ENTERPRISE ARCHITECTURE
State of the Art and Challenges

Jorge Cordeiro Duarte and Mamede Lima-Marques
Centre for Research on Architecture of Information, University of Brasilia, Campus, Brazilia, Brazil

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Abstract: This paper analyzes current approaches for Enterprise Architecture (EA). Current EA objectives, concepts, frameworks, models, languages, and tools are discussed. The main initiatives and existing works are presented. Strengths and weaknesses of current approaches and tools are discussed, particularly their complexity, cost and low utilization. A EA theoretical framework is provided using a knowledge management approach. Future trends and some research issues are discussed. A research agenda is proposed in order to reduce EA complexity and make it accessible to organizations of any size.

1 INTRODUCTION

In current economic and business context, organizational processes and systems need to be constantly reviewed and updated to keep pace with market demands and technology development. The Enterprise Architecture (EA) has emerged as a ”tool” for developing and managing organizational elements providing the instruments for agility in planning and change. It is not just a matter of IT, as many believe, but a matter of knowledge about organization.

Enterprise architecture is a promise for organizations efficiency, but it is still a confusing concept. Since its beginning, many heterogeneous architecture proposals have been developed. They are often overlapping approaches and the underlying concepts are not explicitly defined. Proposals are often complex and their benefits cannot be perceived by users, creating obstacles for its correct understanding in industry and finally its acceptance and use. The lack of a generally agreed terminology in this domain is also a bottleneck for its efficient application.

The aim of this paper is to analyze the state of the art of EA, identifying and evaluating the key concepts and approaches, and propose a theoretical framework and a research agenda to clarify concepts, define scope and expand the use of EA. Section 2 presents the main definitions, concepts and approaches found in the literature. Section 3 identifies the scope, domain areas, elements and EA fundamentals as a discipline. Section 4 details the main theoretical approaches. Section 5 analyzes the current practices, tools and organizational structures. The analysis of the approaches and trends are presented in section 6. A research Conclusions and agenda to EA are presented in Section 7.

2 ENTERPRISE ARCHITECTURE: DEFINITIONS AND CONCEPTS

Definitions of terms related to EA such as enterprise, organization, information, knowledge, organizational elements and domains, models, architecture, information Architecture are first given in order to help understanding EA Concepts. Then, enterprise architecture definition, objectives and elements are presented.

2.1 Enterprise Architecture Related Terms Definitions and Concepts

EA is a kind of architecture, focused on information about enterprise domains and its elements. It deals with information to generate knowledge through models. Following are presented necessary definitions of each one of these terms.

Enterprise. According to ISO 15704 (ISO, 2000), an

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enterprise is one or more organizations sharing a definite mission, goals and objectives to offer an output such as a product or a service. This broad definition covers the extended enterprise (EE) and virtual enterprise (VE) (Vernadat, 2007). EE is a concept which identifies long term integration of suppliers and customers. The idea is to provide the central node with all materials, skills, competencies, knowledge and capabilities it requires at the right time. Material flows are usually optimized in just-in-time (JIT) mode. This is the case of the car industry, aerospace industry, naval industry, semiconductor industry, etc. VE has a dynamic and less stable nature than the extended enterprise. The idea is to put together capabilities and competencies coming from different enterprises but no node in the network plays a central role. This is a cluster or temporary association of existing or newly created business entities offered by several companies to form a new viable business entity to satisfy a timely market need. An example has been the company that built the Channel Tunnel in Europe (now dismantled) (Vernadat, 2007).

Organization. Organization is an entity, public or private, that exists to provide specific services and products to its customers, serving a purpose of its owners, performing functions in a structure that responds to external and internal stimuli (Rood, 1994).

Data. Data is a representation of concepts or other entities, fixed in or on a medium in a form suitable for communication, interpretation, or processing by human beings or by automated systems (Wellisch, 1996). Data is a real thing, a sensory stimulus that we perceive through the senses, a thing perceived, seen, felt, heard (Zins, 2007).

Information. Information is the change determined in the cognitive heritage of an individual (Morris, 1938). Information always develops inside of a cognitive system, or a knowing subject. It is an abstraction that represents something meaningful to someone through text, images, sound or animation (Setzer, 2001).

Knowledge. Knowledge is a fluid mix of experience, values, contextual information and insights that provides a framework for evaluating and incorporating new experiences and information (Horibe, 1999). Inside Knowledge are faced consciousness and object, subject and object. The Dualism of subject and object belongs to the essence of knowledge (Hessen, 2003).

Organizational Element. According to (Kuras, 2003) organizations are complex systems because they are composed of multiple elements and relations. The main parts or elements that enable an organization to attain its objectives are the principles, strategies, people, units, locations, budgets, functions, activities, services, applications, systems and infrastructure (Schekkerman, 2009b).

