Association for Information Systems
AIS Electronic Library (AISeL)

ECIS 2012 Proceedings

European Conference on Information Systems (ECIS)

5-15-2012

UNDERSTANDING THE RELATIONSHIP BETWEEN INTEGRATION ARCHITECTURE AND ENTERPRISE ARCHITECTURE: THE CANONICAL MODEL AS A GOVERNANCE RESOURCE - A CASE STUDY IN A TELECOMMUNICATIONS COMPANY

Fernando Francisco
Technical University of Lisbon and Altran Portugal

Pedro Isaias
Universidade Aberta

UNDERSTANDING THE RELATIONSHIP BETWEEN INTEGRATION ARCHITECTURE AND ENTERPRISE ARCHITECTURE: THE CANONICAL MODEL AS A GOVERNANCE RESOURCE – A CASE STUDY IN A TELECOMMUNICATIONS COMPANY

Francisco, Fernando, ISEG – Technical University of Lisbon and Altran Portugal, Av.das Forças Armadas, 125-3C, 1600-079, Lisbon, Portugal, fernando.francisco@altran.pt

Isaías, Pedro, Universidade Aberta and ADVANCE Research Center - ISEG – Technical University of Lisbon, Rua do Quelhas, 6, 1200-781 Lisbon, Portugal, pisaias@uab.pt

Abstract

The Total Architecture concept is increasingly present at a time when organizations are consolidating plans for the implementation of SOA. The assumption that the integration of heterogeneous systems must be planned is undeniable. Enterprise Architecture has been advocated as a first new step towards systems integration. The nature of its attributes - namely the holistic vision of the organization as the Information System itself and its orientation towards the business process - seems to fit well with the characteristics of EAI. This article summarizes the research performed in an organization implementing SOA. It sought not only to validate the existence of a relationship between Enterprise Architecture and Integration Architecture as expressed in literature, but also to understand its nature more deeply. The result demonstrated the importance of the Canonical Model as a Governance artifact in the regulation of the relationship between the two architectures. The Canonical Model seems to serve in addition as a tool for knowledge sharing between the actors involved in the problem of alignment between business and information systems. A conceptual model is proposed in order to express the logical flow and patterns identified in the relationship.

Key Words: Enterprise Architecture, Integration Architecture, Canonical Model, Governance

1 Introduction

Information Technology (IT), as an engine of Information Systems (IS), is an effective source of strategic competitive advantage (Porter and Millar 1985; Rockart et al. 1996). In this regard, Zachman's framework (1987) for information systems architecture was and is an indispensable reference. Also based on this legacy, Enterprise Architecture was born with its strategic nature influenced by the concept of business process. It seems that it is no longer possible to integrate information systems without a strategic line that reflects the different structural levels where integration must occur and the components and actors who will participate in it. This article summarizes the outcome of a study that looked at the nature of the relationship between Enterprise Architecture - as the product of high-level integration - and Integration Architecture - as an instantiation of the necessary infrastructure for applicational interoperability between processes. The dynamics of this relationship have been extensively analysed, and the importance of the Canonical Model as a regulator of the relationship between the two architectures has been highlighted.

2 Information Systems Integration Strategy

2.1 Planning to architect

There is no ideal model for the planning of Information Systems (Galbraith 1968). However, the ubiquity and cross-functional attributes of IS's make their strategic planning absolutely necessary (Reich and Benbasat 2000; Rockart et al. 1996). The several different paths to achieving this goal are usually framed within the definition of SISP (*Strategic Information Systems Planning*) methodologies. SISP methodologies are classified into two broad categories: *impact* and *alignment* (Lederer and Sethi 1988). Both are used in the Information Systems / Information Technology (IS/IT) planning process (Ward and Peppard 2002).

The IS strategy sets out the requirements of the organization to match the demand for information to support business strategy, identifying the "whys" of planning. On the other hand, the IT strategy focuses on the vision of "how" the organization will match the demand for information, corresponding to the provision of technological skills, resources and services (Ward and Peppard 2002). This process culminates in a high-level view of how to organize all the components of the organization and their respective interrelationships, through artifacts such as dictionaries, matrices, analysis models, and documentation of the human skills required to achieve the goals. As a corollary, the process presents a set of management policies and a portfolio of strategic applications, along with an architecture that describes how to integrate them (Ward and Peppard 2002; Warr 1990).

