# Enterprise Architecture Evaluation: A Case Study on the Purposes of Enterprise Architecture for E-Business

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## ABSTRACT

*Enterprise Architecture (EA) is an ill-understood concept, especially in the context of e-business. The aim of this paper is to explore the elements that make up EA and to classify the kinds of purposes EA could serve for the realization of e-business. Using literature research, we derive three elements of EA frameworks. We applied the EA elements on a running case at a large multinational firm, which is currently migrating towards an e-business platform. In the case study, EA was only useable for descriptive purposes, making EA a valuable instrument for communication and analysis. EA was not useable for prescriptive purposes such as the design or redesign of information systems in relation to changing business processes. The main cause of this is the lack of comprehensive tooling support, something that will hamper using EA for developing and deploying e-business solutions in the future.*

## 1. INTRODUCTION

Businesses are constantly facing the need to adapt to new international legislation, technological innovations, increasing competition and changing customer demands. Adaptability is a multidimensional concept [8], requiring comprehensive alignment between the strategy of a company, its business processes and the supporting information technology (IT). Achieving alignment between business processes and IT requires an integrated approach to all aspects of the enterprise [20]. Various consultancy and research institutes [10][21][24][28][34] suggest using the concept of enterprise architecture (EA) as an integrated approach towards business-IT alignment. Veasy [30] states that one of the key objectives for using architectural concepts is to achieve organizational flexibility and adaptability for complex organizations to manage the increasing rate of change. In addition, EA proponents advocate that the use of EA will leverage strategic adaptability, increased organizational performance and technology integration resulting in significant cost reduction and growth potential [1], [6], [12], [30].

Many EA frameworks e.g. Zachman, TOGAF, DODAF and GERAM were developed [4], [5]. Usually, such EA frameworks are offered with design approaches, modeling notations and principles aimed at guiding architects during the business-IT alignment process.

Although there are many whitepapers on EA presented by consultancy firms and governmental agencies, scientific contributions on EA and its practical value is scarce [2][7]. Moreover, it is unclear what constitutes an EA, as EA is an ill-defined [23] and still evolving concept [14]. In this paper, we derive the main elements of EA by analyzing existing EA frameworks in order to obtain better understanding of what constitutes EA. We endeavor to identify what purposes enterprise architecture should serve in the transition to e-business platforms.

This paper is structured as follows. In the following section, we present the state of the art in EA. Section three presents the research approach. In section four, elements which constitute EA are derived from literature. Next we identify the business needs for EA using a single case study. In section six we develop an EA reference framework. Then we evaluate the purposes of the devised framework in a case study environment. Finally, section eight presents the main conclusions and some directions for further research.

## 2. STATE OF THE ART IN ENTERPRISE ARCHITECTURE

With the original article published in 1987, Zachman [33] was the first to discuss architectural concepts in relation to IT. Zachman's article was his response to the needs of his IBM clients that had requirements for data standards and information sharing strategies across several systems, which called for an overarching architecture [4].

The idea of enterprise architecture is that it can be used to guide design decisions and limit the solution space by setting constraints [16]. Architecture aims at creating some kind of structure in a chaotic environment using systematic approaches [1]. In general, the architecture concept intends to establish standards for the employment of information technologies in ways that responded to strategic and business requirements, and that helps an enterprise to manage the ongoing transition from its current processes and systems to a desired future architecture [27].

Since Zachman's pioneering work [33], IT architects and managers used numerous proverbs in conjunction with the term 'architecture'. The term "enterprise" refers to the scope of the architecture, dealing with the organization as a whole or in case of EA, dealing with multiple departments and organizations rather than with a certain organizational part [7]. Other proverbs (e.g. business, process, application, service, network etc.) usually suggest a certain aspect or technical component that the architecture is meant to depict. Due to the use of the proverbs, it has become evermore complicated to clarify enterprise architecture. Moreover, Khoury & Simoff [18] underline that scarce attention has been paid to the theoretical basis of EA methods and frameworks until now.

## 3. RESEARCH APPROACH

In order to study the concept of EA in a business environment, we adapted the Information Systems Research Framework (ISRF) [9]. The ISRF suggests an interactive cycle of four main steps including: 1) literature review, 2) analysis of the business needs, 3) framework development, and 4) evaluation of the developed framework.

