AthensMBA

ENTERPRISE ARCHITECTURE MODELING OF THE NATURAL GAS PROVIDING COMPANY OF GREECE (DEPA) WITH CASEWISE CORPORATE MODELER SUITE

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ΔΗΛΩΣΗ ΕΚΠΟΝΗΣΗΣ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΕΡΓΑΣΙΑΣ

«Δηλώνω υπεύθυνα ότι η συγκεκριμένη μεταπτυχιακή εργασία για τη λήψη του Μεταπτυχιακού Διπλώματος Ειδίκευσης στη Διοίκηση Επιχειρήσεων, έχει συγγραφεί από εμένα προσωπικά και δεν έχει υποβληθεί ούτε έχει εγκριθεί στο πλαίσιο κάποιου άλλου μεταπτυχιακού ή προπτυχιακού τίτλου σπουδών, στην Ελλάδα ή στο εξωτερικό.

Η εργασία αυτή έχοντας εκπονηθεί από εμένα, αντιπροσωπεύει τις προσωπικές μου απόψεις επί του θέματος. Οι πηγές στις οποίες ανέτρεξα για την εκπόνηση της συγκεκριμένης μεταπτυχιακής αναφέρονται στο σύνολό τους, δίνοντας πλήρεις αναφορές στους συγγραφείς, συμπεριλαμβανομένων και των πηγών που ενδεχομένως χρησιμοποιήθηκαν από το διαδίκτυο».

Ονοματεπώνυμο **Υπογραφή**

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Summary

The need for a fully developed and modernized enterprise has led in the past years to the development of Enterprise Architecture, a mean which helps companies create new, more profitable circumstances under which they are now asked to operate and be lucrative, innovative and competitive. Enterprise Architecture has given many large companies the opportunity to gather all their information and knowledge, process it, and thus move one step further by making all the necessary alterations and progress.

One of the tools used in Enterprise Architecture is the Zachman Framework. It is an actual framework, in which all of the enterprise's data is recorded and processed in many different ways. The main advantage of the Zachman Framework is its holistic view of the enterprise· it can help people describe their company from any possible perspective (the owner's, the planner's, the employee's, the stakeholders' etc.) and regarding any possible information type (data, people, time, place etc.).

One of the software programs used for the modeling of an enterprise is the Casewise Corporate Modeler Suite. It is based on the concept of the Zachman Framework. Simply put, it actually consists of a matrix in the cells of which the user can create diagrams, models, matrices, relationships and many more, representing the company's elements and their associations. It offers the architect many useful applications, such as the 'Simulator', the 'Object Explorer' and the 'Corporate Publisher', all of which act towards the same direction: the integrated development of the company. Using the Corporate Modeler Suite, a company can imprint its 'As – Is' situation, try out some possible 'What – If' scenarios to examine potential alternatives (like cost reduction or resources' reallocation etc.) and finally build a new 'To – Be' situation which may help transform it into a more powerful and advanced company. A strong advantage of the Corporate Modeler is the flexibility it grants the user· one can just use the models already existing in the program, but also develop new ones, according to the needs of each company, thus expanding the program's repository. Also, an important asset of the program is the fact that it can collect all of the information and knowledge that is important to the company in a single database, which is available and can easily be manageable by anyone interested.

The company examined in this paper is Greece's public natural gas providing company, DEPA, which is a large company, consisting of many departments and different operations areas. The Corporate Modeler is a suitable tool for the modeling of DEPA. With its help we

developed models including the company's elements and explored some of the program's aspects (we examined the 'People', the 'Motivation and the 'Function' abstractions). We showed how particular elements are connected and dependent on one another in diagrams, matrices and lists, and we depicted their relationships or associations. The important thing that was achieved is the fact that we combined elements from different aspects of the company and depicted their – sometimes not so obvious – associations. This is actually one of the main advantages of the Corporate Modeler (and of course of the Zachman Framework): the opportunity to combine and relate elements from different perspectives and abstractions and examine the relationships between them.

After having completed the research and the practical application on the program, we can say that the Corporate Modeler is a strong modeling tool, with great potential as far as the adaptability, parameterization and the ability to expand are concerned and that it is particularly suitable for companies who need a program which will adjust to their needs.

Σύνοψη

Η ανάγκη για πλήρως ανεπτυγμένες και μοντέρνες επιχειρήσεις έχει οδηγήσει τα τελευταία χρόνια στην ανάπτυξη της Επιχειρησιακής Αρχιτεκτονικής, ένα μέσο που βοηθά τις επιχειρήσεις να δημιουργήσουν νέες, περισσότερο κερδοφόρες συνθήκες, στις οποίες καλούνται να λειτουργήσουν και να είναι καινοτόμες, ανταγωνιστικές και αποδοτικές. Η Επιχειρησιακή Αρχιτεκτονική δίνει την ευκαιρεία σε μικρές και μεγάλες επιχειρήσεις να συλλέγουν όλες τις πληροφορίες και τη γνώση τους, να τις επεξεργάζονται και έτσι να προχωρούν ένα βήμα μπροστά κάνοντας όλες τις απαραίτητες βελτιώσεις.

Ένα από τα εργαλεία της Επιχειρησιακής Αρχιτεκτονικής είναι το πλαίσιο Zachman. Στην ουσία είναι ένα πλαίσιο, μέσα στο οποίο καταγράφονται όλα τα στοιχεία της εταιρείας και μπορούν να επεξεργαστούν με διάφορους τρόπους. Το κύριο πλεονέκτημα του πλαισίου Zachman είναι η ολιστική οπτική του· μπορεί να βοηθήσει στο να περιγράψει κάποιος μια εταιρεία από οποιαδήποτε οπτική γωνία (αυτή του ιδιοκτήτη, αυτή του εργαζομένου, αυτή του σχεδιαστή κλπ.) και αναφορικά με οποιοδήποτε τύπο στοιχείων (πληροφορίες, ανθρώπους, χρόνο, μέρος κλπ.)

Ένα από τα λογισμικά που χρησιμοποιούνται για τη μοντελοποίηση μιας επιχείρησης είναι το Casewise Corporate Modeler Suite. Είναι βασισμένο στη γενική ιδέα του πλαισίου Zachman. Με απλά λόγια, αποτελείται ουσιαστικά από έναν πίνακα, στα κελιά του οποίου ο χρήστης μπορεί να δημιουργήσει διαγράμματα, μοντέλα, πίνακες, σχέσεις και πολλά άλλα, παραθέτοντας έτσι τα στοιχεία της επιχείρησης και τις μεταξύ τους σχέσεις. Προσφέρει στο χρήστη πολλές χρήσιμες εφαρμογές, όπως το 'Simulator', το 'Object Explorer' και το 'Corporate Publisher', οι οποίες κινούνται όλες προς τον ίδιο στόχο: την ολοκληρωμένη ανάπτυξη της επιχείρησης. Χρησιμοποιώντας το Corporate Modeler Suite, μια επιχείρηση μπορεί να αποτυπώσει την 'As – Is' κατάσταση, να δοκιμάσει κάποια πιθανά 'What – If' σενάρια ώστε να εξετάσει πιθανές εναλλακτικές (όπως μείωση κόστους, ανακατανομή πόρων κλπ.) και τελικά να χτίσει μια νέα 'To – Be' κατάσταση, η οποία θα τη βοηθήσει να μετασχηματιστεί σε μια πιο ισχυρή και εξελιγμένη επιχείρηση. Ένα σημαντικό πλεονέκτημα του Corporate Modeler είναι η ευελιξία που χαρίζει στο χρήστη· κάποιος μπορεί να χρησιμοποιήσει τα μοντέλα που υπάρχουν ήδη έτοιμα μέσα στο λογισμικό, αλλά και να αναπτύξει νέα, ανάλογα με τις ανάγκες τις εκάστοτε επιχείρησης, κι έτσι να επεκτείνει την «αποθήκη» του προγράμματος. Επίσης, ένα δυνατό προσόν του προγράμματος είναι το γεγονός ότι μπορεί κάποιος να συγκεντρώσει σε αυτό όλη την πληροφορία και τη γνώση

που είναι σημαντική για την εταιρεία, αποτελώντας με αυτόν τον τρόπο μία κοινή βάση δεδομένων, διαθέσιμη και εύκολα διαχειρίσιμη από οποιονδήποτε ενδιαφερόμενο.

Η εταιρεία που εξετάστηκε στη συγκεκριμένη διπλωματική εργασία, η οποία εκπονήθηκε στα πλαίσια του μεταπτυχιακού προγράμματος 'Athens MBA', είναι η ελληνική δημόσια εταιρεία παροχής φυσικού αερίου, η ΔΕΠΑ. Η ΔΕΠΑ είναι μία μεγάλη επιχείρηση, με πολλά τμήματα και διαφορετικές λειτουργικές δραστηριότητες, συνεπώς η μελέτη της με το Corporate Modeler υπήρξε άκρως προκλητική.

Το Corporate Modeler είναι ένα κατάλληλο εργαλείο για τη μοντελοποίηση της ΔΕΠΑ. Με τη βοήθειά του αναπτύξαμε μοντέλα που περιλαμβάνουν τα στοιχεία της εταιρείας και διερευνήσαμε κάποιες από τις πτυχές του προγράμματος (πιο συγκεκριμένα εξετάσαμε 'Οργανωτικές Δομές', 'Κίνητρα' και 'Λειτουργίες'). Δείξαμε πώς κάποια συγκεκριμένα στοιχεία συνδέονται μεταξύ τους και εξαρτώνται το ένα από το άλλο, μέσα από διαγράμματα, λίστες και πίνακες, και απεικονίσαμε τις μεταξύ τους σχέσεις. Το σημαντικό που κατορθώσαμε είναι το γεγονός ότι συνδυάσαμε στοιχεία από διαφορετικές πτυχές της εταιρείας και εκφράσαμε τις – πολλές φορές όχι και τόσο εμφανείς – σχέσεις τους. Αυτό είναι στην ουσία και ένα από τα σπουδαιότερα προτερήματα του Corporate Modeler (και φυσικά του πλαισίου Zachman): η δυνατότητα να συνδυάσει κάποιος και να συσχετίσει στοιχεία από διαφορετικές οπτικές γωνίες και διαφορετικές κατηγορίες πληροφορίας και να εξετάσει τις μεταξύ τους συσχετίσεις.

Με την ολοκλήρωση της έρευνας και της πρακτικής εφαρμογής στο πρόγραμμα, καταλήξαμε στο συμπέρασμα ότι το Corporate Modeler είναι ένα δυνατό εργαλείο μοντελοποίησης, με μεγάλες δυνατότητες όσον αφορά στην παραμετροποίηση, την προσαρμοστικότητα και την επεκτασιμότητα και ότι είναι ιδιαιτέρως κατάλληλο για επιχειρήσεις που χρειάζονται ένα λογισμικό που να προσαρμόζεται στις ανάγκες τους.

Introduction

Many companies due to their complexity find it difficult to collect and record all their information in a single database and thus be able to examine, process and evaluate it. Enterprise Architecture helps companies develop a holistic view of their structure and operation· this is done by describing every single element of the business (every organization unit, data element, network location, IT or other type of system, operation etc.) in order to help it act towards the desired goals and mission. A brief reference on Enterprise Architecture (EA) will be made next as a theoretical introduction to the topic examined in this paper, so that the main issues around EA are mentioned and explained.

Enterprise Architecture uses many different concepts, one of which is the Zachman Framework. This helps architects 'build' their companies following a specific structure, which leads to a complete and integrated result. The Framework is analyzed thoroughly in the paper, since it constitutes the basis of the many EA tools and software. The software used in our case was the Casewise Corporate Modeler Suite, which is a modeling package for developing and displaying a company's profile. It is based on the concept of the Zachman Framework, offering the user support and guidance for structuring their business. In order for us to research and evaluate the program, we conducted a case study on the greek natural gas providing company, DEPA. We used the Corporate Modeler in order to model some of DEPA's elements and depict the associations between them. Finally we reached the conclusion that the Corporate Modeler is an appropriate tool for companies that want to model their structure and operation, but also need a program that can adjust to their needs.

1. Enterprise Architecture

As enterprises became bigger and more complex, and as the need for organizing data, processes, structure and people inside the company became more intense, enterprise architecture emerged in order to set a frame where all the above elements would be placed and thoroughly examined. J.A. Zachman was the pioneer of Enterprise Architecture (1984), laying out the foundation for further development and evolution. His aim was to manage the complexity of increasingly distributed systems, as well as create a holistic approach to systems architecture that examined every important element from every important perspective. In 1994 the 'Technical Architecture Framework for Information Management' (TAFIM) was introduced by the Department of Defense of the U.S. Government and four years later the 'Federal Enterprise Architecture Framework' (FEAF) helped in cases of segmented subsets of larger enterprises. In 2003 one of the most famous and widely used frameworks, 'The Open Group Architectural Framework' (TOGAF) entered the EA field, while two years later, in 2005, Gartner collaborated with Meta Group in order to combine architectural frameworks and processes. The history of EA is shown in the following figure.

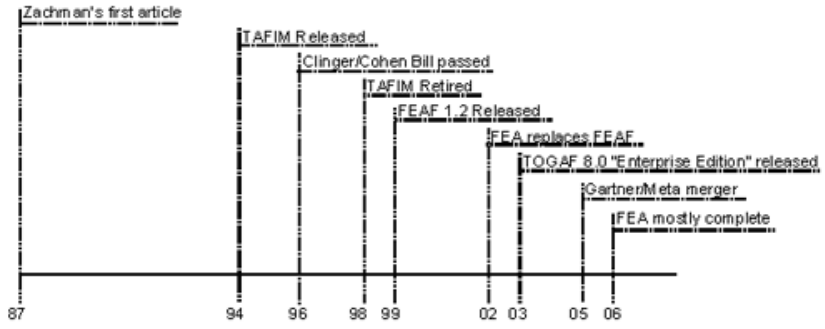


Figure 1.1: The history of Enterprise Architecture

Frameworks: An Enterprise Architecture Framework is actually a 'structure' which contains all the interactions and relationships between the enterprise's elements (people, processes, technology etc.). Using different models, it offers a representation of the multiple points of view of the company's stakeholders. Famous EA Frameworks are 'The Zachman Framework', 'TOGAF', 'DOFAF', 'MODAF', 'FEAF' and others. 'The Zachman Framework' will be mentioned in detail later on in the paper.

