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JOURNAL OF INFORMATION SYSTEMS APPLIED RESEARCH

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Where We are with Enterprise Architecture

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Abstract

Enterprise architecture has been continuously developing since the mid-1980s. Although there is now 35 years of research and use, there is still a lack consistent definitions and standards. This is apparent in the proliferation of so many different enterprise architecture frameworks. Despite the significant body of research, there is a need for standardization of terminology based upon a meta-analysis of the literature. Enterprise architecture programs require commitment throughout an organization to be effective and must be perceived to add value. This research offers an initial basis for researchers who need to expand and continue this research topic with an actual meta-analysis, and for practitioners who would like to use an efficient method for EA projects.

Keywords: Enterprise Architecture (EA), frameworks.

1. INTRODUCTION

Enterprise architecture (EA) is in its adolescent phase (Bucher, Fischer, Kurpjuweit, & Winter, 2006; Schelp, & Stutz, ,2007; Steenbergen, & Brinkkemper, 2008). Like an adolescent, to some it is surprising in its capabilities and to others merely a drain on resources. Enterprise architecture is not new; however, it is also not a mature discipline. We still have not developed a standard definition for what it means to an organization. You will find many definitions in the literature and this is disputably since EA draws on several associated domains and disciplines, such as systems engineering, organizational science, industrial engineering and information systems (Laplame, Gerber, Der Merwe, Zachman, De Vries & Hincklemann, (2016); Jallow, Demian, Anumba, & Baldwin, 2017). EA began in the 1980s and has evolved as a method for overseeing the information technology resources inside an organization (Steenbergen, & Brinkkemper, 2008). Its importance continues to grow (Boar, 1999). De Vies et al. (2014) and Laplame (2012) offered further specific definitions and debate on the significance and

meaning of EA. Deriving from the fields of software engineering, software architecture, and systems engineering, the EA field struggles to distinguish itself and prove that it is a valuable undertaking that is able to generate significant value to the organization.

In the 1980s, IBM started to explore ways to illustrate the organization in an apportioned, isolated, and integrated approach (Carlson,1979; Carlson, 1980; Zachman, 1987). John Zachman (1987) launched his "Framework for Information Systems Architecture" which was later known as the "Framework for Enterprise Architecture, (ZFEA)" afterward "Enterprise Architecture—A Framework™," then the "Zachman Framework for Enterprise Architecture," followed by the "Zachman Enterprise Architecture Framework," and lastly as the "The Zachman Enterprise Framework.

Various present EA frameworks were inspired by the ZFEA such as the Extended Enterprise Architecture Framework (E2AF), Enter- prise Architecture Planning (EAP), the Federal Enterprise Architecture Framework (FEAF) and the Integrated Architecture Framework (IAF) (Schekkerman, 2004).

In 1987, the Object Management Group was established and started the Common Object Request Broker Architecture (CORBA).

In 1992, Sowa and Zachman (1992) extended the original version of the Zachman "Framework for Information Systems Architecture." Also in 1992, Steven Spewak published *Enterprise Architecture Planning Developing a Blueprint for Data, Applications, and Technology*, and promoted the data-centric method. Spewak and Hill (1992) highlighted the need to examine what we do as part of an EA effort, distinct from recognizing corporate business goals and how IT enables business goals.

Schekkerman (2005) conducted a survey by the Institute for Enterprise Architecture Development. He reported that 95% of organizations appreciated the significance of EA and that EA can focus on IT alignment, business change, and a transformation road map. Nonetheless, some organizations placed varying levels of emphasis on architecture themes, such as enterprise architecture (15%), technology infrastructure architecture (15%), security architecture (15%), information systems architecture (14%), information architecture (13%), software architecture (11%), and less on business architecture (10%), and governance architecture (7%).