To analyse the business needs, we use the case study instrument. This approach allows us to investigate EA in a real-life setting [31]. As a case study, we used a multi-national company that is in a transformation process to become an e-business company in some of its operations. We conducted a single case study by analyzing multiple sources of information, including semi-structured interviews with two head architects (one responsible for business and the other for IT), archival analysis and participatory observation.

## 4. ELEMENTS IN ENTERPRISE ARCHITECTURE FRAMEWORKS

Generally EA frameworks embody a constellation of elements which architects consider relevant for modelling both business and IT systems. We found five common elements of EA in the reviewed literature (see table 1).

As first element, we found that most EA frameworks make use of layers [12], which are distinguished using various proverbs (e.g. business, process, organiza-

*Table 1. Some elements of enterprise architecture found in literature*

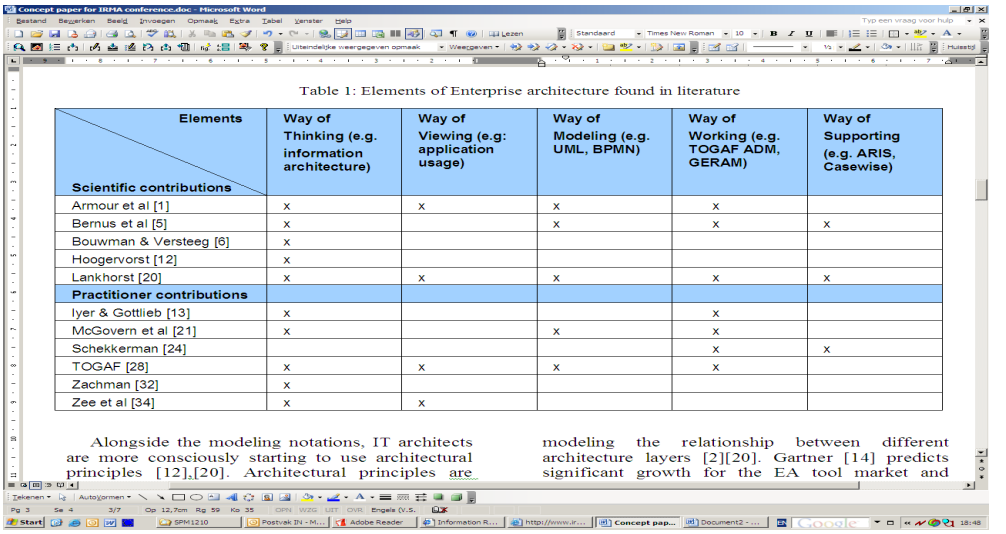


Table 1: Elements of Enterprise architecture found in literature

| Elements / Scientific contributions | Way of Thinking (e.g. information architecture) | Way of Viewing (e.g: application usage) | Way of Modeling (e.g. UML, BPMN) | Way of Working (e.g. TOGAF ADM, GERAM) | Way of Supporting (e.g. ARIS, Casewise) |
|---|---|---|---|---|---|
| Armour et al [1] | x | x | x | x | |
| Bernus et al [5] | x | | x | x | x |
| Bouwman & Versteeg [6] | x | | | | |
| Hoogervorst [12] | x | | | | |
| Lankhorst [20] | x | x | x | x | x |
| **Practitioner contributions** | | | | | |
| Iyer & Gottlieb [13] | x | | | x | |
| McGovern et al [21] | x | | x | x | |
| Schekkerman [24] | | | | x | x |
| TOGAF [28] | x | x | x | x | |
| Zachman [32] | x | | | | |
| Zee et al [34] | x | x | | | |

Alongside the modeling notations, IT architects are more consciously starting to use architectural principles [12],[20]. Architectural principles are

modeling the relationship between different architecture layers [2][20]. Gartner [14] predicts significant growth for the EA tool market and

tion, application, information and infrastructure). These proverbs represent the functionality within an enterprise system [21].

As second common element, we found that EA frameworks often suggest some predefined views. The notion of views is so basic that some researchers consider the Zachman Framework merely as a table consisting of 36 different views on an IT system [24]. In the IEEE1471 Standard for Architectural Descriptions [10], the derivation and definition of views is a crucial step for architectural design. EAs are disclosed by means of views; typically, stakeholders of an enterprise access and use the architecture through views presenting the information they need in a user-friendly format and supported by useful analysis techniques [20]. It is agreed upon that the use of views reduces the size and complexity of architecture layers [10][20][33].