Organizational Domain. The various organizational elements are grouped into domains of specialized knowledge. Kettinger identifies six domains of study of the organization: management, information technology, processes, structure and people (Kettinger et al., 1997). The method ArchiMate (Lankhorst, 2005) also proposes five domains: products, processes, information, applications and technology, as shown in Figure 1. Each one of these domains is composed of a diverse community that shares a specific language (Guizzardi, 2005).

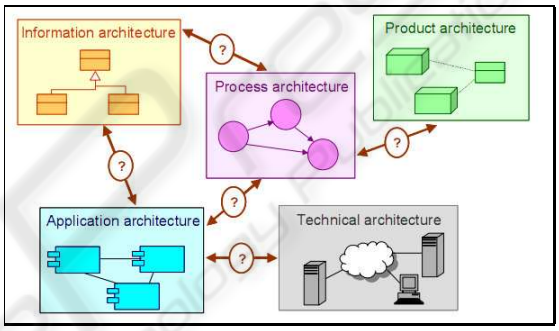

Figure 1: Organizational Domains (Lankhorst, 2005).

Models. A model is an abstraction of reality according to a certain conceptualization (Guizzardi, 2005). Once represented as a concrete artifact, a model can support communication, learning and analysis about relevant aspects of the underlying domain. Models can be formal or informal. Formal models have defined structure and semantics and can be read by the computer, such as ontologies. Informal models are information without defined structure, used to express things or concepts freely (Bernus, 2003). Models can be conceptual or detailed, static or dynamic. Conceptual models show elements, concepts and relationships, such as ontologies. Detailed models show details of the composition of the element under study. Dynamic models show a flow of relations between objects or changes in the state of the object (Butler, 2000). Models can be expressed as text, graphics or formulas (Vergidis et al., 2008). Models can express different levels of details, form physical to social ones as proposed by Stamper (2000) in figure 2.

Architecture. The central idea of architecture is to represent or model (in abstraction) an orderly arrangement of the components that make up a system in analysis and the relationships or interactions of these components (Rood, 1994). Architecture deals

with the structure of important things (buildings, systems or organizations) and their components and how these components are combined to achieve a particular purpose (open Group, 2009). Architecture can be descriptive, describing what exists, or prescriptive, showing something wanted and that still does not not exists (Hoogervorst, 2004).

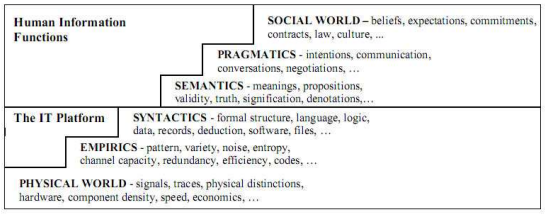

Figure 2: Semiotic Ladder (Stamper et al., 2000).

Information Architecture. The term Information Architecture (IA) was first used by (Wurman, 2000). Wurman's vision is derived from his training as an architect and his main purpose is to extend the key concepts of organizing spaces, developed in architecture, for informational spaces. The term was popularized by (Morville and Rosenfeld, 2006) who define information as the structural design of shared information environments. AI has been widely studied in academy and is the subject of several master theses (Macedo, 2005; de Siqueira, 2008). According to Macedo the purpose of Information Architecture is to enable the effective flow of information through the design of information environments.

2.2 Enterprise Architecture Definitions

There are many definitions for EA. The name of discipline, itself, may vary being referred to as Enterprise Architecture (EA) (Zachman, 1987) or Enterprise Information Architecture (EIA) (Cook, 1996). Examples of EA definitions found in literature: An abstraction of the main elements of the organization and their relationships (Vernadat, 1996); Define the various elements that make up an organization and how they relate and establish the principles and guidelines governing their design and evolution over time (open Group, 2009); A coherent set of principles, methods and models used in the design and construction of the structure, processes, systems and infrastructure of an organization (Lankhorst, 2005); Blueprints which define a complete and systematic position of the current and desired organizational environment (Schekkerman, 2009a); A description of a complex system (the enterprise) at a point in time (Burke, 2006); The structure of components, their relationships, and the principles and guidelines governing their design and evolution over time (DoD, 2007).

2.3 Enterprise Architecture Objectives

Some examples of EA objectives found in the literature: EA intends to model, analyze and communicate the organization. The benefits of EA are the knowledge infrastructure for reporting and analysis by all stakeholders and the possibility of designing new conditions in an organized manner (Lankhorst, 2005). EA is not only an instrument for strategic planning of IS/IT planning but also other business functions, such as compliance control, continuity planning and risk management (Winter and Schelp, 2008). The objectives of the EA are risk and compliance control, project and organizational programs management, portfolios of IT management and integration between business and IT (Schekkerman, 2009a). According to (Rood, 1994) an EA, as a whole, is used in a number of different ways to guide, direct, and manage an enterprise: Is a basis for decision making and planning; Governs the identification, selection and development of standards; is the mechanism for managing change within the enterprise; Enables effective communication about the enterprise.

