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ENTERPRISE ARCHITECTURE: CHARTING THE TERRITORY FOR ACADEMIC RESEARCH[1]

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Abstract

The concept of Enterprise Architecture (EA) has long been considered as a means to improve system integration and achieve better IT-business alignment by IT professionals. Recently, the subject gained significant visibility by IS academics. In this paper we provide an overview of existing EA research and practice and present key functions and benefits of EA as seen by IT professionals based on the results of the SIM Information Management Practices Survey. We then identify and discuss directions for future research, including the development of EA definition and nomological net, as well as development of theoretical propositions regarding EA business value.

Keywords: enterprise architecture, ontology, analysis, design, documentation, IT-business alignment

Introduction

Information systems (IS) have been credited with a variety of organizational benefits, including improved efficiency, automation of repetitive tasks, improvements in inter- and intra-organizational communications, and competitive advantages. The process of creating and implementing an IS is associated with "by-products", such as an assortment of representations of the enterprise and its various aspects, including business process maps, data models, decision trees, and other similar artifacts. Because such representations are often discarded (or at best relegated to storage) after the corresponding systems are implemented, they are considered an expense, and organizations strive to minimize the efforts involved in the creation of such artifacts. Was Fred Brooks (1986) wrong when he opined that getting the requirements right is the essence of being an IS professional?

By implementing pre-packaged enterprise solutions, organizations adopt standard process and data configurations thereby presumably reducing the need to understand their own businesses. Although often resulting in satisfactory outcomes at the sub-system level, this lack of attention to overall context and reusable requirements leads to wide-ranging enterprise degradation since the knowledge about the enterprise needed to implement one system is often lost or otherwise not available

[1] The survey portion of this project was sponsored by the Society for Information Management (SIM), the SIM Enterprise Architecture Working Group (http://eawg.simnet.org), and the IS Research Center at the University of North Texas (http://www.unt.edu/isrc/).

[2] Author's names appear in alphabetical order.

for use when creating or modifying another. The result is the difficult to integrate and change, often misaligned, amalgamation of information systems we call our "legacy" or "stovepipes".

Enterprise Architecture has been suggested as the path to a comprehensive view of enterprise-wide requirements and thereby improved system interoperability and flexibility, as well as at least the onramps and signage on the highway to business-IT alignment. While the concept of EA has gained acceptance among IT professionals, it has been largely considered an "IT thing" resulting in difficulty obtaining broad support from business managers for EA activities. Although many IT and business professionals agree that EA offers significant benefits beyond the IT function, little research exists to support or refute such claims.

The purpose of this paper is to foster a dialog about EA by examining how EA and its benefits are viewed by IT professionals and by suggesting directions for future research. Specifically, we set the stage by reviewing relevant academic research and the state of EA practice. We then present results of a survey of 376 IT professionals, members of SIM, detailing their views on the purposes and benefits of EA and attempt to identify key underlying themes by means of factor analysis. Finally, we propose directions for future research on EA and its business value.

EA in Academic Research and Practice

Enterprise Architecture has evolved from academic and practitioner, as well as federal, state, and local government efforts. The data modeling techniques and system analysis and design methods developed and promulgated in the 1970s and 1980s by ideas like structured analysis and design methods (DeMarco, 1978; Yourdon, 1975), Entity-Relationship diagrams (Chen, 1976), and Information Engineering (Finkelstein and Martin, 1981) laid some of the foundations. The publication of John Zachman's framework for EA in 1987 provided the ontology to tie all the pieces together into the context of the whole enterprise. Yet until recently the construct of EA itself did not enjoy much attention by academics. Although in the last 1990s the term "enterprise architecture" appeared in several academic research publications, such studies either adopted a black-box approach to EA (El Sawy, Malhotra, Gosain, and Young, 1999), or treated EA as a close synonym to Information Architecture (e.g., Miller, 1997), a term commonly used in practice as a synonym for data architecture.

