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► **To cite this version:**

Llanos Cuenca, Andres Boza, Angel Ortiz. (Enterprise) An enterprise engineering approach for the alignment of business and IT strategy. *International Journal of Computer Integrated Manufacturing*, 2011, pp.1. 10.1080/0951192X.2011.579172 . hal-00721641

HAL Id: hal-00721641

<https://hal.science/hal-00721641>

Submitted on 29 Jul 2012

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Journal:	<i>International Journal of Computer Integrated Manufacturing</i>
Manuscript ID:	TCIM-2011-IJCIM-0016.R1
Manuscript Type:	Special Issue Paper
Date Submitted by the Author:	21-Mar-2011
Complete List of Authors:	Cuenca, Llanos; Universidad Politécnic de Valencia, Research Centre on Production Management and Engineering (CIGIP), Department of Business Organization Boza, Andres; Universidad Politécnic de Valencia, Research Centre on Production Management and Engineering (CIGIP), Department of Business Organization Ortiz, Angel; Universidad Politécnic de Valencia, Research Centre on Production Management and Engineering (CIGIP), Department of Business Organization
Keywords:	ENTERPRISE ARCHITECTURES, ENTERPRISE INTEGRATION, STRATEGY, INFORMATION SYSTEMS, INFORMATION TECHNOLOGY
Keywords (user):	Enterprise Engineering, Business and IT Strategic Alignment

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An enterprise engineering approach for the alignment of business and IT strategy

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An enterprise engineering approach for the alignment of business and IT strategy

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IS/IT (hereafter just IT) strategies usually depend on a business strategy. The alignment of both strategies improves their strategic plans. From an external perspective, business and IT alignment is the extent to which the IT strategy enables and drives the business strategy. This paper reviews strategic alignment between business and IT and proposes the use of enterprise engineering to achieve this alignment. The enterprise engineering approach facilitates the definition of a formal dialog in the alignment design. In relation to this, new building blocks and life-cycle phases have been defined for their use in an enterprise architecture context. This proposal has been adopted in a critical process of a ceramic tile company for the purpose of aligning a strategic business plan and IT strategy, which are essential to support this process.

Keywords: Enterprise Engineering, Business and IT Strategic Alignment, Enterprise Architecture Framework

1. Introduction

While potentially offering significant returns, incorporating information systems and information technology (IT) into organizations involves considerable risks, and these risks increase when a strategic plan for this incorporation is not provided. Aligning IT strategy and business strategy is a key process in maintaining business value (Henderson and Venkatraman, 1993; Hirschheim and Sabherwal, 2001; Sabherwal et al., 2001; Peppard and Brey, 2003; Luftman and Ben-Zvi, 2010). Enterprise engineering facilitates formal dialog in enterprise design. The purpose of this paper is to present how these benefits can be translated to strategic alignment by applying an engineering approach. Business and IT strategic alignment engineering is a process involving architecting and designing strategic alignment.

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Enterprise architectures enable alignment in significant ways (Gregor et al., 2007): 1) business and information systems can be modelled together in a common organizational framework. In this case, business and IT domains are integrated and made visible in a common framework, 2) the current and future states of the business and IT are defined and described in detail. The gap analysis between the “as is” and the “to be” states provides a basis for strategic, operational and resource planning.

The Strategic Alignment Model (SAM) (Henderson and Venkatraman, 1993) draws a distinction between the external environment of business strategy and IT strategy; and the internal environment focusing on organizational infrastructure and processes, and IT infrastructure and process. On the other hand, there are two kinds of relationships between the involved domains: (1) strategic fit describing the interrelationship between the external and internal environments of the same domain (“business” or “IT” domain) and (2) functional integration describing the link between the “business” and “IT” domains (Avila et al., 2009).


The importance of IT is reflected by the way it participates in the strategy formulation process. The information technology function should become more influential during the creation of business strategies. The trend is to integrate IT into the formal strategy framework (Luftman et al., 1993). However in the enterprise engineering approach, the enterprise architectures (EA) for enterprise modelling have traditionally focused on only functional integration from an internal point of view in an attempt to solve the problem of the alignment between organizational infrastructure and IT infrastructure to facilitate the implementation and execution of business processes (e.g., CIMOSA (Amice, 1993) and Zachman framework (Sowa and Zachman, 1992)). In relation to strategic fit, EA has attempted to solve this problem by extending its focus, mainly on the business domain (e.g., GERAM (IFIP/IFAC, 1999) and IE-GIP (Ortiz et al., 1999)), so the IT strategy definition remains an open problem in the EA and enterprise engineering field. In this sense, it is difficult to establish alignment from the external perspective between the business strategy and the IT strategy.

This paper uses an enterprise engineering approach to review alignment by identifying the gaps and needs between business and IT strategic alignment. To go

about this, new building blocks and new life-cycle phases, which are to be used in enterprise engineering, have been defined to establish this alignment in accordance with ISO 15704 (2000) and ISO 19440 (CEN 19440, 2007), to include both the concepts used in methodologies and references architectures within an encompassing conceptual framework that allows the coverage and completeness of such approach.

This paper is organized as follows: firstly, Section 2 introduces the enterprise engineering and enterprise architecture concepts. Section 3 offers a review of business and the IT strategic alignment. Section 4 identifies the relationships between alignment and enterprises architecture. Next, Section 5 proposes the enterprise engineering approach for the external perspective of business and IT alignment by identifying new life-cycle phases, the building blocks required and the associated templates to be defined. Section 6 describes the proposed framework which is applied in a ceramic tile company. Finally, Section 7 provides a summary of the conclusions.

2. Enterprise engineering and enterprise architecture

Enterprise engineering (EE) concerns the analysis, optimization and re-engineering of all or part of the business processes, information systems and organization structures in an enterprise or an enterprise network (Vernadat, 1996). EE concept can also be used to align the corporate strategies with the use of product lifecycle management technologies (Penaranda et al., 2009). According to Hoogervorst (2009), the engineering approach offers important benefits such as: (1) a formal approach for addressing organized complexity as well as the realization of a unified and integrated design, (2) the formal identification of  ordination actions defines clear responsibilities.

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To ensure that this design is carried out coherently, the enterprise architecture concept arises. Enterprise architecture (EA) is defined as a way to structure and

design the company's organization and operations. Architecture makes operation description possible (with different levels of detail) and provides a relevant modelling process (Cuenca et al., 2006). EA is a coherent set of principles, methods and models used in the design of an enterprise's organizational structure, business processes, information systems and infrastructure (Lankhorst, 2004). EA is the outcome, albeit an evolving one, of a strategic planning and management process to which an enterprise architecture framework is applied to describe both the current (as-is) and future (to-be) states (Tang et al., 2004).

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The framework applied to the enterprise is a logical structure used for classifying and organizing the enterprise's descriptive representations, which are significant for both its management and the development of its systems (Inmon et al., 1997).

The framework should also simplify enterprise architecture development since it helps to articulate how the different components of the enterprise architecture relate to one another (Martin and Robertson, 2004; Bittler and Kreizman, 2005). The framework should provide a general mechanism for defining views. Views are used in enterprise modelling because the complexity of an enterprise makes it impossible for a single descriptive representation to be humanly comprehensible in its entirety (Martin and Robertson, 2004).

Another adjacent concept to EA is Enterprise Modelling (EM). EM describes in detail the EA from various viewpoints and permits the specification and implementation of systems (Chen et al., 2008). According to Vernadat (1996), EM is the set of activities or processes used to develop the various parts of an enterprise model to address a given modelling purpose. The use of these models in enterprise

engineering can cut design times and improve modelling consistency (Chen and Vernadat, 2004).

Enterprise models have a life cycle that is related to the life cycle of the modelled entity. The life cycle of an enterprise model is the result of the model development process by which models are created, made operational and finally discarded (CEN 19439, 2006). EM uses modelling languages, methods and tools chosen according to the enterprise's life-cycle phase (or life cycle activity). The life cycle of a business entity can be represented in enterprise reference architectures or architecture frameworks (IFIP/IFAC Task Force, 1999). A modelling language construct or building block is a textual or graphical part of a modelling language devised to represent the diverse information on common properties and elements of a collection of enterprise entities in an orderly way. Building blocks provide common semantics and enable the unification of the models developed by different stakeholders in the various model development phases. They may be specialized and/or organized into structures for specific purposes; for example, for an industry sector or for a particular kind of enterprise concern such as maintenance. In turn, such structures and/or generic modelling language constructs can be used for developing particular models for a specific enterprise (CEN 19440, 2007). Several architecture frameworks exist today, and they all have a modelling framework organizing enterprise model, which may have to be created during the life of a business entity (Bernus et al., 2003).

The relationships between the elements described above are shown in Figure 1.

'Insert Figure 1 here'

According to the IFIP/IFAC Task Force (1999) and ISO 15704 (2000), there are two types of architectures: system architectures (sometimes referred to as Type 1 architectures) that deal with the design of a system, e.g., the part of a system in overall enterprise integration. The other type of architecture is enterprise reference projects (sometimes referred to as Type 2 architectures) that deal with the organization of the development and implementation of a project, such as enterprise integration or other enterprise development programs. In other words, Type 1 architectures represent the system or sub-system in terms of its structure and behaviour. Type 2 architectures are actually frameworks whose aim is to structure the concepts and activities/tasks required to design and build a system. These Type 2 architectures are mainly devised throughout the system's life cycle to show what has to be done to model, design, and implement an integrated enterprise system (Chen et al., 2008).

Examples of Type 1 architectures are: ENV 13550 Enterprise Model Execution and Integration Services (EMEIS), Manufacturing Automation Programming Environment and Open Management Architecture (CORBA)

Among the Type 2 architectures, the most well-known are: the Computer Integrated Manufacturing Open System Architecture (CIMOSA) (Amice, 1993), the Purdue Enterprise-Reference Architecture (PERA) (Williams et al., 1996), the GIM architecture (Doumeingts et al., 1992), GERAM (IFIP/IFAC, 1999), IE-GIP (Ortiz et al., 1999), in the reference architectures; and the Zachman framework (Sowa and Zachman, 1992), TOGAF (Open Group, 2009), DoDAF (DoD AF, 2007), Enterprise Architecture Planning (EAP) (Spewak, 1993), Integrated Architecture Framework (IAF) (Schekkerman, 2003), and the Federal Enterprise Architecture Framework (FEAF) (CIO, 1999) architectures that have emerged in the field of information systems.

