EAFoC: Enterprise Architecture Framework Based on Commonality

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Abstract The recent rapid development in information systems (ISs) has resulted in a critical need for integration and interoperability between heterogeneous ISs in various domains, using specific commonalities. However, stovepipe systems have been caused due to inconsistencies in planning IS architecture among stakeholders. So far, there has been no research on an enterprise architecture framework (EAF) that can satisfy with the coefficient factors of system architecture (SA) and enterprise architecture (EA). This paper proposes a new EAF that can resolve the problems inherent in existing legacy EAFs and their features. EAFoC (Enterprise Architecture Framework based on Commonality) is based on commonality that can be satisfied as the coefficient factors in both SA and EA within a common information technology (IT) domain. Thus, it should be possible to integrate an established heterogeneous framework for each stakeholder’s view. Consequently, the most important contribution of this paper is to establish the appropriate EAFoC for the development of consistent IS architecture, smooth communication among stakeholders, systematic integration management of diversified and complicated new IT technologies, interoperability among heterogeneous ISs, and reusability based on commonality with other platforms.

Keywords enterprise architecture (EA), enterprise architecture framework based on commonality (EAFoC), enterprise integration (EI), requirements engineering process, system architecture (SA)

1 Introduction

As information technology (IT) becomes an increasingly important part of daily life, nations and organizations must have adequate IT systems to survive such intense competition. The architectures of information systems (ISs) are becoming increasingly complex and are changing rapidly to match IT development. Stakeholders developing ISs review these issues differently, resulting in potential communication problems with regard to maintaining alignment with IS development. Furthermore, there are situations where developers create stovepipe systems, and these systems do not allow interoperability with other systems or each other. This can result in “information islands” [1,2].

The framework of an IS to be developed should be consistent from stakeholders’ viewpoint. This is necessary for future interoperability with heterogeneous IS systems. In the current state of IS development, Enterprise Architecture Frameworks (EAFs) such as development blueprints, were not established properly in the early stage of IS development and, as a consequence, middleware more costly than the original IS development, must be installed for interoperability.

To achieve enterprise integration (EI) among heterogeneous ISs, it is very important to satisfy the technical requirements of IT; there is also a need for information technology management (ITM). These days, several technologically advanced countries are adopting EAF as an optimal solution to various IS integration problems in the field of IS architecture [3-6].

However, legacy EAFs do not include systematic stages of SA (System Architecture) and EA (Enterprise Architecture) development at a maximum or minimum level; they also lack specific processes such as an EAF development process for developing IS architecture and templates. Therefore, it is difficult to apply them to real IS architecture development. The development process of IS architecture is also emphasized, based on EAFoC (Enterprise Architecture Framework based on Commonality). Commonality between frameworks is extracted; commonality proposed in this paper refers to the minimum common content that is reusable and easy to apply to IT system development in each domain. That is, it is the coefficient factor to be satisfied for both EA and SA features in a common IT domain. Therefore, for systematic ITM, this research proposes new EAFoC, correcting problems in current legacy EAF. Legacy EAFs have a similar disadvantage when solving the stovepipe system problem; for example, a new EAF has to satisfy both EA and SA [3,5,7-10] inside a common IT domain. EAFoC in this research was approached from the problem that previous EAFs overemphasized either EA or SA, and there was no structured development process.

The general outline of this research is as follows. First, IS EA to be developed, develops SA for identified projects and implements this SA. Thus, this research attempted to align EAFoC through vertical, horizontal, and scope integration of stakeholders’ viewpoints of information system development, is defined. Products to be developed using EA and SA procedures are specified as mandatory and supporting from stakeholders’ viewpoints, and specific guidelines for development are crafted into a requirements engineering process. This is the optimal solution to solve the integration and interoperability problems presented in previous research.

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Previous work\cite{11,12} is described as follows. The first is focused on national defense EAF that can be applied in the military domain. The second is to propose an outline of EAF based on a common IT domain for improving interoperability among heterogeneous systems. Therefore, in this paper, an advanced EAF model is proposed, to be satisfied with coefficient factors in SA and EA.

