A Method to Define an Enterprise Architecture using the Zachman Framework

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ABSTRACT

The proliferation of IT and its consequent dispersion is an enterprise reality, however, most organizations do not have adequate tools and/or methodologies that enable the management and coordination of their Information Systems. The Zachman Framework provides a structured way for any organization to acquire the necessary knowledge about itself with respect to the Enterprise Architecture. Zachman proposes a logical structure for classifying and organizing the descriptive representations of an enterprise, in different dimensions, and each dimension can be perceived in different perspectives.

In this paper, we propose a method for achieving an Enterprise Architecture Framework, based on the Zachman Framework Business and IS perspectives, that defines the several artifacts for each cell, and a method which defines the sequence of filling up each cell in a top-down and incremental approach. We also present a tool developed for the purpose of supporting the Zachman Framework concepts. The tool: (i) behaves as an information repository for the framework's concepts; (ii) produces the proposed artifacts that represent each cell contents, (iii) allows multi-dimensional analysis among cell's elements, which is concerned with perspectives (rows) and/or dimensions (columns) dependency; and (iv) finally, evaluate the integrity, dependency and, business and information systems alignment level, through the answers defined for each framework dimension.

Categories and Subject Descriptors

[**Organizational Engineering**]: Enterprise Architecture – *frameworks, methods and tools.*

General Terms

Management, Documentation, Design.

Keywords

Zachman Framework, Enterprise Architecture, Business Architecture, Information Architecture, Application Architecture.

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1. INTRODUCTION

Any organization has an Information System supporting the business. There is no doubt that IS supports decision making, coordination, and control and may also help managers and workers analyze problems, visualize complex subjects, and create new products [7]. According to a study conducted in the 1990's [8], Information Architecture was referred to as one of the most important issues to address in IS management and as stated by Zachman, "with increasing size and complexity of the implementation of information systems, it is necessary to use some logical construct (or architecture) for defining and controlling the interfaces and the integration of all of the components of the system" [14].

Taking this into consideration, it is necessary to define an Enterprise Architecture in an organization to gain the associated advantages of that architecture, therefore, it is a better option to simplify the IS management. Some architecture's advantages are,

- It acts as a way to pass from chaos and disagreement to order and structure [6];
- It enables an integrated vision and a global perspective of informational resources [8];
- It enables the discovery and elimination of redundancy in the business processes reducing information systems complexity [3];
- It contributes to having information systems that reflect common goals and performance measures for all managers, to encourage cooperation rather than conflict, and competition within organisations [11];
- It becomes the bridge between the business and technical domains [13].

Attending to the previous advantages, "the leaders of the organization must have a clear vision of the desired future state of the entire system, including such dimensions as its business, its organization and its ways of working. This vision must be used as a common context both for diagnosing the need for changes and for managing the process of change, so that it acts as an integrating force for the multitude of apparently disparate changes to be made." [2]. The role of Enterprise Architecture is to help achieve this previous vision, being able to capture the "entire system" in all its perspectives and dependencies, such as, business, information system and technical perspectives.

2. ENTERPRISE ARCHITECTURE DEFINITION

Sometimes, the term "Enterprise Architecture" refers to that group of people responsible for modeling and then documenting the architecture. Other times, the term denotes the process of doing this work. More commonly, when we are referring to the Enterprise Architecture, we are referring to the models, documents, and reusable items (as components, frameworks, objects, and so on) that reflect the actual architecture [1].

However, in the EACommunity (www.eacommunity.com), Enterprise Architecture is a framework or "blueprint" for how the organization achieves the current and future business objectives. It examines the key business, information, application, and technology strategies and their impact on business functions. Each of these strategies is a separate architectural discipline and Enterprise Architecture is the glue that integrates each of these disciplines into a cohesive framework (see Figure 1).