According to Roger Sessions (2007) 'The Open Group Architecture Framework' (TOGAF) considers the enterprise as the unity of the following four elements: Business Architecture, which includes the business processes, Application Architecture, which describes specific applications and the interactions between them, Data Architecture, which refers to the

business' datastores and their organization, and lastly Technical Architecture, which includes the business' hardware and software infrastructure. The main difference between TOGAF and 'The Zachman Framework' is that the second helps one categorize their artifacts, whereas the first gives you a process for creating them.

Another well-known framework is 'The Federal Enterprise Architecture' (FEA), which again according to Roger Sessions (2007) has both a comprehensive taxonomy, like Zachman, and an architectural process like TOGAF, thus being the most complete methodology of these three. FEA consists of five reference models: business, service, components, technical and data, and being built for one of the most complex organizations in the world (the U.S. Government) surely shows that it is more than a system of models; it combines everything necessary to unite hundreds of segments and functions under a single enterprise architecture.

Definition 1: Enterprise architecture (EA) is the process of translating business vision and strategy into effective enterprise change by creating, communicating and improving the key requirements, principles and models that describe the enterprise's future state and enable its evolution. The scope of the EA includes the people, processes, information and technology of the enterprise, and their relationships to one another and to the external environment. Enterprise architects compose holistic solutions that address the business challenges of the enterprise and support the governance needed to implement them. Enterprise architects use the EA process to discover the target state that the organization wishes to invest in and then helps the organization understand its progress toward the desired state [Gartner, 2012].

Definition 2: Enterprise architecture is the organizing logic for business processes and IT infrastructure reflecting the integration and standardization requirements of the company's operating model. The operating model is the desired state of business process integration and business process standardization for delivering goods and services to customers [MIT Center for Information Systems Research, MIT CISR].

Figure 1.2: Enterprise Architecture components

In other words, Enterprise Architecture (EA) is a set of tools used by companies for the analysis of their structure, guiding principles, processes, infrastructure and core capabilities in order for them to be able to respond to changes rapidly and with success. The process of a company's re-engineering is done much more easily and effectively when EA is part of its philosophy and principles. But EA is also very useful in the company's everyday operation and improvement of its performance, since it contributes in cost and time saving and other troubleshooting. It is very important that the enterprise architect understands the company's vision, mission and strategy in order to set up the company's EA model in the best possible way to meet its objectives. EA's basic goals are effectiveness, efficiency, agility and durability. EA is applicable to all kinds and types of enterprises, both public and private, single or joint ventures, entire businesses or corporations, local or international. Building the EA is a time and energy consuming process, which demands large quantities of both human and material resources and a lot of collaboration between everyone that might be affected by it (that means not only the owner of the company and the architect, but also the stakeholders, managers, even the workforce of the company). However continuous maintenance, update and development are essential in order for the EA to be successful and useful long term.

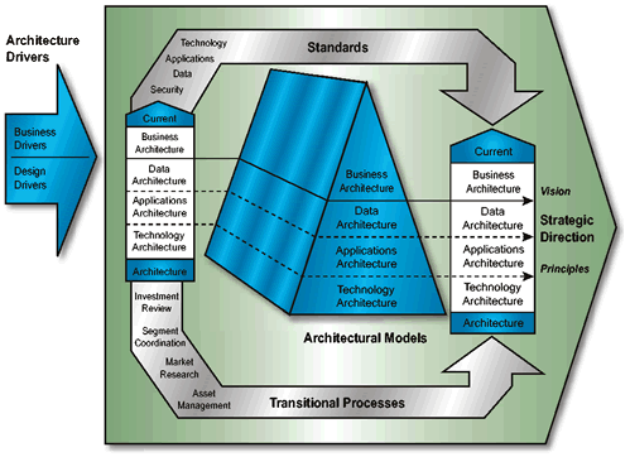


Figure 1.3: The FEAF structure as an example of EA planning

One of the most famous and widely used (due to its compatibility with SAP software) I/S Architectures is the 'Architecture of Integrated Information Systems' (ARIS). It is made up of 4 main views, which encloses all of the enterprise's elements. These are: the 'Data' view, the 'Function' view, the 'Process' or 'Control' view and the 'Organization' view. The 'Data' view includes the enterprise's information objects, their attributes and the relationships between them, the 'Function' view includes the process structure of the system, the 'Process' or 'Control' view describes the static connections between the objects of the data, function and organization views, and the dynamic, chronological process flows, and lastly, the 'Organization' view describes the organizational elements and their relationships (e.g. organization chart and roles in the performing of processes). Through this model, the complexity of an enterprise is gradually decomposed and the whole system is described completely.

Today there are a few EA tools in the market, which provide guidance and support to companies which want to analyze and optimize their portfolio of business processes, organizational structures, information flows, technology infrastructure etc. Along with the development of EA came also the development of EA designing tools, which now offer architects many possibilities regarding data processing, presentation and storage. Some of the companies that manufacture such tools are: 'alfabet', 'avolution', 'BiZZdesign', 'orbus software', 'sparx systems', 'casewise', 'IBM', 'troux', 'mega' and others.

As John A. Zachman (2001) said about the importance of EA:

"There are four reasons why you do Architecture: "Alignment," "Integration," "Change," and "Reduced Time-to-Market." Do you care that the systems I/S is producing actually are aligned with Management's requirements and warrant the expenditure of funds allocated to

I/S? Do you care whether the data in the Enterprise means the same thing to anyone who uses it, that messages can be cost-effectively transmitted and received whatever time of day or night or day of the year, and that business rules can be uniformly enforced throughout the Enterprise? Do you care whether changes to the Enterprise can be made with minimum time, disruption, and cost? Do you care whether I/S can produce "custom" implementations on demand, reducing their time-to-market to virtually zero? If you care about any or all of these things, you are going to do architecture, because without Architecture, you cannot do ANY of these things. You can't "cost – justify" Architecture. Architecture is not an expense. Architecture does not displace any other costs. Architecture is an asset. You can save orders of magnitude more money and time, but you have to invest in Architecture to enable you to do something you otherwise are unable to do, namely: "Alignment," "Integration," "Change," and "Mass Customization."
Architecture is an Information Age idea. "Cost – justification" is an Industrial Age idea."

Modeling techniques are the best way to efficiently manage business assets. Even when it is difficult to start the whole process of the business analysis, EA still provides a context, a navigation tool for defining project scope and checking project completion.

Some more definitions of terms that will be used in the paper, but are also really useful for understanding the whole concept of architecture are the following:

- Architect: One whose responsibility is the design of an architecture and the creation of an architectural description.
- Architectural artifact: A specific document, report, analysis, model, or other tangible that contributes to an architectural description.
- Architectural description*: A collection of products (artifacts) to document an architecture.
- Architectural framework: A skeletal structure that defines suggested architectural artifacts, describes how those artifacts are related to each other, and provides generic definitions for what those artifacts might look like.
- Architectural methodology: A generic term that can describe any structured approach to solving some or all of the problems related to architecture.
- Architectural process: A defined series of actions directed to the goal of producing either an architecture or an architectural description.
- Architectural taxonomy: A methodology for organizing and categorizing architectural artifacts.
- Architecture*: The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution.

- Enterprise Architecture: An architecture in which the system in question is the whole enterprise, especially the business processes, technologies, and information systems of the enterprise.

The above definitions are given by Roger Sessions (2007) except for the ones marked with an asterisk (*), which are taken mostly from IEEE-1471-2000 [01].

2. The Zachman Framework

2.1. The evolution of the Framework

John A. Zachman (born December 16, 1934), a business and IT consultant and pioneer of Enterprise Architecture, is the father of the famous and widely used 'Zachman Framework'. In 1984 John A. Zachman created the first representation of 'The Zachman Framework', which was a bit different from what we know as Zachman Framework today. It consisted of only 3 columns (the structure of the current framework will be analyzed later on), and was a framework for Information Systems Architecture, since Enterprise Architecture did not yet exist. Later on, using IBM graphics support, the appearance of the framework started changing, with new models being added in the matrix cells, until 1993, when John A. Zachman decided to officially call his framework 'Enterprise Architecture – A Framework', slowly replacing 'Information Systems' with 'Enterprise' Architecture and trying to familiarize I/S people with it. That was the first time the rows were defined as "Contextual", "Conceptual", "Logical", "Physical" and "Out–of–Context", showing that each row was a representation of a transformation of the row above and not a more detailed layer of it.
By 2001 the other 3 columns were presented, colors had been added, models contained different diagrams, the graphic design was superior but the framework still bore some problems (e.g. it still used I/S terminology, lots of adjectives, a deemphasized row 6 etc.).

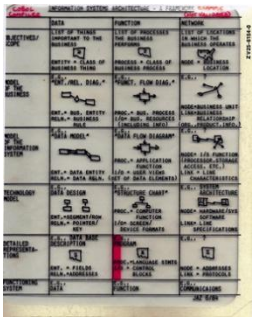


Figure 2.1: The first form of the Framework

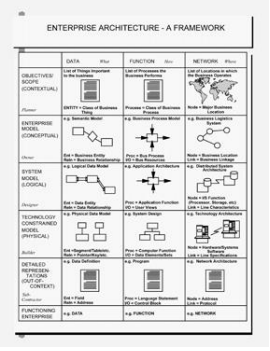


Figure 2.2: A following form of the Framework

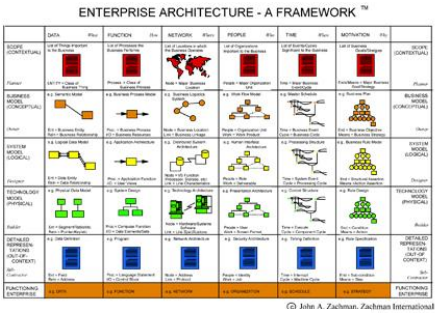


Figure 2.3: The form of the Framework in 2001

Figure 2.4: The form of the Framework in 2004

Figure 2.5: The most recent form of the Framework

These problems disappeared in the 2004 version, the 'The Zachman Framework^{2TM}', which used more generic business terminology and non-modified nouns, making the framework more precise and more attractive to managers and businessmen. Finally, in 2011 'The Zachman Framework for Enterprise Architecture: The enterprise Ontology' was presented, the final version, over which John Zachman had total control and which was graphically designed totally in-house. This version 3.0 fully supported the concept of transformation between rows (vertically) and of the integration between the columns (horizontally). Additional meta-model changes occurred as well in order to clear all misunderstandings and confusions. Although the changes that were imposed on the initial framework overall were many (e.g. Column and Row names, Roles, Cell names, Entity names, Icons, modeling objectives, use of lines to indicate horizontal integrations, use of crooked arrows to indicate vertical transformations, refined definitions and names, no use of adjectives in the graphic, primitive models etc.), some core principles remained the same. Such examples are the theory and logic of the framework, the use of Things and Relationships, the communication interrogatives of the columns, the uniqueness of each cell, the two-dimensional matrix form and the completeness of the framework.

2.2. The Framework

The Zachman Framework is probably the most famous EA Framework today, one that is being used by many EA building companies and in many EA tools. It is based on the idea of managing the size and complexity of information systems and how these systems should support the business objectives of the enterprise. John A. Zachman found it 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 [John A. Zachman, 1987]. He based his concept on classical architecture and related a company's structure and operation to the construction of a building. For example if someone wanted to build a house (the objective)

they would have a concept in mind of how they wanted the final structure to look like. This would include e.g. the size, shape, intent etc. given of course some constraints. Then they would hire an architect for the implementation. The architect would then try to fit all the owner's perceptual requirements into his drawings, which would depict the final product from the owner's perspective. These drawings are normally developed to the level of detail required for the owner to understand and accept the design. Afterwards the architect produces the house's plans, which are a designer's representation of the final product and include drawings of the wood or metallic structure, of electromechanical systems, of material relationships etc. These are the plans that the owner will give the contractor who will build the house, in order to show him exactly what he wants the house to look like. The contractor will produce his plans (based on the architect's plans), which will represent the builder's perspective, and will include all sorts of engineering details necessary for the construction itself. Each section of the house will be constructed by a different sub-contractor (e.g. electrical, ventilation, floors, paintings etc.), who will prepare his shop plans, which are an out-of-context specification of what actually will be constructed or assembled. The last phase is the actual building of the house. In conclusion a number of 'architectures' were used during the construction of the building.

The concept that was just analyzed can easily be applied to the information systems area, since there are also many different people, perspectives and objectives included there. In the following table Zachman points out the analogies that exist between the two areas.

Generic	Buildings	Information Systems
Ballpark	Bubble charts	Scope/Objectives
Owner's representation	Architect's drawings	Model of the business (or business description)
Designer's representation	Architect's plans	Model of the information system (or information system description)
Builder's representation	Contractor's plans	Technology model (or technology-constrained description)
Out-of-context representation	Shop plans	Detailed description
Machine language representation	-	Machine language description (or object code)
Product	Building	Information System

Table 2.1: Architectural representations and analogs in the building and I/S sectors

It is very important to point out that the difference between the representations is in the essence and not so much in the level of detail. This is something that Zachman himself insisted on communicating to the Information Systems people· the fact that it is not about breaking down the company's structure or processes into simpler and more detailed ones, it

is about describing the company, its processes, structure, objectives from different points of view, different perspectives of the various players. These players include: the owner of the business, the people who run the organization, the systems analyst who has to represent the business in a disciplined form, the designer who applies specific technologies and applications in order to drive the business towards its deliverables, the builder of the system and of course the system itself.