2.4 Enterprise Architecture Elements

To achieve its objectives EA requires several elements. The project IFIP-IFAC proposed an ontology of these elements called GERAM (Generalized Enterprise-Reference Architecture and Methodology) (IFIP-IFAC, 1999). This ontology identifies the following elements in the architecture: concepts, methodologies, languages, models concepts and constructs, reusable templates, modeling tools, reference models, business modules and operation systems.

Another ontology proposed for EA is IEEE 1471 recommended practice for architectural description of software (IEEE, 2000). This proposal has sixteen elements: mission, environment, system, architecture, stakeholder, architecture description, view, concern, viewpoint, model, rationale, and library viewpoint as shown in figure 3. This recommended practice addresses the activities of creation, analysis and sustainment of architecture software-intensive systems, and the recording of such architectures in terms of architectural descriptions.

3 ENTERPRISE ARCHITECTURE APPROACHES AND FRAMEWORKS

This section suggests a classification for current EA approaches nas presents the main proposals.

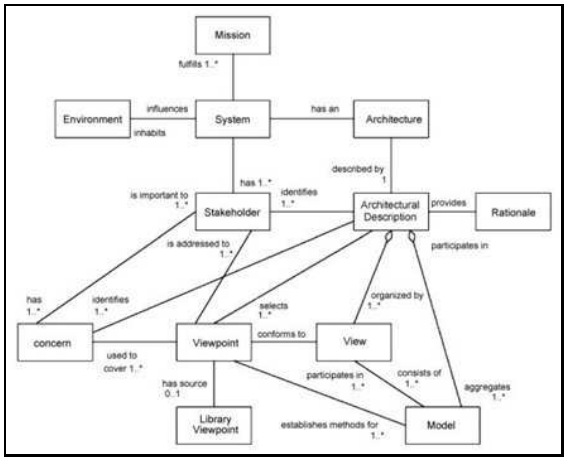

Figure 3: IEEE-1471 Framework (IEEE, 2000).

3.1 Enterprise Architecture Approaches

Since middle of the 1980s several proposals of EA appear. The diverse proposals have different approaches aiming different objectives. Table 1 shows a classification of proposals in five approaches: Strategic EA, enterprise modeling, enterprise modeling methods and standards, enterprise architecture language and Information Architecture.

Table 1: Evolution of Technology and System Applications.

Approach	Objective	Proposal
Strategic EA	Blueprints showing enterprise and technical infrastructure	(Ross et al., 2006)
Enterprise Modeling	Framework of organizational models	(Zachman, 1987)
Enterprise modeling methods and standards	Framework, methods and standards for organizational models	(open Group, 2009; DoD, 2007)
Enterprise architecture language	Framework and language to model architectural models	(Lankhorst, 2005)
Enterprise Information Architecture Approach	Infrastructure for modeling the enterprise information	(Morville and Rosenfeld, 2006)

3.2 Strategic Enterprise Architecture

According to EA strategic approach, EA should not be a huge collection of organizational models, but instead, a group of strategic maps (Ross et al., 2006). To be used strategically, EA has two sides: business and technology. On the business side it is necessary to identify organization operational model. This model defines whether the company is centralized or decentralized and whether its processes are standardized or not. Once identified this enterprise model of operation, IT must define the technical architecture that supports this model. This architecture can extend or limit organizational strategies as shown in figure 4.

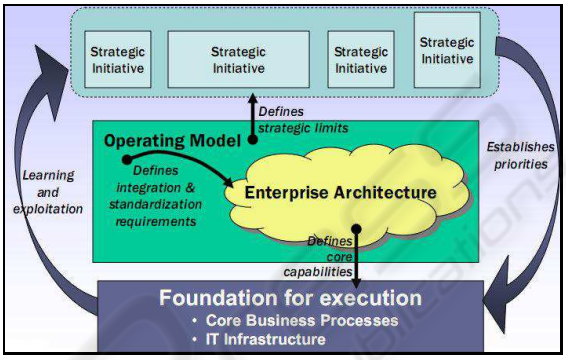

Figure 4: Strategic EA Conponents (Ross et al., 2006).

This proposal does not need many models, only those needed to show the main enterprise and technical components and how they relate to each other. Ross suggests only a blueprint showing the main elements of business, application, security and technology as shown is figure 5. Whittle and Myrick refer this approach as EBA (Enterprise Business Architecture) (Whittle and Myrick, 2004).

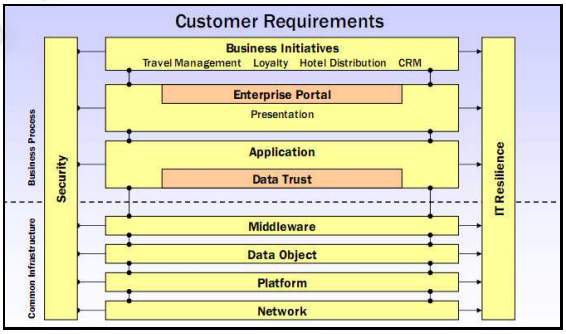

Figure 5: Strategic EA Metamodel(Ross et al., 2006).