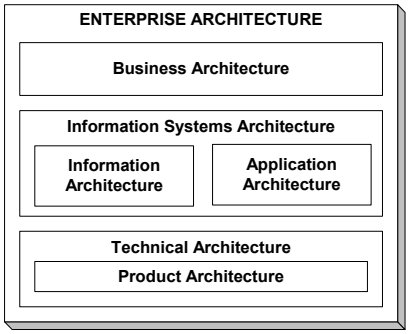

Figure 1. Architecture Relationships [5]

The Business Architecture is the result of defining the business strategies, processes, and functional requirements. It's the base for identifying the requirements for IS, which support the business activities.

The Application Architecture provides a framework focused on developing and/or implementing applications to fulfill the business requirements and to achieve the quality necessary to meet the needs of the business.

The Information Architecture describes the data's physical and logical aspects, as well as the management of the data resources. It's the result of modeling the information that is needed to support the business processes and functions of the enterprise.

The Technical Architecture provides the foundation that supports the applications, data and business processes identified in the other three architectural layers. The Technical Architecture identifies and plans the computing services that form the technical infrastructure for the enterprise.

The Product Architecture is a subset of Technical Architecture and it identifies standards and configurations for the enabling technologies and products within the Technical Architecture.

Although all of these architectures compose the Enterprise Architecture, in this paper we will exclude the Technical Architecture and consequently the Product Architecture.

3. THE ZACHMAN FRAMEWORK

The Zachman Framework [14] for Enterprise Architecture (see Figure 2) was formally published in 1987, its aim was described as an architecture that represents the information systems' artifacts, providing a means of ensuring that standards for creating the information environment exist and they are appropriately integrated. It proposes a logical structure for classifying and organizing the descriptive representations of an enterprise, in different dimensions, and each dimension can be perceived in different perspectives. The Zachman Framework (www.zifa.com) helps govern the architectural process with the dependency, coherence, and traceability needed for an enterprise to manage change, and to ensure that the alignment is achieved.

In this framework, the architecture is described across two independent aspects, the rows represent the different perspectives which may be used to view a business, a situation, an opportunity, or a system and, the columns represent the different dimensions which apply to each perspective of the business, situation, opportunity, or system.

3.1 Perspectives

The Zachman Framework was developed taking into consideration all the participants involved in the planning, conception, building, using and maintaining activities of an organization's Information Systems [6].

- Scope (Planner's Perspective) – The planner is concerned with positioning the product in the context of its environment, including specifying its scope.
- Enterprise Model (Owner's Perspective) – The owner is interested in the business deliverable and how it will be used.
- System Model (Designer's Perspective) – The designer works with the specifications for the product to ensure that it will, in fact, fulfill the owner's expectations.
- Technology Model (Builder's Perspective) – The builder manages the process of assembling and fabricating the components in the production of the product.
- Detailed Representations (Subcontractor's Perspective) – The subcontractor fabricates out-of-context components which meet the builder's specifications.

3.2 Dimensions

While the rows in the Zachman Framework describe the IS participant's views, the columns provide a focus on each dimension while keeping the others constant [4].

- Data (What?) – Each of the rows in this column address the understanding of, and dealing with, any enterprise's data.
- Function (How?) – The rows in the function column describe the process of translating the mission of the enterprise into successively more detailed definitions of its operations.
- Network (Where?) – This column is concerned with the geographical distribution of the enterprise's activities.
- People (Who?) – The fourth column describes who is involved in the business and in the introduction of new technology.

- Time (When?) – The fifth column describes the effects of time on the enterprise.
- Motivation (Why?) – This domain is concerned with the translation of business goals and strategies into specific ends and means.

4. A METHOD TO DEFINE AN ENTERPRISE ARCHITECTURE USING THE ZACHMAN FRAMEWORK

Throughout this paper, the framework used to produce the Enterprise Architecture will be the Zachman Framework, although others can be applied. The Organizational Engineering Center (Centro de Engenharia Organizacional (CEO), in Portugal) proposes a framework for enterprise modeling. The CEO framework provides a restricted set of business objects, defined in a UML profile, used for Enterprise modeling [12]. But the Zachman Framework is certainly the most widely known framework in the Enterprise Architecture context. The reason for its extensive use is due to that fact that it is a very flexible framework. The Zachman Framework does not impose a method and it does not restrict any user to a set of pre-defined artifacts.