During the early and mid 2000s, EA gained visibility through a number of prominent academic publications (albeit mostly still appearing in practitioner-oriented academic journals). Ross (2003) suggested EA as a roadmap for IT-business alignment, an issue of uppermost importance for IT professionals (Luftman, 2003). A recent article by Venkatesh, Bala, Venkatraman, and Bates (2007) provided a review of EA maturity at the Veterans Health Administration. Boh and Yellin's (2007) research examined the effect of EA on information sharing and integration across disparate units in an enterprise. Other noteworthy developments included the development of the four-stage EA maturity model by the MIT's Center for Information Systems Research's (Ross, Weill, and Robertson, 2006) and the release of the book *Enterprise Architecture as Strategy* (Ross et al. 2006). Reflecting the perceived importance of EA research, the Association for Enterprise Architects began publishing the *Journal of Enterprise Architecture* in 2005.

The practitioner view of EA has been largely shaped by John Zachman's ontology of the enterprise and its architecture, which was used at IBM in the early 1980s, first published in 1987, additionally detailed in 1992 (Zachman, 1987; Zachman and Sowa, 1992), and further elucidated with the publication of the Enterprise Framework Standards (Zachman, 2005, 2007). Zachman was the first to contend that "the business strategy and its linkage to information systems strategy … ultimately manifest themselves in architectural expression" (1987, p. 277). Interestingly, since Zachman's "Framework for EA" is about the whole enterprise and spans the logical-physical continuum as well as identifying the need to independently define the enterprise in terms of all six interrogatives (i.e., who, what, where, why, when, how), it can provide IS researchers a means for categorizing EA-related publications, models, tools, and so on.

The US Congress passed several pieces of legislation in the 1990s in an effort to improve government management as well as IT investment. The Clinger-Cohen Act (CCA) required that every federal agency have a Chief Information Officer (CIO) responsible for, among other things, an Information Technology Architecture. Responding to the need for guidance as federal agencies began to create their EAs, the Office of Management and Budget (OMB) facilitated the creation of a federal CIO Council which sponsored the development of the Federal Enterprise Architecture Framework (FEAF) in 1999 (OMB, 1999). OMB and the General Accountability Office (GAO) published *A Practical Guide to Federal Enterprise Architecture* in 2001 to provide guidance on setting up an EA program and for developing and maintaining an EA (OMB, 2001). Around

that time the GAO also developed an EA Maturity Model and a set of measures to assess EA progress and practices (GAO, 2003).

Despite all this, in 2002 the federal government still did not have a government-wide architecture or even a set of standards upon which to implement its e-government initiatives. Thus OMB began to promulgate architectural guidance and implementation standards through five reference models (Business, Performance, Service Component, Data, and Technical). Many private groups offer various EA-related trainings and certifications programs; both Gartner and Forrester have EA research practices, and many vendors offer EA-related conferences, services, and products. Yet, with little EA-related university-level education in place[3], the EA practice world remains somewhat disjointed and stove-piped. The need for a more consistent conceptualization of EA lead to the recent formation of the SIM EA Working Group (SIMEAWG) charged with the study and dissemination of successful EA practices. In the next section we present the results of the SIMEAWG-sponsored survey that reflects the views of EA held by IT professionals.

EA functions and benefits: SIMEAWG Survey

In order to better understand the view of IT professionals regarding the value of EA, a survey was conducted under the auspices of the SIMEAWG. Preliminary definitions of EA functions and benefits were developed by the authors based on existing EA literature, including EA maturity models as well as EA and IT-business alignment research (e.g., Luftman and McLean, 2004; Luftman, 2007; van der Raadt, Hoorn, and van Vliet, 2005; van der Raadt, Soetendal, Perdeck, and van Vliet, 2004). Enterprise architecture maturity models were integrated as a foundational structure of many of the questions within the survey. This provided an opportunity to capture and assess the processes, capability, performance, maturity, and quality of EA activities conducted in industry. A variety of EA maturity models were reviewed, with a core of four EA maturity models used for instrument development. Additionally, the key IT and business alignment enablers and inhibitors posited by Luftman and McLean (2004) were integrated into the survey to reflect the importance of alignment to EA. The definitions of EA functions and benefits were further refined through a modified Delphi study approach with an expert group of EA professionals from industry and academia. The final survey included six statements related to the key purpose and functions of EA and 20 statements regarding potential benefits of EA. The respondents were asked to express their agreement or disagreement with the suggested statements on a 5-point Likert scale.