3.3 Frameworks to Enterprise Modeling

One of the first proposals for EA is Zachman framework which had its first version in 1987 and has been constantly updated with the latest release in 2008 (Zachman, 1987). Zachman framework proposes organizational modeling in thirty-six models. These models are structured in six rows and six columns.

The six columns indicate domains of organization knowledge and models are related to: Information (what), Processes (how), People (who), Locations (where), Time (when) and Reasons (why). The six lines show level of detail in each domain: Contextual, Conceptual, Logical, Physical, Component and Instance. Thus, Zachman framework is a matrix and each cell is a kind of model as shown in figure 6. Zachman does not propose a methodology nor suggests good practices, only the matrix of models. Many authors have completed the proposal suggesting languages to elaborate each model or group of models (Pereira and Sousa, 2004; Cook, 1996)

	What (Data)	How (Function)	Where (Locations)	Who (People)	When (Time)	Why (Motivation)
Scope (contextual) Planner	List of things important to the business	List of processes that the business performs	List of locations in which the business operates	List of organizations important to the business	List of events/ cycles important to the business	List of business goals/strategies
Enterprise Model (conceptual) Business Owner	e.g. Semantic Model	e.g. Business Process Model	e.g. Business Logistics System	e.g. Workflow Model	e.g. Master Schedule	e.g. Business Plan
System Model (logical) Designer	e.g. Logical Data Model	e.g. Application Architecture	e.g. Distributed System Architecture	e.g. Human Interface Architecture	e.g. Process Structure	e.g. Business Rule Model
Technology Model (physical) Implementer	e.g. Physical Data Model	e.g. System Design	e.g. Technology Architecture	e.g. Presentation Architecture	e.g. Control Structure	e.g. Rule Design
Detailed Representation (out-of-context) Subcontractor	e.g. Data Definition	e.g. Program	e.g. Network Architecture	e.g. Security Architecture	e.g. Timing Definition	e.g. Rule Definition
Functioning System	e.g. Data	e.g. Function	e.g. Network	e.g. Organization	e.g. Schedule	e.g. Strategy

Figure 6: Zachman Framework (Correia and Silva, 2005).

3.4 Frameworks, Methods and Standards to Enterprise Modeling

The Open Group Architecture Framework (TOGAF) is an EA Framework which describes a methodical process along with a set of supporting tools (open Group, 2009). There are 3 main components of TOGAF: Architectural Development Method(ADM) - a process used to derive an Enterprise Architecture for an organization; Enterprise Continuum - a ”virtual repository” for architectural assets of the organization (models, patterns and architecture descriptions) and TOGAF Resource Base - a set of resources, including guidelines, templates, and background information to aid in the ADM. The ADM helps to describe how to develop an Enterprise Architecture through the examination of business requirements as shown in figure 7. There are nine main areas to help define the Enterprise Architecture Preliminary Phase, architecture vision, Business Architecture, Information Systems Architecture, Data Architecture, Applications Technology Architecture, Opportunities and Solutions, Migration Planning Implementation Governance, Architecture Change Management. The Open Group maps out how to use the ADM to populate the Zachman

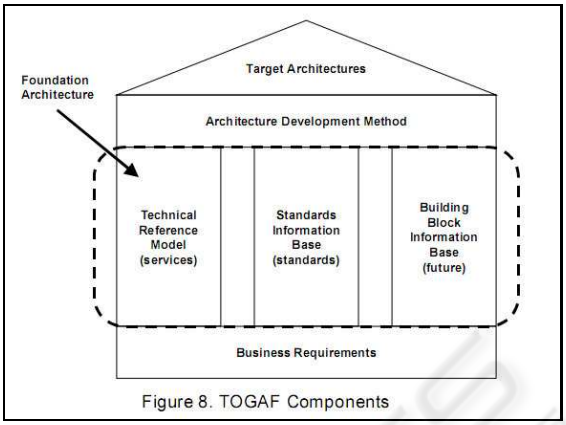

Figure 7: TOGAF Framework (Arbab et al., 2002).

Framework in various steps.

There are other proposals similar to TOGAF combining frameworks with method and guidelines, especially in the U.S. government. DoDAF is the proposal of the Department of Defense (DoD, 2007) and the FEAF is the federal government (FEA, 2007).

3.5 Enterprise Architecture Language

Archimate proposal (Lankhorst, 2005) was submitted in 2005 as a result of the project developed at Telematica Institut (now Novay), Netherlands. Archimate is a matrix like Zachman, but proposes a language and specific models for EA. The matrix has only 3 rows and 3 columns as shown in figure 8. The lines indicate models for business , information and technology and the columns indicate models in active, behavior, and passive level. Models in seven domains are suggested to fill the cells of the matrix: Product; Organization; Information; Processes; Application; Data and Infrastructure. Archimate is now part of The Open Group line of products.