The third common element in EA frameworks is the modeling notation. The modeling notation refers to a language allowing for description of the components and the relationships in the architectural layers. While the most frequently used notations for modeling EA are languages originating from the software engineering field such as the Unified Modeling Language (UML) and IDEF, some languages are emerging specifically for the description of business processes such as the Business Process Modeling Notation (BPMN) [5]. We emphasize that the EA modeling notations found in literature are not only different in their syntax and semantics; they also differ in the objectives they aim to achieve. Consequently, there is currently no single modeling notation suitable for modeling multiple distinguished architecture layers.

As a fourth element, we found architectural development approaches. Spewak [27] was amongst the first to discuss the EA planning process, considering the fact that the original Zachman framework does not propose an EA design approach. The design approaches constitute a way of working or a prescriptive process model, which specifies the activities, required for migrating from the current situation to a target situation. Hence, the design approaches provide a process-oriented view of information system development. Examples of EA development approaches are TOGAF-ADM [28] and GERAM [5].

Usually, the third and fourth element some architectural principles [12],[20]. Architectural principles are considered guidelines that describe the constraints imposed upon the organization, and/or the decisions taken in support of realizing the business strategies [15]. In this way, principles restrict the design freedom of designers and set the direction for the future.

Finally, tools are necessary to support EA frameworks. By nature, EA requires the interconnection and accumulation of large amounts of information from different sources [20]. Modeling the content and relationships of enterprise elements can only be successful if supported by adequate tooling [2][14]. Most of the EA tools currently on the market have started as CASE (Computer Aided Software Engineering) tools [5] and are not yet capable of modeling the relationship between different architecture layers [2][20]. Gartner [14] predicted significant growth for the EA tool market and predicts current tools will evolve into more comprehensive and customizable tools capable to model all layers of the enterprise.

In order to create some clarity, we classified the elements mentioned according to the terms used by Sol [25]. This framework has proven to be useful in similar research [15] on working with information systems. This framework compromises a way of thinking, controlling, working, viewing, modeling and supporting as six interrelated aspects to capture a problem area and has proved to be helpful in similar research [15].

We relate the way of thinking to the concept of layers in architectural development. The way of controlling refers to the overall management (e.g. financial, risk) of EA and is left out of table 1. The way of working refers to the steps taking to develop an EA. The way of modeling relates to modeling notations for EA. Finally, the way of supporting refers to repository tools for electronically documenting and relating the current processes, information flows and applications. We illustrate the elements after a brief discussion of the business needs.

## 5. THE BUSINESS NEEDS: A CASE STUDY

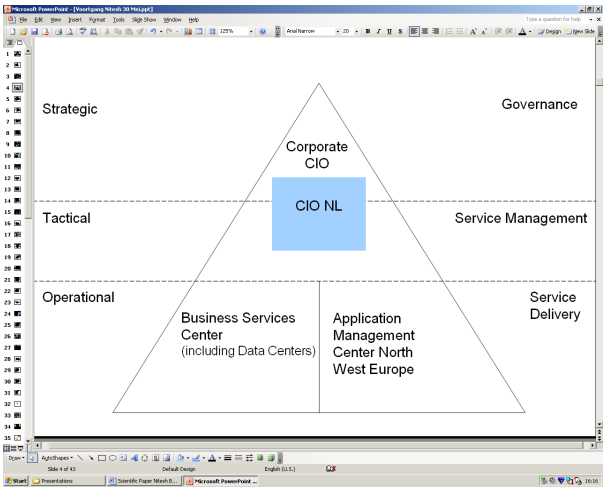
We conducted a case study at a major multinational company operating in over two hundred countries. The goals of the case study are to 1) understand the need for EA for e-business and 2) describe an environment in which an EA framework can be applied.

Within the multinational, the various country-oriented units are using their own customer relationship management (CRM) system. Consequently, there are more than hundred different systems throughout the entire firm. As these systems were developed separately, it is difficult to gather customer information on the global level. In order to attain synergy and reduce cost, the companies Corporate CIO (Corporate Information Office) plans to deploy a common SAPCRM landscape. The objective is to move from separate systems towards a shared CRM architecture, designed to support information exchange for cross-country sales.