EA produces a different background to present decision-making in the IT world. It permits the corporation to dispute customary methods that stop change and to mold enabled situations that interrupt older patterns of control whilst reinventing their critical inputs in a novel way. EA involves a socio-technical base, where the human part is interlocked with the technological part while forming a framework for an efficient organizational system (Applebaum, 1997; Cherns, 1976; Trist, Higgin, Murray, & Pollock, 1963). In its operational configuration, EA offers a paradigm for IT that outlines and connects data, hardware, software, and communications means, as well as sustaining the enterprise (Richardson, Jackson & Dickson,1990). EA is valuable to any organization, as it offers the blueprints to advance and create an information system and IT inside an organization. EA is a practice and developing field meant to advance the administration and operation of complex organizations and their information systems. Many believe that EA may occupy a primary part facilitating the design of future enterprises (Lapalme, Gerber, Van der Merwe, Zachman, Vries, Hinkelmann (2016).

Zachman (1987, 1999), occasionally described as the father of EA, declared that stating how to describe EA produces problems, as a series of architectural interpretations and depictions exist, instead of a sole architecture. The immaturity of EA (approximately 20 years) has resulted in the lack of a consistent definition. Zachman viewed EA as a collection of basic, descriptive artifacts that establish the knowledge substructure of the organization (2000a). Even though EA is useful and is taught in universities around the world, there are no industry-standard terms to define the boundaries of EA as a conceptual framework, as an applied framework, and as a set of constructs.

The objective of this research is to examine the theoretical and applied foundations of EA in regards to two of its main prominent features: (a) the techno-centric aspect of EA, followed by (b) its interdisciplinary makeup that comprises business, engineering, information sciences, and project management, among others. The purpose of the paper is to expand the advancing an EA frameworks to continue to move towards demonstrating that it provides a positive return on investment for organizations. To this objective, this research in progress will generate the subsequent contributions:

- It discusses the center and scope of EA by defining the boundaries of what EA should adopt.

- It reviews the existing frameworks to propose a unified framework that can be used to generate significant value to the organization.

The remainder of this paper is organized as follows: the literature review, discussion of the needs for standardization, and the resulting issues.

2. LITERATURE REVIEW

2.1. The Era of Enterprise Architecture

In 1997, interest in EA was mounting in both the government and business sector. Zachman not only declared that the era of EA is here, he also declared EA as the issue of the era (Zachman, 1987). The U.S. government's view was in alignment with Zachman's statement. In January of 1998, the CIO Council Strategic Plan, directed by the Clinger-Cohen Act of 1996, guided the advancement and protection of a Federal Enterprise Architecture to exploit the advantages and uses of information technology within the government.

In 2012, OMB Circular A-130, "Management of Federal Information Resources" was reviewed and re-released, including communication comparable to the 1997 OMB memo. The reviewed Circular A-130 defined EA as the precise depiction and record of the existing and anticipated connections amongst industry and management processes and information technology. It explains the present architecture and intended architecture to incorporate the guidelines and principles and systems life cycle information to enhance and sustain the situation that the organization desires to produce and sustain by controlling its IT portfolio. Moreover, the EA should present a plan that will allow the company to sustain its existing situation and additionally function as the roadmap for evolution to its intended setting.

Beznosov (2000), in his technical report on information EA problems and perspectives offered a discussion on the various definitions for EA as does the draft *Enterprise Architecture Body of Knowledge* (EABOK) presented by Hagan (2004). The EABOK assumed that EA encompasses illustrations of industry practices or processes, data, computing systems for mission-related and business support, networks and additional technology substructure for both the existing and intended architectures. The EA comprised a standard profile, security specifications, and an evolution or transition plan. EA is connected to the organization strategic plans and is a main base for investing decisions.

2.2. Enterprise Architecture and Frameworks Defined

Typically, an enterprise is outlined as an established business or organization to produce a product or extend a service.

The IEEE Standard 1471-2000 (2000) defines architecture as the structural configuration of a system represented in its pieces, their connections to each other, the ecosystem, and the driving principles for development and growth. Architecture is the outline of any arrangement of structure, whether physical or conceptual, actual, or virtual. Architecture has several meanings in the systems engineering community where Rechten (2001) defines architecture as the top down description of the structure of the system, while Maeir (1998) defines architecture as the set of information that defines a system's value, cost, and risk. Bernard (2006) defined enterprise architecture from a program and documentation perspective.