However, having a strategy of IS/IT is not by itself a guarantee of success (Lederer and Sethi 1988; Reich and Benbasat 2000). The strategic alignment of business with the information systems is a continuous and adaptable process that can be business- or technology-oriented (Henderson and Venkatraman 1999). The focus is always on the organizational capacity to use IT as a valuable resource, while also considering the perspective of social behaviour and the sharing of knowledge among stakeholders (Reich and Benbasat 2000).

2.2 Architecting to integrate

It is impossible to accommodate the organizational complexity without a structural logic (Sowa and Zachman 1992; Zachman 1987). This structural logic is the Architecture, which according to Warr (1990) is *"all the components both technical and non-technical which affect the supply of information to the organisation. It is also concerned with how these components are linked together and how they function as a whole. The whole being the Architecture"* (Warr 1990, pp. 8-9). Architecture is made of

high-level logical views that facilitate the integration of decentralized information, eliminating redundancies and lags that generate different versions of the same fact (Zachman 1987). It's an evolving entity, and a way to observe in detail the logic of the organization without losing a sense of scale (Sowa and Zachman 1992). Architecture's scope is a mix of technology, data, methods, people and competences (Warr 1990; Zachman 1987), defined by the abstraction of a set of boundaries (conceptual, logical, physical and transformation). Each of these boundaries represents a different perspective of the end product (Sowa and Zachman 1992).

Enterprise Architecture inherits some of the principles proposed by Zachman (Pereira and Sousa 2004), but extends its scope towards the business process. It considers the company to be the information system itself, and as such the final product (Brown 2008; Ross et al. 2006). It represents the organization's desired level of standardization and integration, reflecting the logic of critical business processes and the infrastructure which will support them (Ross et al. 2006). Enterprise Architecture incorporates rules that express the vision and culture of the organization, serving as a prescription for the system design. It contains a combination of styling and engineering that ensures the quality of the final object. Its role is the discovery of requirements, and the modelling, planning and construction of objects in their own environment. From its prescription must result the holistic vision of all its components. The most important benefits of its adoption are the development of more efficient IT processes, increased portability of applications, improved interoperability and network management, and greater ability to procure heterogeneous solutions (IFEAD 2006; TOGAF 2009). Enterprise Architecture can be seen as a set of inter-related architectures, representing different perspectives of the final product (Table 1):

Architecture	Level	Actor	Restrictions	Boundary	Output/ Model
Organization	Organization	-	-	Organizational	Responsibilities and functions
Business	Processes	Owner	Usability	Conceptual	Processes identification
Information	Data Entities	Architect	Information	Logical	Entities and Relationships
Application	Applications	Developer	Functionality	Functional	Applications Functionality
Technology	Infrastructure	Support	Construction	Physical	ICT, I/O devices

Table 1. Levels of Enterprise Architecture, adapted from Sowa and Zachman (1992) and Gama et al. (2007).

The Information and Application Architectures, supported by the Technology Architecture constitute the Information Systems Architecture. Together they are responsible for the communication between systems and the Business Architecture (Gama et al. 2007). The Organizational Architecture allows the identification of the stakeholders of the processes and applications and the owners of informational repositories. Its inclusion reflects the need to consider the increasingly important role of people, since the focus on technology tends to dismiss them (Gama et al. 2007; Warr 1990).

The integration of information makes it more accessible and consistent, so that it facilitates decision making by managers. It can be data- or process-driven; these approaches are complementary rather than mutually exclusive (Chang 2006; Themistocleous 2002). Despite the importance of ubiquitous data-oriented integration, the process-based organization is increasingly using process-driven integration to improve business results (Brown and Ross 1999). In fact, the most important factor in integration nowadays seems to be the recognition of the business process (Silva 2003).
The organizational reality contains information systems based on different technologies and operating systems communicating in incompatible protocols. Some of the application systems have emerged in order to integrate these heterogeneous systems. The EAI – Enterprise Application Integration, for

example, saw its success largely explained by the ERP's inability to fulfill the plan of homogenous integration of information systems (Themistocleous and Irani 2002). The intra-organizational integration of heterogeneous information systems can be achieved through the EAI (Irani et al. 2003). EAI is not only a tool or set of tools, but also a methodology for functional integration of modern and legacy applications, regardless of the types of databases supporting it (Manouvrier and Ménard 2008). It combines traditional technologies with new technologies for integration of applications. This combination supports a wide interoperability, which allows the interconnection of other integration solutions (Irani et al. 2003), while keeping the focus on the business processes. EAI can be applied strategically, to affect a large number of critical processes and services, or tactically, to solve a specific problem (Themistocleous and Irani 2002).