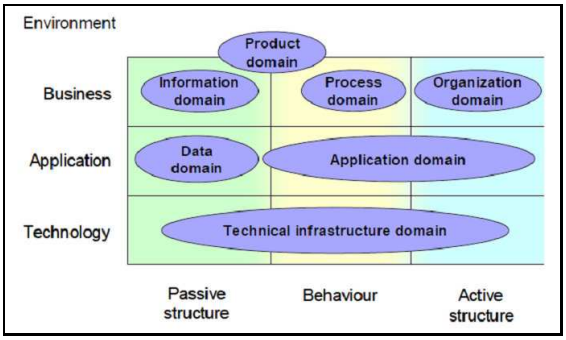

Figure 8: Archimate Framework (Lankhorst, 2005).

ArchiMate proposes a metamodel for each domain with a ontology, indicating the elements and relations

in that domain. Figure 9 shows the ontology for the business domain.

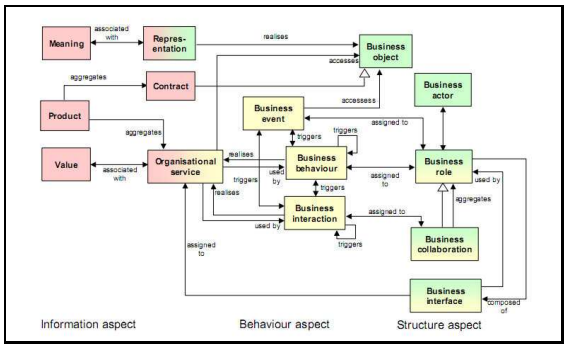

Figure 9: Archimate Meta Model for Business Domain (Lankhorst, 2005).

3.6 Information Architecture

The Enterprise Information Architecture (EIA) approach to EA is an Information Architecture (IA) approach extension for the organization environment (Morville and Rosenfeld, 2006). This approach is different of other EA approaches because it does not consider information systems as the central focus. Figure 10 shows a proposal where EA, EIA and content management (CM) approaches working together [1]. The main focus of this alliance is architectural information identification, classification and delivery working with semantics, metadata, taxonomies, controlled vocabularies, ontologies and search.

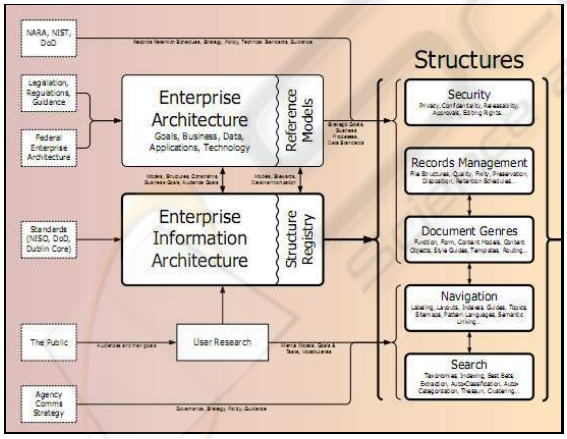

Figure 10: EA and Knowledge Management Efforts (James Melzer, 2009).

[1] www.jamesmelzer.com

4 ENTERPRISE ARCHITECTURE PRACTICE

This section presents a review of the literature about EA practice, analyzing tools, organizational structures and strategies.

4.1 Enterprise Architecture Tools

Schekkerman (2009) publishes an extensive annual survey of the various EA tools in the market. It is important to note that following Zachman proposal, the architecture can consist of models from various domains which can lead to the conclusion that any modeling tool can be considered as a tool for EA. This is the focus of Schekkerman analyzes. The study shows most of the tools meet only part of architecture domains and no tool is specialized in EA, They provide resources to make many other things such systems or processes modeling. There also other reviews of EA market analyzing Strengths and Weakness of theirs resources (Ernst et al., 2006). Research institutes, such as Gartner and Forrester, also publish annual reports assessing the tools to EA. Both consider that only six or seven companies meet the requirements for an EA tool. These requirements are: resources to model the various domains, specific resources to model architecture and identify relations between models, support for the main frameworks, resources for managing projects, resources for publishing on the Web, collaboration resources and a repository for storing and retrieving models. The main companies that offer tools with these requirements are: IBM (System Architect and Rational) [2], IDS Scheer (ARIS tools) [3], Metastorm [4], Troux Technologies [5] and Alphabet [6]. Figure 11 shows a screen of System Architect tool where relations between models are presented.

None of these tools was born in EA market and none is dedicated solely to EA. Some are specialized in modeling systems, such as IBM tools, and others are specialized in modeling processes such as ARIS. Figure 12 shows the diverse functions offered in IBM Telelogic solution. Enterprise architecture is one among several resources it offers.