An invitation to participate in the survey with an embedded hyperlink to the web-based survey was sent out by e-mail to individuals on SIM's membership list. Measures were taken so that each participant could not participate in a survey more than once. Over the subsequent six weeks, three reminder e-mails were sent to individuals who had not completed the survey. A total of 376 quality responses were received, which represents a 13.13 percent response rate, this is consistent with other surveys of SIM members. Analysis of demographic data showed 42.2 percent of respondents were C-level executives, Directors represented 32.2 percent. 'Other' roles accounted for 21 percent. Enterprise Architects accounted for 4.3 percent of respondents (see Table 1). Nearly two-thirds of respondents (63 percent) had enterprise-wide responsibilities, 16 percent had business unit responsibilities, while the remaining 21 percent had departmental or team responsibilities.

[3] No academic degrees, majors, or even minors in EA exist, and no college courses devoted to EA in the USA of which we are aware, aside from some college-affiliated programs directed at the federal government in Washington, DC.

Table 1 – Respondent Job Title Details

	Frequency	Percent
Board Member	1	.3
CEO	8	2.1
CIO	100	26.6
VP	38	10.1
CTO	13	3.5
Director	121	32.2
Enterprise Architect	16	4.3
Other	79	21.0
Total	**376**	**100.0**

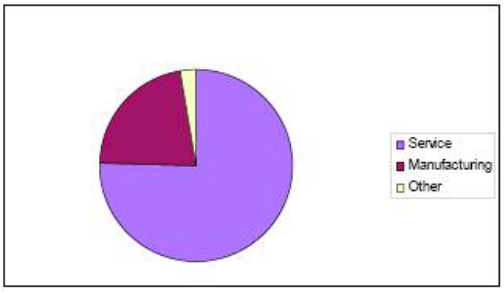

Figure 1 – Industry Representation

On average, respondents had been in their current position for 4.3 years; however, most (58 percent) had less than 3 years job tenure. Seventy-five percent of respondents were from service industries, twenty-two percent from manufacturing (See Figure 1). The size of organizations represented in the survey varied greatly. Although some organizations had annual sales in excess of $50 Billion, 50 percent of organizations had annual sales under $750 Million. In terms of employees, most organizations (60 percent) have less than 2,500. The size of IT departments also varied. The median IT operating budget was approximately $5 Million; 75 percent of organization had less than 300 IT employees.

For questions regarding the purpose and functions of EA, there was overwhelming agreement by respondents on five out of six suggested functions of EA. For example, 92 percent of respondents agreed or strongly agreed that EA provides a blueprint of an organization's data, applications and technology; 89 percent of respondents agreed or strongly agreed that EA is also considered a tool for organizational planning (see Table 2 for more details).

Table 2 – Purpose & Function of EA

	Mean	Std. Dev.
Provides a blueprint to the organization	4.397	0.682
A planning tool	4.249	0.676
Facilitate systematic change	4.016	0.739
A tool for decision making	4.134	0.709
An Alignment tool	4.083	0.857
Communicating organizational objectives	3.667	0.903

For questions regarding the potential benefits of EA, we found the majority of respondents agreed or strongly agreed to the suggested EA benefits (19 of the 20 items had Agree and Strongly Agree responses accounting for more than 60 percent, The top 5 are shown in Table 3). For example, 87 percent of respondents agreed or strongly agreed that EA helps improve interoperability among IS. The only suggested EA benefit that did not support of the majority of respondents was related to improvement of organizational trust.

Table 3 – Benefits of EA

	Mean	Std. Dev
Improved interoperability among Info. Systems	4.336	0.718
Improved utilization of IT	4.252	0.696
Aligning business objectives with IT	4.139	0.801
More effective us of IT resources	4.024	0.738
Better situational awareness	3.946	0.715