3 A Conceptual Model for the Relationship

According to Linthicum (1999), the integration occurs at four levels - data, applications, methods and interfaces - requiring the use of different technologies. Several frameworks for application integration architecture have been proposed (Al-Mosawi and Sahraoui 2009; Losavio et al. 2005). Al-Mosawi and Sahraoui (2009), for instance, proposed a framework that resumes application integration architecture into three distinct categories: processes, applications, and technology. Each has different requirements and represents different components of integration. The proposal by Al-Mosawi and Sahraoui (2009) has the merit of presenting a convergence towards a common vision, but omits the human factor. Proposals by Cummins (2002) and Losavio et al. (2005), which consider the architecture's users, were for this reason also reviewed in this investigation. Together with the TOGAF (2009) and the IFEAD (2006) proposals, Sowa and Zachman's (1992) Extended Framework served as a reference for the analysis of enterprise architectures. Tables 2 and 3 summarize the set of enterprise and integration architecture frameworks reviewed in this research, and indicate the different levels of integration provided in their formulation.

Reviewed Framework	Organization	Business	Information	Application	Technology
Sowa and Zachman (1992)	X	X	X	X	X
IFEAD (2006)	X	X	X	X	X
TOGAF (2009)	X	X	X	X	X

Table 2. Enterprise Architecture: Reviewed Frameworks.

Reviewed Framework	People	Processes	Entities	Applications	Mechanisms
Cummins (2002)	X	X	-	X	X
Losavio et al. (2005)	X	X	X	X	X
Al-Mosawi and Sahraoui (2009)	-	X	-	X	X

Table 3. Integration Architecture: Reviewed Frameworks.

Systems integration requires deep knowledge about critical business processes (Lam and Shankararaman 2007). Enterprise Architecture, by its own nature, contains this type of knowledge (Ross et al. 2006). Until the appearance of EAI, information technology presented serious barriers to the focus on business processes (Lam and Shankararaman 2007; Themistocleous 2002). The combination of a full view of all organization components, providing the desired knowledge about which processes access which data, who their owners are, and where the events related to them occur, seems to be the major contribution of Enterprise Architecture to Integration Architecture. This synergy appears to move toward the concept of Total Architecture (Brown 2008).

The understanding of the relationship between Integration and Enterprise Architecture involves the understanding of what they have in common, namely the equivalence in their constituting layers and

the obvious focus on business processes (Al-Mosawi and Sahraoui 2009; Cummins 2002; Losavio et al. 2005; Gama et al. 2007; IFEAD 2006; TOGAF 2009).

Enterprise Architecture, in combination with other strategic planning outputs, is the first glimpse of the systems that will be necessary to ensure interoperability. It forwards the information which a company needs in order to know what processes to integrate and why to integrate them. This relationship is reinforced by the advantages derived from its adoption, whose emphasis on interoperability, heterogeneity, and applicational portability, as well as the focus on business process efficiency, has an unmistakable connection with the most relevant EAI attributes. Lam and Shankararaman (2007) affirm that Enterprise Architecture offers to Integration Architecture a deeper understanding of the existing portfolio of technology and applications, a wider identification of possible integration strategies, the definition of architectural patterns, and the development of a robust and flexible technical framework. This coincides with the statement by Vasconcelos et al. (2004) that the most important features of integration must be properly specified in the information systems architecture, and is supported by Chorafas (2002), when he admits the existence of an ongoing iterative process between architecture and infrastructure. As technology supports business, Enterprise Architecture emphasizes the process and its owner role (Gama et al., 2007). The incentive to consider is the business benefit derived from the use of technology (IFEAD 2006; Henderson and Venkatraman 1999). In the conceptual model proposed (Figure 1), the cycle reaches its conclusion when the benefits derived from systems integration are effectively felt at the level of business integration, reflecting gains in the form of increased revenues and reduced costs (Themistocleous 2002).