The subsequent sections of this paper are organized as follows. Section 2 introduces the comparison of legacy EAFs in the phase of EA and SA. Section 3 describes the proposed EAoC model using mathematic formalism. In addition, a concrete model for matching EAoC, illustrative mandatory and supporting products are presented. Section 4 presents the IS architecture for product development process using EAoC. Section 5 presents how the framework is applied using requirements engineering, allowing for development of EA as well as SA. The proposed EAoC model is also quantitatively evaluated in terms of alignment and interoperability of ISs with stakeholders’ participation in the development of the IS system in the military domain using the EA effectiveness index measuring matrix method as a case study. Section 6 is the conclusion.

2 Related Work

2.1 Enterprise Architecture

The term “enterprise architecture” originated from the ideas of “business” and “organization”. Enterprise architecture includes the process defined by sets of activity units. EA describes the business process of IT by creating a relationship between IS architecture used in the organization and in each system\cite{13,14}. EA also defines strategic information resources as strategic business assets, according to new technology and information in need of adapting to changing requirements\cite{15,16}.

The Enterprise Architecture Framework (EAF) is a way of examining an enterprise and detailed architecture composed by the enterprise’s features; it is also the highest level of framework concept to explain the relationship between these entities. An EAF provides directions for developing various architectures and organizing detailed architecture models and architectures that manage tasks inside an enterprise as well as communication to develop the complicated structures of an enterprise\cite{17}.

2.2 Zachman Framework

This framework was presented by John A. Zachman in 1987. It consists of six columns and five rows with respective views and perspectives of planner, owner, designer, builder and sub-contractor. Their attributes are presented by 5W1H (what, how, when, who, why)\cite{18,19,20}. The Zachman Framework (ZF) provides clarity in a complicated enterprise, making it possible to identify models for some projects, and is an important factor in alignment. The ZF is the de-facto framework for providing a model that accurately describes an enterprise’s cell, however this framework is too idealistic in developing IS architecture. Furthermore, it is challenging to apply because there is no definition of specific products\cite{8}. Another disadvantage is that there is no process for application of the architecture, making it difficult to develop an architecture product.

2.3 C4ISR AF

The Command, Control, Communication, Computer, Intelligence, Surveillance, and Reconnaissance Architecture Framework (C4ISR AF) was developed by the Architecture Working Group (AWG) of the United States Department of Defense in 1997. This framework presents a series of rules to control the arrangement of system components, interaction and interdependence to sub-components in a three-dimensional structure composed of operational, system, and technical views\cite{3,4,9}.

Especially, C4ISR AF provides 27 concrete templates to facilitate target IS development by using operational, systematic and technical architectures’ view. However, it does not provide conceptual perspectives and views as in the ZF and support the development process guidelines for detailed architecture.

2.4 Standard Based Architecture

In 1996, the United States Department of Defense developed Standard Based Architecture (SBA), which includes seven processes performed in stages\cite{10}. Although it is simple, it provides an effective procedure for stakeholders to follow; it is a standard architecture that describes business, information, applications and how-to mapping for the technology view. However, it lacks concrete methodology for adapting to IS development. SBA is a framework for the development of standard-based architecture, and can be applied to the development of EA as well as SA. It clearly defines the process and detailed activities at each stage and provides a template of the product. However, this framework lacks a detailed method and theory for application development.

2.5 Federal Enterprise Architecture Framework

The Federal Enterprise Architecture Framework (FEAF) introduced in 1998 by the Chief Information Office (CIO) consortium provides guidelines for EI to the United States federal government\cite{7}. It is based on prioritizing certain architecture segments according to common business practices, while providing a continuous mechanism for identification, development, and documentation. The role of this framework is to integrate each segment for EA. In the first step of the process, an architectural segment is selected, a vital part is determined, and then priority is developed separately for each segment. Lastly, the segment can be integrated into