We conducted the case study at the CIO in the Netherlands. In collaboration with the CIO's of nine other west European countries, the Dutch CIO is planning and anticipating the roll out of the global SAPCRM. In doing so, the Dutch CIO is devising a future CRM architecture for the Netherlands in collaboration with the Business Services department (BS) and the Application Management Center (AMC). The following figure depicts the relationships between the stakeholders involved.

In this figure, both Corporate CIO and the Dutch CIO (CIO NL) operate on a strategic level, respectively looking at the global environment and the local situ-

*Figure 1. The layered governance structure*




ation within a country. For each country, the migration from the existing CRM architecture to the CRM target architecture must be specified individually.

However, developing such a comprehensive architecture for the SAPCRM rollout requires a detailed description of the current sales processes, information flows, application services provided by AMC and infrastructure services provided by BS. As the role of some application, meant to support some specific process at any given department, may change in the future, the relations between the processes, information flows and applications needs to be described as well. Therefore, the main problem the Dutch CIO faces is the development of a comprehensive architecture describing the current and future relations between the processes, information flows and applications.

## 6. REFERENCE FRAMEWORK

In order to analyze the alignment of the CRM processes and the supporting IT, we developed a reference framework. The reference framework should enable both business and IT designs to focus specific layers and the establishment of the link to corresponding elements [10]. The term 'reference' also indicates that the framework is generic and can be used in similar companies.

The reference framework we propose contains three main parts: aspects, layers and five ways of Sol [25].

The top level of the cube shows some essential aspects of EA for the stakeholders. These aspects are adapted from a multi-client study by the Nolan Norton Institute [34], mainly because their study showed that the five aspects (governance, objectives, cost, capabilities and change-processes) are the primary IT concerns of 17 large companies.

The side level of the framework represents the five 'ways of information systems' suggested by Sol [25]. We believe that an explicit description of the ways of controlling, working, viewing, modeling and supporting are essential for architectural development.

*Figure 2. The reference framework*

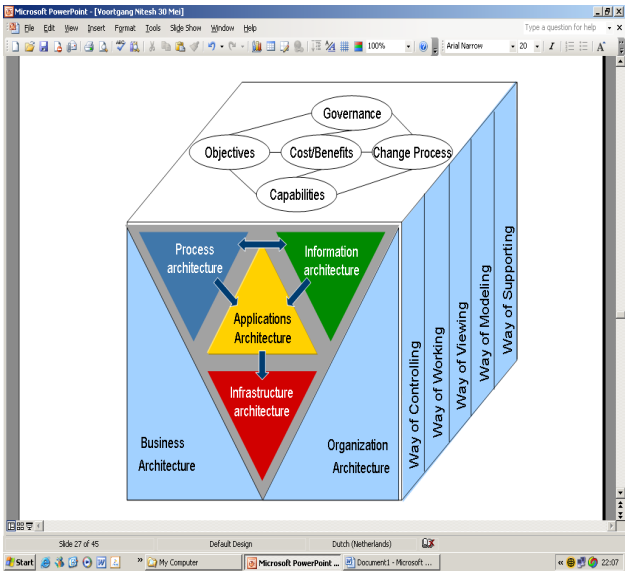



*Table 2. Application of the framework elements*

| | Elements | Findings |
|---|---|---|
| Aspects | Governance | The governance structure is left implicit, some planning and control mechanisms are in place steering the e-business projects on a global level. |
| | Objectives | The objectives for the SAPCRM project are clearly documented and well communicated throughout all countries. The objectives were formulated using a top-down approach. |
| | Cost-benefits | The costs of the project are estimated on a global level, the benefits and risk (e.g. data migration and versioning) are not yet agreed upon. |
| | Change process | The change processes required for the migration from the current CRM platform to the future SAPCRM are not prescribed. |
| | Capability | The required capabilities for the project are not stated in the project documents. |
| Layers | Business Architecture | Stakeholder representatives are working on various business plans during the implementation of SAPCRM. |
| | Organization Architecture | The roles of the actors are explicit while the responsibilities of the actors and their relationships with the other layers are vague. |
| | Process Architecture | The CRM process architecture are well documented and communicated. |
| | Information Architecture | The information objects and their relationships are not modeled. |
| | Application Architecture | There is a static list of all the applications in the enterprise, however not in relation to the other layers. |
| | Infrastructure Architecture | The infrastructure services required for CRM applications are clear, however, not in relation to the other layers. |
| Ways | Way of controlling | There are some generic cost, quality and security mechanisms defined and used. |
| | Way of working | Architectural development is still intuitive and unstructured, except for the process layer. |
| | Way of viewing | Generally, the three-tier view (presentation, logic and data) is used for the categorization of (e-) business solutions. Other views are not standardized. |
| | Way of modeling | No common modeling language is defined or used in the firm, except for process modeling. |
| | Way of supporting | ARIS and maybe Casewise, however, there is no tool for modeling all layers in relationship to each other (there is no integrated tooling support). |