3.1 The importance of the Service concept

The inclusion of the Services level at the Integration Architecture with the corresponding Services perspective on the Enterprise Architecture side (Figure 1), reflects the importance of this concept in Integration Architecture nowadays. In fact, even in some organizations which still do not have a service-oriented-architecture fully implemented and matured, the Service concept as a basic unit of development is being generalized. When developing new services over an *Enterprise Service Bus* (ESB), organizations making these developments depend on the referenced business process characteristics. It is common to recognize, in the functional and technical specifications for the development of new services, explicit information regarding the business process from the Enterprise Architecture perspective; that is, the specifications contain the different perspectives of the new service to respond to the business process from the point of view of Business and Information Architecture, but also identify applications that should be integrated at the Application Architecture level, as well as technology at the Technology Architecture level (e.g. web services, adapters, etc) that should support the interoperability of the process.

3.2 The role of the Canonical Model

The Canonical Model defines all critical informational entities to the business processes, as well as their nomenclature, attributes and operations. These definitions are generally used directly in the development of new services in the context of service-oriented architectures, and in the generation of messages within XML-based transactions. The Canonical Model's first function is to guarantee that the information systems are able to communicate in a common language and use the same terminology as business. The second is to facilitate the integration process between different applications, ensuring that all the heterogeneous information systems can communicate in a language understandable by all. It also regulates the boundary between the Business Architecture and the Information Architecture.

The Canonical Model makes the connection between what was defined in terms of Enterprise Architecture and the development and integration of all information systems at the Information Architecture level (Figure 1). The responsibility for the development and maintenance of this

document belongs to the architecture teams, and the application integration department and development teams should comply strictly with its guidelines.

To Weill and Ross (2004), it is the behaviour that creates value and not the strategy itself. As a subdiscipline of Governance, IT Governance specifies the set of policies which are required to implement and encourage the desired behaviour in the use of information technology. Its main goal is to ensure that investments in IT generate business value. It achieves this by managing the organization's assets and defining the roles and responsibilities involved in their management (Brisebois et al. 2007; Weill and Ross 2004). In this sense, the Canonical Model seems to assume an IT Governance role, in the way that its purpose is precisely to constrain and encourage what is understood as the ideal behaviour or practices to be followed by integration actors. This ability to influence the relationships between different actors seems to fit the social perspective scope of the alignment between business and information systems. For Reich and Benbasat (2000), the alignment problem is deeply rooted in the communication and knowledge-sharing difficulties between the actors in the process of business/IS synchronization.

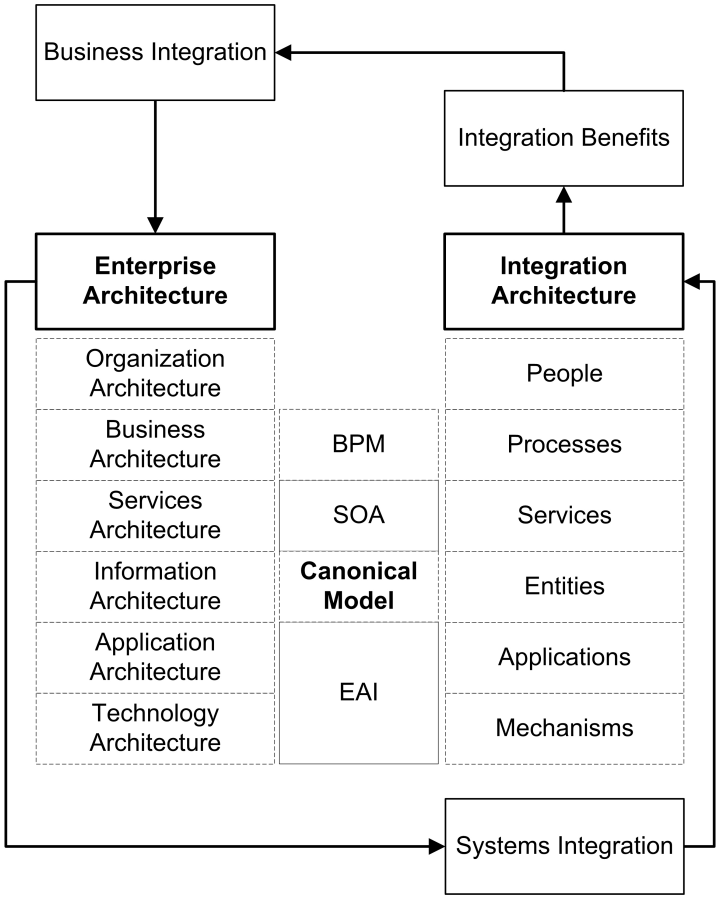

Figure 1. Conceptual Model for the Enterprise Architecture/ Integration Architecture Relationship.