Type 2 architectures identify and define different views. The number of views differs in each EA. The most common are: Business, Resource, Organization, Information, Data, Application, and Technological Views.

The Business View contains the business processes and business entities in a company; the Resource View comprises capabilities and resources; the Organization View comprises organization levels, authority and responsibility; the Information View contains input and output process; the Data View defines the types and data sources needed to support the Information View; the Application View identifies the application needs and data presentation; finally, the Technological View determines the technology to be used and defines how this technology should be used.

All enterprise architectures contain views within their frameworks; however, life cycles, building blocks and how the building blocks fit together, are not defined by them all, thus making the alignment between components difficult (Cuenca et al., 2010). To enhance and facilitate alignment, this proposal not only defines the building blocks, but indicates in which life-cycle phase and modelling view they will be assigned.

3. Business and IT strategic alignment

The information systems of an organization consist of the information technology infrastructure, data, application systems, and personnel that employ IT to deliver information and communications services in an organization (Davis, 2000). Thus, the IS concept combines both the technical components and human activities within the organization, and also describes the process of managing the life cycle of organizational IS practices (Avgerou and McGrath, 2007). Information systems can improve the organization's competitiveness through a well-defined set of resources for the construction, composition and implementation of a competitive advantage for

Comment [I2]: We agree with the Referee, these authors have been included to enrich the definitions with up-to-date references, and Henderson and Venkatraman are referenced below.



the company (Porter, 1980; MacFarlan, 1984). Strategy is a broad-based formula for the way the business is going to compete, what its goals should be, and what policies should be carried out to achieve these goals. The essence of formulating competitive strategy lies in relating a company to its environment (Porter, 1980).

Two approaches deal with Business and IT strategic alignment: (1) Strategic IS planning (SISP) (King, 1978; Ang et al., 1995; Hartono et al., 2003; Newkirk and Lederer, 2006; Silvius, 2007) and (2) IT alignment (Henderson and Vekatraman, 1993; Luftman et al., 1993; Bergeron et al., 2004; Avison et al., 2004; Chen et al., 2005; Wegmann et al., 2005; Derzsi and Gordijn, 2006; Bleistein et al., 2006; Vargas et al., 2008).

Strategic IS planning consists of the development of various methodologies that incorporate the strategic objectives of the corporation into the information systems plan while attempting to create management information systems (MIS) applications that will improve the corporation's competitive position (Ang et al., 1995).

Business and IT alignment is the extent to which the IT strategy enables and drives the business strategy (Luftman et al., 1993; Reich and Benbasat, 2000). According to Reich and Benbasat (1996), IS-Business alignment is defined as the extent to which the IT mission, objectives, and plans support and are supported by the business mission, objectives and plans. In this definition, objectives refer to the goals and strategies of an organizational unit. Luftman (2000) defines IS-Business alignment as applying IT appropriately and in a timely way in harmony with business strategies, goals and needs. It can be addressed by these two questions: (1) how is IT aligned with business and; (2) how should or could business be aligned with IT.

Mature alignment evolves into a relationship where IT and other business functions adapt their strategies together.

A number of strategic alignment models have been proposed. The two key models that have attracted most attention from researchers are (Avison et al., 2004): the MIT90s model (Scott Morton, 1991) and the Strategic Alignment Model (SAM) (Henderson and Venkatraman, 1993).

According to the MIT90 model, for an organization to fully capture IT value, IT should be aligned with business strategy, structure, management processes, as well as with individuals and roles. The MIT90 dimensions affected are: (1) IT structure, processes and individuals and roles are unaligned with the business strategy (2) there is some alignment of processes and roles, yet the IT structure is still largely unaligned, (3) further alignment of IT processes and roles, (4) the IT structure is aligned with business strategy, processes and roles, (5) IT supports the business strategy.

The MIT90s model identifies conceptual integration among the different change factors and demonstrates one 'classic' route that firms may follow. The MIT90s model argues that a successful organization has a high fit among its strategy, structure, roles and skills, management processes and technology, and between that configuration and its business environment (Scott Morton 1991). The 'classical' or conventional alignment model starts with a change in strategy. This changes structure which, in turn, leads to change in processes, technology and individuals and roles.

According to Sakka et al. (2010), and in comparison with the MIT'90 model, SAM makes a distinction between the external perspective of IT (IT strategy) and the internal focus of IT (IT infrastructure and process).

SAM (Figure 2) is composed of four quadrants that consist of three components each. These twelve components define what each quadrant is as far as

alignment is concerned. All the components working together determine the extent of alignment for the company being assessed (Henderson and Venkatraman, 1993; Papp, 2001, Sakka et al., 2010).

The four quadrants are (Henderson and Venkatraman, 1993):

- Business strategy at the external level of the business domain. It is structured by three components: business scope, business competencies and business governance.
- Organizational infrastructure and processes that form the internal level of the business area. This domain is composed of three components: administrative infrastructure, skills and business processes.
- IT strategy at the external level of the IT domain. It is structured by three components: technology scope, systemic competencies and IT governance.
- IT infrastructure and processes that form the internal level of the IT area. Likewise, it is formed by three components: IT architecture, IT skills and IT processes.

'Insert Figure 2 here'

There is a total of twelve perspectives or types of relationship toward the alignment of business and IT which include four fusion perspectives. The four original perspectives, as described by Henderson and Venkatraman (1993), are: (1) strategic execution: this perspective views the business strategy as the driver of organization and IT infrastructure; (2) technology potential: this perspective views the business strategy as the driver of an IT strategy to support the chosen business strategy and the required IT infrastructure; (3) competitive potential: this alignment perspective is concerned with the exploitation of emerging IT capabilities to impact new products and services; (4) service level: in this perspective, the business strategy role is indirect. The four new non-fusion perspectives are, (5) organization IT infrastructure: this perspective results in process improvements from information technology and the application of value to the business processes; (6) IT infrastructure strategy: the focus of this perspective is the improvement of the information technology strategy based on the implementation of emerging and existing

information technology infrastructures; (7) IT organization infrastructure: in this perspective, IT is the driving force and architect by which visions and processes are carried out; (8) organization infrastructure strategy: this perspective exploits the capabilities to enhance new products and services, influence strategy, and develop new relationships. In fusion, the pivot and the anchor domain are not adjacent to one another, but rather across from each other on the diagonal. The fusion perspectives are: (9) organization strategy fusion: results from the combination of IT organization infrastructure and IT infrastructure strategy perspectives, which both impact the business strategy. The basis of this fusion perspective is that it is technology driven, that IT is a solution and that it plays a dominant role in the business; (10) the organization infrastructure fusion perspective. This fusion combines the competitive potential and service level perspectives whose result is an anchor of IT strategy and organization infrastructure being the impact area. This fusion perspective is based on the performance of IT and the organization's determination of its value; (11) Information technology strategy fusion is the third fusion perspective. It results from combining the organizational IT infrastructure and the organizational infrastructure strategy. This perspective explains to top level management how IT must be developed to bring into effect a strategic change in the business. The final fusion perspective is (12) the information technology infrastructure fusion perspective. It results from the combination of the strategy execution and technology potential perspectives. The focus of this perspective is a new, emerging IT architecture which is the cost of success in the business' future (Papp and Luftman, 1995; Luftman et al., 1993; Coleman and Papp, 2006).

Other approaches have addressed business and IT alignment (Chen, 2007).

- Via Architecture: (1) software architecture: BITAM (Chen et al., 2005), etc. (2) enterprise architecture: the Zachman framework (Sowa and Zachman, 1992), TOGAF (Open Group, 2009), DoD (DoDAF, 2007), FEAF (CIO, 1999), etc.
- Via Governance: (1) business performance management: balanced scorecard (Kaplan and Norton, 1996), (2) IT governance: COBIT (ITIG, 2005) service management: ITIL, Maturity Model (Luftman et al., 2010), etc.

The enterprise architecture approach corresponds to the objective of this paper and will be discussed in the next section. The Balanced Scorecard (BSC) for the remaining proposals is, primarily, a strategy management tool; so it rarely works without top-level executive sponsorship. If companies skip the initial step of mapping out a business strategy with clear cause-and-effect relationships, they can end up measuring factors that do not link to business performance (Chen et al., 2005). BSC concepts have been applied to the IT function and its processes. The corporate contribution perspective evaluates the performance of the IT organization from the executive management viewpoint. The customer orientation perspective evaluates IT performance from the internal business users' viewpoint. The operational excellence perspective provides the IT processes performance from the IT management viewpoint. The future perspective shows the readiness for future challenges of the IT organization itself (Van Grembergen and De Haes, 2005.); COBIT: the ITGI (IT Governance Institute) has developed a framework to control information technology under the name of Control Objectives for Information and related Technology (COBIT), this provides organizations with a set of guidelines for implementing IT governance controls in technology processes. ITIL: The Information Technology Infrastructure Library was published by the British Government. IT service management refers to the provision of IT services and the support needed to suit the organization's business needs. ITIL provides a set of best practices for IT service management. The alignment maturity model provides a comprehensive vehicle for

Comment [13]: Reference inserted: Luftman J., Ben-Zvi T. Dwivedi R., Rigoni E. IT Governance: An Alignment Maturity Perspective 2010. International Journal on IT/Business Alignment and Governance, 1(2), 13-25.

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organizations to evaluate business-IT alignment in terms of where they are and what they can do to improve alignment (Luftman, 2000).

The starting point for the proposal will be enterprise architectures and how they address the business and IT strategic alignment. In this paper we will centre on those perspectives where the business strategy or IT strategy is the anchor domain, which correspond to the four original perspectives described by Henderson and Venkatraman, as well as to the fusion perspectives: organization infrastructure fusion and IT infrastructure fusion. These are the perspectives relating with the IT strategy, and this is poorly defined in the enterprise architecture approach.