To examine the dimensionality of EA benefits and functions constructs, we performed Principal Component Factor Analysis with a varimax rotation. Factor loadings greater than 0.5 were considered adequate to identify practical significance This was also the demarcation used for cross-loading. (Hair, Black, Babin, Anderson, and Tatham, 2006). Two survey items failed this crossloading criterion and were removed from the analysis. Bartletts test of sphericity was found to be significant ($p<.000$ $\chi^2=3741.111$, $df=300$) However, this test is sensitive to large sample sizes; to complement the result, a Kaiser-Meyer-Olkin test was performed. The KMO measure of sampling adequacy was .908, meaning that the correlation matrix is suitable for factor analysis. The five factors (see Table 4) were retained based on a scree plot, explaining a total of 59 percent of the variance. Relatively low variance explained could be attributed to low variability in respondents' perspectives of the benefits, purpose, and function of EA. The factor solution confirmed the construct validity of the survey with all questions related to EA benefits loading high on factors one, two, and three, and questions related to functions of EA loading on factors four and five. The three factors representing EA benefits were interpreted as IT benefits, broad organizational benefits and benefits for goal achievement.

IT benefits was representative of the first factor with many of the survey questions associated within an IT-centric context (eg. "More effective use of IT resources", "Improved utilization of IT", and "Faster development of information systems"). The second factor, broad organizational benefits, showed a definite difference in its component survey questions, with a transition to a broader, organization-wide view (eg. "Standardizes organizational performance measures, "Better collaboration within the organization", and "Improves trust in the organization"). Finally, the third factor, benefits for goal achievement, seemed descriptive of its underlying survey questions with such goal-oriented questions as "Improved goal attainment", "Aligning business objectives with IT", and "Less wasted resources on projects".

The interpretation of the two factors related to EA functionality proved less straightforward. However we believe these two factors represent the practitioner view of EA. First of all, the fourth factor can be seen within the context of EA as a planning tool, providing aspects useful for developing the "to be" architecture. The survey questions within this factor, "Provides a blueprint of an organization", "A planning tool", and "A tool for decision making", show this forward looking characteristic of EA. The final EA functionality factor, consisting of questions with language such as "A snapshot in time", "Facilitating systematic change", and "Communicating objectives", indicate a representation of the current state of EA, the "as is" view. By knowing this current state, an organization can facilitate change.

An analysis of variance was performed to determine if demographic factors measured in this study influenced the respondents' views regarding EA. None of the demographic variables such as position held, experience, education, organization size, or industry were found to have a significant effect on respondent perceptions of either EA's functions or benefits.

This finding seems to be counterintuitive on the surface: it was expected that demographic factors influence the perceived value of technology tools and constructs. In this case, there was a high degree of agreement with regards to most EA functions and benefits among the respondents. This may be a result of asking about hypothetical benefits, what EA should and can be, and not about the state of EA in a specific enterprise. Measurement of actual EA practices is a direction for future research to overcome this limitation, as might improvements to the job title selection.

Table 4 – Factor Analysis

	1	2	3	4	5
Reduced IT complexity	**0.680**	*0.140*	*-0.103*	*0.082*	*0.138*
More effective use of IT resources	**0.674**	*0.189*	*0.224*	*0.088*	*0.033*
Improved ROI on IT Spending	**0.669**	*0.113*	*0.289*	*0.045*	*0.091*
Improved utilization of IT	**0.652**	*0.148*	*0.339*	*0.271*	*0.029*
Faster development of Info. Systems	**0.638**	*0.280*	*-0.044*	*0.112*	*0.058*
Improved interoperability among Info. Systems	**0.607**	*0.223*	*0.128*	*0.295*	*-0.153*
More responsive to change	**0.568**	*0.175*	*0.428*	*0.039*	*0.083*
Improves Info. Systems security	**0.563**	*0.375*	*-0.062*	*0.300*	*-0.057*
Standardizes org. performance measures	*0.169*	**0.774**	*-0.049*	*0.132*	*0.030*
Better collaboration within org.	*0.205*	**0.773**	*0.216*	*-0.002*	*0.094*
Improves trust in the org.	*0.356*	**0.672**	*0.227*	*-0.074*	*0.157*
Improved communication within org.	*0.065*	**0.647**	*0.404*	*0.109*	*0.168*
Assists with organizational governance	*0.281*	**0.592**	*0.197*	*0.163*	*0.025*
Reduced org. stovepipes	*0.266*	**0.569**	*0.215*	*0.033*	*0.187*
Improved Org communication and Info. sharing	*0.185*	**0.514**	*0.459*	*0.042*	*0.182*
Less wasted resource on projects	*0.334*	*0.185*	**0.684**	*-0.004*	*0.054*
Aligning business objectives with IT	*0.071*	*0.194*	**0.671**	*0.339*	*0.002*
An Alignment tool	*-0.061*	*0.192*	**0.635**	*0.331*	*0.139*
Improved goal attainment	*0.383*	*0.330*	**0.575**	*0.034*	*0.189*
Provides a blueprint of organization	*0.212*	*0.059*	*0.068*	**0.758**	*-0.104*
A planning tool	*0.180*	*-0.013*	*0.209*	**0.753**	*0.248*
A tool for decision making	*0.185*	*0.152*	*0.181*	**0.690**	*0.280*
A snapshot in time of an org.	*0.012*	*0.150*	*-0.089*	*0.006*	**0.671**
Facilitate systematic change	*0.270*	*0.033*	*0.233*	*0.241*	**0.654**
Communicating organizational objectives	*-0.081*	*0.219*	*0.344*	*0.114*	**0.642**
Variance Explained (%)	16.2	14.85	11.75	9.04	6.79