According to Zachman (2008), The Zachman Framework™ is a *schema* - the intersection between two historical classifications that have been in use for literally thousands of years. The first is the fundamentals of communication found in the primitive interrogatives: What, How, When, Who, Where, and Why. It is the integration of answers to these questions that enables the comprehensive, composite description of complex ideas. The second is derived from reification, the transformation of an abstract idea into an instantiation that was initially postulated by ancient Greek philosophers and is labeled in the Zachman Framework™: Identification, Definition, Representation, Specification, Configuration and Instantiation.

Since the Zachman Framework™ classification was observed empirically in the structure of the descriptive representations (the architecture) of buildings, airplanes and other complex industrial products, there is substantial evidence to establish that the Zachman Framework™ is the fundamental structure for Enterprise Architecture and thereby yields the total set of descriptive representations relevant for describing an Enterprise.

More specifically, the Zachman Framework™ is an ontology - a theory of the existence of a structured set of essential components of an object for which explicit expressions is necessary and perhaps even mandatory for creating, operating, and changing the object (the object being an Enterprise, a department, a value chain, a “sliver,” a solution, a project, an airplane, a building, a product, a profession or whatever or whatever).

The Zachman Framework™ is not a methodology for creating the implementation (an instantiation) of the object. The Framework is the ontology for describing the Enterprise. The Framework (ontology) is a structure whereas a methodology is a process [John A. Zachman, 2008].

Figure 2.6: The Zachman Framework

The Zachman Framework a two-dimensional 6x6 matrix, where the rows correspond to the Reification Transformations (the different perspectives of the players) and the columns to the Communication Interrogatives (What, How, Where, Who, When, Why). The top row represents the most generic perspective of the company, while the lower rows are more concrete. The last row represents the real elements of the company (data, people, systems etc.). An upper row does not necessarily have a more comprehensive understanding of the whole organization than a lower row. The columns describe the types of abstractions that define all the perspectives, which are based on the six questions mentioned earlier. Each cell in the matrix describes a model that the company might document. All cells are unique, distinguishable from one another and primitive, which means that each one can be modeled independently. All cells are necessary in order for the Framework to be complete and for the company to be completely described. However some companies might not fully define all cells (some may be of greater interest and use to the company than others) · still the definition of all cells is obligatory for a holistic description of the company.

Analyzing each row (perspective) we have:

1st row: Scope (Contextual) Planner's View: Here a general picture of the enterprise is drawn, regarding the business' nature, direction and purpose, the scope of the system and

some boundaries that are imposed. The relation and the interaction to the environment in which the enterprise is operating in, are also mentioned here. It depicts in gross terms the important things to the business, its size, shape, partial relationships, external requirements and drivers, cost and the basic necessary things to establish the context for any system development effort. This row's models are business function models.

2nd row: Business Model (Conceptual) Owner's View: In analogy to the construction of a house (the concept mentioned earlier) these are the architect's drawings. They depict the final product from the perspective of the owner. Regarding an enterprise, this row consists of models that constitute the designs of the business and show business entities and how they relate. It actually defines in business terms the business nature, including its structure, functions, organization etc. For that to happen, models, architectures and descriptions are used, that focus on the usage characteristics of the business' products. This row's models are business process models.

3rd row: System Model (Logical) Designer's View: The business here is defined in more strict information terms. Again according to the analogy, these are the architect's plans, the translation of the drawings into detailed requirements representations from the designer's perspective. This row describes models, architectures and descriptions used by the engineers and those who mediate between the desirable and the technically possible outcome. More specific the models in this row correspond to the system model designed by a system analyst who must determine the data elements, logical process flows and functions that represent business entities and processes. In comparison to the 2nd row, we could point out that the 2nd row describes e.g. business functions as perceived by the people performing them, whereas the 3rd row describes the same functions as transformations of data. Furthermore, the 2nd row describes the things that are important to the company (in business terms), whereas the 3rd row describes the things about which the company must collect and maintain information and describes that information. This row's models are logical models.

4th row: Technology Model (Physical) Builder's View: This row describes the way technology will be used to address the information processing needs of the business that were mentioned in the previous rows. This 'step' includes the contractor's plans which represent the builder's perspective and contains the constraints of tools, technology and materials. In this row the models, architectures and descriptions reflect the view of the technicians, engineers and contractors, who will actually build the final product. The focus here is on the

final result and the possible constraints. The technology models of this row adapt the information systems models to the details of programming languages, input / output devices, required supporting technology, relational databases, user interfaces etc. This row's models are physical models.

5th row: Detailed Representations (Out-of-Context) Sub-contractor's View: This row represents the sub-contractor's view via the shop plans, which specify details of parts or subsections of the final product. The models of this row concern software developers when the design is implemented with modules and components acquired from others. In other words, they are addressed to the programmers who code individual modules without actually caring about the overall context of the system. Models of this row regard software components, program listings, database specifications, networks etc. that constitute a system, all of which are expressed in terms of particular languages. This row's models are 'as – built'.

6th row: Functioning Enterprise: The real, implemented system is described here. This row is an actual representation of the running business, its elements, data, people etc. It is not so much a perspective, as it is the depiction of the real business, which underlies all the perspectives mentioned above.

Abstractions (Columns) →

Perspectives (Rows) ↓

The Zachman Framework	DATA *What (Things)*	FUNCTION *How (Process)*	NETWORK *Where (Location)*	PEOPLE *Who (People)*	TIME *When (Time)*	MOTIVATION *Why (Motivation)*
SCOPE (Contextual) *Planner*	List of things important to the business *Entity = Class of business thing*	List of processes the business performs *Function = Class of business process*	List of Locations in which the business operates *Node = Major business location*	List of Organizations important to the Business *People = Major organizations*	List of Events Significant to the Business *Time = Major business event*	List of Business Goals/Strategies *Ends/Means = Major bus. goal/Critical success factor*
BUSINESS MODEL (Conceptual) Owner	Semantic Model *Ent = Business entity* *Rein = Business relationship*	Business Process Model *Proc = Business process* *I/O = Business resources*	Business Logistics System *Node = Business location* *Link = Business linkage*	Work Flow Model *People = Organization unit* *Work = Work product*	Master Schedule *Time = Business event* *Cycle = Business cycle*	Business Plan *End = Business objective* *Means = Business strategy*
SYSTEM MODEL (Logical) *Designer*	Logical Data Model *Ent = Data entity* *Rein = Data relationship*	Application Architecture *Proc = Application function* *I/O = User views*	Distributed System Architecture *Node = I/S function (Processor, Storage, etc.)* *Link = Line characteristics*	Human Interface Architecture *People = Role* *Work = Deliverable*	Processing Structure *Time = System event* *Cycle = Processing cycle*	Business Rule Model *End = Structural assertion* *Means = Action assertion*
TECHNOLOGY MODEL (Physical) *Builder*	Physical Data Model *Ent = Segment/Table, etc.* *Rein = Pointer/Key*	System Design *Proc = Computer function* *I/O = Data elements/ sets*	Technology Architecture *Node = Hardware/ System software* *Link = Line specifications*	Presentation Architecture *People = User* *Work = Screen format*	Control Structure *Time = Execute* *Cycle = Component cycle*	Rule Design *End = Condition* *Means = Action*
DETAILED REPRESENTATIONS (Out-of-Context) *Sub-Contractor*	Data Definition *Ent = Field* *Rein = Address*	Program *Proc = Language statement* *I/O = Control block*	Network Architecture *Node = Addresses* *Link = Protocols*	Security Architecture *People = Identity* *Work = Job*	Timing Definition *Time = Interrupt* *Cycle = Machine cycle*	Rule Specification *End = Sub-condition* *Means = Step*
FUNCTIONING ENTERPRISE	Actual Business Data	Actual Application Code	Actual Physical Networks	Actual Business Organization	Actual Business Schedule	Actual Business Strategy

Figure 2.7: The Framework's structure in terms of models

Analyzing each column (interrogatives) we have:

What? (The **Data** description): This column answers the question 'What is it made of?'. It actually refers to the material composition of the product and in the case of software systems the data. A simple and illustrative model is used here, the 'Entity - Relationship - Entity' model. Each row deals with the enterprise's data in a different way.

How? (The **Function** description): This column answers the question 'How does it work?'. All the functions and transformations of the product are described here. The goal is to translate the mission of the enterprise specific operations. The model used here is the 'Process – Input / Output – Process' model.

Where? (The **Network** description): This column answers the question 'Where are the business elements located?'. The focus here is on the geometry or connectivity of the product and in the case of the enterprise on its logistics network and the geographical distribution of its activities. The model used here is the 'Node – Line – Node' model.

Who? (The **People** description): This column answers the question 'Who does what work?'. It describes who is involved in the business and in the introduction of new technology. It is about the people and the manuals and the operating instructions or models they use to perform their tasks. The model used here is the 'People – Work – People' model.

When? (The **Time** description): This column answers the question 'When do things happen?'. It focuses on the timing, life cycles and schedules of business activities and the effect of time on the business. The model used here is the 'Event – Cycle - Event' model.

Why? (The **Motivation** description): This column answers the question 'Why do things happen?'. It includes the way the business' goals, plans and strategies are translated into specific ends and means and the constraints, rules and policies that apply to an enterprise's efforts. The model used here is the 'End – Means - End' model.

2.3. The Framework cells

More specifically the content of each cell of the Framework is described here.

1st row – Data: This cell describes the things that are important to the business, the high – level data classes that are related to the business' functions. It is a list of things that concern any company in this industry, affecting its direction and purpose. The aim is to capture the enterprise's main deliverables and their associated business objects.

1st row – Function: This cell includes a list of activities, processes, high – level functions the business performs. The aim here is to identify the enterprise's main value chains. Statistically there are usually at most 3 or 5 core business processes in an enterprise.

1st row – Network: This cell includes a list of locations where the business operates, the business' sites. The aim here is to identify the impact of the geographical distribution in process analysis.

1st row – People: This cell includes a list of organizational units and each unit's mission. In other words it describes the stakeholders related to each business function. The aim here is to identify the business' organizational units and furthermore analyze customer segmentation according to product delivery.

1st row – Time: This cell describes the business cycle and the overall business events that are related to each function. It is actually a list of events significant to the enterprise. Here the aim is to understand how and when the environment interacts with the enterprise.

1st row – Motivation: This cell describes the business goals, strategies, objectives and performance measures related to each function. Here the aim is to identify which corporate objectives are drivers for both Business and IT projects.

2nd row – Data: This cell describes business data· it is actually the business person's view. It tries to define the data scope required in the context of a business process or function and make clear that business data models enable data responsibility management.

2nd row – Function: This cell describes the business processes and their definitions and the business process value chains in terms of activities and sequencing. These activities are the steps in a business process and define what is to be done in the process independently of any organizational concern.

2nd row – Network: This cell describes the locations related to each business process. It is a more detailed communication chart, which describes how the various locations interact with each other· a map of geographical sites which describes geographical deployment for business processes.

2nd row – People: This cell describes roles and responsibilities in each business process. It includes a full organizational chart, linked to the function column, with skill sets and requirements in security apart from roles. It provides an overview of the enterprise

structure, the hierarchy of the business' organizational units, specifies the persons that play the roles in each unit and shows at which site the units are located. The aim here is to describe the implementation of a business process from an organizational point of view.

2nd row – Time: This cell includes the master schedule· when functions are to happen and under what circumstances. In other words it describes the events for each business process and the sequencing of integration and process improvements. The aim is to relate business events to their business results including timing and sequencing rules.

2nd row – Motivation: This cell describes the business plan· the policies, procedures, standards, rules and constraints into which the strategies and goals of the enterprise are translated and that apply to business processes. The aim is to define the plan in terms of project, in order for the corporate objectives to be realized.

3rd row – Data: This cell describes logical data models and data relationships underlying enterprise information. It is a disciplined translation of the business person's view (described in the data cell of the 2nd row). The aim is to define the rules for data management and data storage.

3rd row – Function: This cell describes the logical representation of information systems and their relationships. It portrays the business activities in terms of data transforming processes, described exclusively in terms of the conversion of input data into output data. The aim here is to describe the software environment for an application, a site, an organizational unit or the entire enterprise.

3rd row – Network: This cell describes the logical representation of the distributed system architecture for all business locations. It produces the architecture for data distribution, itemizing what information is created where, and where it is to be used. The aim here is to describe the enterprise architecture deployment expressed in terms of sites, servers, networks, nodes etc.

3rd row – People: This cell describes the logical representation of access privileges constrained by roles and responsibilities. In this cell, the potential interaction between people and technology starts to be specified, specifically in terms of who needs what information to do their job. In other words, the aim of this cell is to identify the interaction points between organizational units and system resources.

3rd row – Time: This cell describes logical events and their triggered responses constrained by business events and their responses. It defines the business events which cause specific data transformations and entity state changes to occur. Here the aim is to define the transition cycle for business objects in relationship with business events.

3rd row – Motivation: This cell describes policies, standards and procedures associated with a business rule model. Here, business rules may be expressed in terms of information that is or is not permitted to exist. This includes constraints on the creation of rows in a database as well as on the updating of specific values. It includes model enterprise business rules in terms of their intents (objectives / requirements) and the means of having the resulting constraints (constrained business process / real procedure).

4th row – Data: This cell describes database management system type requirements constrained by logical data models. A specific design approach (and a specific database management system) is defined here. The aim is to model the physical representation of the enterprise business data.