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4. Business and IT strategic alignment in enterprise architecture



According to Chen (2007), the enterprise architecture approach does not define how to align and what to align. In this sense, we have analyzed whether some perspectives of alignment are taken into account in enterprise architectures, as well as the different components to be modelled. As shown below, in reference architectures for enterprise modelling, strategic alignment is conducted from a business strategy to the organizational infrastructure, and the IT strategy is hardly defined. So, it is necessary to improve the definition of the IT strategy and the alignment with business strategy in enterprise architecture.

Of the different proposals for enterprise architectures, we have selected the most relevant in the research area and its implementation in enterprises (Whitman et al., 2001; Vasconcelos et al., 2004; Narman et al., 2007; Greefhorst et al., 2006, Chen et al, 2008). The analysis was carried out by partially following the proposal of Avila et al. (2009) which identifies between two other aspects to be analyzed: Alignment Sequence (Table 1) and Involved Domain (Table 2).

4.1 Alignment Sequence

The involved domains can be classified as an anchor domain, a pivot domain or an impacted domain. The anchor domain is the greatest strength among the four domains. This is the area that drives the changes to be applied to the pivot domain. The pivot domain is the area that will receive focus, and where the changes will be addressed by the anchor quadrant. The impacted domain will be directly affected by the change made to the pivot domain (Henderson and Venkatrama, 1993; Luftman et al., 1993). As mentioned above, in this paper we consider the business strategy or IT strategy as an anchor domain.

Based on this classification, the main enterprise architectures have been analyzed.

'Insert table 1 here'

In the table above, we can see how most of the proposals addressing the business architecture sequence alignment with the business strategy "anchor domain" have an impact on IT infrastructure and processes, which means that IT will be seen as an element supporting the organization, and not as a competitive advantage. In some enterprise architectures, the IT strategy acts as an "anchor domain", but does not direct the business strategy. Moreover, the reference architectures (GERAM and IE-GIP) do not identify the elements associated with the IT strategy, but only those covered by the first sequence.

4.2 Involved Domain

According to Avila et al. (2009), the involved domains correspond to "What domains should be aligned toward the IS domain?" For each involved domain, Table 2 shows the life-cycle phases of enterprise architectures involved in their establishment.

There are proposals such as those by Zachman or DoD whose modelling frameworks do not include life-cycle stages; however, several studies have

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established close relationships with all the phases defined by GERAM, thus identifying them as life-cycle stages (Noran, 2003, Noran, 2005; Saha, 2004).

Table 2 shows the lack of definition of the IT strategy in the referenced architectures. The life-cycle phases defined by these architectures do not include those that allow the definition of the IT strategy, which will be precisely the aim of implementing this proposal.

'Insert table 2 here'

For each life-cycle phase associated with each Involved Domain, the modelling language used may be identified (as indicated in Figure 1).

The life-cycle phases in enterprise modelling follow a sequential process beginning with the business strategy formulation. This formulation will be done in the identification and conceptualization phases (GERAM, IE-IP, TOGAF, EAP, IAF, B-SCP and BITAM) or in the business architecture (FEAF, DoDAF and Zachman). When the business strategy is defined, we can continue defining the elements in organization infrastructure and processes (perspective 1) or with the IT strategy (perspective 2). Some enterprise architectures allow the fourth perspective to be followed (service level), TOGAF includes the Architecture Development Method (ADM) cycle. The ADM can be adapted, for example, if the business case for doing architecture at all is not well recognized, thus the creation of an architecture vision is almost always essential; moreover, a detailed business architecture often needs to come next to underpin the architecture vision, to detail the business case for the remaining architecture work, and to also secure the active participation of key stakeholders in that work. In other cases, a slightly different order may be preferred; for example, a detailed inventory of the baseline environment may be done before

undertaking the Business Architecture (Open Group, 2009). However it is not possible to follow perspective 3.

One of the benefits of enterprise engineering is that it allows a more formal definition of the various elements of the enterprise system by modelling together business and IT.

In this proposal, building blocks are used as a modelling language to obtain this benefit and to establish a formal definition. According to ISO 19440 (CEN19440, 2007), each building block is associated with a given life-cycle phase and modelling view. For GERAM and IE-GIP, it is necessary to define new life-cycle phases that allow the modelling of the IT strategy and the alignment with the business strategy into which the new building block is incorporated.

4.3. Related Works

This section presents other proposals that relate alignment models with enterprise architectures.

Wegmann et al. (2005) proposes an EA framework and an associated tool that provide alignment checking throughout the functional and organizational hierarchies. This framework does not include strategic alignment.

Pereira and Sousa (2005) show how the alignment between business and IT can be disaggregated into four different dimensions, which present some heuristics to ensure such an alignment. These authors do not include strategic alignment, and the heuristics is a permanent list.

Plazaola et al. (2007) proposes a meta-model based on Luftman's strategic business and information technology alignment. This proposal facilitates the relationship to enterprise architecture through the definition of artifacts for modelling Luftman's maturity model. Luftman's theory diagram is constructed by representing

the criteria, attributes and alignment level for each attribute expressed by its set of conditions and properties. Each alignment level has a causal relationship to the corresponding attribute, while attributes have a composition relationship with their corresponding criterion. However, benefits will only become important once the alignment assessment has been incorporated into an organization; using the model as a prescriptive tool. On the other hand, the following questions remain unsolved: How does the EA integrate with the other components? Who does the analysis? What form does evolution take?

Wang et al. (2008) propose an Enterprise Architecture Development Method (EADM) to develop enterprise architectures with a view to covering business and IT needs. They provide no formal definition of the EA framework and how to define the IT strategy and strategic alignment.

The proposal presented in this article overcomes the gaps identified in previously related works.

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5. Enterprise engineering approach for the external perspective of business and IT alignment

This section includes the proposed business and IT strategic alignment using enterprise engineering. Firstly, the main IT strategy components have been identified. Secondly, these components have been considered to define the new building blocks to be used in an enterprise architecture context.

5.1 IT strategy components

It is necessary to identify what **elements** must be included in the IT strategy for them to be later included in the enterprise architecture framework. These elements correspond to Henderson and Venkatraman's components and Luftman's components; moreover, we have extended the review to identify the new elements to be taken into

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account. Strategy can be implemented through the strategic management process components (Hill and Jones, 2001): (1) vision: an end-state toward which the organization strives, (2) mission: it defines what we should be doing. The organization's primary activity that achieves the vision, (3) goal: it defines where we are going. An abstract statement of intent whose achievement supports the vision, (4) strategy: it defines what routes we have selected; that is, the long-term activity designed to achieve a goal.

Moreover, and as mentioned previously, the IT strategy at the external level is structured by three components: technology scope, capability and skills and IT governance (Henderson and Venkatraman, 1993).

- Technology scope: scope is defined as the set of specific technologies that support the business strategy or which may shape new strategic initiatives in the future.
- Capability and skills: capability and skill or systems competencies are those attributes of IT strategy that could contribute positively to the creation of new business strategies or better support of existing business strategies.
- IT Governance: governance refers to the organizational mechanisms required to obtain the required competencies.

To do this review, the online literature (Compendex, IEEE Xplore, Inspec, NASA via SCIRUS, Science Direct and Web of Science) was searched using the following search terms: strategy, strategic alignment, business strategy, IT strategy, IS strategy, strategic planning of information systems.

Table 3 shows part of the analytical results, and presents three new components in addition to those defined by Henderson and Venkatraman: portfolio, maturity model, and data strategy.

'Insert table 3 here'

- Portfolio: an application portfolio is defined as a collection of projects and/or programs and other works grouped together to facilitate effective management to meet the strategic business objectives (PMI, 2006). Projects tend not fully relate with the organization's strategic objectives so the portfolio consideration is important in early life-cycle phases.

Comment [15]: In accordance with the referee 's wishes, the description of the Henderson and Venkatraman has been included

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Deleted: A capability is more than an organizational resource, or combination of resources it is the organization's ability to mobilize resources and other capabilities to accomplish an organizational objective (Adams et al., 2004). In this case, capability and skill refer to the set of capabilities associated with information technology

Deleted: (Henderson and Venkatraman, 1993). It refers to the governing policies and principles that exist within the organization to guide the IT operating activities (Adams et al., 2004)

- **Alignment** Maturity Model: maturity models are a suitable vehicle to be used by cross-organizational collaborations to gain a deeper understanding of how they progress toward better business-IT alignment (Santana et al., 2008). According to Luftman (2000), this model involves five levels of strategic alignment maturity: (1) Initial/Ad Hoc Process, (2) Committed Process, (3) Established Focused Process, (4) Improved/Managed Process, (5) Optimized Process. All five levels of alignment maturity focus on a set of alignment criteria. These six criteria are: 1. Communications Maturity, 2. Competency/Value Measurement Maturity, 3. Governance Maturity, 4. Partnership Maturity, 5. Scope & Architecture Maturity, 6. Skills Maturity.
- **Data Strategy**: data are the facts about objects, events or other entities. They will be associated with data sources and how these data are retrieved and analyzed. From an information management perspective, key data concerns are typically associated with data protection/storage, and records management and regulatory compliance (Buchanan and Gibb, 2007).

The summary table (Table 3) shows that even though each identified component has been taken into account by several authors, no author explicitly provides each and every one of them. The governance criterion in Lutman's maturity model includes the prioritization process and IT investment management attributes which the application portfolio, which is represented in Figure 3 in light grey.

IT leadership may be defined as the ability of the CIO, or a similar role, to articulate a vision for IT's role in the company and to ensure that this vision is clearly understood by the managers throughout the organization. If the CIO is not able to talk in business-oriented terms at an executive level, their impact at that level will be minimal (Van Grembergen and De Haes, 2010). Including data strategy and portfolio components at the strategic level could facilitate this communication between business and IT managers.

5.2 Building block and life cycle proposed

The IT strategy components identified must be incorporated into the enterprise architecture framework to facilitate the IT strategic definition and alignment with the business strategy. This paper defines it according to ISO 19440 (CEN 19440, 2007), which provides a set of modelling elements for the unified framework. In some cases,

building blocks inherit the standard, so new building blocks are not necessary; in other cases, new building blocks have been elaborated.