4 Research Methodology

In this study an interpretive perspective was adopted. It was assumed that studying the relationship between Enterprise and Integration Architectures as defined in the research objective was only possible through the subjective interpretation of the participating actors' different behaviours and expectations. In fact, the objective is to increase the knowledge about a nondeterministic phenomenon in a complex and sometimes elusive organizational context. Also, the data types that are supposed to be analysed do not always present a completely regular nature, so an interpretive approach in their treatment and analysis is justified. The relationship between Enterprise and Integration Architectures is a relatively recent phenomenon. It was therefore important to use research techniques that provided freedom of action and methodological diversity to understand the concepts in the complex and irregular environment of a systems integration department. This irregularity is present not only in the practical field, but also at the theoretical level, as terms such as 'architecture', 'Enterprise Architecture' and 'Information Systems Architecture' are conceptually confused all the time. This striking lack of regularity seemed to offer an ideal opportunity for a qualitative approach.

The use of a case study as a strategy is generally considered to fit well into the spirit of Information Systems research (Benbasat et al. 1987; Walsham 1995; Yin 2003). As mentioned before, the research objective is to understand and describe the relationship between Integration and Enterprise Architectures; the study will thus be categorized as a descriptive case (Yin 2003). However, there was an important component of the study that made it in some way closer to the explanatory category: the fact that it went beyond the mere description of the relationship between the two mentioned architectures, and tried to determine accurately the nature of that relationship.

A single case study was carried out, based on a replicable case study protocol (Yin 2003). Such a design allowed a prolonged study of the organization. It should be possible to generalize from it as it would be in a unique experience (Yin 2003). The use of triangulation is recommended by Yin (2003) and Benbasat et al. (1987) in order to increase the credibility of the results. For this reason, throughout the study, evidence from several sources has been used for triangulation: documentation (technical and functional specifications for integration projects, architecture specifications and references, internal policies, training, websites, intranet, RSS and internal audit reports); physical artifacts (during the process of participant observation, the researcher had access to the application integration software and hardware used by the organization); and interviews. Regarding the interviews, the researcher tried to follow the established in the case study protocol, while offering some freedom to the interviewee in order to probe new perspectives. The interviews took place in person and via email and phone. The respondents included people from different functions in business and IS. It was also possible to hold informal conversations in a non-structured way with managers, developers and consultants throughout the research period.

In accordance with Yin's holistic perspective (Benbasat et al. 1987; Yin 2003), the organization where the integration architecture and infrastructure are effectively implemented was considered to be the case study analysis unit.

5 Case Study

5.1 Description

The respondents and the studied organization have their anonymity protected, as implicitly agreed with them. Because of that, during this case study description, the organization will be called ORG_TI. ORG_TI is a business unit owned by the multinational ORG_CORP. It operates in the telecommunications services sector and it currently has about 500 employees, while ORG_CORP has

about 10,000 employees worldwide. ORG_TI's structure and organizational dynamics are greatly influenced by ORG_CORP. ORG_CORP has a vertical management model, with limited ability to change, due to a quaint and isolated information systems infrastructure. The study focused on ORG_TI's Department of Information Systems, with emphasis on their systems integration team. Because of the nature of the problem, another independent business unit had to be studied: ORG_BUS. This unit is responsible for the architecture and specification of new services. It is also responsible for the development and maintenance of ORG_CORP's Canonical Model.

5.2 Information Systems environment

Heterogeneity of application systems is the IS reality at ORG_TI. There are in-house developed application systems based on legacy software (e.g. C and 4th generation languages), side-by-side with object-oriented applications built over J2EE and .NET platforms. There are also packaged application systems that have been recently acquired, such as SAP or SIEBEL. Next is presented a brief summary of the IS diversity at ORG_TI:

- Customized systems or legacy systems developed in-house: CRM_A, CRM_B, Billing, Customer Loyalty Application;
- Acquired software packages: Siebel (CRM), SAP (ERP), MicroStrategy and SAS (Business Intelligence).
- Most relevant database systems: Oracle, IBM Informix.

5.3 Information Systems integration evolution

- Peer to Peer, mid 90's to 2002:
  - Hard-coded logic;
  - Batch integration and stored procedures invocations;
  - High cost for new interfaces development.