4th row – Function: This cell describes specifications of applications that operate on particular technology platforms. All data conversion processes are converted here into the definition of program modules and how they interact with each other. Pseudo – code is produced at this stage.

4th row – Network: This cell describes specification of network devices and their relationships within physical boundaries. In other words the data distribution is translated into the kinds of computer facilities that are required in each location. The aim of this cell is to describe the enterprise physical technology environment showing the actual hardware and system software at the nodes and lines of their systems.

4th row – People: This cell describes the specification of access privileges to specific platforms and technologies. The actual interface between each person and the technology is designed here, including issues of interface graphics, navigation paths, security rules, ergonomic requirements and presentation style (format).

4th row – Time: This cell describes the specification of triggers to respond to system events on specific platforms and technologies. The events become program triggers and messages, and the information processing responses are designed in detail.

4th row – Motivation: This cell describes the business rules constrained by information system standards. Here the business rules are converted to program design elements.

5th row – Data: This cell describes data definitions constrained by physical data models. It is a detailed representation of the data on the computer (tablespaces etc.). The aim here is to provide automatically data definition immediately available for database managers and developers.

5th row – Function: This cell describes programs coded to operate on specific technology platforms. It is the conversion of pseudo – code into source and object code. The aim of this cell is to provide automatically source code and workflow executable scripts to development teams.

5th row – Network: This cell describes network devices configured to conform to node specifications. Here, the facilities requirements are translated into specifications of particular computers, protocols, communication facilities etc.

5th row – People: This cell describes access privileges coded to control access to specific platforms and technologies. The design is converted into the outward appearance of each program, as well as the definitions of access permissions in terms of specific tables and / or columns each user can have access to.

5th row – Time: This cell describes timing definitions coded to sequence activities on specific platforms and technologies. It actually includes specific programs of the designs produced in the 4th row.

5th row – Motivation: This cell describes business rules constrained by specific technology standards. It actually includes specific programs of the designs produced in the 4th row.

6th row – Data: This cell describes data values stored in actual databases· it constitutes the working database.

6th row – Function: This cell describes functioning computer instructions. This is where the code is linked and converted to executable programs.

6th row – Network: This cell describes the implemented communications facilities. It includes sending and receiving messages between locations.

6th row – People: This cell describes the enterprise's personnel and stakeholders working within their roles and responsibilities. Here we actually have trained people using the new system.

6th row – Time: This cell describes timing definitions operating to sequence activities. Here business events are correctly responded to by the system.

6th row – Motivation: This cell describes operating characteristics of specific technologies constrained by standards. Here is the point where the business rules are enforced.

	Data (What)	Function (How)	Network (Where)	People (Who)	Time (When)	Motivation (Why)
Objectives / Scope	List of things important to the enterprise	List of processes the enterprise performs	List of locations where the enterprise operates	List of organiza-tional units	List of business events / cycles	List of business goals / strategies
Model of the business	Entity relationship diagram (including m:m, n-ary, attributed relationships)	Business process model (physical data flow diagram)	Logistics network (nodes and links)	Organization chart, with roles; skill sets; security issues	Business master schedule	Business plan
Model of the information system	Data model (converged entities, fully normalized)	Essential Data flow diagram; application architecture	Distributed system architecture	Human interface architecture (roles, data, access)	Dependency diagram, entity life history (process structure)	Business rule model
Technology model	Data architecture (tables and columns); map to legacy data	System design: structure chart, pseudo-code	System architecture (hardware, software types)	User interface (how the system will behave); security design	"Control flow" diagram (control structure)	Business rule design
Detailed represe-ntation	Data design (denormalized), physical storage design	Detailed Program Design	Network architecture	Screens, security architecture (who can see what?)	Timing definitions	Rule specification in program logic
Function system	Converted data	Executable programs	Communi-cations facilities	Trained people	Business events	Enforced rules

Table 2.2: The Framework's cells

2.4. The Framework rules

There are some rules that apply to the Zachman Framework in order for it to be complete and correctly defined. These rules are:

1st rule: 'The Framework's columns don't have to be in a specific order'.

Since each column represents a different question regarding the enterprise, and no column is more important than another, they don't have to be in a particular order in the matrix. Besides, this is why the columns do not appear in the same order in every figure of the Framework, in contrast to the order of the rows, which is always the same.

2nd rule: 'Each column represents a simple, generic model'.

As already mentioned before, each column is descriptive of a single independent variable within the analytical target, the enterprise. Therefore, the basic generic model of each column is very simple· it represents the variable to which it refers (Data, Time, People etc.) as related to itself. The following figure shows the generic descriptions of the Framework and the models that correspond to each one of them.

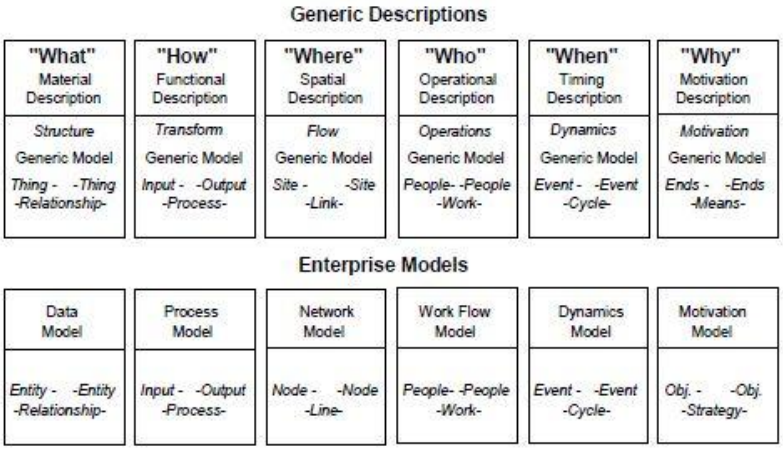


Figure 2.8: The columns of the Framework and their models

3rd rule: 'The basic model of each column is unique although they are interconnected'.

Rule 2 mentions how each column is described by one simple model, which depicts the relationship between elements of the enterprise. During the analysis, each one of these models has to be customized according to the constraints, terminology and requests of the row's perspective. In other words, starting from generic, the models of the cells have to be adjusted and extended, in order to embody possible constraints and manage probable change. However, no matter how much the model might be adjusted, it must not be altered or lose its original structure and cause.

A very important issue here and a matter that often causes confusion, is the fact that moving down rows while examining a particular column, does not mean increasing the level of detail in the cells, but recording the transformation that is taking place from row to row. Cells of different rows contain different information, different models, different views. The level of detail might increase within the cell. Of course some models might allow or need more detail than others, but that doesn't have to do with the level of detail between rows.

4th rule: 'Each cell is unique and doesn't contain items from other cells'.

The Zachman Framework is a very useful analytical tool, because it is normalized, complete and has been the same for many decades. Each one of its rows and columns is unique; therefore each cell of the Framework is unique. There is no redundancy or deficiency. As a result no meta-concept can be classified in more than one cell.

5th rule: 'Combining the cells in a row forms a complete description of that row'.

As already mentioned, each row of the Framework represents a distinct view (the owner's view, the designer's view etc.) of the people involved in the enterprise. The cells that belong to each row, each answer a specific question (What, Who, Where etc.) which correspond to the Framework's columns. As a result, the combination of the cells along a row fully describes this row's perspective, where all the business elements are examined by multiple aspects.

6th rule: 'The logic is generic and recursive'.

The classification scheme of the Framework was established quite independently of their application in the Framework. John A. Zachman learned about the Framework classification logic by empirically observing physical objects like airplanes, buildings, battleships, locomotives, computers, etc. Therefore, clearly, the Framework logic can be used to classify descriptive representations of any physical objects, but also conceptual objects like enterprises or departments within enterprises, or projects within a department or (computer) programs within a project etc. Apart from that, the Framework could be used to classify the descriptive representations of a cell of the Framework. In this sense, it is like a fractal. In conclusion, the Framework is generic· it can be used to classify the descriptive representations of any object and therefore to analyze anything relative to its architectural composition, and also recursive, since it can be used to analyze the architectural composition of itself.

7th rule: 'Do not add rows or columns to the Framework' / 'Do not change the names of rows and columns of the Framework' / 'Do not create diagonal relationships between cells'.

The Zachman Framework as constructed by its creator is a complete scheme that describes completely any object, project or entire enterprise. It includes all of the business' elements perceived from all possible points of view. Thus no additional rows or columns are needed. As far as the columns are concerned, if one can answer all of the six questions, one can derive answers to any other question about the subject (or object) being described, in our

case the enterprise. That is, the answers to these primitive questions would constitute the total knowledgebase for the object one is describing.

These are the primitives, that is, you must have all of them to be complete. They are also comprehensive, that is, additional interrogatives add no new information. In fact, additional interrogatives introduce redundancies and discontinuities and denormalize the classification scheme. Tracing back to the analogy of the house construction, one can realize that all of the mentioned elements (drawings, plans, architects, designers etc.) are indeed adequate for the completion of the construction· otherwise someone would have added more elements over the years in order to specify more things. Exactly the same thing applies to the Zachman Framework· nothing more is necessary to complete it.

Another rule that accompanies the rule above is the 'Do not change the names of rows and columns of the Framework' rule. Given the fact that the Framework is complete and normalized, any change of the rows', columns' or cells' names would cause misunderstandings and confusion to people using the Framework. The names given by John A. Zachman himself have up to today set a communication standard, which doesn't need to be changed. Apart from that, changing the name of something (e.g. a row) can easily 'mislead' to the change of its meaning, which of course would have disastrous results, since it would cause great confusion, but mostly because it would change the whole Framework, possibly introducing deficiencies and denormalization of the Framework.

The existence of words and languages helps people communicate their ideas. However it is very common for people to speak the same language and use the same terminology, but to still get confused and not actually understand one another. The same thing may happen within the enterprise. The managers might be speaking with the employees but the two parties might understand different things, given their different perspectives. In order for this misunderstanding to be avoided, one must not create diagonal relationships between cells when using the Zachman Framework. All cells are related to one another with horizontal and vertical relationships. These relationships complete the Framework. Any other relationship (e.g. diagonal) would cause semantic discontinuity and leave big holes for misinterpretation. The structural reason for banning diagonal relationships is because the cellular relationships are transitive· changing a cell logically may impact some or all cells in the same row and the same column. When things start changing, the only way to manage the impacts of the change is to manage the vertical and horizontal relationships. Because there is no structural logic defining diagonal relationships, the problem of change management approximates infinity. Therefore, the way to address changes within the enterprise is to project the

impacts of the change vertically and horizontally, and then determine the changed diagonal relationship between that cell and other cells in different rows and columns by inference.

All of these three rules have to do with the completeness and adequacy of the Framework. If any one of them is violated, then the result will be confusion and deficiency.

2.5. The benefits of the Zachman Framework

If one considers the Framework objectively, they will definitely admit that it offers the enterprise many benefits such as standardization and adaptability. The Zachman Framework is considered a substantial EA standard and has become an industry benchmark· many EA tools use the logic of the Framework (if not the Framework itself) and many other architecture frameworks are compatible and can be integrated with Zachman, because it has been so widely implemented. The Zachman Framework is more mature and horizontal than other existing frameworks· it therefore establishes the basis for the additional use of other methodologies and frameworks.

Another important advantage of the Framework is its simplicity. The Framework's definition is based on a single outline representing the viewpoints and layers to be taken into account in the definition of the architecture. This simplifies understanding of the working framework and expectations. However, the completeness of the framework makes it possible to go down to a level of detail and complexity comparable to that of architecture frameworks aimed at particularly demanding industries like Defense and Finance. The Zachman Framework is considered to be the most straightforward Enterprise Architecture, given its simplicity and ease of understanding.

Lastly, the Zachman Framework offers great flexibility to enterprise architects, to interpret, execute and deal with the different artifacts and activities that are required for the construction of the EA system. Each enterprise has the opportunity to adapt the Framework to its own needs and requirements, since all elements of the Framework (artifacts, representations etc.) are adjustable.

The Zachman Framework provides enterprises with a navigation tool that acts as a compass for enterprise modelers. It helps them set a starting point and then define the whole project. It provides a context in which business and IT architects can build systems that reflect the business' mission. It can successfully be used as a tool for defining project scope, but also as a learning tool for EA. It helps architects organize their thoughts (because of its structure)

and guides them through the building process. Also it ensures that all necessary aspects are taken into consideration· it is complete.

2.6. Comparison of Enterprise Architecture methodologies

Since the framework used in this paper is the Zachman Framework there is no reason for a deeper analysis of the other well known and widely used frameworks, such as TOGAF, FEAF and Gartner (that are already mentioned earlier). However in order to understand better the significance and contribution of each framework and the strengths and weaknesses of each one of them, a comparison between these four frameworks is made.

The most obvious way to compare the frameworks is by pointing out their similarities and differences regarding their views and abstractions. The views comparison can be more quantifiable than the abstractions one. Since the Zachman Framework has already been analyzed earlier in the paper, its views and terminology will be used to represent the stakeholders' perspectives of the other frameworks as well. The following tables sum up the three methodologies (Zachman, TOGAF and FEAF).

Framework	Planner	Owner	Designer	Builder	Subcontractor	User
Zachman	Scope	Business Model	System Model	Technology Model	Detailed Representations	Functioning System
FEAF	Objectives/Scope Planner's view	Enterprise Model Owner's view	Information Systems Model Designer's view	Technology Model Builder's view	Detailed Specifications Subcontractor's view	
TOGAF		Business Architecture view	Technical Architecture views			

Table 2.3: Comparison of the views of Zachman, FEAF and TOGAF

Framework	What	How	Where	Who	When	Why
Zachman	Data	Function	Network	People	Time	Motivation
FEAF	Data Architecture (entities=what)	Applications Architecture (activities=how)	Technology Architecture (locations=where)			
TOGAF		Decision-making guidance		IT resource guidance		

Table 2.4: Comparison of the abstractions of Zachman, FEAF and TOGAF

It is clear that the FEA Framework corresponds to the first three columns of the Zachman Framework. It contains guidance and it is basically oriented towards Enterprise Architectures rather than IT Architectures. The rows of the FEA Framework correspond to the rows of the Zachman Framework. TOGAF is very strong on the business architecture and technical architecture aspects. It is one of the most comprehensive with regards to the actual process involved, as it will also be mentioned later on. This framework provides guidance towards principles for decision making, guidance of IT resources and architecture principles. It is gauged towards open systems development.