It should be noted that some of the above-identified elements have no direct translation to a building block, but will be the elements of a building block. This is the case of the elements vision, mission, goal, strategy, and scope. These items are included in the new building block IT Conceptualization. The other components are associated with a building block. Capability and Skills, and Governance may be modelled with existing building blocks in the standard, Role and Capability Set building block in the case of Capability and Skill and Cell Organization, and the Organization Unit building block in the case of governance. The corresponding building blocks will be defined for the portfolio, the maturity model and the data strategy building block (Table 4).

'Insert table 4 here'

This proposal seeks to improve the IT strategy definition and its alignment with business strategy elaborated on the proposed building blocks. It is not easy to accomplish this alignment; therefore we propose a mechanism to assess the integration between the business strategy and the IT strategy. The use of two techniques is proposed:

- Alignment Heuristics: rules for reviewing the alignment of business and technology at the strategic level. Heuristics is meant to warn that the situation will require further analysis and justification.
- Correspondence Strategic: the use of the strategic dependency model and the strategic relationships model of framework i * as a graphical representation of the relationships of the dependencies between the actors.

The techniques used originate from the works of Pereira and Sousa (2005) and Yu (1995), respectively. Both techniques are easy to use by those in charge of

different areas, and can work in parallel with other existing methods or techniques in the company, which justifies their choice.

In the business engineering approach that we follow in this paper, each building block is associated with a view and modelling phase. It is, thus, necessary to identify the exact modelling phase that will incorporate these building blocks. As noted in the involved domains table (Table 2), there are no life-cycle phases associated with the IT strategy in the GERAM reference architectures and in IE-GIP.

We therefore propose the definition of new phases. The IE-GIP context is more complete than GERAM to be taken as a starting point. Moreover, the conceptualization phase of GERAM was extended in IE-GIP to enable the definition of the business strategy (business conceptualization phase), the as-is and to-be processes (business process definition), and an action plan was established to change the state (master plan). To facilitate the understanding of the life-cycle phases proposed and their integration into IE-GIP, a similar name has been assigned to the new phases but, in this case, IT has been applied. This extension is reflected in Figure 3 below:

'Insert Figure 3 here'

The horizontal relationship in each phase shows the alignment between business and IT. On the other hand, each phase is related with a previous one, and is followed to enforce or review the plans provided (vertical relationships). In this proposal, IT can take action as an anchor domain, a pivot domain and an impact domain.

The content of each phase is explained in the next section.

5.3 Building Block description and associated template

This section details the proposed building block purpose. Building blocks will be described according to ISO 15704, and the following will be indicated for each one:

- Description
- Purpose
- Where to use it
- Template

The template refers to those elements to be defined for each building block. These elements may refer to individual attributes or to other building blocks. All the templates have a common header which indicates the type (attribute that can be used to group the instances of each building block), name, identification and design responsible (responsibility for the design and maintenance engineering for this building block).

IT conceptualization

Description: building block IT conceptualization is marked if the information required to define the IT strategy has been completed. A joint analysis must also be carried out with the business conceptualization.

Purpose: the purpose of this building block is for the company to confirm if the IT strategy has been fully established. The purpose of this template is not to evaluate the alignment, but to check if the corresponding elements of IT strategy have been defined. The information associated with the mission, vision, critical success factors, etc., will be defined by the participants assigned. IT objectives may precede the formulation of business objectives and can be used as input to their development. Conceptualization will be defined for the enterprise and for the business entity (whole or part of a single or networked enterprise).

Where to use it: the building block used in the IT conceptualization phase is associated with the information view.

Template: Figure 4

‘Insert Figure 4 here’

Alignment heuristics

Description: with this building block, alignment heuristics is defined by indicating the views involving the cells or organizational units participating in its definition, the question associated with the heuristics, the answer value, as well as the response date.

Purpose: Alignment heuristics is used in this case to detect any weakness in the business and IT alignment. By using this building block, different views are related by an alignment question. The company will react with improvement actions depending on the answer obtained. Examples of these questions can be: Does IT provide agility in responding to changing business needs?, Does IT allow minimize operating costs?, Does IT improve payment supplier relationships?

Where to use it: the building block is used in the IT conceptualization phase and is associated with the technological view.

Template: Figure 5

‘Insert Figure 5 here’

Strategic dependencies model

Description: the strategic dependencies model is based on the i * framework (Yu, 1995). The strategic dependency building block represents the resource, plans, task or goal dependencies among the different actors (roles, organizational units, organization cells or set of roles). It also indicates whether or not dependency is critical for the business entity. Strategic dependencies model identifies three elements 1) Depende Actor, who is depended upon on a dependency relationship; 2) Depender, the

depending actor on a dependency relationship and 3) Dependium Element around which a dependency relationship centres.

Purpose: the purpose is to detect any dependencies between the actors. It allows, for example, the identification of bottlenecks with those actors whose dependency on other actors is excessive. Moreover, the direction of the relationships can be mapped into Venkatraman's SAM sequences when the dependee belong to business area and the depender belong to IT area, and conversely. For example the decision to deploy an ERP (anchor domain) drives the changes to be applied to business strategy (pivot domain).

Where to use it: the building block is used in the IT conceptualization phase and is associated with the application view.

Template: Figure 6

'Insert Figure 6 here'

Application Portfolio

Developing an IT portfolio is a dynamic process by which a company identifies the current list of projects (applications and services) or new projects. The main feature is that the portfolio progresses in the right direction to maximize the values it can provide to the business. Each asset comprising the portfolio may be associated with different types of strategic objectives, which can identify technological deficiencies and weaknesses. A classification matrix can be used to illustrate how IT application or services are allocated within the company (McFarlan, 1984). We propose to analyze IT applications according to strategic importance by taking into account the dynamic aspect of the portfolio and the focuses on the concept of alignment with strategic business objectives and innovation in technology. Furthermore, the people making the business decisions have, in many cases, little knowledge of the IT enablement they

are asking for and what it can (and cannot) do for them. Changing this behaviour requires organizations to better integrate their business planning process with their IT planning process (Kaplan, 2005). The strategic orientation of the applications portfolio may improve CEO/CIO mutual understanding and therefore facilitate the alignment of an organization's IT with its business strategy (Johnson and Lederer, 2010). To do this, three building blocks have been proposed: the as-is portfolio, the to-be portfolio, and the applications and services portfolio that contains the to-be applications or services to be implemented.

As-Is portfolio

Description: it represents the list of the business entity's applications or services by identifying the code and the expiry date of a new portfolio review, and the list of the participants involved in the analysis of the applications or services. It also indicates if it is associated with achieving a business goal, and assesses whether any of the expected benefits have been obtained, plus their integration with other applications. It also identifies the value assigned by the classification matrix and the improvement actions proposed.

Purpose: the purpose of the portfolio of as-is applications and services is to support the information associated with each application and its relation with the business objectives.

Where it is used: in the IT process definition phase and is associated with the technological view.

Template: Figure 7

'Insert Figure 7 here'

To-be portfolio

Description: represents the list of applications or future services by identifying their source, launch date, list of the participants involved by analyzing the application or service, as well as the associated business objectives, and information on evaluating and prioritizing investments. Then there are the proposed classification matrix and the connection with the portfolio as-is applications, if they exist.

Purpose: the purpose of the portfolio of the to-be applications and services is to support the information associated with each application and its relationship with business objectives and the as-is applications. There must be at least one relationship with a business objective.

Where it is used: it is used in the IT process definition and is associated with the technological view.

Template: Figure 8

'Insert Figure 8 here'

Applications and services portfolio

Description: the applications and services portfolio in this phase includes those that have been identified in the portfolio of the to-be applications and services, and those that remain in the as-is portfolio. This portfolio is linked to the business goal as it also identifies the business process to use this application. It includes the launch date, the people responsible in the business and the IT area for this application or service. It is necessary to include the implementation document and to state planning and development.

Purpose: this building block intends to document and prioritize the business entity's applications and services and characteristics.

Where it is used: this building block is used in the master plan phase and is

associated with the technological view.

Template: Figure 9

‘Insert Figure 9 here’

Maturity model

Description: the maturity model building block is to identify the level of the business entity’s maturity and IT maturity by identifying the selected criteria and the assigned level. It is also important to identify the people responsible for assigning the attribute level as various participants may have different perceptions of the alignment value, as well as the date when the corresponding attribute is analyzed or reviewed, and the level at which maturity is assigned. The last assigned level should be saved to see the changes that have followed. It also defines the average level of the participant’s criterion, where the average is between the values of the attributes at this level, as well as in a networked organization, where collaborations among different participants are made possible by IT, the average level of the network criterion corresponding to the average value among all the participants for this particular criterion.

Purpose: defines the maturity level of alignment to the business entity as the only participant or all the participants in an extended or virtual enterprise.

Where it is used: in the IT definition stage process and is associated with the application view.

Template: Figure 10

‘Insert Figure 10 here’

The new life-cycle phases will be incorporated into Table 5 as follows:

‘Insert table 5 here’

On the other hand, new blocks can be integrated into the standard and may relate to other building blocks. The proposed building blocks can be used as a modelling language in the other enterprise architectures.

6. Case study

This proposal has been applied to a ceramic tile company. The company is made up of 3 production plants, a central warehouse and 28 selling points. The production plants manufacture product lots following a make-to-stock strategy. One same product type can be manufactured in any of the production plants. Orders are prepared in the central warehouse to be dispatched and delivered to the selling points in accordance with each selling point's orders. The 3 production plants employ an ERP and other applications: a specific production program, another program for forecast calculations, and spreadsheets for production planning. In some cases, communication among the various participants takes place through the application shared, and across the network in other cases.

6.1 Identification phase

Collaborative order management was the selected business entity because it is a critical process for the company. Information systems and information technology are essential to support this process.