- 1st phase of application integration, 2002 to 2010:
  - Installation of a tactical ESB:
  - Greater consistency of integrated systems;
  - High diversity of integration technologies centralized in EAI;
  - CRM synchronization;
  - Extension of legacy systems life cycle;
  - Severe performance problems remained at CRM;
  - Process integration of new services quiet limited and complex.

- 2nd phase of application integration, 2009 to 2011:
  - Strategic development of a corporate business process oriented ESB:
  - Elimination of integration technologies diversity;
  - Intense use of Webservices based in SOAP/WSDL;
  - New services implementation responsibility has passed to the corporate ESB;
  - Corporate reuse of services interfaces.

5.4 Analysis of evidence

5.4.1 Enterprise Architecture and the Canonical Model

The corporate Canonical Model demonstrated the existence of an active strategic policy of synchronization between Business and Information Systems. The Canonical Model is under the responsibility of ORG_BUS and defines all critical informational entities to the business processes. Based on what was previously defined at the Enterprise Architecture strategic thinking, the Canonical Model is used to define the nomenclature, operations and attributes of entities. It has revealed itself as a fundamental reference in the new services development documents and technical specifications. The entities described in the Canonical Model are transversal to the ORG_CORP and are made available in the ORG_CORP corporate ESB deployed services, which means that any other strategic business unit may invoke specific services developed by ORG_TI simply by following the Canonical Model directives.

5.4.2 Full focus on Business Processes

Requests for development of new services are always oriented towards business processes, and built over the new corporate ESB, which is now the most important reference in terms of process interoperability. In the examined documentation of requests for new developments, it was found that ORG_BUS documents and specifies the information related to the business process from the perspective of the Business Architecture and from the point of view of the Information Architecture. Also the applications at the Application Architecture level, as well as the technology in the Technology Architecture that should physically support everything else are identified in ORG_BUS specification documents. Coincidentally or not, almost every new service development whose documentation was analysed in the study revealed that Web services based on WSDL and SOAP protocol are being intensively used, and are recommended to all development teams by ORG_BUS. The boundary between the Business and Information Architectures is regulated by the Canonical Model.

5.4.3 Rising of SOA

As mentioned before, SOA was being implemented in ORG_TI. SOA implementation analysis at ORG_TI allowed the consolidation of knowledge about the dynamics of Enterprise Architecture's influence over Integration Architecture.

There are services duly catalogued and referenced in a specific catalogue developed for this purpose. Process migration from the older structure to the service-oriented architecture is running as *needed*, with the exception of top priority requests that come directly from the administration. This type of request is usually related to new business processes, or the necessity to improve the access and flexibility of existing ones. SOA is being implemented within two life cycles: the reduced, which considers services that already exist and have been rolled out in production, and the normal, which considers new services to be developed. The corporate ESB supports the implementation of the recently acquired SOA applications.

6 Conclusions and Further Work

The relationship between Enterprise and Integration Architectures is a top-down relationship. Integration Architecture reflects the level of standardization already defined in Enterprise Architecture regarding the relationships and integration needs of critical business processes. In the current organizational context, where heterogeneity of applications and cross-functional business processes are the reality, and where the ability to respond to unpredictable changing needs is the priority of top

management, it is increasingly necessary to ensure that before the urge to answer on time, Integration Architecture does not become chaotic. Different systems usually communicate in different protocols, and the different needs of stakeholders for applications and processes may sometimes be contradictory and counterproductive if not properly coordinated. It is therefore necessary to ensure that a pattern is followed in terms of developing services to respond to business processes. This can – in part – be achieved by using a Canonical Model that prevents the Integration Architecture from becoming inconsistent with the business strategy.

The Canonical Model ensures that different systems communicate in a common language. Performing at the Information Architecture level, and in some way linking Enterprise and Integration Architectures, it additionally contributes to increased coherence between different data banks. An organization that considers these issues will present an Integration Architecture that is prepared to manage change in a more organized and coherent way. Nowadays, organizations are quickly replacing old integration mechanisms by a general use of interfaces based on web services. Not only is the middleware adopting this kind of technology, but almost every single applicational system inside the organization is doing so. They tend to see SOA as an open window to the future and business agility. We have now achieved a stage of maturity in understanding the Total Architecture concept as proposed by Brown (2008). In this sense, the model and the experience related in this article may represent a direct contribution and may become a valuable asset in the interpretation of the times that came, and are here to stay.