Another tool that can be used for the comparison of the frameworks is the Systems Development Life Cycle (SDLC). As its name reveals, SDLC constitutes a process (as a whole) of developing system or software to meet certain requirements. Its basic stages are: understanding why the system should be built, checking the project's feasibility, analyzing problems, choosing the system design and architecture, implementing and testing it and finally delivering the system as a product to the client. The whole process is done through several development phases· each one continues and refines what's done in the previous phase. These discrete phases are: planning (understanding why the system should exist and defining its requirements), analysis (problem identification and analysis), design (the way the system operates in terms of process, data, hardware, infrastructure etc.), implementation (the actual building, testing and installation of the system) and maintenance. Taking the SDLC in mind one can examine whether the frameworks encompass all of its stages. As it is clear in the table below, all frameworks tend to be heavy on planning and analysis, since their objective is to provide guidance, whereas most if not all are weak in addressing the maintenance of a system.

SDLC Phase / Framework	Planning	Analysis	Design	Implementation	Maintenance
Zachman	+	+	+	+	-
FEAF	+	+	+	+	Detailed Subcontractor's View
TOGAF	Principles that support decision making across enterprise, provide guidance of IT resources, support architecture principles for design and implementation				

Table 2.5: Comparison of Zachman, FEAF and TOGAF using the SDLC

Continuing with the comparison of the frameworks, one of the areas the Zachman Framework is doing very well in is taxonomy completeness. This actually shows at what point the framework allows one to use the methodology to classify the various architectural artifacts. This is one of Zachman's Framework greatest advantages and it is almost the entire focus of Zachman. The other three methodologies don't focus so much on this area.

On the other hand, process completeness is not one of Zachman's strengths. Contrary to TOGAF and Gartner, which are both really strong in this area, the Zachman Framework does not fully guide you through a step by step process for creating an enterprise architecture. Although the Framework covers the whole enterprise as far as people, data, place etc. are concerned, it doesn't actually offer the architect much help during the building process. One might say that this gives the architect freedom to choose and determine the elements that are important to the enterprise and the way he can mix them· on the other hand this can be very confusing and puzzling. TOGAF includes the Architecture Development Method (ADM), which is a recipe for creating architecture and a process for creating artifacts, in comparison to the Zachman Framework which shows how to categorize the artifacts.

Another area in which TOGAF, but mostly FEAF is very strong is the reference-model guidance. FEAF is especially useful in helping the architect build a relevant set of reference models. The Zachman Framework doesn't focus that much on this area.

Practise guidance refers to how much the framework helps the architect assimilate the mindset of enterprise architecture into one's organization and develop a culture in which it is used and valued. This is a primary focus of Gartner's architectural practise and not so much Zachman's. Along with practise guidance comes maturity modeling, which refers to how much guidance the methodology gives the architect in assessing the effectiveness and maturity of different organizations within the enterprise in using enterprise architecture. Here FEAF comes first and then follows Gartner, whereas TOGAF and Zachman don't really focus on this area.

FEAF and Gartner focus also very much on guiding the architect into effective autonomous partitions of the enterprise, which is very useful for dealing with complexity.

Another area in which almost all frameworks are strong, is the prescriptive catalogue, which refers to how well the methodology guides the architect in setting up a catalogue of architectural assets that can be reused in future activities. The Zachman Framework has a built - in repository, which can be further enriched and maintained for future projects.

Another very important element that affects enterprise architecture methodologies is the length of time one is likely to be using the methodology before they start using it to build solutions that deliver high business value. Here Gartner is the best choice but TOGAF is nearly as good. FEAF and Zachman are not very strong on this area. A reason for that is that Zachman is a very complex methodology, which means that architects need a lot of time to explore it, become acquainted to it and be able to manipulate it. Along with the limited available information on building projects using the Zachman Framework, it renders it as a rather 'difficult' framework. On the other hand, the Gartner methodology was developed by one of the best known IT research and consulting organizations in the world, Gartner, which makes it a more 'handy' enterprise architecture practice, given that it was originally developed having in mind that it would be used for building solutions and delivering business value (while Zachman focused on achieving a holistic description of the enterprise).

In practical terms now, each methodology can get one locked – in to a specific consulting organization by adopting it. Low vendor lock – in indicates that one has more flexibility and is not dependent on only one consulting organization. Gartner and Zachman offer such freedom to enterprise architects, while FEAF and TOGAF don't as much.

Last but not least is the information availability, which is a very useful element to architects and refers to the amount and quality of free or inexpensive information on each methodology. Because enterprise architecture and in particular these frameworks are not very old, it is very important that information and guidance regarding them exists and is available to architects. The least information available is for the Gartner framework, whereas the most is for TOGAF. FEAF and Zachman are somewhere in the middle. As a result it is quite difficult to find inexpensive information and knowledge about these frameworks. Otherwise there is an entire education and consulting firm, the *Zachman International*, which offers training and certification on the Zachman Framework.

The conclusion of this comparison is the fact that none of the above methodologies is really complete on its own. Each has its strengths and weaknesses and they all differ in terms of their approach and level of detail. The majority of the frameworks are abstract in that due to their generality of terms, one might then question the validity or the ability to work accurately within that framework. The Zachman Framework appears to be the most comprehensive framework of those studied. It uses a number of viewpoints related to the different aspects. Most frameworks only represent a small number of viewpoints and aspects. Many enterprises use a blended approach, in which the architect creates a new

methodology, according to the company's needs and specific areas of concern, which consists of elements of different methodologies and practices. Others find that one of the existing methodologies suits them well and thus use it to develop their enterprise architecture.

3. Casewise & Corporate Modeler

Since 1989, Casewise helps organizations and their people to understand their business operations, and improve the way in which they perform through the provision of software and consultancy solutions. Supporting many of the world's leading organizations across a wide range of markets, Casewise solutions enable organizations to visualize, understand, analyze, audit and continually enhance complex operating processes and IT infrastructures.

Figure 3.1: The Casewise Corporate Modeler Suite logo

Casewise helps transformation within an organization to be realized by offering software that provides business analysis, enterprise architecture and workflow optimization capabilities. The software enables organizations to plan, communicate, analyze and articulate change activities throughout the organization.

The Casewise products and services support Business and IT transformation activities. They allow companies to document any aspect of the business, from high level strategy through process and IT infrastructure – quickly and easily. The Casewise portfolio includes products for Business Process Analysis, Business Process Management, Enterprise Architecture and Governance, Risk & Compliance. Casewise products allow sharing and collaborating with all parts of their organization, from core team members to senior executives.

As well as providing services around the implementation and deployment of Casewise solutions, the Professional Services Group team also provides an assistance with matters such as technical implementation, training, enablement and enhancement right through to methodology and framework support. The Casewise service offering revolves around 3 main areas: Projects, Enablement and Training.

Casewise has delivered its solutions to over 3,000 blue-chip corporations worldwide, the majority of which are market leaders in their own sectors. In addition, Casewise has also established long term partnerships with many of the leading global management consultancies, many who have embedded their own in-house methodologies into Casewise's modeling software.

Some of Casewise's partners are:

- Consulting partners: Accenture, Capgemini, corso, csc, Deloitte, KPMG, pwc and others.
- Resellers: a&p consulting, HMS, mindbiz informatics.
- Technology partners: IBM, Microsoft, Lanner, Oracle, PNMSOFT and others.

The company's customers specialize in different sectors, such as:

- Central & Local Government, Public sector & Not-For-Profit: HM Revenue &Customs, Hampshire County Council, NASA, Teach for America and others
- Electrical & Engineering: Siemens, SAIC
- Energy, Utilities, Oil & Gas: aps, BG Group, Eneco, Eni, Repsol YPF, TOTAL and others
- Finance, Insurance & Banking: BNP PARIBAS, Crédit Agricole, ING, LLOYDS BANKING GROUP, RBS, UBS and others
- Management Consultancies: Accenture, CAPITA, PA Consulting Group, HP, KPMG, Deloitte and others
- Pharmaceuticals, Biotech & Healthcare: AMGEN, GALDERMA, ANIOS, MERCK, PFIZER, syngenta and others
- Retail: Ahold, Ed, fnac, Estée Lauder, Gucci, LA REDOUTE and others
- Services, Transport & Logistics: ACCOR, DAMEN, LAN, MANPOWER, Transport for London, volaris and others
- Technology & Media: Business Connexion, Novell, THOMSON REUTERS and others
- Telecommunications: euranet, Global Crossing, MTS, radio france and others

3.1. Casewise Modeler

This leading enterprise modeling solution enables teams to document, visualize, analyze, and optimize their organization's business processes, applications and systems. It is able to capture a true picture of processes and operations of even the most complex organizations. The collaborative nature of this package allows all stakeholders to contribute to, and learn from, user-friendly, amazingly informative models. It offers risk-free simulations, the ability to plan for change and a unique insight into business efficiency practices. The Corporate Modeler yields valuable information that facilitates for better, quicker and more profitable decisions to be made.

The Corporate Modeler links together business and IT modeling within one multi-user environment for Business Process Analysis and Improvement, Business Process

Management, and Enterprise Architecture as well as Governance, Risk & Compliance efforts. With the Corporate Modeler one can:

- Capture the 'As-Is' situation
- Test out 'What-if?' scenarios
- Communicate, implement and manage 'To-Be' enterprise improvements
- Respond to challenges faster in the future
- Continually improve processes

It is known that effective communication of both the organization's goals and method of achieving them are central to delivering real and lasting change, and the Corporate Modeler delivers exactly that. This clear documentation also gives consultants, analysts, IT professionals, all the insight into the organization they need to make informed and productive decisions.

Corporate Modeler is highly configurable and customizable. In fact, it is often admitted that it is the easiest tool on the market to extend and customize. It is designed to be flexible and provide numerous options and configuration settings that govern the user experience with the tool.

The Corporate Modeler Suite consists of three types of applications:

- Modeling & Administrative: Corporate Modeler, Model Explorer, Matrix Manager and Object Explorer
- Publishing: Corporate Publisher
- Links: Automodeler

The Corporate Modeler is used for drawing diagrams that model business processes, system behavior and organizational hierarchies. The diagrams allow people to visualize how objects interact with one another in order to form processes, data flows or system behaviours.

Figure 3.2: Corporate Modeler

The Model Explorer, which is a Windows Explorer style program, is used for exploring and managing the objects in the models created with the Corporate Modeler. It is necessary to explore one's data in order to centrally control one's repository.

Figure 3.3: Model Explorer

The Matrix Manager is used for viewing the object associations in the models as a table (matrix). This allows people to analyze how, when and to what ends the objects in the models interact.

Figure 3.4: Matrix Manager

The Object Explorer provides quick and easy access to all objects and associates objects. It offers the chance to browse the models, searching and filtering to locate specific objects and the objects they are associates with.

Figure 3.5: Object Explorer

Apart from these four applications, the Corporate Modeler Suite offers the Image Gallery, which is used for viewing, copying, pasting and deleting all of the images available when editing Corporate Modeler models. Also, the Admin Tools is used for maintaining the integrity of data and for licensing multiple users.

Figure 3.6: Image Gallery & Admin Tools

The Corporate Publisher is used for publishing model data (or part thereof) in HTML or Word format. Publishing data enables people who do not have access to the Corporate Modeler to view one's model data.

Figure 3.7: Corporate Publisher

Along with the Corporate Publisher comes the Stylesheet Builder, which is a web page used for creating Cascading Style Sheets (.css) for use with one's published HTML output.

Figure 3.8: Stylesheet Builder

Lastly, the Automodeler is used for converting business process and system data created in Microsoft Office programs, so that it can be used as a basis for Corporate Modeler diagrams. Converting data allows new users to get started with the Corporate Modeler Suite very quickly.

Figure 3.9: Automodeler

The potentials of the Corporate Modeler Suite are numerous. One can create and edit objects (that depict the business' elements) and models (where all the information about the business is stored), draw all sorts of diagrams (e.g. business process diagrams, hierarchy diagrams, organization charts, Gantt charts, network diagrams, data flow diagrams and many others), create associations between objects, enrich objects' properties, administer users and user access, run simulations in order to identify and eliminate delays and

inefficiencies etc. Of course the Corporate Modeler Suite offers all kinds of drawing possibilities (e.g. different palettes, templates, great visualization through the depiction of elements on real maps, images etc.) that a respectable designing program would offer. But there are also some extra designing features, which grant modelers great ease and convenience. One of these features is the 'explode' function, which allows the user to connect two or more diagrams that share a parent – child relationship (an explosion is a link from an object on one diagram to another diagram). Another important feature is the 'swim lane', which is typically represented as an elongated rectangle and helps modelers make associations on diagrams by simply dragging processes into them. A swim lane is an organization or a location, which is responsible for the processes placed on them.

All these applications and features make the Corporate Modeler Suite very practical and easy to use and one of the most powerful Enterprise Architecture tools.

The Casewise Modeler Suite v2009.2 version was used in this paper.