[2] http://www-01.ibm.com/software/rational/
[3] http://www.ids-scheer.com/index.html
[4] http://www.metastorm.com/
[5] http://www.troux.com/
[6] http://www.alfabet.com/

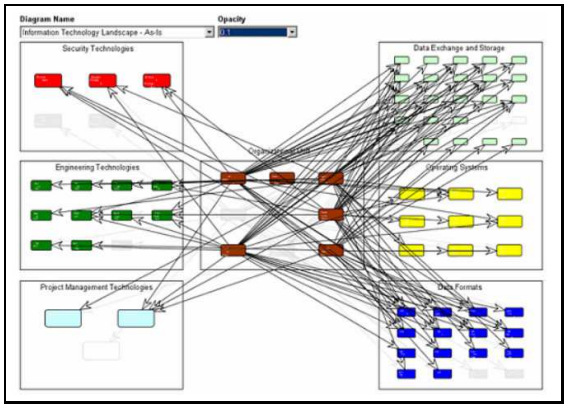

Figure 11: Models Relations in System Architect Software.

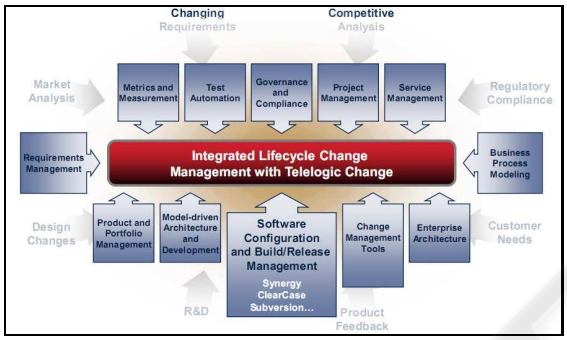

Figure 12: Telelogic software Components.

4.2 Enterprise Architeture Reference Models

There are a great number of Operation Reference (OR) Frameworks that can serve as templates, radically simplifying the creation or improvement of architectural models. The Supply Chain Council's SCOR (Suply Chain Operational Framework) [7] and the Tele management Forum's eTOM (enhanced Telecom Operations Map) [8] are proposal in specific areas of suply chain and telecom. Figure 13 shows a template of eTOM that shows organizational architecture domains and its relation such as strategy, infrastructure, product, operations, and enterprise management.

Another reference model that can be used to build specific model is the OMG Business motivation model (BMM) that details the element of modeling organizational objectives and goals. Many authors have published works suggesting models of enterprise ontologies which can be used as a skeleton for building a specific architecture model, saving time

[7] http://www.supply-chain.org/

[8] http://www.tmforum.org/BusinessProcessFramework/1647/home.html

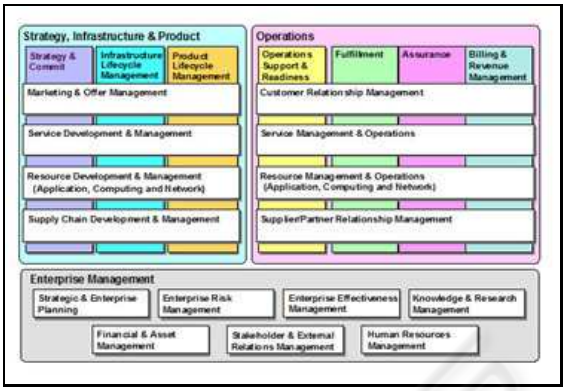

Figure 13: eTOM reference model.

and bringing consistence (Jussupova-Mariethoz and Probst, 2007; Emery, 2007).

4.3 Enterprise Architeture Strategies

Many EA programs do not succeed because they are not well implemented. It is recommended to to implement an EA program in five steps: Initiate the effort; Describe where we are; Identify where we would like to be ;Plan how to get there; Implement the architecture (Boster et al., 2000).

Initiate the Effort. Develop an architecture framework;Create readiness for architecture Build the architecture team; Identify and influence stakeholders; Encourage open participation and involvement; Reveal discrepancies between current and desired state.

Describe where we are. Characterize the baseline architecture; Make it clear to everyone why change is needed.

Identify where we would Like to Be. Develop the target architecture; Communicate valued features; Energize commitment; Create a plan for transition activities.

Plan how to Get there. Develop the transition plan; Execute the target architecture Communicate the transition plan; Establish sound management structure; Build support for the architect.

Implement the Architecture. Maintain/enhance the target architecture; Develop new competencies and skills; Reinforce architecting practices

This plan of action is structured in many methodologies such as EA Gartner Framework (Burke, 2006), shown in figure 14. First, a architectural effort must be implemented. Then, it is necessary to document a current situation and design an expected one. All these efforts must be based on principles and

requirements guided by business strategies and environment trends. A transition plan must be made to reach desired state. All the process must be managed and governed.