A framework is a method to understanding EA. Accordingly, it is also a method to understanding the dynamics of an enterprise. A framework is a configuration, outline, or a plan. A framework is a group of assumptions, views, guidelines, and measures that document a method to describing realism. Frameworks help individuals organize and assess comprehensiveness of integrated models of their organizations (Armour, Kaisler, & Bitner, 2007). Frameworks suggest an enterprise structure through which organizations advance. An EA framework is consequently a way of sense-making in the composite ecosphere of change, in the domain of EA (Bernus, Noran, & Molina, 2015)..

EA is the architecture that illustrates an enterprise as an arrangement of distinctive information systems, with connections (combination points) to each other and the environment (Hagan, 2004). Additionally, EA has to include discourse on the standards directing the design and growth of the information systems and IT.

EA builds the capability to identify and determine the lasting appeals to mix, configure, transform, and sensitize the business to technology and to the market.

There have been many definitions of EA presented by various researchers. EA has been

defined as a theoretical framework of how an enterprise is created, outlining its main elements and the connections among these elements (Rood, 1994). According to Armour et al. (2007), EA is a meta-architecture that comprises many information systems and their relations (technical infrastructure). Yet, since it may also encompass additional views of an organization—which can incorporate work, process, and information—it is at the top level in the architecture pyramid. Chung and McLeod (2002) presented EA as a thorough mockup of an enterprise, a principal sketch, which works as a planning, configuration, and mixing guide and force for an enterprise. The Electronic Government Act of 2002 described EA as the strategic information resource that outlines the mission, the needed data to achieve the mission, along with the technologies needed to execute the mission. Perks and Beveridge (2003) outlined EA as the group of strategic and architectural elements that embody the information, corporate system, and technical architectures. The Open Group defined EA as the harmony across all the different components that make up an enterprise and how those components connect (Schekkerman, 2004). EA is the chain of practices, procedures, methods, and relationships needed to initiate an enterprise-wide inclusive and dependable IT architecture for supporting the enterprise's business activities (Kaisler, Armour & Valivullah, 2005). EA also incorporates the provisional procedures for applying innovative technologies in response to the varying mission needs. The Meta Group, which merged with Gartner in 2005, described EA as the holistic expression of an organization's key business and processes.

The EA should contain a standard architecture, a target architecture, and a migration outline (U.S. Department of Commerce, 2007). Thus, EA is recognized as the central initiative—either in part or as a whole—extended to its suppliers, partners, or customers, including the standards governing its design and growth (Open Group, 2003 & 2009) (Winter, & Schelp, 2008) (Zachman, 2000a). EA involves both corporate strategy and technology [29] [36] (U.S. Department of Commerce, 2007). EA has a process model that guides the EA development (U.S. Department of Commerce, 2007).

Schekkerman (2008) asserted that EA is a comprehensive manifestation of the organization, a principal proposal that represents a collaboration force amongst phases of business planning such as goals, ideas, schemes, and governance principles. EA focuses on attributes of business operations such as business terms, enterprise configuration, procedures and data; parts of mechanization such as information systems and databases; and the supporting technological infrastructure of the business (Schekkerman, 2005)

According to Zachman (1997), Armour, Kaisler, and Bitner (2007), the Open Group Architecture framework (TOGAF) (2003, 2009), and Langenberg and Wegmann (2004), EA is a significant tool for operationalizing and instigating policies and strategies. The primary motive behind the need of an EA is to provide the basis for future technological expansion and to verify the current technology and process structures of an enterprise. EA encompasses a collection of exceptionally precise information and artifacts for future re-use. It allows companies to attain the exact balance between IT competence and business innovation. It can also decrease development, support and maintenance costs, increase portability of applications, develop interoperability, and offer an improved capability to tackle key enterprise-wise issues such security, governance, privacy, and mobilization (Open Group, 2003). EA is also considered the blueprint of the architectural framework that drives and communicates the business strategy and information systems visions (Armour, Kaisler, & Bitner, (2007)

Though there are numerous definitions of enterprise architecture, each points to the need for a framework to act as a coordinating function. Frameworks coordinate the varying levels of organizations and information systems and serve as a planning tool for prioritizing IT resource allocation.