Nevertheless, these aspects that are the framework's advantages, can be converted into negative issues, for example, once this flexibility misrepresents its aim, to describe an architecture that represents the information systems' artifacts. If we do not have a set of possible artifacts for each cell and even worst a method that enables us to fill up the framework in the definition of the Enterprise Architecture for an organization, the expected result will be distinct and impossible to validate due to the level of dispersion that each user will place.

Attending to the previous causes, we will propose a set of artifacts and a method to define an Enterprise Architecture using the Zachman Framework.

Before that, it is important to refer once again to the fact that in the context of this work, we are only going to consider, as components of Enterprise Architecture, the Business Architecture, Information Architecture and Application Architecture.

4.1 Artifacts

In this section, we present a possible set of artifacts that can represent the cell content for each cell in the Zachman Framework's Scope, Enterprise Model and System Model perspectives.

We understand artifact to mean, any kind of representation, model or diagram, which supports the cells intention. The proposed artifacts do not oblige us to follow any type of pre-defined notation. However, a notation exists that contemplates the representation for a cell, this representation will be advised as the artifact associated to that cell. The proposed artifacts will enable the establishment of direct correspondence between the cell content and a form of representation.

Using the Zachman Framework as support to develop an Enterprise Architecture, the artifacts used should be easily understood by business people, which implies some technical separation, and these artifacts should represent only and exclusively the content of each cell.

The following table (see Table 1) presents the proposed artifacts for each cell.

Table 1. Artifacts and the Zachman Framework

	What	How	Where	Who	When	Why
Scope (Planner)	List of Things Important to the Business	List of Processes the Business Performs	List of Locations in which the Business Operates	List of Organizations important to the Business	List of Events Significant to the Business	List of Business Goals/Strategies
	- List	**- Hierarchical list or tree**	**- Hierarchical list or tree**	**- List**	**- List**	**- Indented list**
Enterprise Model (Owner)	Semantic Model	The Business Process Model	The Business Logistics System	Work Flow Model	Master Schedule	Business Plan
	- Entities Diagram **- Entities Dictionary**	**- Entities vs. Processes Matrix** **- Processes Dictionary** **- Activity Diagram**	**- Functional Decomposition**	**- Organization Chart** **- Processes vs. Organization Matrix**	**- Business Execution Plan**	**- Business Table**
System Model (Designer)	Logical Data Model	Application Architecture	The Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rules
	- Classes Diagram	**- Systems vs. Processes Matrix** **- Systems vs. Entities Matrix** **- Systems Dictionary**	**- Systems Diagram**	**- Systems vs. Roles Matrix**	**- State Diagram**	**- Systems vs. Business Rules Matrix**
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

4.2 Method

The proposal of a method associated to the Zachman Framework introduces a unique and exclusive ambition, the definition of a structured manner to use the framework in the development of an Enterprise Architecture.

Bearing this in mind, there is no best methodology, some methods and techniques may seem to work better than others, but such differences are most likely the result of the people involved and the organizational commitment [10]. The proposed method maps onto the Zachman Framework and fundamentally on the associated artefacts, defining the fulfilling order and framework cells' dependency in a top-down and incremental approach.

4.2.1 Rules of Fulfilling

Attending to Zachman [6], there is no column order, however, the lines must be fulfilled from top-to-bottom. Based on this, a framework's method of fulfilling is proposed, in which the order of fulfilling the cells and which cells are needed to fulfil the others is defined, showing the dependency among the proposed artifacts.

Table 2. Rules of Fulfilling

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

In the previous table (see Table 2), the content of each cell represents, on the first position, the cell's identification, on the second position, the order of fulfilling and, on the third position the dependency cells to each other.

4.2.2 The Method: Step by Step

Step 1. There is no dependency among cells' concepts. So, the order of fulfilling for this row is totally free. The cells can be executed in parallel (see Table 3).

Table 3. The Method: Step 1

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

Step 2. The Entity Diagram, artifact of the cell 'G', must be elaborated, taking into consideration, the "things" described on the cell in the row above (see Table 4).