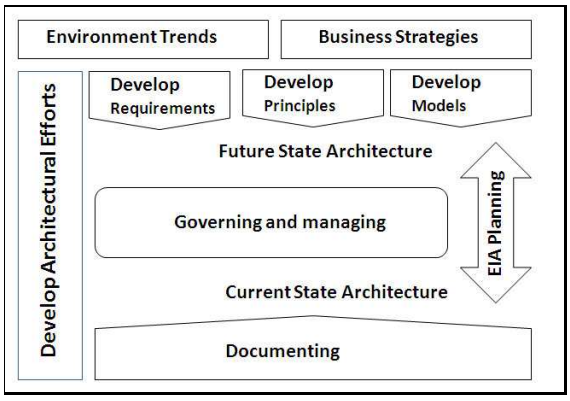

Figure 14: Gartner Framework (Burke, 2006).

4.4 Organizational Structures for Enterprise Architeture

To reach its goals EA must have an organizational structure with a group responsible for it (Harmon, 2003). (Rosenfeld, 2007) proposes a structure with an EA board and an EA operational management team. This team must have a central staff and also specialists distributed in local departments that contributes to EA contents. The central staff does not generate content. The central staff must implement and manage an infrastructure to EA and identify and publish EA policies and guidelines. As Rosenfeld states, EA is a mix of users, context and context (Rosenfeld, 2007). EA community is composed by users and content generators that are also users. Each user needs a specific vision of architectural elements. Each content contributor deals with a specific content level. It is a function of EA staff to know who does content and who needs information. The enterprise Architect is the main professional for EA. Given the interdisciplinary nature of EA, the enterprise Architect must have a general knowledge of various discipline (Strano and Rehmani, 2007). These discipline, among others, are business strategy, financial management, organizational dynamics, business process design, and information technology.

The National Association of State Chief Information Officers (NASCIO) (Nascio, 2003) proposes a maturity model for assessing EA organizational approaches maturity (EAMM). According to this assessment methodology, EA comprises five levels of maturity: The lowest level is when there is no EA approach and the highest one is when organization has departments working together as contributors to the architecture and its processes and metrics assess the effective contributions of EA.

4.5 EA Practice

Current Research on EA practice does not present a positive situation. A survey published by Gartner (Burke, 2006) identifies that only 25% of EA initiatives can be considered active and mature. 50% of them take 2 steps forward and 1 step back and 25% have failed repeatedly. An investigation of perception and practice of EA found that IT professionals still do not perceive EA as an organizational effort, but an IT initiative which indicates that EA is not properly implemented (Kappelman and Salmans, 2007). The same survey shows that the identification of requirements is still a great challenge in information systems development which shows the necessity of change in systems development processes. Another study identified that only 6% of organizations have an appropriate degree of maturity in the modularization of its information systems (Ross et al., 2006). The literature is plentiful in perceptions that EA, though admittedly to be an important tool, it is not a standard practice in organizations, mainly considering medium and small ones (Vernadat, 2007).

5 ASSESSMENT OF CURRENT EA APPROACHES

This section provides an assessment of each of the five types of approaches outlined in previous review. For each approach strengths and weaknesses are analyzed and recommendations on their use are proposed.

Strategic EA. The strength of this approach is allowing organization to identify the essence of business and mode of operation and combine the best technology strategy to meet these strategic requirements. This approach addresses only top management and does not meet operation management requirements. It is essencial to map business and technology strategies. It Must be used in conjunction with other approaches.

Enterprise Modeling. The strength of this approach is allowing organization to identify business and technology engineering in a wide variety of models from various domains and in different levels of detail. It is considered architecture because it lays out an architectural classification of models. It is an approach too broad that makes technical staff confused. IT does not indicate who makes models and how. It does

not separate efficiently frontiers between architecture and engineering. Use this approach determining this frontier, indicating when, why, how and by whom the models must be made. The architectural models can be used for navigation in the structure of models starting with the conceptual vision (architecture) to reach the more detailed level (engineering).

Enterprise Modeling Methods and Standards. The power of this approach is to allowing organization to identify business and technology architecture with a method and best practices. It is useful because lays out the architectural classification of models and determines how, why and who should develop the models. It is an approach also too broad that makes the technical staff confused, because there is no clear boundary between engineering and architecture activities. Use this approach after clarifying these boundaries.

Enterprise Architecture Language. The strength of this approach is to offer a specific language for architecture models. It defines clearly EA boundaries suggesting only architectural modeling trough metamodels. The approach does not indicate methods and best practices. To be used in conjunction with other approaches.

Enterprise Information Architecture Approach. The strength of this approach is to provide an integrated view of organizational information fleeing the technological paradigm. The approach established an infrastructure for organizational knowledge gathering content, models, semantics and metadata. It organizes organizational information and serves different audiences. It can become complex to manage, because joins together many different concepts such as IA, EA, ECM and enterprise collaboration. To be used in a broader initiative of EIA, linking all organizational information in only one effort.

6 ENTERPRISE ARCHITECTURE CHALLENGES

EA has many proposal with many approaches. Why, then, many organizations fail to implement the EA approach. Ambler (Ambler, 2009) tries to explain the reasons for failure in the efforts of EA:

- There isn't an enterprise architecture effort.
- Skewed focus.
- Project teams don't know the enterprise architecture exists.
- Project teams don't follow the enterprise architecture.
- Project teams don't work with the enterprise architects.
- Outdated architecture.
- Narrowly focused architecture models.
- Dysfunctional "charge back" schemes.
- A "do all this extra work because it's good for the company" attitude.