2.3. Enterprise Architecture Frameworks

Enterprise architecture frameworks (EAFs) have been utilized to design, plot, and supervise broad enterprise deployments for more than three decades. EAFs are significant instruments employed by systems engineers and are vital to describing enterprise information architectures. They are progressively used as a surrogate for managing whole organizations, or in other words, enterprises. Enterprises denote complex, multi-disciplinary, socio-technical systems.

An enterprise architecture framework (EAF) represents a methodology to support an organization in certifying that its principal systems meet particular common tasks or objectives.

Given that the motivation for adopting enterprise architecture is to control change and intricacy, it is significant that one may overlook the need to

retain and develop the architecture itself (Magoulas, Hadzic, Saarikko, & Pessi, 2012).

Enterprise architecture models or frameworks are created to help managers better understand the organization's assets, operations, and production, resulting in improving decision-making. EA involves numerous forms of architectures, each with its unique structure of deliverables, analysis methods, processes, and participants. Due to the significance of the role of EA in the existing business environment, numerous enterprise architectural frameworks have been created and suggested by researchers and practitioners such as Zachman's IS Framework (1987) the Index Model (Boar, 1999, TOGAF (2003), and DoDAF, among others.

Enterprise architecture is envisioned to deliver the essential plasticity to complete change in the fast-paced IT and corporate environments (Cook, 1996; Veasey, 2001; Watson, 2000). Enterprise architecture offers a stage to steadily address all the activities in the organization and several linked concerns, such as the information and technology that maintains the business processes and activities.

There are many EA frameworks (EAF) available to assist the architects in their work (Sage & Cuppan, 2001). Matthes (2011) stated that there is about 50 different EA frameworks. In his publication, Matthes offers a comprehensive review of 34 EA frameworks, founded on distinctly structured and well defined principles. Existing EA frameworks have some shortcoming and inadequacies. These setbacks influence the absence of standard EA framework and its implementation in any enterprise

A sample by developers of the frameworks and industry is presented in Table 1.

Table note. Also for NIST are the following:
DRAGON 1 (Open Group)
BRM (Sanjeev Mishra)
OBASHI
SOMF (Michael Bell)
ASSIMPLER (Mandar Vanarse)
PEAF (Kevin Smith)
Avancier Methods (AM)
Dynamic Enterprise
Extended Enterprise Architecture Framework (E2AF, Schekkerman)
EACOE (https://eacoe.org/)
Index Model (Boar, 1999)
BPTrends EA (Harmon, 2007)
Model Driven Architecture (MDA) (Miller, Ambler, Cook, Mellor, Frank, & Kern,2004).
Integrated Architecture Framework (IAF)

Table 1. Enterprise architecture frameworks

Consortia	Government	Defense	Open Source	Proprietary
TOGAF	EASAAF (European)	AGATE (France)	MEGAF	Zachman
ARCON	GEA (Queensland)	DNDAF (Canada)	Praxeme	SAP Enterprise Architecture Framework
GERAM	TEAF (U.S. Treasury)	DoDAF (US)	SABSA	IFW (IBM Information Framework)
IDEAS Group	NORA (Dutch)	MODAF (UK)		SAM
ISO 19439	FEAF (U.S. Federal CIO Council, 2006)	NAF (Nato)	TRAK	Purdue Enterprise reference architecture (Theodore Williams)
RP-ODP	FDIC (U.S. Federal Deposit Insurance)	NASCIO		IAF (Capgemini)
	NIST (U.S. National Institute of Standards and technology)			DYA (Sogeti) *See also Table note.