The Case Study analysis of evidence helped to reinforce what was obtained during the Literature Review. The inclusion of the Canonical Model in the proposed conceptual model is an example of that contribution. Indeed, it seems there is an ongoing relationship between what is understood to be the Integration Architecture and what is defined as Enterprise Architecture. The existence of the Canonical Model is obviously not a surprise. The different perspective to consider here is maybe the fact that the Canonical Model can be used – and is in fact being used – as an IT Governance artifact. If developed and maintained within the scope of the Enterprise Architecture/Integration Architecture relationship, it may bring to the organization important features in the struggle for the perfect alignment between IS and Business.

Even if it is considered that a well-constructed single case study can legitimately generalize from its results (Yin, 2003), we admit that it would be interesting and important to replicate this study in other organizations with the same or similar characteristics, in order to better understand the nature of the relationship between Enterprise Architecture and Integration Architecture. This would allow us to measure the extent of the use of the Canonical Model as a strategic IT Governance artifact, and to keep track of the most relevant integration technologies, proving or not, that the dominance of web services is increasingly evident.

Acknowledgements

The authors want to acknowledge the ADVANCE research centre from ISEG – Technical University of Lisbon – strategic project reference: PEst-OE/EGE/UI4027/2011 – Information Systems and Operations track.

References

Al-Mosawi, A. and Sahraoui, S. (2009), A Common Framework For Comparing Different EAI Approaches, *In Proceedings of the European and Mediterranean Conference on Information Systems (EMCIS) Late Breaking Papers, 2009*, *13-14 July*, The Crowne Plaza, Izmir, Turkey.

Benbasat, I., Goldstein, D.K. and Mead, M. (1987), The Case Research Strategy in Studies of Information Systems, *MIS Quarterly,* Vol.11, No.3 (September 1987), pp. 369-386.

Brisebois, R., Boyd, G. and Shadid, Z. (2007), What is IT Governance and Why is it Important for the IS Auditor, *The IntoIt Journal*, (25 August), pp. 30-35, Available at: <www.intosaiitaudit.org>, [Accessed 21 May 2011].

Brown, C.V. and Ross, J.W. (1999), *The IT Organization of the 21st Century: Moving to a Process-Based Orientation*, CISR WP No. 306 Sloan WP No. 4078 -Massachusetts Institute of Technology, Available at: <http://dspace.mit.edu/bitstream/1721.1/2752/1/SWP-4078-43797411-CISR-306.pdf>, [Accessed 21 June 2011].

Brown, P.C. (2008), *Implementing SOA: Total Architecture in Practice*, e-book, Addison Wesley Professional.

Chang, J.F. (2006), *Business Process Management Systems: Strategy and Implementation*, Auerbach Publications, Boca Raton, Florida.

Chorafas, D.N. (2002), *Enterprise Architecture and New Generation Information Systems*, CRC Press LLC, Boca Raton, Florida.

Cummins, F.A. (2002). *Enterprise Integration- Architecture for Enterprise Application and Systems Integration*, John Wiley & Sons Inc, New Work, NY.

Galbraith, J.R. (1968), Achieving Integration through Information Systems*, Working Paper: Sloan School of Management,* Library of the Massachusetts Institute of Technology, 362-68, Available at: <http://hdl.handle.net/1721.1/46763>, [Accessed 20 August 2011].

Gama, N. et al. (2007), Integrar a Arquitectura Organizacional na Arquitectura Empresarial, (Integrating Organizacional Architecture in Enterprise Architecture), *7ª Conferência da Associação Portuguesa de Sistemas de Informação (CAPSI 2007).*

Henderson, J.C and Venkatraman, N. (1999), Strategic Alignment: Leveraging Information Technology for Transforming Organizations, *IBM Systems Journal*, Vol.38, No.2 and 3, pp.472-484.

IFEAD - Institute For Enterprise Architecture Developments (2006), *Extended Enterprise Architecture Framework Essentials Guide*, version 1.5, Available at: < http://www.enterprise-architecture.info/>, [Accessed 21 May 2011].

Irani, Z., Themistocleous, M. and Loveb, P.E.D. (2003), The Impact Of Enterprise Application Integration On Information System Lifecycles, *Information & Management*, Vol.41, pp.177-187.

Lam, W. (2005), Investigating Success Factors in Enterprise Application Integration: A Case-Driven Analysis, *European Journal of Information Systems*, Vol.14, pp.175-187.