4. DEPA

The enterprise examined in this paper is DEPA (in Greek the name stands for: public corporation for gas supply), Greece's public gas corporation, which first imported natural gas in Greece. DEPA with its long standing presence in the greek energy market consists now of a modern and competitive group of companies with a dynamic presence in the energy sector and has a real contribution to the economic development of the country, the protection of the environment and the improvement of the standard of living of the citizens in the local communities. With continuous gas pipeline extensions and the creation of new regional Gas Supply Companies (EPAs), the DEPA group brings natural gas to more regions in the country. DEPA, with its long term gas supply contracts, contributes to the country's security of supply while developing initiatives for the role of Greece as a transit country to the rest of Europe from countries with abundant gas reserves.

Figure 4.1: DEPA's logo

DEPA's vision is to further connect the energy future of the country to the european networks and to support Greece's integration in the energy highways in an era where energy constitutes a decisive factor in the structure of geopolitical balances.

The strategic goals of DEPA aim to:

- Preserve the leading role in a liberalized domestic energy market.
- Create and exploit development opportunities in Greece by increasing the penetration rate of natural gas on a national level as well as by assuming a leading role as an energy player in the region.

DEPA promotes specific strategic initiatives with the objective:

- To provide gas to its customers from diversified sources under competitive prices.
- To assume a leading role in the region by developing the necessary infrastructure and by supplying gas to the regional markets.
- To create a modern and dynamic organization facing the demands of competition while contributing to the development of an efficient market with "green" characteristics.

The company's Group structure is shown in the following figure.

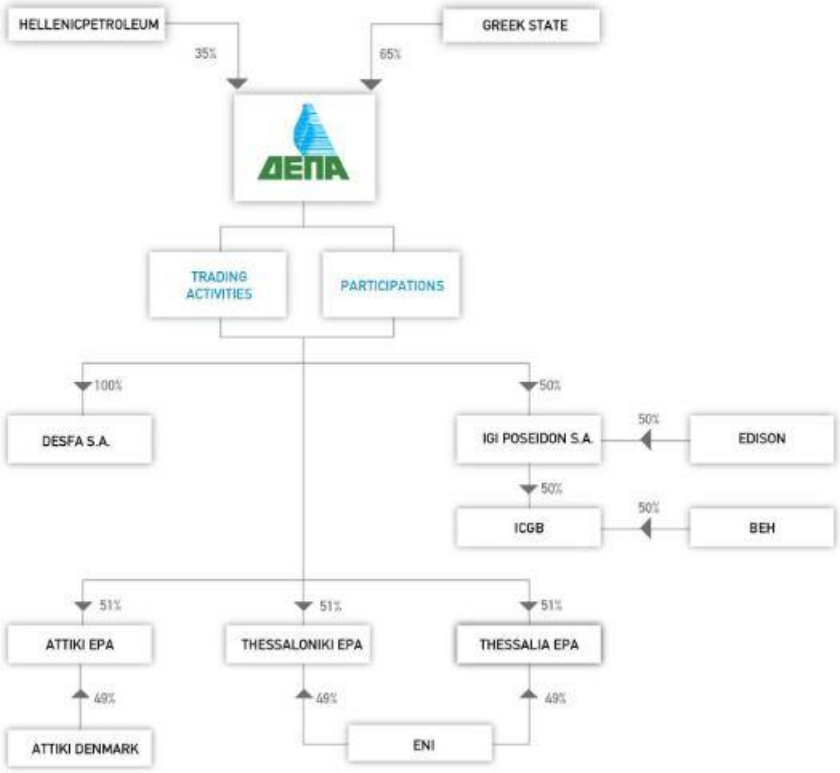


Figure 4.2: DEPA Group's structure

DESFA S.A. is the Administrator of the Natural Gas System, established in March 30, 2007 as the Greek TSO. Its scope is to operate, maintain, manage, exploit and develop the National Natural Gas System (ESFA) and its interconnections, ensuring that the system is financially viable and technically reliable to meet customers' needs in the safest way.

The Gas Supply Company (EPA) Attica S.A. is owned by the DEPA group together with Shell Gas B.V., with stakes of 51% and 49% respectively. The management of the EPA is carried by the Investor. Its main scope is to develop and supply with natural gas the broader Athens region through medium and low pressure gas networks.

The Gas Supply Company (EPA) Thessaloniki S.A. is owned by the DEPA group, and ENI Hellas spa, with stakes of 51% and 49% respectively. Its main scope is to supply with natural gas the Thessaloniki region through medium and low pressure networks.

The Gas Supply Company (EPA) Thessalia S.A. is owned by the DEPA group, and ENI Hellas spa, with stakes of 51% and 49% respectively. Its main scope is to supply with natural gas the Thessalia region through medium and low pressure networks.

IGI Poseidon S.A. is a joint venture between DEPA (50%) and Italy's Edison (50%). The company has undertaken the design, finance, construction and, later, operation and maintenance of the Greece-Italy underwater natural gas pipeline, along with a natural gas compression station on the western Greek coast. This pipeline is part of the ITGI (Italy-Turkey-Greece Interconnector) which will allow gas produced in the Gaspian region to flow to Europe.

ICGB AD was incorporated in January 2011, by IGI Poseidon S.A. and Bulgarian Energy Holding EAD, each holding 50% stake. The company is responsible for designing, constructing and operating the Interconnector Greece-Bulgaria (IGB), which is part of the ITGI System (Interconnector Turkey-Greece-Italy), and will facilitate natural gas flows to SEE Europe.

Among the strategic objectives of DEPA is the continuous natural gas supply at competitive prices, maintaining its leading position in the domestic market, while enhancing its presence inside and outside of Greek territory by developing new applications and natural gas services.

DEPA is the immediate natural gas supplier of:

- Electricity producers
- Large customers with annual consumption of over 10 million m3
- Gas Supply Companies (EPAs)
- End users in regions where Gas Supply Companies have not yet been established.
- Gas-powered vehicles

DEPA's focus is on new technologies and commercial activities. Cutting-edge applications include:

- cogeneration and air conditioning
- remote regions' supply with compressed natural gas (CNG)
- natural gas use in the agriculture sector

Fully aware of the responsibility of its leading role in the revitalization of the Greek economy entails, since its establishment DEPA has incorporated Corporate Social Responsibility practices in its overall business strategy. The voluntary adoption of CSR principles consistently reflects the company's unwavering ethical commitment to a code of conduct which, along with its growth and development, ensures DEPA's positive contribution to the community and the environment.

First and foremost, this strong association of CSR practices with financial growth ensures numerous tangible benefits for the company:

- transparency and clear-cut operating procedures
- more effective corporate governance
- improved work environment
- enhanced human resources performance

Especially in today's evolving and increasingly competitive business environment, DEPA's CSR programs and initiatives create added value and improve its long term prospects, decisively contributing to:

- the establishment of a comparative advantage, making DEPA more competitive, more resilient and, certainly, more attractive to consumers
- boosting the company's value
- enhancing public trust

As part of its CSR agenda on environmental protection and community welfare, DEPA has launched a multifaceted program including a series of initiatives that focus on:

- supporting "green" business ventures
- improving public welfare, especially that of stakeholder communities
- promoting Greek culture and civilization
- sponsoring the arts, letters and sciences
- supporting sports and education
- respecting human values

- actively protecting the environment, a fundamental company priority

The development of a comprehensive and systematic CSR program and the further improvement of related practices and procedures fully integrated with the company's management and operations, as well as with its overall community and environmental protection strategies, is a key priority for DEPA.

Recognizing that Responsible Corporate Behavior leads to sustainable business success, DEPA remains committed to a corporate strategy that consistently incorporates socially responsible practices.

Given the 'friendly' relationship between natural gas and the environment, at DEPA environmental protection is inseparably linked with sustainable development. The company is firmly committed to the principle that productivity and growth should stay in lockstep with the minimization of the company's environmental footprint. DEPA's commitment to the protection of the environment is reflected in the company's daily practices, while its abiding respect for the environment is mainly expressed through concrete actions based on its overall environmental strategy. To implement this strategy, DEPA has adopted an Environmental Management System, which adheres to international environmental protection standards and advanced sustainable development practices. As part of this system's application, DEPA ensures that any company activity that may have an environmental impact complies with Greek legislation. Moreover, it initiates actions that reduce these impacts and consistently sets objectives that improve its environmental performance.

The company's main objective is to minimize any impacts on the landscape, the natural resources, the atmosphere and the quality of life of local communities, regardless of location. Both during construction and operation, DEPA complies with the most rigorous environmental standards stipulated by Greek and European legislation. The company's natural gas installations have been constructed in compliance with international environmental standards and have been certified by independent organizations.

In addition to its environmental management practices, DEPA conducts R&D projects aimed at protecting and enhancing the environment. One of the most important inroads in this direction is the powering of vehicles with natural gas, which can result in significant financial (the cost of natural gas is 1/3 that of gasoline) and environmental benefits. In this context, DEPA has taken the lead in influencing developments and initiating cooperative efforts to

expand the use of natural gas by not only an increasing number of both public and private vehicles (i.e. local government authority waste collection vehicles, buses, taxis, etc.,) but also by an increasing number of regions throughout Greece. As part of these efforts, the company has initiated regional pilot programs for the gas powering of vehicles, such as the one scheduled for the city of Volos in 2012 -involving the installation of natural gas pumps at local petrol stations funded by DEPA- or the one pertaining to Thessaloniki, Greece's second largest city. The company's medium term objective is the development of the required infrastructure for natural gas refueling stations in the country's major cities and throughout the national road network.

Another project highlighting DEPA's sensitivity to environmental issues is the 'EcoMobility' program, an environmentally friendly transportation campaign aspiring to raise awareness among teenagers regarding the adoption of new modes of urban mass transit, including the development of Green Transport. The program is addressed to secondary school students throughout Greece and aims to heighten their environmental awareness, while encouraging the development of new transportation habits. Falling under the auspices of the Ministries of Education, Transport, the Environment and Citizen Protection, as well as the European Commissioner for the Environment, this program is further supported by the country's leading universities and scientific institutions [DEPA Corporate Website, 2012].

Many of the information mentioned in the company's description will constitute the data input for parts of the models built with the help of Corporate Modeler. For example, the company's strategy and vision is an important element used in the framework, in order to make the planner's perspective (motivation) clear. Also, the organization chart of the company will be created and the 'Function' column will be enriched with models.

5. DEPA case study

Next we will examine the application of the Corporate Modeler Suite software on the company DEPA, which was mentioned earlier in the paper. The reason why DEPA was chosen for the research of this paper is because it is a large, properly structured company, with all necessary departments, divisions and operation areas. Additionally, DEPA is a technical company and it was very interesting and challenging to examine how this type of enterprise can be analyzed with the help of such software (because it is more common to use this tool for the analysis of companies with a production operation system). Lastly, it is a very modern company, with concerns about all current issues concerning the world and the

environment and all these aspects can be depicted into the Corporate Modeler Suite's models. Apart from that, DEPA is a public company and it would be very intriguing to try and analyze such a company in the same way and with the same means that private companies are analyzed and structured.

The software was used to create models of the company, according to the data and information given to us by DEPA itself. In cases where there was no available data, it is mentioned in the text that the values or elements entered in the models are not DEPA's data, but have resulted through research and logical thought and assumption. One of these cases is the simulation process that was executed, for which not all necessary data was known to us and therefore some assumptions were made. Anyway, all this information is mentioned further below.

For the creation of the models most of the Corporate Modeler Suite programs were used. The actual models were built in Corporate Modeler, while new objects and object types were created with the help of Model Explorer. All matrices depicting the relationships and associations between objects were created in Matrix Manager. Finally Object Explorer was used throughout the process for searching, manipulating and editing of objects, diagrams etc. Of course many existing objects of the Corporate Modeler Suite were used and also the models - diagrams were developed on the existing diagram templates offered by the software. The point in this paper was to go deep into some of the framework's aspects and not so much to extend the software and its capabilities· that's why no new templates were designed. Of course we created all new elements that were necessary (e.g. objects and categories) in order for our research to be complete.

The areas – aspects that were examined in this paper were the 'motivation', the 'function' and the 'people' abstraction. Again we stress that the goal was not to extend the framework and develop all kinds of models in each cell, but to investigate some of the framework's areas (cells) and comprehend their existence and function. That's why we didn't focus on completing every row and column of the framework, but go as far as the available data allowed us. The cells of the Zachman Framework that have been examined in the paper are the following: from the 'Motivation' column the 1st, 2nd and 3rd row cells, from the 'Function' column the 1st, 2nd, 3rd and 4th row cells and from the 'People' column the 1st and 2nd row cells. The selection of the cells in the 'people' column was due to the available data. The selection of the cells in the 'motivation' column was made having in mind that this column is the least examined and developed generally and so we tried to comprehend as much as

possible and create some models that fit into these cells. Lastly, the selection of the cells in the 'function' column was made of course based on the data we had available, but also keeping in mind that some of DEPA's functions can be analyzed into business dynamics models or system dynamics models, or both and so it would be interesting to investigate the differences between these two types of models and the necessary elements used for their creation. As far as the 'place' column is concerned, there was no important reason for exploring its cells, since DEPA is a greek company which operates locally and its network (as this is analyzed in this column) is very limited. The data for the 'data' column can be almost infinite and organizing it was not the point of this paper.

Another element that was important for us to examine was the way some of the company's functions are related and what happens when it is time for all of them to work in a specific row in order to produce a result. That is why we ran a simulation, in a particular business process (which is actually a sequence of processes) and by analyzing the results we tracked some important elements for the smooth operation of the process. The whole simulation is mentioned in detail further below in the paper.