IT governance has been modelled through an organization unit and an organization cell. Two organization cells were identified in the IT area: the IT Board (composed of the CIO and the CFO organization units), and the Steering Committee (composed of the CIO, the CFO, the external consultancy manager and the data manager organization unit). Currently in the company, the CIO depends on the CFO.

6.2 Process conceptualization and IT conceptualization phase

Business and IT conceptualization was carried out after identifying the business entity. Such conceptualization has meant a change in the way the company defines the strategy (without involving the IT area until now).

Several interviews with the managers appointed by the company were conducted. The outcome of these interviews has been specified in the templates associated with each building block.

The results of these interviews reveal the need of consistent and reliable information for IT to support collaborative order management.

In addition to the company's organizational structure, the information systems and technologies department depends on the CFO, which limits most investments in this area due to economic factors. IT is seen as business support and not as a competitive advantage.

The business conceptualization template appointed by IE-GIP and IT conceptualization template appointed in this proposal were completed.

Not all the organization units from the business and IT area contributed to conceptualization as expected; defining alignment heuristics has enabled the identification of those aspects that were not well resolved in conceptualization.

On the other hand, the strategic dependencies model was employed to identify and represent the dependencies between business and IT which, in turn, enabled them to represent the responsibilities shared between two or more stakeholders.

The strategic dependencies model has helped identify dependencies between actors, which have allowed the detection of bottlenecks and vulnerabilities. Thus, the dependencies between two actors are modelled without having to analyze the actions carried out by each depending actor to meet the dependency objective (objective, resource or task).

- First, we had to identify the actors involved, as follows:
 - Suppliers
 - Manufacturers
 - Distributors
 - Customers (including retailers and end customers)

Besides, the inclusion of a new actor has been proposed, this being the computer system (IT) which, in turn, includes the information system and the technology to be used. In this way, the strategic relationship with IT could be represented.

In a first analysis, the company identified approximately 12 strategic relationships that enabled the following analysis:

The objective “to facilitate coordination and collaboration” is the same objective met by the IT, but a number of dependency relationships participate with different actors. This enables the identification of IT as a bottleneck since the actor depends on various dependency relations.

- On the other hand, we identified the “Customer” actor as a vulnerable actor because it is a dependent actor involved in too many dependencies. The same applies to “Manufacturers”.

This analysis has proved very useful to detect the exact situation of this company, which has been identified through the strategic dependency model. This model firstly shows the importance of the IT area, and secondly its proper functioning; thus, both Manufacturers and Customers may not achieve their objectives and meet their expectations because of other actors.

6.3 IT process definition phase

Traditionally, the relationship between the applications and business processes comes about at the requirements definition level, and not at the strategic level.

Having an ERP system is considered crucial for the company and of a high strategic importance. The current system is negatively impacting the company's ability to grow and it does not meet the business needs.

The application and services portfolio has enabled the company to link the enterprise business processes to applications and services at the macro level through goals. This has also allowed applications to be prioritized.

After analyzing the current situation (as-is), the analysis of the future situation (to-be) was done. Replacing the old system with a new ERP that integrates the remaining applications was proposed in the selling points.

An example of an instance of the to-be portfolio template is shown below in Figure 11. This template depicts the business objectives to be achieved in the business entity through deploy of the ERP system.

'Insert Figure 11 here'

The maturity model has allowed a detailed analysis of the alignment between business and IT. Values from 1 to 5 were allocated, where 1 represents the lowest value. For this particular case, 43 attributes were identified and classified as 6 criteria.

The company's result was below 2, which represents an emerging alignment; this encourages the company to improve certain aspects. Furthermore, being able to save the obtained values enables the firm to know its evolution.

6.4 IT Master plan

The action plan document was generated in this phase. This document reflects the work undertaken in previous phases, as well as that delivered to the management team to validate continuity. This phase will also consider prioritization, as well as the investment planning services and applications based on the portfolio (as-is and to-be), as defined in the previous phase.

At this point, the company will continue with the requirements definition phase. Thanks to the element proposed herein, the company under study has improved its alignment between both the business and IT strategies. Among other benefits, we can summarize that the application of this proposal has allowed the company to define new decision makers in the IT area at the strategic level, and know how to coordinate and integrate the different plans with other business strategic decision makers. This definition has improved the information exchanged and information processing. The application and service portfolio building block have allowed applications and services to be documenting and prioritized in accordance with IT decision makers' requirements and business needs.

Different reports from the company and external interviews have allowed us to assess how the decisions made at the strategic level have successfully led to the organization achieving its objectives.

7. CONCLUSIONS

This paper has identified the necessary components to model the IT strategy and enhance the alignment of IT and business strategies. The elements defined by building blocks by following an enterprise engineering approach, and described according to ISO 15704, are: IT conceptualization, alignment heuristics and the strategic dependencies model (used in the IT conceptualization phase); as-is portfolio, to-be portfolio and maturity model (used in the IT process definition phase); applications and services portfolio (used in the master plan phase). The proposal put forward has been developed and guided by the need to incorporate the IT strategy into enterprise architecture frameworks.

The utilization of building blocks enables them to be integrated with other enterprise modelling constructs and provides their definition with more flexibility.

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The application performed in a ceramic tile company has helped validate the usefulness of the proposed modelling framework. This proposal has also led to the joint definition of IT and business strategic concepts.

This research work is part of ongoing research in the enterprise engineering field. Future lines of work will address the integration of this proposal with architecture measurement performance and its associated information system to make alignment with the business strategy possible. Moreover, the analysis will be extended to incorporate all the alignment sequences.

REFERENCES

- AMICE 1993. *CIMOSA: Open System Architecture for CIM*. 2nd extended revised version. Springer-Verlag, Berlin.
- Ang, J., Shaw, N. and Pavri F., 1995. Identifying Strategic Management IS planning parameters using case studies. *International Journal of Information Management*, 15 (6), 463-474.
- Avila, O., Goepp, V., and Kiefer, F., 2009. Understanding and classifying information systems alignment approaches. *Journal of computer information systems*. 5 (1), 2-14.
- Avison, D., Jones, J., Powell, P. and Wilson, D., 2004. Using and Validating the Strategic Alignment Model. *Journal of Strategic Information Systems*, 13(3), 223-246.
- Avgerou, C., and McGrath, K., 2007. "Power, Rationality, and the Art of Living through Socio-Technical Change," *MIS Quarterly* (312), 295-315.
- Bergeron, F., Raymond, L., and Rivard, S., 2004. Ideal patterns of strategic alignment and business performance. *Information & management*, 41(8), 1003-1020.
- Bernus, P., Nemes, L., Schmidt, G. 2003. *Handbook on enterprise architecture*. Berlin: Springer.
- Bittler, R.S. and Kreizman, G., 2005. *Gartner Enterprise Architecture Process Evolution*. ID: G00130849.
- Bleistein, S.J., Cox, K., Verner, J. and Phalp, K.T., 2006. B-SCP: A requirements analysis framework for validating strategic alignment of organisational IT based on strategy, context, and process. *Information and Software Technology* 48 , 846–868.
- Buchanan, S. and Gibb, F., 1998. The information audit: An integrated strategic approach. *The International Journal of Information Management*, 18(1), 29–47.
- Buchanan, S. and Gibb, F., 2007. The information audit: Role and scope. *International Journal of Information Management*, 27, 159–172.
- CEN/ISO 19439, 2006. *Framework for Enterprise. Modelling*.
- CEN/ISO 19440, 2007. *Enterprise integration: Constructs for enterprise modelling*.

- Chen, D. and Vernadat, F., 2004. Standard on enterprise integration and engineering-state of the art. *International Journal of Computer Integrated Manufacturing*, 17(3) 235-253.
- Chen, D., Doumenings, G. and Vernadat, F., 2008. Architectures for enterprise integration and interoperability: past, present and future. *Computers in industry* 59, 647-659.
- Chen, H.M, Kazmana, R. and Garg A., 2005. BITAM: An engineering-principled method for managing misalignments between business and IT architectures. *Science of Computer Programming*, 57, 5-26.
- Chen, H.M., 2007., SOA, Enterprise Architecture, and Business-IT Alignment: An Integrated Framework, *Proceedings of the 6th International Workshop On System/Software Architectures(IWSSA'07)*.
- CIO 1999 *Chief Information Officer Council. The Federal Enterprise Architecture Framework*. CIO Council.
- Clempner, J. and Gutierrez, A., 2002. Administración y ejecución de un plan estratégico de tecnología de información. *Revista digital universitaria. Mexico*. 3(1).
- Coleman, P. and Papp, R., 2006. Strategic alignment: Analysis of perspectives, *Proceedings of the 2006 Southern Association for Information Systems Conference*.
- Cuenca, Ll., 2009. *Marco arquitectónico para la propuesta IE-GIP. Extensión de la Arquitectura CIMOSA*. Aplicación a una empresa del sector cerámico. Thesis (PhD). Universidad Politécnica de Valencia.
- Cuenca, Ll., Ortiz, A. and Boza, A., 2010. *Business and IS/IT strategic alignment framework*. Emerging Trends in Technological Innovation. Doctoral Conference on Computing, Electrical and Industrial Systems. *IFIP International Federation for Information Processing (314)* 24-31..
- Cuenca, Ll.; Ortiz, A., and Vernadat, F., 2006. From UML or DFD models to CIMOSA partial models and enterprise components. *International Journal of Computer Integrated Manufacturing*, 19 (3), 248-263.
- Davis, G. B., 2000. *Information Systems Conceptual Foundations: Looking Backward and Forward*, in Organizational and Social Perspectives on Information Technology, R. Baskerville, J. Stage, and J. I. DeGross (eds.), Boston: Springer, 61-82.
- Derzsi, Zs. and Gordijn, J., 2006. A Framework for Business/IT Alignment in Networked Value Constellations. *Proceedings of the workshops of the 18th International Conference on Advanced Information Systems Engineering (CAiSE 2006)*, Namur University Press, Belgium, 219-226.
- DoD AF 2007. *Architecture Framework. Version 1.5. Volume I: Definitions and Guidelines. DoD Architecture framework Version 1.5*.
- Doumeings, G., Vallespir, B., Zanettin, M. and Chen, D., 1992 *GIM: GRAI IntegratedMethodology. A methodology for designing CIM systems*. GRAI/LAP. UniversitéBordeaux 1, versión 1.0.
- Gad, J. 2005. *IT Governance: An Integrated IT (Information Technology) Framework and Roadmap: Planning, Deploying and Sustaining for Competitive Advantage*. IT Governance-Work-in-Progress 5/5/05.
- Gindy N., Morcos M., Cerit B., Hodgson A. 2008. Strategic technology alignment roadmapping STAR® aligning R&D investments with business needs. *International Journal of Computer Integrated Manufacturing*, 21 (8), 957 – 970.