Interpreting survey results

Respondents of this survey appear to have a consistent perspective on the function and benefits of EA. Equally interesting was the unexpected strength in agreement for the functions and the benefits. Six out of seven functions had agreement rates greater than 60 percent. The one exception ("EA as a snapshot in time of an organization") could be indicative of a more IT-centric view of EA's purpose or may be the result of the use of the terms "snapshot" or "in time" in the wording of the question. Although IT-related benefits received higher support among the respondents reflecting a traditionally IT-centric view of EA, many identified organizational benefits which received support of over 60 percent of respondents. This suggests that IT professionals see EA as a broader initiative expanding beyond the boundaries of the IT function. This is consistent with the Zachman EA framework and enterprise ontology (1987, 1999, 2007) as well as with the view that EA is likely to emerge as a broad organizational function encompassing IT as one of its elements (Ross, 2008).

Outlining Directions for Future Research

With relatively scarce EA-related academic research and practitioners still struggling to harness the business value of EA, there is a unique opportunity for IS academics to produce research of high relevance by establishing theoretical underpinnings of EA and its business benefits. If the business value of EA is widely accepted, IS academics will claim "ownership" of an intellectual asset that is of interest to other business disciplines (Wade, Biehl, and Kim, 2006). In

developing EA theory, several key research directions can be identified. First it is critical to gain a better understanding of what EA is. Second, it is important to define the nomological net of EA and thereby to better understand the position of EA in relation to other business and IT constructs. Finally, a theoretical understanding of business and IT benefits should be developed. Next we elaborate on each of the aforementioned directions.

Establishing a clear academic definition of EA

Examination of various definitions of EA, as well as of the common usage of the term in practitioner literature suggests there is little agreement about the very nature of the EA construct. In many cases EA is treated as a black box, a tool that is useful in the achievement of a variety of goals. As such it is viewed as a planning tool, as a blueprint for organizational data, and so on. Among those who care to look inside the black box of EA, agreement lacks on two issues: the meaning of the word "enterprise" and the meaning of the word "architecture". The "enterprise" portion of EA is understood by some as a synonym to "enterprise systems", yet by others as equivalent to "business" or "organization". For example, Miller (1997) adopted an IT-centric view of EA when he examined the benefits of EA planning for the implementation of client-server technology. Gregor, Hart, and Martin (2007), while examining the EA's role in enabling alignment, adopt a somewhat broader definition of EA by the International Organization for Standardization (ISO): "a descriptive representation of the basic arrangement and connectivity of parts of an enterprise (such as data, information, systems, technologies, designs, business processes)" (p. 97). Ross' definition of EA (Ross, 2003, Ross and Beath, 2006), although somewhat IT-centric, expands the concept more into the organizational domain and sees EA as a tool to align IT with the enterprise through its processes, presumably themselves aligned with the strategic objectives of the organization.