5.1. The 'People' column

In the 'people' column the models represent the organizational structure of the enterprise. The model used in this column is the 'Organization Hierarchy' diagram, which shows hierarchical relationships between the units of the business. The main elements in this type of model are: the organizational units and the 'hierarchy links', which are the lines that connect the units with each other, giving them however, a hierarchy relationship. 'Hierarchy links' have no properties (name, description etc.) and are added to the diagram by simply dragging the corresponding symbol from the objects' palette to the diagram (the same way a connector is added), or by pressing F12. An object that appears above another object in the diagram and is connected via a hierarchy link, is the parent object (it is higher up in the hierarchy)· the object below is the child object. Hierarchy diagrams enable one to quickly describe high-level information and are very useful to people like managers, who are not interested in details.

The elements used in this column's cells are the company's organizational units, its directions, its departments, their divisions and so on. For the creation of the column's models, apart from the existing organizational units of the software (object type: organization, categories: enterprise, department type, department, division, role) a new

category was introduced under the object type ‘organization’. The new category is named ‘Body’ and represents a team of people elected or appointed who oversee the activities of the company. A ‘body’ can be permanent, or temporary. For example it can be composed for a specific purpose and have specific duties.

In DEPA’s case an example of a ‘Body’ is the Board of Directors. It is a group of people elected or appointed, who make the decisions regarding the company’s progress and supervise the company’s management.

Another example of an organizational ‘Body’ is DEPA’s committees. These are composed only when needed and consist of members of the company. For example, the competitions committee’s role is to supervise and control the procedures of the competitions that DEPA conducts for the assignment of its projects. Apparently these committees do not exist permanently, but are composed when a competition is running and are decomposed after the conclusion of the competition. A model (entity model) has been created, that fully describes the composition of a competitions committee and the associations between all involved parties of the company, and will be presented later on.

The creation of the new category ‘Body’ was simply done by adding the new category in the ‘General’ tab of the ‘Organization Properties’ dialog box. By selecting ‘Edit’ next to the drop – down list of the ‘Category’, one can define a new category. The procedure is shown in the following pictures.

Figure 5.1: First step of the creation of the new Category ‘Body’

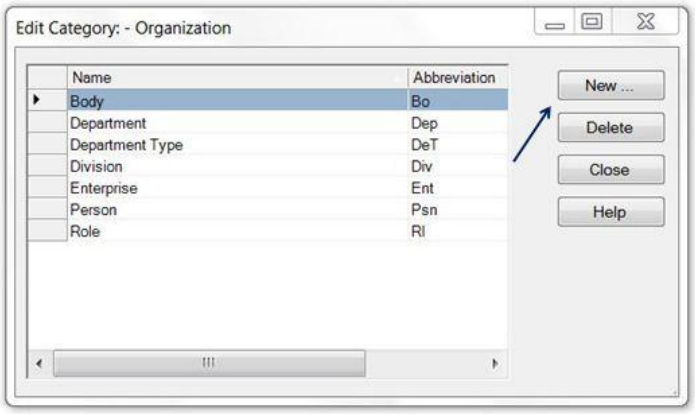


Figure 5.2: Second step of the creation of the new Category 'Body'

1st row: Planner's view, contextual. In this row the model created is the organization chart of the enterprise. The organizational units used in the chart are: the 'enterprise' (DEPA), the 'body' (Board of Directors), the 'role' (President & CEO, Vice President & Deputy CEO, Activities Manager & Consultant) and the 'department type' which refers to all of DEPA's Directions (13 in total). The model is shown in the following picture. Note that the different organizational units are also represented by a different color.

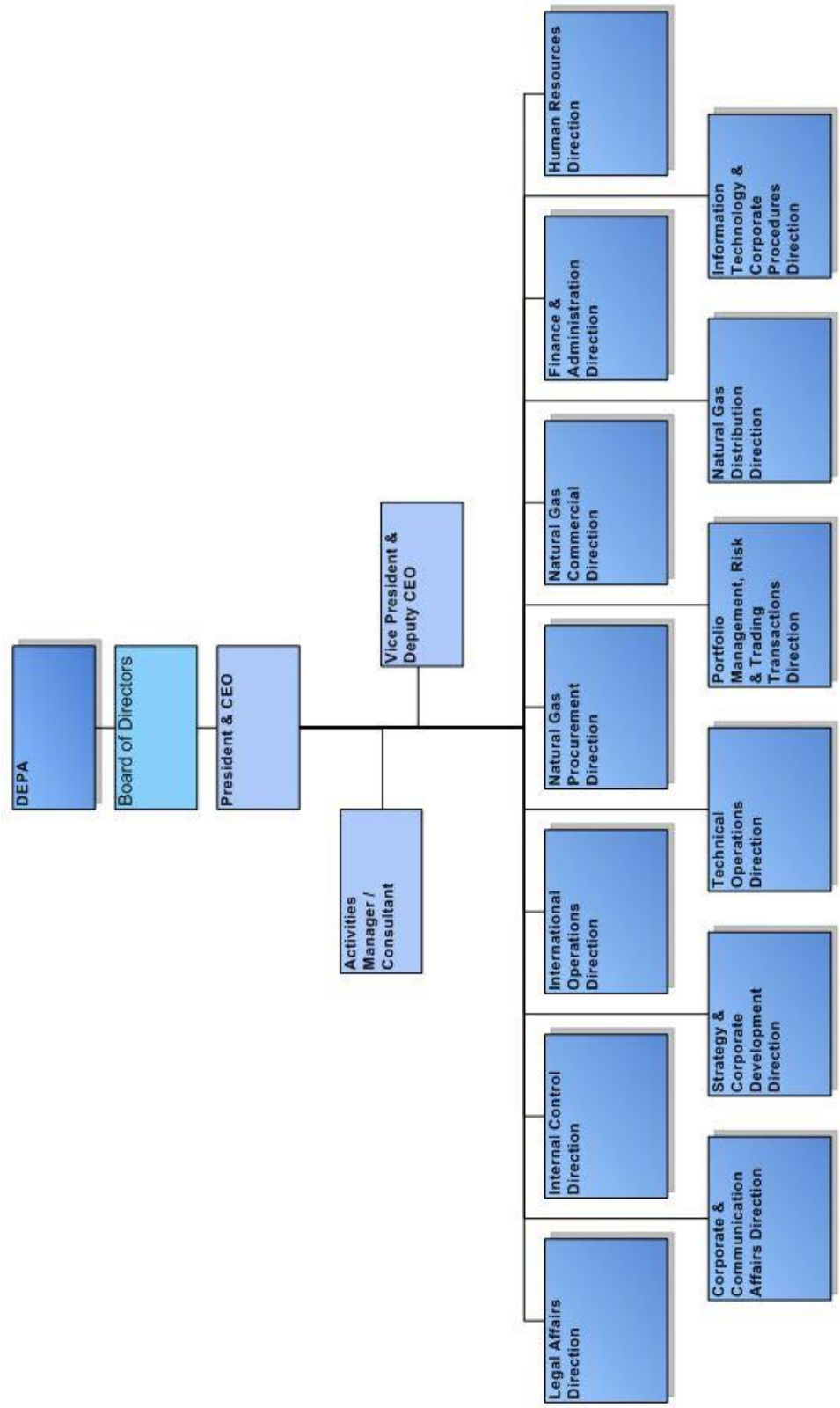


Figure 5.3: DEPA's organization chart

2nd row: Owner's view, conceptual. In this row a more detailed organizational structure is described. Here all department types of the enterprise are decomposed into their subsidiary departments. The model uses the hierarchy from the organizational chart of the 1st row and more detailed sub-divisions (in this case the 'departments') are added under each of the top-level nodes. Because DEPA is not such a big company, meaning that it only operates in Greece (regardless of its collaborations with foreign companies), the objects on the diagram are actual departments (placed in Greece). An example of this decomposition is shown in the following picture, where the 'department type' "Natural gas distribution Direction" is decomposed into its subsidiary 'departments' according to the hierarchy rule.

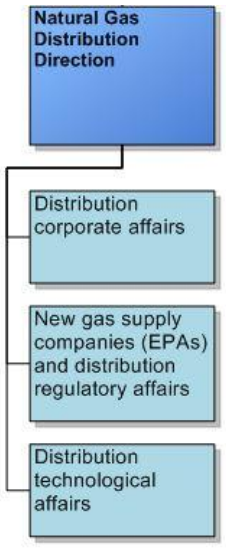


Figure 5.4: Decomposition of the 'Natural Gas Distribution Direction'

Note again that the 'department type' is represented by the dark blue color, whereas the subsidiary 'departments' are represented by the light blue color.

Subsequently follows the entire diagram of the 2nd row with all of DEPA's departments. Due to lack of space the diagram is divided into two pictures.

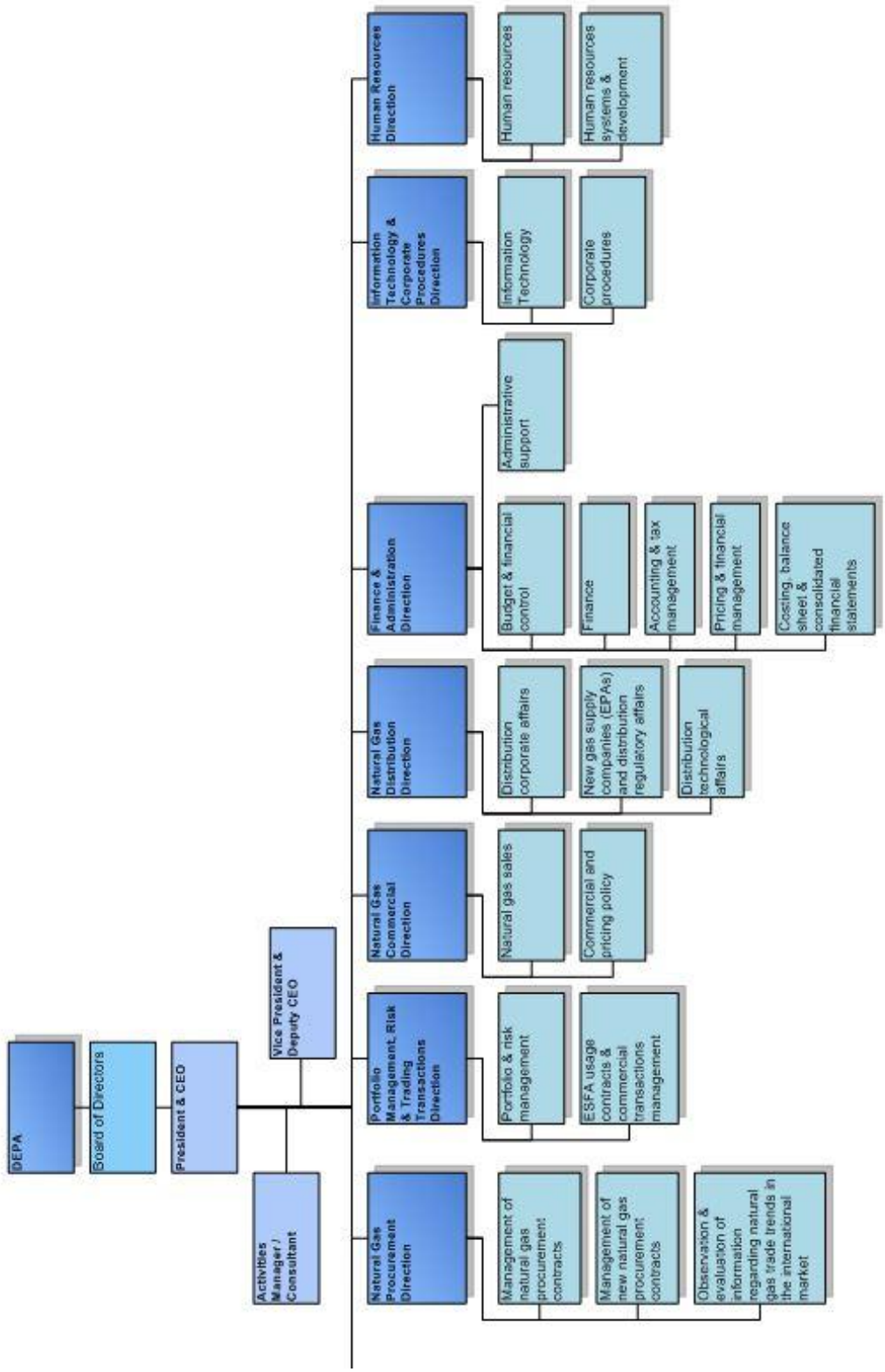


Figure 5.5: DEPA's organization chart with departments (part 1)