Table 4. The Method: Step 2

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

Step 3. The Classes Diagram, artifact of the cell 'M', has the Entities Diagram as its base.

The Processes vs. Business Entities Matrix, artifact of the cell H, refers to the business processes of the row above and uses the business entities that are presented on the Entities Diagram. The execution's order is indifferent (see Table 5).

Table 5. The Method: Step 3

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

Step 4. The Functional Decomposition must be fulfilled based on the above row's artifact, indicating for each place the functional units and business processes. The artifact of the cell 'K', Business Execution Plan, uses the above rows listed events associating the business processes of the cell 'H' to these.

Table 6. The Method: Step 4

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

The Business Table, artifact of the cell 'L', uses the goals and strategies listed on the row above, relating these with business processes that exist on the cell H. The Systems vs. Processes Matrix, artifact of the cell 'N', uses the business processes of the cell 'H'. This matrix can be fulfilled based on the Processes vs. Business Entities Matrix (see Step 3). The order of fulfilling the artifacts in this step is free, being able to fulfill them in parallel (see Table 6).

Step 5. The Organization Chart, artifact of the cell 'J' is created by referring to the organization list defined on the row above and taking into concern the Functional Decomposition, cell 'I'. The Processes vs. Organization Matrix, artifact of the cell 'J', is elaborated based on the Organization Chart artifact and the Functional Decomposition. The Application System Diagram, artifact of the cell 'O' and the State Diagram, artifact of the cell 'Q', have the application systems that exist on the cell 'N' as their base. The Systems vs. Business Rules Matrix, artifact of the cell 'R', has the application systems defined on the cell 'N' and the goals and strategies that exists on the cell 'L' as its base. The order of fulfilling the artifacts in this step is free, being able to fulfill them in parallel (see Table 7).

Table 7. The Method: Step 5

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

Step 6. The Systems vs. Roles Matrix, artefact of the cell 'P', has the application systems defined on the cell 'N' and the people/functions that exist on the Organization Chart, cell 'J', as its base (see Table 8).

Table 8. The Method: Step 6

	What	How	Where	Who	When	Why
Scope (Planner)	A, 1	B, 1	C, 1	D, 1	E, 1	F, 1
Enterprise Model (Owner)	G, 2, A	H, 3, (B+G)	I, 4, (C+H)	J, 5, (D+I)	K, 4, (E+H)	L, 4, (F+H)
System Model (Designer)	M, 3, G	N, 4, H	O, 5, N	P, 6, (J+N)	Q, 5, N	R, 5, (L+N)
	Data	**Function**	**Network**	**People**	**Time**	**Motivation**

4.2.3 Anchor Cells

Analyzing the framework's perspectives we verify the existence of a concept related to the Zachman Framework, that we designate as an "anchor cell". In row 2 and 3, on the perspectives, Business Model and System Model, the anchor cell is the cell correspondent to the processes column. On the Business Model's perspective the relationships between each framework dimension are defined, having as their base, the elements presented on the How/Process column. The Business Processes, column 2,

- create/use the entities of column 1
- are associated to one or more functional units defined in column 3
- are associated to functions and people of column 4
- take place on events defined in column 5

- support one or more strategies defined in column 6.

The same happens to the Systems Model perspective, where the relationships among each framework's dimension are defined having as their base the elements present on the How/Process column. The Systems, column 2,

- managed the data of column 1
- are divided into one or more logical parts, column 3
- are used by people, column 4
- have one or more processing cycles, column 5

support one or more business rules defined, column 6.

For us an anchor cell is a cell that on any framework's perspective has an aggregate function relatively to the other cells.

4.3 Tool

With the purpose of supporting the Zachman Framework's concepts, as well as the artifacts and method proposed, a tool was developed whose main functionalities are:

- it behaves as an information repository for the concepts in the Zachman Framework;
- it allows us to produce several artifacts related to each framework cell.