- Goedvolk, J.G., de Bruin, H. and Rijsenbrij, D.B.B. 1999. Integrated Architectural Design of Business and Information Systems, *Proceedings of the Second Nordic Workshop on Software Architecture (NOSA'99)*.
- Goethals, F.C., Lemahieu, W., Snoeck, M. and Vandembulcke J.A. 2007. The data building blocks of the enterprise architect. *Future Generation Computer Systems*, 23, 269–274.
- Greefhorst, D., Koning, H. and van Vliet, H. 2006. The many faces of architectural descriptions. *Inf Syst Front* 8, 103–113.
- Gregor, S., Hart, D., Martin, N., 2007. Enterprise architectures: enablers of business strategy and IS/IT alignment in government. *Information Technology & People* 20(2), 96-120.
- Gutierrez, A., Orozco, J. and Serrano, A., 2006. Using tactical and operational factors to assess strategic alignment: an sme study. *European and Mediterranean Conference on Information Systems (EMCIS)*.
- Hartono, E., Lederer, A., Sethi, V. and Zhuang Y. 2003. Key Predictors of The Implementation of Strategic Information Systems Plans. *The Data Base for Advances in Information Systems*, 34 (3).
- Henderson, J.C. and Venkatraman, N., 1993. Strategic alignment: Leveraging information technology for transforming organizations, *IBM systems journal*, 32(1), 472-484.
- Hill, C.W.L. and Jones, G.R., 2001. *Strategic management: An integrated approach*. 5th ed. , Boston: Houghton Mifflin.
- Hirschheim, R. and Sabherwal, R. 2001. Detours in the Path toward Strategic Information Systems Alignment. *California Management Review*, Fall 44(1), 87–108.
- Hoogervorst, J. 2009. *Enterprise Governance and Enterprise Engineering*. Springer.
- IFIP/IFAC Task Force, 1999. *GERAM: Generalized Enterprise Reference Architecture and Methodology*, Version 1.6.2, Annex to ISO WD15704, IFIP/IFAC Task Force.
- Inmon, W. H., Zachman, J. A., and Geiger, G. J., 1997. *Data stores, data warehousing and the Zachman framework*. New York, NY: McGraw-Hill.
- ISO 15704 2000. *Requirements for Enterprise Reference Architecture and Methodologies*, ISO TC184/SC5/WG1, N423.
- ITGI 2005. *CobiT 4.0. The Control Objectives for Information and related Technology*.
- Johnson, A.M. and Lederer, A. L., 2010 CEO/CIO mutual understanding, strategic alignment, and the contribution of IS to the organization. *Information & Management* 47, 138–149.
- Jonkers, H., Lankhorst, M., van Buuren, R., Bonsangue M., and van Der Torre, L., 2004. Concepts for modelling enterprise architectures. *International Journal of Cooperative Information Systems*, 13(3), 257–287.
- Kaplan, R. and Norton, D., 1996. *The Balanced Scorecard*. Harvard Business School Press.
- Kaplan J., 2005. *Strategic IT portfolio management. Governing Enterprise Transformation*. PRM.
- King, W. R., 1978. Strategic Planning for Management Information Systems. *MIS quarterly*. 2(1), 27.
- Lankhorst, M.M., 2004. Enterprise Architecture Modelling - the Issue of Integration. *Advanced Engineering Informatics. Engineering Computing and Technology*, 18(4), 205.

- Leonard, J. 2007. Sharing a vision: comparing business and is managers' perceptions of strategic alignment issues. *Australasian Journal of Information Systems*, 15(1).
- Lindström, A., 2006. An Approach for Developing Enterprise specific ICT Management Methods *Architectural Principles to Measures (IAMOT 2006)*.
- Luftman J., 2000. Assessing business-IT alignment maturity. *Communications of the association for information systems*, 4(14).
- Luftman, J. N., Lewis, P.R., and Oldach, S. H., 1993. Transforming the enterprise: The alignment of business and information technology strategies. *IBM Systems Journal*, 32(1), 198.
- Luftman, J.N., Ben-Zvi T., 2010. Key Issues for IT Executives 2010: Judicious IT Investments Continue Post-Recession. *MISQE 9* (4).
- Luftman, J.N., Ben-Zvi, T., Dwivedi, R. and Rigoni, E. 2010. IT Governance: An Alignment Maturity Perspective. *International Journal on IT/Business Alignment and Governance*, 1(2), 13-25.
- Maes, R., 1999. *Generic Framework for Information Management*. Prime Vera Working Paper, Universiteit Van Amsterdam.
- Maes, R., Rijsenbrij, D., Truijens, O. and Goedvolk, H., 2000. *Redefining Business-IT Alignment Through A Unified Framework*. Universiteit Van Amsterdam/Cap Gemini White Paper.
- Martin, R. and Robertson, E., 2004. *Architectural principles for enterprise frameworks*. Technical Report No. 594
- McFarlan, F.W., 1984. Information technology changes the way you compete, *Harvard Business Review*, 62(3), 98–103.
- Melville, N., Kraemer, K., and Gurbaxani, V., 2004. Review: Information technology and organizational performance: an integrative model of IT business value. *MIS Quarterly*, 28(2), 283-322.
- Narman, P., Johnson, P., Nordstrom, L., 2007. Enterprise Architecture: A Framework Supporting System Quality Analysis. 11th IEEE International Enterprise Distributed Object Computing Conference. 130-141.
- Newkirk, H.E., Lederer, A., 2006. Incremental and Comprehensive Strategic Information Systems Planning in an Uncertain Environment. *IEEE Transactions on engineering management*, 53(3).
- Noran, O., 2003. An analysis of the Zachman framework for enterprise architecture from the GERAM perspective. *Annual Reviews in Control* 27 (2003) 163–183.
- Noran, O., 2005. A systematic evaluation of the C4ISR AF using ISO15704 Annex A (GERAM). *Computers in Industry* 56 (2005) 407–427.
- Open Group, 2009. The Open Group Architecture Framework.
- Ortiz, A., Lario F. and Ros L., 1999. IE-GIP. A proposal for a Methodology to Develop Enterprise Integration Program. *Computers in Industry*. 40, 155-171.
- Panetto H., Bařna S. and Morel G., 2007. Mapping the IEC 62264 models onto the Zachman framework for analysing products information traceability: a case study. *Journal of Intelligent Manufacturing*, 18, 679–698.
- Papp, R. 2001. *Strategic Information Technology: Opportunities for Competitive Advantage*, Hershey, PA: Idea Group Publishing.

- Papp, R., and Luftman, J., 1995. Business and IT Strategic Alignment: New Perspectives and Assessments, *In Proceedings of the Association for Information Systems, Inaugural Americas Conference on Information Systems, Pittsburgh, PA, August 25-27.*
- Pernaranda, N., Mejia, R., Romero, D. and Molino A., 2010. Implementation of product life cycle management tools using enterprise integration engineering and action-research. *International Journal of Computer Integrated Manufacturing*, 23 (10), 853-875
- Peppard, J. and Breu, K., 2003. Beyond Alignment: A coevolutionary view of the information systems strategy process. *In: Twenty-fourth International Conference on Information Systems.*
- Pereira, C. and Sousa P., 2005 *Enterprise Architecture: Business and IT Alignment*. ACM Symposium on Applied Computing.
- Plazaola, L., Flores, J., Silva, E., Vargas, N. and Ekstedt, M., 2007. An Approach to Associate Strategic Business-IT Alignment Assessment to Enterprise Architecture. *Conference on Systems Engineering Research, Stevens Institute of Technology Campus, USA.*
- PMI, 2006 *The Project Management Institute Standard for Portfolio Management.*
- Porter, M.E., 1980. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. The Free Press, New York.
- Reich, B. and Benbasat, I., 1996. Measuring the linkage between Business and Information Technology Objectives *MIS Quarterly March* 55-81.
- Reich, B. and Benbasat, I., 2000 Factors that Influence the Social Dimension of Alignment between Business and IT Objectives. *MIS Quarterly* 24 (1), 81–113.
- Sabherwal, R. Hirschheim, R. and Tim, G., 2001. The Dynamics of Alignment Organization. *Science*, 12(2), 179-197.
- Saha, P., 2004. Analyzing the open group architecture framework form the GERAM perspective. www.opengroup.org
- Sakka, O., Millet, P-A. and Botta-Genoulaz, V., 2010. An OWL based ontology of SCOR model: a prerequisite for strategic alignment. *8th International Conference of Modelling and Simulation - MOSIM'10 "Evaluation and optimization of innovative production systems of goods and services"*.
- Santana, R.G., Daneva, M., van Eck, P.A.T. and Wieringa, R.J., 2008. Towards a business-IT alignment maturity model for collaborative networked organizations. *In: Proceedings of the International Workshop on Enterprise Interoperability Munich, Germany, 70-81.*
- Schekkerman, J., 2003. *How to survive in the jungle of Enterprise Architecture Frameworks*. Trafford Publishing, Victoria, BC.
- Scott-Morton, M., 1991. *The corporation of the 1990s: Information technology and organizational transformation*. Oxford: Oxford University Press.
- Silvius, G. A. J., 2007. Business and IT alignment in theory and practice. *Proceedings of the 40th Hawaii International Conference on Systems Sciences*. Hawaii.
- Simonsson M. and Ekstedt M., 2005. *Prioritizing it governance: literature vs practice*, Ph.D. Dept. of Industrial Information and Control Systems - Royal Institute of Technology.
- Sledgianowski, D. and Luftman, J.N., 2005. IT-Business Strategic Alignment Maturity: A case study. *Journal of Cases on Information Technology*, 7(2), 102–120.

