenting the performance targets, and developing an EA for enterprise, comprising business, data, services, and technology architectures.
- Investment and Funding Strategy- considers how the project will be funded.
- Program-Management Plan and Execute Projects - creates a plan for managing and executing the project, including milestones and performance measures that will assess

project success.

FEA, like DODAF is an EAF-in-practice, but its enterprise encompasses Federal Government of the USA. FEA is one of the more fragmented EAF and currently spans five documents: a five-part Reference Model (RM), a methodology, a maturity model, a best-practices guide as well as considerations as to how to have FEA compliment Service Oriented Architecture. The FEA Reference Model consists of the following models:

- Performance RM – for identifying and standardizing measurement of EA output;
- Business RM – for alignment the Federal EA beside practical;
- Service Component RM – for organizing hidden component and service for reprocess;
- Technical RM – for organizing current standard and technology in use;
- Data RM – for providing a standard technique for description, categorization and allocation the information inside the Federal Government.

The Federal Segment Architecture Methodology (FSAM) is offered as a means to implement FEA within a manageable segment of the Federal Enterprise, and follows a logical progression through project launch, strategic intent, system requirements, conceptual solutions, and preliminary planning. Moreover, FSAM offers a separate document delineating guidance to implement and adapt these initial plans to the specific context of the Federal Segment. A Practical Guide to the Federal Enterprise Architecture provides a process for developing an EA. The process steps overlap with those in the Spewak EAP processes. The Practical Guide adds governance more on tools, establishing a Program Management Office (PMO), transitioning, and marketing the EA. The practitioner can combine Practical Guide and EAP process ideas [1], [8].

V. Results

Based on the proposed framework a review on related research papers ([1]-[3], [6], [7], [11], [12], [15], [16], [18], [20]-[23]) and particular guideline of each selected EAIM was conducted in order to specify selected EAIMs based on comparison criteria. Table I shows the summary of results. Besides, the results of this study based on defined framework are:

Concepts: TOGAF provides appropriate governance and repository rather than the other by utilizing a specific model for them. Although, TOGAF describes required business and IT architecture in ADM, it more focuses on IT development and could not provide appropriate alignment between business and IT. Since FEA is derived by EAP, almost theirs attributes are same. However, EAP had some changes in 2006, but significant part of EAP still is strategy plan that designed based on four architecture layers including: business, data, application, and infrastructure. Although, DODAF is designed for specific domain, it almost considers all EA concepts in acceptable manner. In contrast of other EAIMs, Gartner more focus on development process and support adequate EA concepts.

Modeling: Utilizing appropriate modeling for both business and IT domains is essential for EAIM. Gartner and DODAF do not present a method for consistency and traceability. Although, FEA, EAP, and TOGAF provide appropriate methods for modeling, they are different in learning and using. TOGAF provides broad documents about its method and process but access and employing of them need more time rather the others. TOGAF mentioned that EA architects must select needed process for project from TOGAF phases and this is the place that causes difficult using due to its provide complexity on project. Dynamic EA aspect and complexity are the new issue which do not support by all selected EAIMs.

Process: TOGAF views EA implementation as continual process, thus it more focuses on continuum and repository. Moreover, TOGAF use requirement process in order to support ADM phases which other EAIMs do not use this feature. EAP and FEA like previous criteria have same condition, but, since EAP made for generic purpose, it updates in 2006 and support continual process. DODAF uses required activities in each process attribute in order to support EA implementation in DOD organization, but it does not use requirement process properly. Although Gartner does not consider all concepts attributes efficiently, it considers EA implementation by efficient plan that it comes from their vast experiences. The following results are achieved based on this research:

In concepts: almost most of mentioned EAIM cover all concepts. Strategy and Artifacts are supported by most EAIMs; in contrast Alignment and Repository are not utilized in most EAIM.

In modeling: EAP and FEA are in same situation (high grade) and TOGAF has fluctuates situation (in some attributes has high grade and in the others has low grade). Moreover, DODAF and Gartner are located in the last respectively. Selected EAIM do not have specific plan for depiction complexity and dynamic aspects of EA.

In process: although, step by step structure, detailed design, and implementation are most usable attributes in EAIMs, requirement, maintenance, and continual need to consider more due to lack of consideration in most EAIM.

TABLE I
SUMMARY OF COMPARISON

Aspects	EAP	TOGAF	DODAF	Gartner	FEA
Concepts					
Alignment	L	M	M	M	L
Artifacts	M	H	M	M	M
Governance	M	H	M	M	L
Repository	M	M	M	M	M
Strategy	H	H	H	M	H
Modeling					
Easy to use	M	L	M	M	M
Easy to learn	M	L	M	M	M
Traceability	M	H	L	L	M
Consistency	M	H	L	L	M
Different Views	M	M	M	L	M
Complexity	L	L	L	L	L
Dynamic	L	L	L	L	L
Process					
Requirement	L	H	L	L	L
Step by Step	M	M	M	M	M
Detailed Design	M	M	M	M	M
Implementation	M	M	M	M	M
Guidelines	M	H	M	L	H
Maintenance	L	M	L	L	M
Continual	M	H	L	L	L

Notation: H: high consideration or detailed and clear description; M: medium consideration or little description; L: low consideration or high level description

VI. CONCLUSION

This study presents the framework for evaluation of EAIM. The framework has proved its ability in evaluation of different EAIM, even if these methodologies are of very different nature. Based on the proposed framework we carry out comparison in three aspects: concepts, modeling, and process.

Particularly, the framework has been successfully applied for comparing five selected EAIM which they are different in scope and process.

According to the results obtained from the comparison, it must be underlined that current EAIM are neither complete nor effectiveness in order to support and covers all demands of EA implementation, because most of them are do not consider all needed process, modeling, and concepts by together.

In addition, although some EAIMs such as TOGAF have a highest grade in all mentioned aspects, they are still need to decrease complexities of process and modeling. Moreover, lack of consideration on maintenance, requirements and continual process are notable items which need to consider.

Finally, although this research does not cover all existing EAIM, selected EAIM are most well-known in EA project and some others EAIM are inspired from them. Furthermore, the proposed framework cover only a portion of the EAIM lifecycle or are focused exclusively on specific aspects of the development process. We will continue this research in future by providing comprehensive framework and selecting more EAIM. This research aims are useful for those who are looking for appropriate EAIM for theirs project by provided information, especially for practitioners and enterprise architects.

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