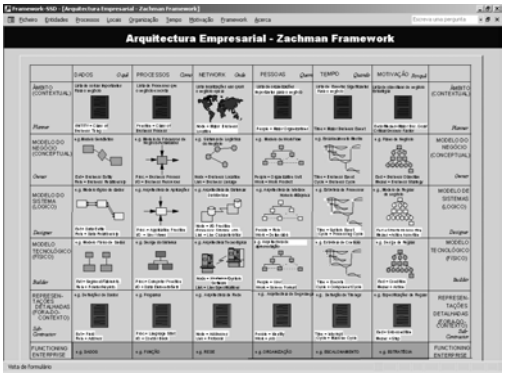

Figure 2. Tool's Main Form

This tool can also be an information system decision support tool, particularly in the issues relating to the Enterprise Architecture because,

- it allows a multi-dimensional analysis of the concepts' interconnection that exist in each cell, namely in the dependency between perspectives (rows) and/or dimensions (columns);
- it supports an analysis of the alignment level between Enterprise Architecture components [9].

4.3.1 Information Repository

For each one of the Zachman Framework's cells specific forms were developed that enable data entry of the cell's concepts. Using this data, it is possible to perform common operations such as create, edit, remove, search and print, as well as, filter the records according to the criteria defined for each cell.

4.3.2 Proposed Artifacts Support

For the proposed artifacts, with exception of those which have graphical representation, such as the Entities Diagram or Activity Diagram, all the others are supported by the tool, being created from the introduced elements of each cell.

4.3.3 Multi-Dimensional Analysis

As a utensil for information systems management, the tool enables a multi-dimensional analysis of the elements of each cell, making it possible to define a set of conditions, as well as the row and/or column dependencies. This results in a visualization of the elements that satisfy the true condition of intersection about the defined criteria through the framework's perspectives and dimensions.

This functionality also makes it possible to analyze the traceability among concepts of each cell, either at row or column level.

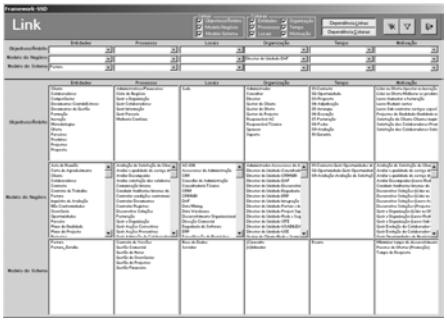

Figure 3. Multi-dimensional Analysis Form

4.3.4 Alignment

In the alignment form's functionalities (see Figure 4) it is possible to visualize all the rules defined for each alignment dimension. This area corresponds to the upper part and is represented in a tree view. The bottom-left part of the form, the list box, is composed of all the cases that fail the rule selected on the tree. The list box can be populated with informational entities, business processes or applications systems, depending which rule is selected. In the bottom-right part is the alignment levels for each one of the alignment dimensions.

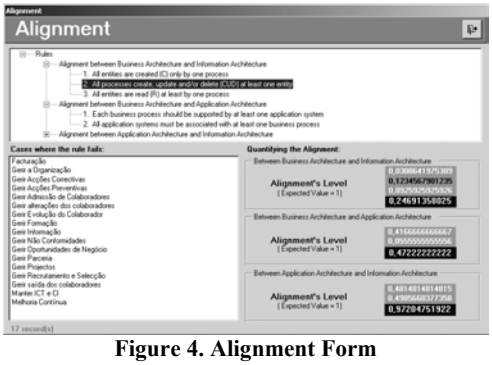

Figure 4. Alignment Form

5. CONCLUSIONS

The development and effective implementation of an Enterprise Architecture is a major challenge for organizations. In this paper

we presented a method that provides guidance in the development of an organization's Enterprise Architecture, contributing significantly to information system management and above all to the understanding of the architectural components.

Almost everyone knows the Zachman Framework, but there are some difficulties to instantiate the cells. With the proposed method it is possible to conduct the Enterprise Architecture's development in an easy, perceptive and effective way, applying the artifacts of each cell in a proper manner and having as a final result, all the cells fulfilled.

However, throughout the duration of this work, the utilization of the method confirmed the existence of a concept, a new concept related to the Zachman Framework, that we designate as an "anchor cell", and this concept enables us to understand which semantic relationship exists between cells on any of the framework's perspectives.

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