- Sowa, J. and Zachman, J., 1992. Extending and formalizing the framework for information-systems architecture. *IBM systems journal*. 31(3), 590.
- Spewak, S., 1993. *Enterprise Architecture Planning: Developing a Blueprint for Data, Applications, and Technology*, Wiley.
- Tang, A., Han, J. and Chen, P., 2004. *A Comparative Analysis of Architecture Frameworks*. Technical Report SUTIT-TR2004.01, Swinburne University of Technology.
- Van Grembergen, W. and De Haes, S., 2005. Measuring and Improving IT Governance Through the Balanced Scorecard. *Information systems control journal*, 2.
- Van Grembergen W. and De Haes S.. 2010. A research Journey into Enterprise Governance of IT, Business/IT alignment and Value Creation *International Journal on IT/Business Alignment and Governance*, 1(1), 1-13.
- Vargas, N. Plazaola, L., and Ekstedt, M., 2008. A consolidated strategic business and IT alignment representation: A framework aggregated from literature. *Proceedings of the 41st Hawaii International Conference on System Sciences*.
- Vasconcelos, A., Mira, M., Fernandes, A., and Triblet, J., 2004. An Information System Architectural Framework for Enterprise Application Integration. *Proceedings of the 37th Hawaii International Conference on System Sciences*. 1-9.
- Vernadat, F., 1996. *Enterprise Modelling and Integration. Principles and applications*. Chapman&Hall.
- Wang, X., Zhou, X. and Jiang, L., 2008. A method of business and IT alignment based on enterprise architecture. *Service Operations and Logistics, and Informatics* 1, 740-745.
- Wegmann, A., Balabko, P., Le, L., Reveg, G. and Rychkova, I., 2005. A Method and Tool for Business-IT Alignment. in Enterprise Architecture. *Proceedings of the caise. Porto Univ, Porto, Portugal*.
- Weill, P. and Broadbent, M., 1998. *Leveraging the new infrastructure*. Boston, MA: Harvard Business School Press, 294.
- Whitman, L., 2001. A taxonomy of a living model of the enterprise. *Proceedings of the 2001 Winter Simulation Conference*. 848-855.
- Williams, T.J., Rathwell, G. A. and Li, H., 1996. *A handbook on master planning and implementation for enterprise integration programmes*. Report n8 160, Purdue Laboratory for Applied Industrial Control, Purdue University, W. Lafayette.
- Yu, E., 1995. *Modelling Strategic Relationships for Process Reengineering*. Thesis (PhD). University of Toronto.

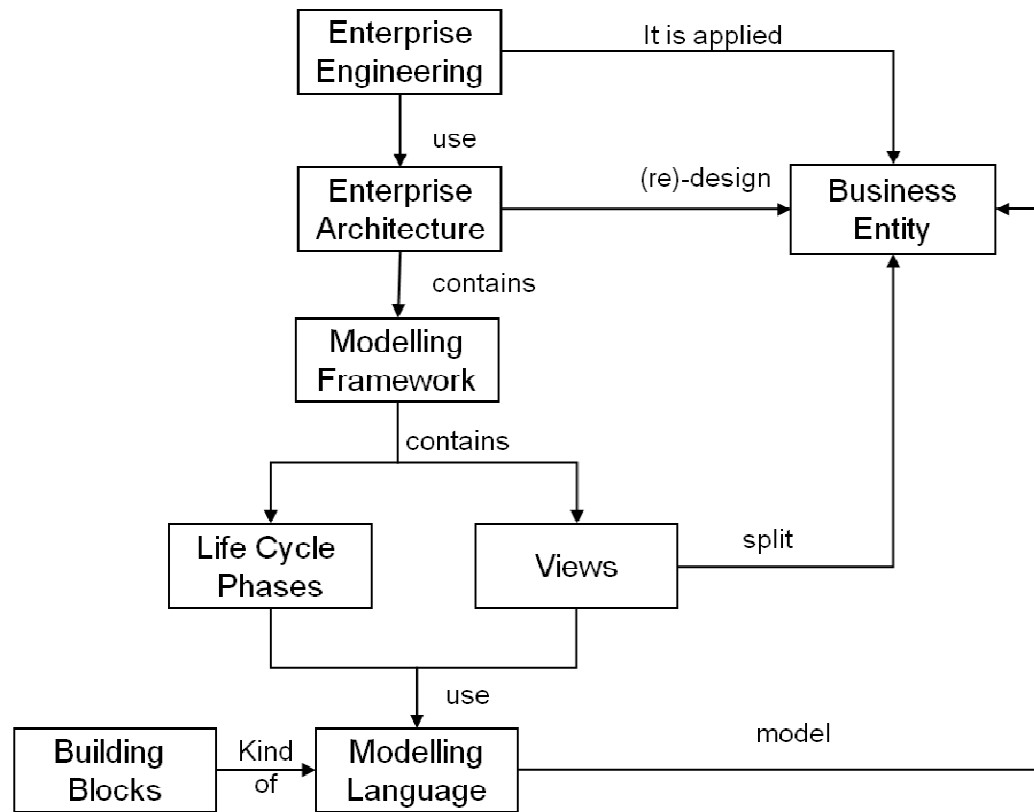


Figure 1. Enterprise engineering and relationships (Cuenca, 2009)

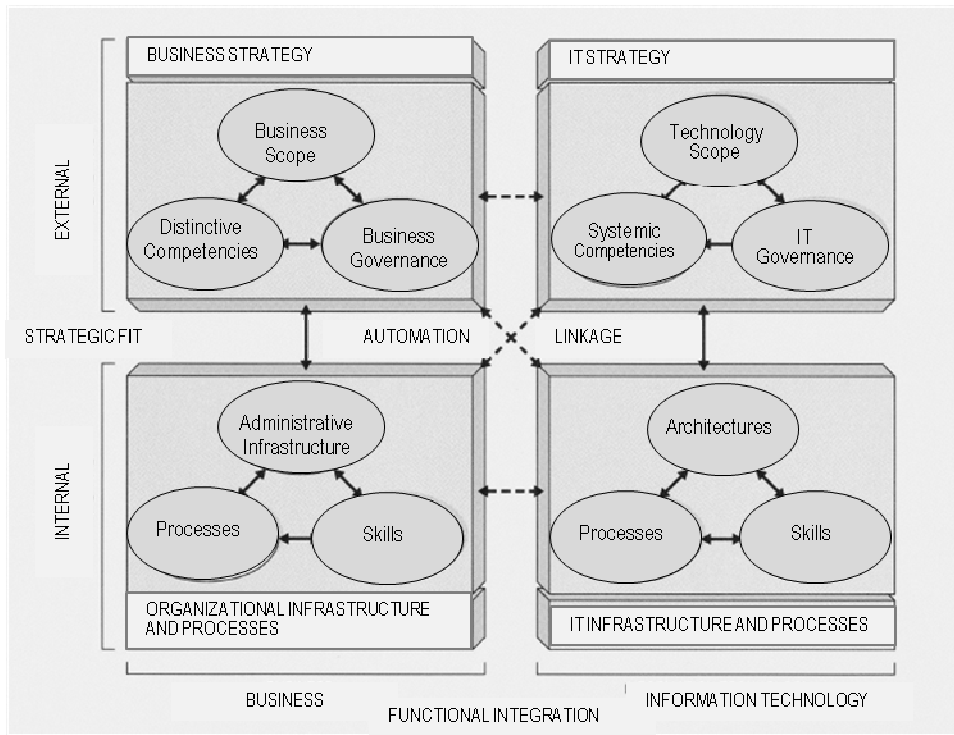


Figure 2. Strategic alignment model (Henderson and Venkatraman, 1993)

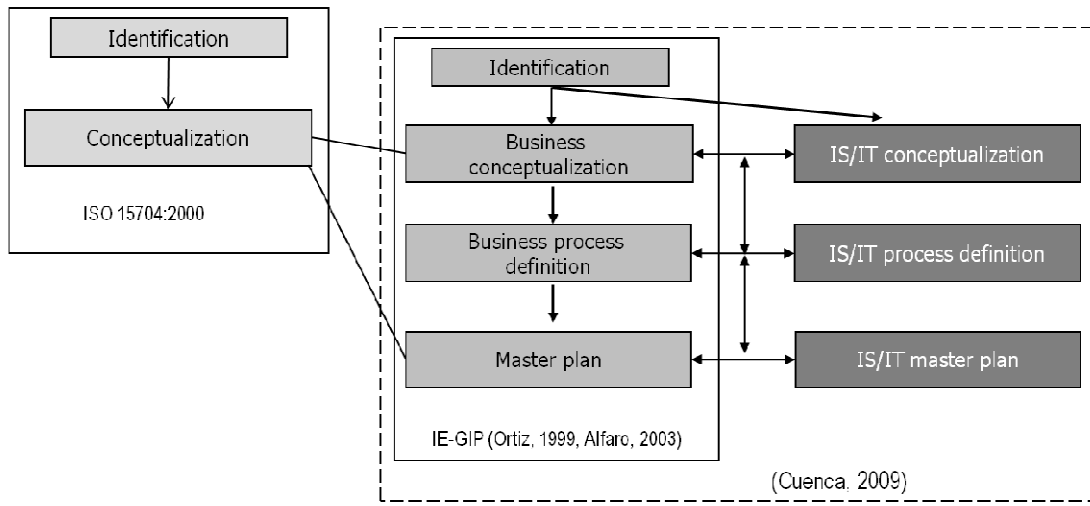


Figure 3. Life-cycle phase extension (Cuenca, 2009)