EA, considering the breadth of its goals, undoubtedly has many challenges, as identified by Khoury (Khoury, 2007):

- **Abstraction Challenge:** EA models need to be in an suitable level of abstraction. Details must satisfy uficientes para satisfazer aos diversos interessados;
- **Cognition Challenge:** models need to be represented in a language that is intelligible to all stakeholders;
- **Collaboration Challenge:** EA needs the cooperation of other communities to develop and maintain current models of the architecture;
- **Communication Challenge:** models of the architecture must be communicated to all stakeholders; engagement challenge: the entire organization can benefit from models of architecture and many can help develop them. The challenge is the involvement of all;
- **Update Challenge:** organizations are very dynamic and the information contained in the models can quickly downgrade.

7 ENTERPRISE ARCHITECTURE THEORETICAL FRAMEWORK

This section presents a theoretical framework that comprises the main topics discusses in this review.
Analyzing main current EA approaches it is easy to visualize that they came from technology. It is also clear that no approach is complete to be used in a isolated fashion. It is necessary to accommodate the various approaches in a single platform. Almost all current approaches make a great confusion between architecture and engineering. No approach solve all challenges EA have. For this reason, many authors claim that the EA is not yet mature. We surely need a new paradigm. EA surely is and must be considered an organizational Enterprise Information Architecture approach. EA must be a index for technology and for

business. Everybody in organization must have access to architectural information that leads to operational information. This information will be available only if key people in organization contribute as information architects in an ongoing and collaborative manner. With this focus, EA needs fundamentals, theories and tools more appropriate than those currently available.

We propose in figure 15, an EA theoretical framework which consolidates current theory and incorporates a EIA approach to EA. This framework incorporates the necessary IA elements to EA and vice versa. In our approach, EA must work in conjunction with Content management and EIA efforts contribution with artifacts and using a organizational knowledge base. It makes no sense EA efforts to manage models only. Words are models to. Models are knowledge as all other organizational content. Organizational content features important information for models and vice versa. Organizational contents must be associated with models. A marketing campaign has important information for business and needs business information. It makes sense to have two worlds of information.

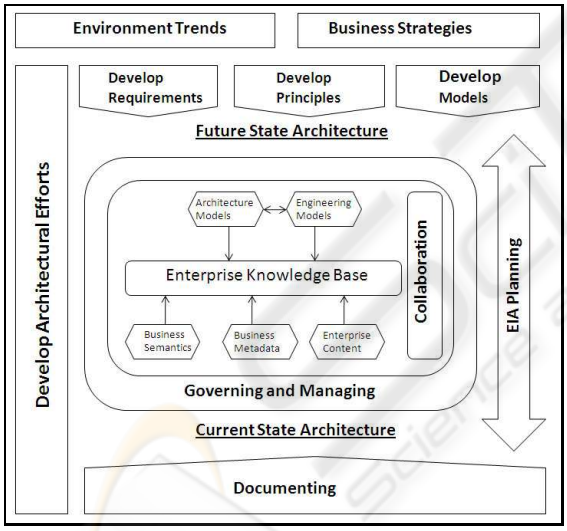

Figure 15: A KM-EA Framework.

8 CONCLUSIONS AND RESEARCH AGENDA

This paper presented a review of current literature on concepts and approaches to EA, contributing to a better understanding of the state of the art and the challenges of this field of research and practice. Analyzing EA research and looking at EA practice it is easy to see that, even though EA is seen with optimism on a medium and long run, the current reality is not good. Most of the professionals who could be using the existing proposals consider approaches still confusing and complex and tools much expensive. It is not clear for systems analysts the boundary between modeling a system and modeling an application architecture. It is not clear for business analyst the difference between a process model and an a business architecture model. It is not clear to both professionals who should make engineering models and architecture ones.

If EA boundaries are not clear to professionals, they are not clear to executives either. So, EA initiatives are not properly structured. A poorly structured EA initiative is a sure failure. EA is certainly a complex initiative considering the existing approaches. The expectation is that over time it becomes mature to be implemented in a less complex manner. For this to happen it is necessary, above all, better approaches and more specialized and affordable tools.

A new agenda of EA research is needed. Research must clarify EA boundaries, and provide unique foundations and theories. EIA approaches must come to EA and so research must come in this direction. EA tools must be specialized in EA, not a extension of other objetives. EA methods and tools must be possible of customization to organization needs simplifying its use. EA, EIA and CM tools must join efforts to build a tool which allows access to all organizational information and content with security. This new tool must be able to help collaboration between people in order to increase continually information and models available. It must have semantic and metadata resources in order to make easy classifying and accessing all kinds of models and contents. EA, EIA and CM, together, can help organizations make architecture come true.

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