2.4. Enterprise Architecture Perspectives

2.4.1. The federal government perspective. The history of EA in the U.S. federal government may best be reviewed by examining the regulations and actions taken by Congress in the past 20 years. As we know, Zachman was a primary contributor in the U.S. Department of Defense's (DoD) effort to initiate EA in 1994, which was formerly identified as the Technical Architecture Framework for Information Management (TAFIM) (Sessions, 2007). Inside the DoD, the usage of architecture encompasses a large area, starting with the creation of TAFIM. In 1996, Congress approved a bill recognized as the Clinger-Cohn Act of 1996, or the Information Technology Reform Act, which instructed all federal agencies to employ IT planning processes to develop the efficacy of IT investments. This act assisted in the evolution and development of enterprise architecture frameworks. These included the Federal Enterprise Architecture (FEA), and Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR), which was renamed as Department of Defense Architecture Framework (DoDAF) (U.S. Federal CIO Council, DoD Deputy Chief Information Officer, 2005).

2.4.2. The private sector perspective. The emerging discipline of enterprise architecture is traced to Zachman (1987). According to Zachman (1987), several reported disputes included (a) the management of complexity in the distributed computing environment and (b) multiple and differing methodologies to systems architecting that decreases complication within the design of IT-enabled systems. EA offers the basis for high-performing enterprises to implement their strategies. Additionally, it aids in breaking down complications while driving change by aligning business, technology, and strategies, and ultimately improving decision-making. Moreover, according to Hoogervorst (2004) there is a bigger need for an integrated design of the enterprise.

3. CONCLUSION

The advancement of the discipline is revealed in numerous existing scientific publications. Within three decades, Gampfer, Jurgens, Muller and Buchkremer (2018) identified about 4000 journal articles and conference papers of which EA is a main subject. The review of EA uncovers numerous interpretations and definitions of EA where some concentrate on mission, strategy, and vision (Rood, 1994), while others concentrate on the aspects of business and resulting technology. In addition, the focus of EA research has shifted from understanding EA in the early years to managing EA today.

At present, organizations still struggle with the number of various disintegrated models, tools and frameworks and methods recommended to them by numerous disciplines and researchers, and the subsequent agreement is less than consistent (Doucet et al., 2008).

Despite the benefits that enterprise architecture claims to provide, for more than a decade, writers and organizations raised concerns about enterprise architecture as an effective practice. To provide an integration model, recommendations can be made for future development of a unifying framework for enterprise architecture. These include the following:

1. The manner in which EA is defined varies, so we need to identify a common definition of the terms enterprise and framework in the context of enterprise architecture research.
2. The scholarly literature indicates that enterprise architecture frameworks presuppose different disciplinary frameworks. So, within our future project, the architecture of the models and their interrelationships will be investigated. The results will be used to develop a unified framework.

The EA community is presently broken by industry (IT/systems engineering, industrial, public sector, defense, service businesses, scientific/applied research and by schools of thinking. Academia, research society, Industry Associations in addition to government bodies need to get together to work on advancing the body of knowledge, and resolve all ambiguities in this field (Bernus,Noran & Molina, 2015). Our future research will develop and review a standard taxonomy of enterprise architecture that will pave the way for EA as a freestanding discipline. We will review closely GERAM, the sense-making instrument that may be utilized by anyone working on the development of their own respective architecture frameworks. Bernus, Noran & Molina (2015) stipulated that GERAM may be a significant baseline meta-framework for EA.

EA projects comprise two principal methods: an Enterprise Architecture Framework (EAF), and an Enterprise Architecture Implementation Methodology (EAIM) (Rouhani, Mahrin, Nikpay, Ahmad & Nikfard, 2015). The use of an enterprise architecture framework within an organization

requires a commitment to an enterprise architecture program and a culture conducive to its maintenance. Although frameworks can provide a useful guide and standardize documentation, they also can be viewed as requiring additional processes within the organization. The value of an enterprise architecture program must therefore be demonstrated. EA frameworks define processes that must be followed, so the processes must support the needs of the organization. Enterprise architecture frameworks look to be comprehensive in scope, though most have been criticized for failing to address key components of an information technology program. Significant differences exist within the myriad of frameworks, so sifting through all of them to pick which one most closely aligns with an organization's needs can be burdensome. Any enterprise must weigh the benefits and drawbacks when considering adopting or adapting EA.

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