Even less uniform is the understanding of the meaning of "architecture". The most common understanding of the term is a collection of artifacts (models, descriptions, etc.) that define the standards of how the enterprise should function or provide an as-is model of the enterprise (Kaisler, Armour, and Valivullah, 2005; Khoury, Simoff, and Debenham, 2005). Yet others equate EA with the process of defining standards and creating as-is models and descriptions. More broadly, Bernard (2005) declares that "EA provides a holistic view of an enterprise" (p. 23) and Kappelman (2007) opines that EA is about "creating and using a shared 'language' (of words, graphics, and other depictions) to discuss and document every important aspect of the enterprise" so stakeholders can align their thinking and thereby align the resources of the enterprise (p. 25). The presence of such definitional multidimensionality suggests that perhaps there is a room for decomposing EA into a set of simpler, inter-related constructs. Knowledge management literature (Nonaka and Konno, 1998; Nonaka, Takeuchi, and Umemoto, 1996; Polanyi, 1958) dealing with tacit and explicit knowledge provides one possible theoretical lens for defining such constructs. Actor network theory (Callon and Latour, 1981, Sarker, Sarker, and Sidorova, 2003; Walsham, 1997) provides a tool for examining EA from the negotiation, power and politics point of view.

Establishing theoretical foundations of EA benefits

While the majority of the IT practitioners agree EA has a variety of potential benefits for IT and business in general, such claims are not consistently theoretically grounded. The role of IS research is to establish a theoretical foundation for examining such benefits. As a first step, a typology of EA benefits should be developed. The results of the SIM survey provide a first glimpse into types of EA benefits by distinguishing among IT-related, goal-related, and general organizational benefits of EA.

The next step involves developing and testing theoretical propositions for specific EA benefits. For example, EA has been often cited as an enabler of alignment between IT and business (Gregor, Hart, and Martin, 2007; Ross, 2003; Sauer and Willcocks, 2004; van der Raadt et al., 2005). Further research is needed to solidify such claims, and to examine contextual and other factors that may influence such a relationship. Similarly, theoretical foundations should be developed for other types of benefits. For example, an information processing view of the firm could be used to approach EA benefits for intra-organizational communication. With growing interest in organizational agility as a source of competitive advantage (Venkatesh et al., 2007), attention has been drawn to organizational modularity. The modularity theory (Shilling, 2000, 2001) could provide a link between EA and benefits related to organizational responsiveness to change. More broadly, research could examine the role of EA in achieving any enterprise design objective (e.g., aligned, agile, centralized, etc.).

Conclusions and Limitations

In this paper we examine how IT practitioners view EA and its benefits. While the results presented here are rather exploratory in nature, the main contribution of this study is to highlight the importance of EA and to inspire for future research on the topic. As evident from the results presented in this paper, both IS practitioners and academics believe EA has multiple benefits, not only for IT management, but for organizations as a whole. EA is seen by practitioners as both a **planning tool** and a **representation of the current state** of the enterprise. However, to ensure the value of EA is realized it is important to get a deeper understanding of how EA may lead to the desired organizational outcomes. Because there is often a lack of a common definition of EA, it is crucial to establish such a definition, as well as to relate it to other established IT and organizational constructs. Further research should focus on specific benefits of EA and how they can be best achieved.

It is important to mention some important limitations of this study. First, we focused on perceived *potential* benefits of EA, which partially explains the lack of variance among different types of organizations. Therefore, a natural extension of this study would be to measure the perceived organizational benefits of EA and to relate them to specific EA practices and organizational characteristics. In addition, the high degree of agreement on the benefits of EA could be partially explained by the selection bias: because survey participation was optional it is likely that those who do not perceive the value of EA as high did not respond to the survey. Although we tried to avoid such selection bias by not putting the term "enterprise architecture" in the survey title, it is still a concern.

In conclusion, we believe EA presents immense challenges and opportunities. IT practitioners and academics have the first shot at taking advantage of the opportunity and challenge of EA. Thus there is a unique opportunity for IS researches to leverage their knowledge and experience and to carve a new existential niche that would help foster and perhaps even ensure respect of the IS academic discipline by business practitioners and academics alike. Unless our vision for the future of the IT profession is only technical expertise related to our IT sub-systems, IS academics and researchers should seek to encourage a vision of broader things for IS professionals. Perhaps it's time for something new, something different, something that helps us see past the IT stovepipe to the whole enterprise including its technologies. That something is enterprise architecture.

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