*Table 3. Possible purposes of EA*

| Timeline / Purposes | Ex-ante | Ex-post |
|---|---|---|
| Descriptive | Communication instrument | Analysis instrument |
| Prescriptive | Design instrument | Redesign Instrument |

The cube front depicts the architecture layers as these four layers are already widely used for IT modeling throughout the firm.

In the following section, we illustrate the application of this framework and discuss the purposes of EA.

## 7. EVALUATION OF EA PURPOSES

Using a tabular structure, we present the application of the framework elements on the CRM case of the multinational. A comprehensive description of the case study can be found in [2]. The following table summarizes the main case study results.

Using the proposed framework as an analysis instrument, we found that the firm, more specifically the Dutch establishment, does not cover all of the elements for architectural development. Especially elements such as an enterprise wide way of working, modeling and supporting are still lacking. This means that for CRM processes there is no complete documentation of the information flows, supporting applications and infrastructure services. Moreover, there is no description of the relations between these layers, making it difficult to determine which processes and information flows will be affected by introducing SAPCRM. Therefore, we cannot say that the firm has an integrated approach for aligning business with IT.

However, application of the framework showed that the EA elements in the framework do have purposes when planning for the deployment of SAPCRM. We summarized the possible purposes in the following table.

First, we distinguish two types of elements: descriptive and prescriptive. An EA element is prescriptive when it limits the freedom of the architect and systems engineers, for example when specifying particular ways of working, viewing or modeling. When an element does not suggest any guidelines or specific approaches such as the aspects and layers, the element is descriptive.

A descriptive element allows for documentation and analysis of for instance the business processes in the company. On the other hand, a prescriptive element should help in setting a common way of designing, redesigning and supporting the architecture layers.

When an EA framework (set of elements) is used prior to the actual implementation of an e-business solution (e.g. SAP CRM), the major roles it could play are those of a communication instrument or a design instrument. On the other hand, when a framework is used to look at the functioning of a specific service or application, the framework functions as an analysis instrument or a redesign instrument.

In the case study, we found that not all of the elements of EA (proposed in our framework) are in place. The elements in place are the aspects and layers, which were management used mainly for communication and analysis, limiting the use of EA to descriptive purposes.

## 8. CONCLUSIONS

In the paper, we explored the ill-defined concept of Enterprise Architecture (EA) using literature research by identifying its main elements and purposes. We illustrated the elements and potential purposes for e-business using a case study. We reviewed a variety of academic and practitioner contributions to gain insight in what constitutes an EA. As a result, we found that EA is an organization specific constellation of three main elements: aspects, layers and ways for architectural development.

While the aspects (e.g. governance, capabilities) represent the more high-level managerial side to EA, the layers depict a vertical decomposition of processes, information flows, applications and infrastructure services.

Application of the developed EA framework on the case study allowed us to identify four possible instrumental purposes of EA frameworks. The purposes are communication, evaluation, design and redesign instrument. The case study showed that without a repository-based tool containing descriptions of the enterprise's processes, information objects and applications, EA is only useful as a communication and evaluation instrument. Considering the number of business processes and the underlying IT applications, a repository tool is essential in order for EA to be used as a design or redesign instrument.

Our findings are based on a single case, therefore we suggest further research on the purpose of EA for firms in the transition towards an e-business platform. We underline the need for more comprehensive repository based tooling support, supposedly with a modeling notation that is suitable to describe and relate both business (processes, structures and actors) and IT (information objects, applications and services).

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