Lam, W. and Shankararaman, V. (2007), *Dissolving Organisational and Technological Silos: An Overview of Enterprise Integration Concepts, Enterprise Architecture and Integration: Methods, Implementation, and Technologies* - Information Science Reference (an imprint of IGI Global), Hershey, New York.

Lederer, A.L. and Sethi,V. (1988), The Implementation of Strategic Information Systems Planning Methodologies, *MIS Quarterly*, Vol.12, No.3, pp.445-461.

Linthicum, D.S. (1999), *Enterprise Application Integration*, Addison-Wesley, MA.

Losavio, F., Ortega, D. and Perez, M. (2005), Comparison of EAI Frameworks, *Journal of Object Technology,* Vol.4, May 2005, pp. 94-114.

Manouvrier, B. and Ménard, L. (2008), *Application Integration: EAI, B2B, BPM and SOA*, John Wiley & Sons, Inc, Hoboken, NJ.

Pereira, C.M. and Sousa, P. (2004), A method to define an Enterprise Architecture using the Zachman Framework, *In Proceedings of the 2004 ACM symposium on Applied computing* (SAC '04). ACM, New York, NY, USA, 1366-1371.

Porter, M.E. and Millar, V.E. (1985), How Information Gives You Competitive Advantage, *Harvard Business Review*, Vol.63, No.4, (July-August 1985), pp.149-162.

Reich, B.H. and Benbasat, I. (2000), Factors That Influence The Social Dimension Of Alignment Between Business And Information Technology Objectives, *MIS Quarterly*, Vol.24, No.1, pp.81-113.

Rockart, J.F, Earl, M.J. and Ross, J.W. (1996), Eight Imperatives for the New IT Organization, *Sloan Management Review*, Fall, pp.43-55.

Ross, J.W., Weill, P. and Robertson D.C. (2006), Enterprise Architecture as Strategy – Creating a Foundation for Business Execution, Harvard Business School Publishing, Boston - Massachusetts.

Silva, M.M. (2003), *Integração de Sistemas de Informação*, (Information Systems Integration), FCA - Editora de Informática, Lisboa.

Sowa, J.F. and Zachman, J.A. (1992), Extending and Formalizing the Framework for Information Systems Architecture, *IBM Systems Journal*, Vol.31, No.3 (June 1992), pp.590-616.

TOGAF - The Open Group (2009), The Open Group Architecture Framework, Available at: <www.opengroup.org/architecture>, [Accessed 20 July 2011].

Themistocleous, M. G. (2002), *Evaluating the Adoption of Enterprise Application Integration in Multinational Organizations*, Doctor of Philosophy Thesis, Brunel University, London, Available at: <http://bura.brunel.ac.uk/handle/2438/5524>, [Accessed 6 May 2011].

Themistocleous, M. and Irani, Z (2002), Evaluating and Adopting Application Integration: The Case of a Multinational Petroleum Company, In *Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS'02)-Volume 9 - Volume 9* (HICSS '02), Vol. 9. IEEE Computer Society, Washington, DC, USA, 286.

Vasconcelos, A. et al. (2004), An Information System Architectural Framework for Enterprise Application Integration, *In Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04) - Track 8 - Volume 8* (HICSS '04), Vol. 8. IEEE Computer Society, Washington, DC, USA, 80225.2.

Walsham, G. (1995), Interpretive Case Studies In IS Research: Nature And Method, *European Journal of Information Systems*, Vol. 4, No.2, pp. 74-81.

Ward, J. and Peppard, J. (2002), *Strategic Planning For Information Systems*, 3rd edition, John Wiley & Sons Ltd., Baffins Lane, Chichester.

Warr, A. (1990), *Bridging the Gap - Implementing Information Systems (IS) Strategies*, Cranfield School of Management, Cranfield, Bedford, Available at: <https://dspace.lib.cranfield.ac.uk/bitstream/1826/325/2/SWP1091.pdf>, [Accessed 31 July 2011].

Weill, P. and Ross, J. (2004*), IT Governance: How Top Performers Manage IT Decision Rights For Superior Results,* Harvard Business School Press, Boston, MA.

Yin, R. K. (2003), *Case Study Research: Design and Methods*, 3rd Edition, Applied Social Research Methods Series Vol. 5, SAGE Publications, Thousand Oaks.

Zachman, J.A. (1987), A framework for information systems architecture, *IBM Systems Journal* Vol.26, No3, (September 1987).