Type:	
Name: IS/IT Conceptualization	
Identification: CIT-	
Design responsible: <i>Organization unit</i>	
Participants: <i>OC- and/or OU- participants in IS/IT conceptualization</i>	
IS/IT Conceptualization	
<input type="checkbox"/>	IS/IT Mission in enterprise
<input type="checkbox"/>	IS/IT Vision in enterprise
<input type="checkbox"/>	IS/IT Goal in enterprise
<input type="checkbox"/>	IS/IT Strategy in enterprise
<input type="checkbox"/>	Data Strategy in enterprise
<input type="checkbox"/>	IS/IT CFS in enterprise
Joint analysis	
<input type="checkbox"/>	Joint analysis between IS/IT strategy and business strategy in enterprise
IS/IT Scope and Governance	
<input type="checkbox"/>	IS/IT Scope in enterprise
<input type="checkbox"/>	IS/IT Governance in enterprise
IS/IT conceptualization in Business Entity	
Business Entity: <i>Business entity identification</i>	
Name: <i>Business entity name</i>	
<input type="checkbox"/>	IS/IT Mission in business entity
<input type="checkbox"/>	IS/IT Vision in business entity
<input type="checkbox"/>	IS/IT Goal in business entity
<input type="checkbox"/>	IS/IT Strategy in business entity
<input type="checkbox"/>	Data Strategy in business entity
<input type="checkbox"/>	IS/IT CFS in business entity
Joint analysis	
<input type="checkbox"/>	Joint analysis between IS/IT strategy and business strategy in business entity
IS/IT Scope and Governance in business entity	
<input type="checkbox"/>	IS/IT Scope in enterprise
<input type="checkbox"/>	IS/IT Governance in enterprise

Figure 4. IT conceptualization template

Type: Name: Heuristics name Identification: HE- Design responsible: <i>Organization unit</i>
Id-1: View identification Id-2: View identification Business entity: Business entity name Participants: Organization unit and/or organization cell Question: Text Date check: Date Answer: Text Improvements proposed: Text

Figure 5. Heuristic template

Type: Name: Dependency name Identification: SD- Design responsible: <i>Organization unit</i>
Participants: Organization unit and/or organization cell Depender actor: Role, Organization unit, Organization cell, set of roles Dependee actor: Role, Organization unit, Organization cell, set of roles Dependum: objective, resources, plans or task dependency Type: normal or critical Chart: Graphical representation

Figure 6. Strategic dependencies model template

Type: Name: Name of the application or service Identification PT.As-Is- Design Responsible: The unit in charge of design and the maintenance of this building block
Identification of the application or service: Code Description of the application or service: Text Validity date: Time or date until an application is considered operative Participants: List of the units or cells involved in analyzing the application or program Is it associated with one of the business entity's business objectives?: nil or list of the business entity's business objectives Have any of the expected benefits been obtained?: Text Is it integrated with the remaining applications?: Boolean (yes, no) Classification according to the proposed matrix: Tasks to be carried out: Text. The tasks to be carried out with this application or service according to the state of the matrix.

Figure 7. As-is portfolio template

<p>Type:</p> <p>Name: Name of the application or service</p> <p>Identification: PT.To-Be-</p> <p>Design Responsible: The unit in charge of design and the maintenance of this building block</p>
<p>Identification of the application or service: Code</p> <p>Description of the application or service: Text</p> <p>Is it associated with the business entity's business objective?: list of the business entity's business objectives</p> <p>Launch date: Start time or Launch Date</p> <p>Participants: List of the units or cells involved in analyzing the application or program</p> <p>Has a process to assess IT investments been put forward?:</p> <p>Has a method to analyze the risk of investments been proposed?:</p> <p>Has any method to prioritize IT investments been proposed?:</p> <ul style="list-style-type: none"> - costs / profits - risk - strategic alignment - others _____ <p>Classification according to the proposed matrix:</p> <p>Does it replace any application defined in the AS-IS portfolio?</p> <p>- Indicate any there may be: _____</p> <p>Does it include a Business case?:</p>

Figure 8. To-be portfolio template

Review Only

Type: Name: application or service name Identification: AP-/SER- Design Responsible: <i>Organization unit</i>
Description: Text Business entity objectives associated: OB List Priority: Text Start date: Date Responsible: Organization unit and/or organization cell Interlocutor: Organization unit Business Process: Nil or BP List Project implementation: Text Feasibility of implementation: Text

Figure 9. Applications and services portfolio

Type: Name: Maturity model name Identification: MM- Design Responsible: <i>Organization unit</i>
Participant: Organization unit or organization cell Business entity: Business entity name Criterion: Text Attribute: Text Attribute Level: [1..5] Responsible: Organization unit and/or organization cell Date review: Date Last level assigned: Nil or level Criterion average level: Number Criterion average level in network: Number





Figure 10. Maturity model template

Original Peer Review Only

Type: Name: ERP Identification: PT.To-Be-1-ERP Design Responsible: L.C.G.
Identification of the application or service: ERP09 Description of the application or service: To be completed Is it associated with the business entity's business objective?: Yes OB-tobe1: Integrate with Decision Support Systems (DSS). OB-tobe2: provide a central and comprehensive system OB-tobe3: enable easy communication with clients and partners improving the communication channel to ensure the constant flow of key information OB-tobe4: leverage demand forecasting capabilities of ERP systems OB-tobe5: accomplish the needs of new customers OB-to be6: accomplish the needs of current customers Launch date: To be defined Participants: OC-1: IT Board organization cell OC-2: Steering committee organization cell Has a process to assess IT investments been put forward?: Yes Has a method to analyze the risk of investments been proposed?: Yes Has any method to prioritize IT investments been proposed?: To be defined - costs / profits - risk - strategic alignment - others _____ Classification according to the proposed matrix: view matrix Does it replace any application defined in the AS-IS portfolio? Yes - Indicate any there may be: __The old main system and other applications__ Does it include a Business case?: It will be included

Figure 11: To-be portfolio template in the case study

Table 1. Alignment sequence covered by enterprise architecture

Enterprise Architecture	Alignment Sequence (Henderson and Venkatraman, 1993)				
	Anchor Domain	Pivot Domain	Impacted Domain	Graphical Notation	
GERAM (IFIP-IFAC Task Force, 1999) IE-GIP (Ortiz et al., 1999) Zachman (Sowa and Zachman, 1992). TOGAF (Open Group, 2009) EAP (Spewak, 1993) IAF (Schekkerman, 2003) FEAF (CIO, 1999) DoD AF (2007) B-SCP (Bleistein, 2006) BITAM (Chen, 2005)	Business Strategy	Organizational Infrastructure and Processes	IT Infrastructure and Processes		1 Strategy Execution
Zachman (Sowa and Zachman, 1992) TOGAF (Open Group, 2009) EAP (Spewak, 1993) IAF (Schekkerman, 2003) FEAF (CIO, 1999) DoD AF (2007)	Business Strategy	IT Strategy	IT Infrastructure and Processes		2 Technology Potential
	IT Strategy	Business Strategy	Organizational Infrastructure and Processes		3 Competitive Potential
Zachman (Sowa and Zachman, 1992) TOGAF (Open Group, 2009) BITAM (Chen, 2005)	IT Strategy	IT Infrastructure and Processes	Organizational Infrastructure and Processes		4 Service Level

New Only

Table 2. Involved domain

SAM quadrants (Henderson and Venkatraman, 1993)				
Business			IT	
Enterprise Architecture	Strategy	Organizational Infrastructure and Processes	Strategy	IT Infrastructure and processes
GERAM	Identification Conceptualization	Requirements Design Implementation		Requirements Design Implementation
IE-GIP	Identification Business Conceptualization Business Process definition Master plan	Requirements Design Implementation		Requirements Design Implementation
ZACHMAN	Objectives / Scope	Business Owner's view	Objectives / Scope	Architect's view Builder's view
TOGAF	Vision	Business Architecture	Information Systems Architecture	Application Architecture Technology Architecture
EAP	Planning Initiation Business Modelling	Data Architecture	Current systems and technology	Applications Architecture Technology Architecture Implementation/ Migration Plans Planning Conclusion
IAF	Contextual Layer Conceptual Layer	Logical Layer Physical Layer	Contextual layer Conceptual Layer	Logical Layer Physical Layer
FEAF	Business Architecture	Business Architecture	Information Architecture	Information Systems Architecture Data Architecture HW, SW and communications
DoDAF	Operational View	Operational View	System View	Technical View
B-SCP	Context Business strategy	Business Process		IS description
BITAM	Business model	Business architecture	Business model	Business architecture IT architecture

Table 3. IT strategy components according to various authors

References	IT Strategy Components	Scope	Capability and Skill	Governance	Portfolio	Maturity Model	Data Strategy
Adam et. al, 1995							
Avila et al., 2009							
Buchanan and Gibb, 1998 ; 2007							
Clempner and Gutierrez, 2002,							
Derzsi and Gordijn 2006							
Gad, 2005							
Goethals et al., 2007							
Gutierrez et al., 2006							
Henderson and Venkatraman, 1993							
Gindy et al., 2008							
Goedvolk, 1999							
Jonkers et al., 2004							
Kaplan and Norton, 1996							
Lankhorst, 2004							
Leonard, 2007							
Lindström, 2006							
Luftman, 2000							
Maes, 1999 and Maes et al., 2000							
Melville et al., 2004							
Newkirk and Lederer, 2006							
Panetto et al., 2007							
Santana et al., 2008							
Simonsson and Ekstedt, 2005							
Sledgianowski and Luftman, 2005							
Weill and Broadbent, 1998							

Deleted: Clempert, 2002

Comment [11]: New IJCM reference has been included

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Table 4. IT components and the associated building block

<i>IT Components</i>	<i>Building Block</i>
Scope	IT Conceptualization
Capability and skill	Role (CEN 19440, 2007) Capability Set (CEN 19440, 2007)
Governance	Organization Cell (CEN 19440, 2007) Organization Unit (CEN 19440, 2007)
Portfolio	Application Portfolio
Maturity model	Maturity Model
Data Strategy	IT Conceptualization

Table 5. Incorporation of new life-cycle phases

	Business		IT	
Enterprise Architecture	Strategy	Organizational Infrastructure and Processes	Strategy	IT Infrastructure and processes
IE-GIP	Identification Business Conceptualization Business Process definition Master plan	Requirements Design Implementation	IT Conceptualization IT Process definition IT Master plan	Requirements Design Implementation

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