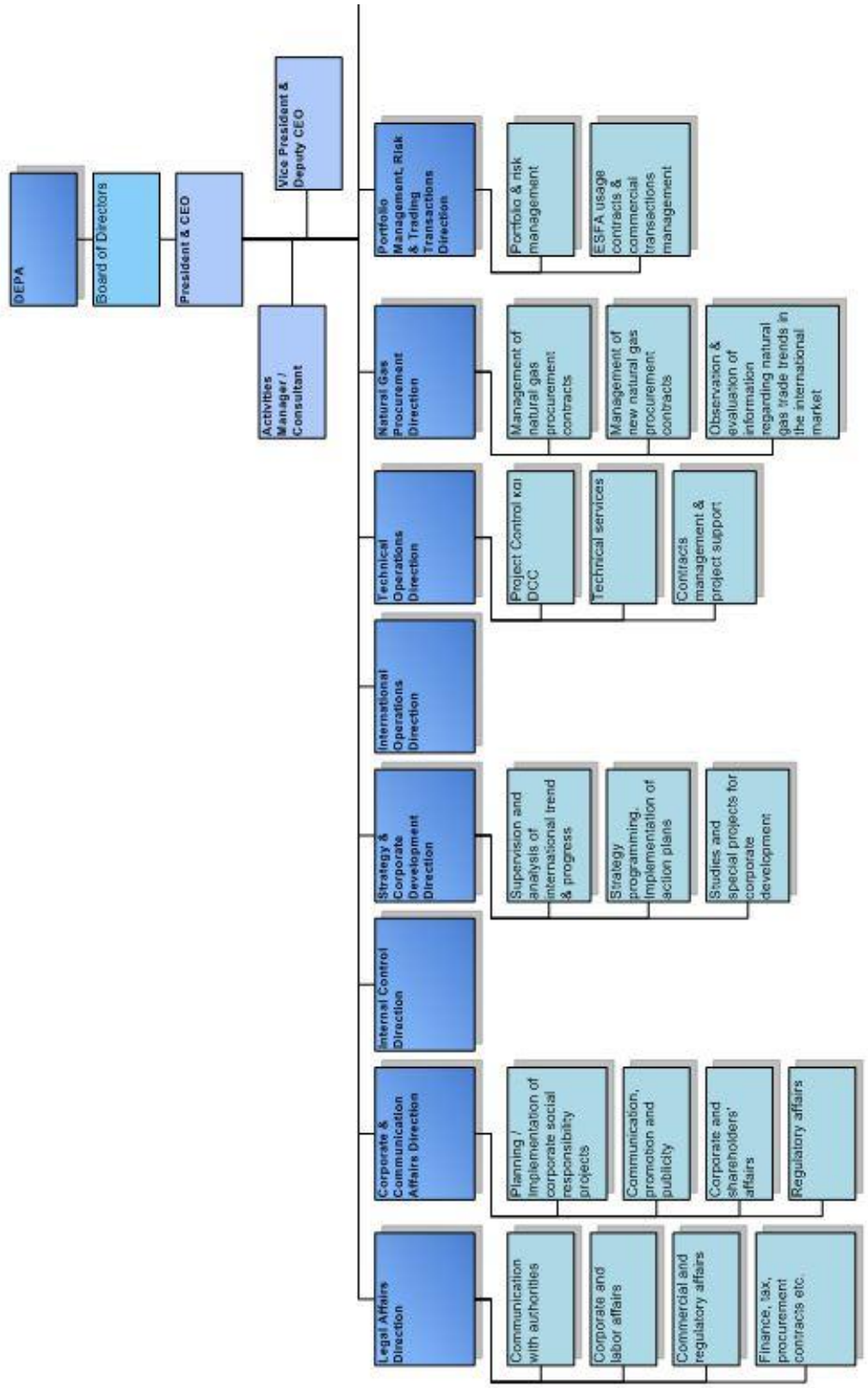


Figure 5.6: DEPA's organization chart with departments (part 2)

5.2. The 'Process' column

In the 'Process' column the models represent the functional structure of the enterprise. Here is where all the functions and operations of the company are described, according to each perspective.

The models of this column have many types. For example the model of the 1st row is a simple list of the company's main processes and includes a hierarchy diagram, whereas the 2nd row includes a list of 'Business Dynamics Models', the 3rd a list of 'System Dynamics Models' and so on. All these different types of models will be explained and analyzed further in the paper.

In this row's models the objects that are used (in our case) are: the 'business process' and some of its categories, the 'organization' and some of its categories, the 'internal / external event / result', the 'application', the 'issue', the 'process break' and the 'documentation'. All of the above mentioned objects will be referred to as we analyze the column's models.

1st row: Planner's view, contextual. This cell includes a list of high - level business processes the enterprise carries out as its business. These processes constitute the 'Enterprise Areas' and are the basic operation functions of the enterprise.

Because DEPA is a big company and deals with many different function areas and because the aim of this paper was not to analyze the whole company, but focus on some issues and more specifically the management of DEPA's technical projects, the only 'Enterprise Area' mentioned here is 'Project Management'. However in order to show the form of this cell's content, we cite the following picture. It is clear that the model here is a 'Process Hierarchy' diagram with the 'Enterprise' on top and the company's 'Enterprise Areas' below.

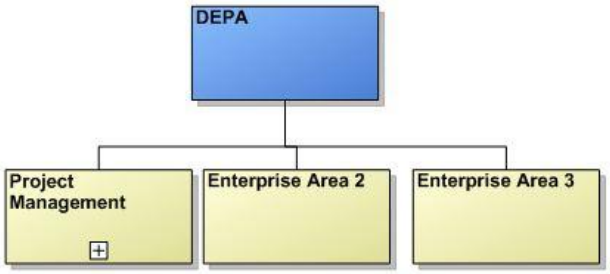


Figure 5.7: DEPA's Enterprise Areas

The ‘Enterprise Area’ ‘Project Management’ has a ‘+’ icon on it and symbolizes that it expands to another diagram. This is called ‘explosion’ and is mentioned in detail later in the paper. In our case, the ‘Enterprise Area’ ‘Project Management’ consists of 30 subsidiary processes, which are presented in the following picture. The model used to show the connection between the ‘Enterprise Area’ and the ‘Business Processes’ is a ‘Process Hierarchy’ diagram, as in the previous model, and shows how major business processes (here ‘Project Management’) break down into smaller ones.

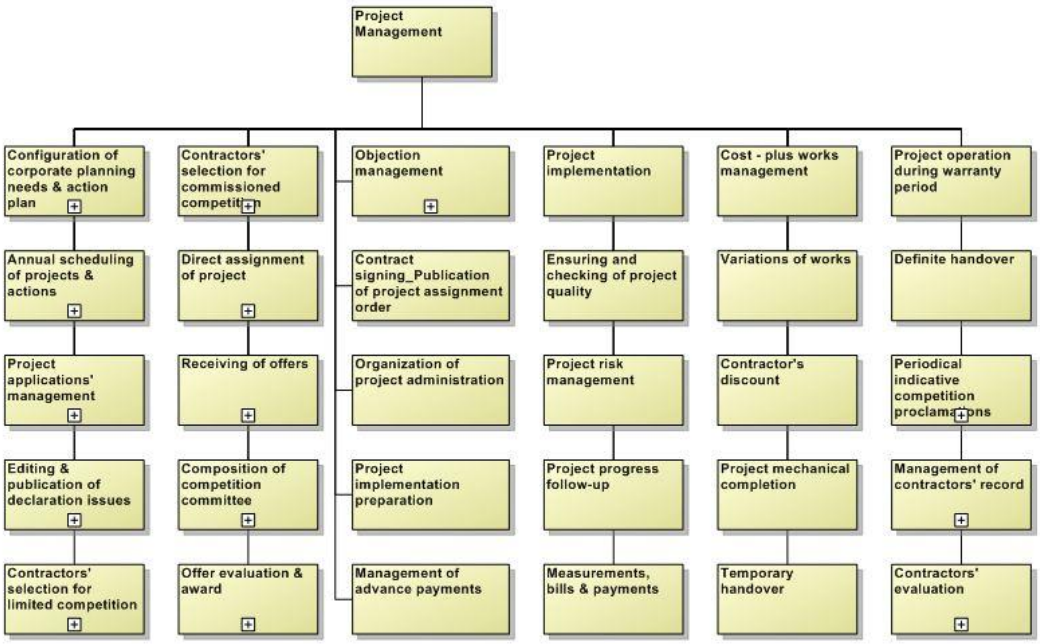
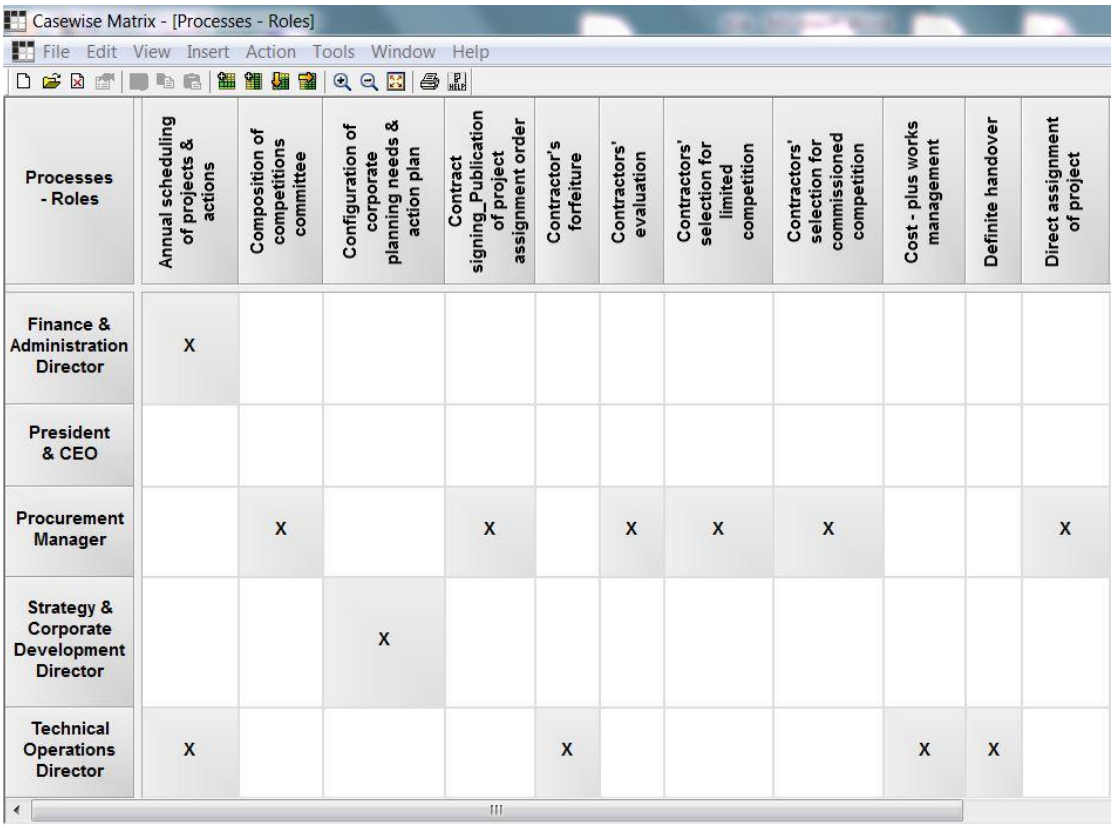


Figure 5.8: ‘Project Management’ explosion

For each of these 30 processes, a specific person is responsible. For example the ‘Procurement Manager’ is responsible for the process ‘Receiving of offers’. The associations between the above 30 processes and the ‘Roles’ responsible for them, are represented in the following matrix. The association is marked by an ‘X’ in the appropriate cell. The columns of the matrix correspond to the ‘Processes’ and the rows to the ‘Roles’. Only part of the matrix is cited here, because of its large size. The columns and rows are sorted alphabetically.



Processes - Roles	Annual scheduling of projects & actions	Composition of competitions committee	Configuration of corporate planning needs & action plan	Contract signing_Publication of project assignment order	Contractor's forfeiture	Contractors' evaluation	Contractors' selection for limited competition	Contractors' selection for commissioned competition	Cost - plus works management	Definite handover	Direct assignment of project
Finance & Administration Director	X										
President & CEO											
Procurement Manager		X		X		X	X	X			X
Strategy & Corporate Development Director			X								
Technical Operations Director	X				X				X	X	

Figure 5.9: 'Process – Roles' Matrix

2nd row: Owner's view, conceptual. This cell consists of a list of the enterprise's 'Business Dynamics Models' (BDMs). It is a simple list, not a hierarchy diagram, including all business processes that have been "exploded" into a BDM. The object used here is the 'Business Process' and the '+' icon marked on them indicates that they have been "exploded" into another diagram.

All of the subsidiary business processes, which belong to the 'Enterprise Area' 'Project Management' and which have been 'exploded' into a BDM are presented in the following picture, which is the 2nd row's cell. The 'Enterprise Area' on top is 'Project Management' and below follow all the other processes.

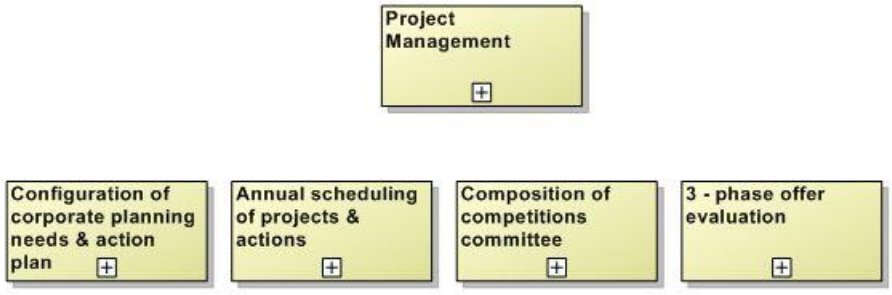


Figure 5.10: List of BDMs

At this point we should mention that the process '3 – phase offer evaluation' that is included in the BDM list, is an 'Elementary Business Process' because it is part of the process 'Offer evaluation & award'. The latter is composed by two elementary processes, as it is shown in the following 'Process Hierarchy' diagram.

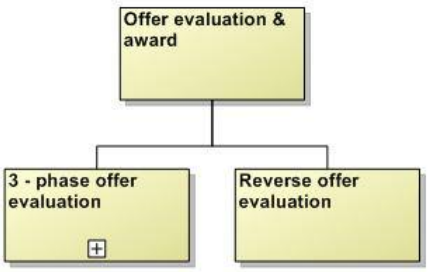


Figure 5.11: 'Offer evaluation & award' decomposition

Each of the processes of the BDM list has a '+' icon on them which means that they have been "exploded" into one or more diagrams. In this cell the type of diagram that interests us is the 'Business Dynamics Model', so this is the one that we are going to focus on at this point. However we are going to explain shortly how the 'explode' option works. By clicking on the 'explode' icon (the '+' symbol) the 'Explode Diagram' dialog box opens, showing all the diagrams the specific process has been 'exploded' into. For example, the first process 'Configuration of corporate planning needs & action plans' has been 'exploded' into two diagrams, a BDM and a SDM (details on these types of diagrams will be given afterwards), as it is shown in the picture.

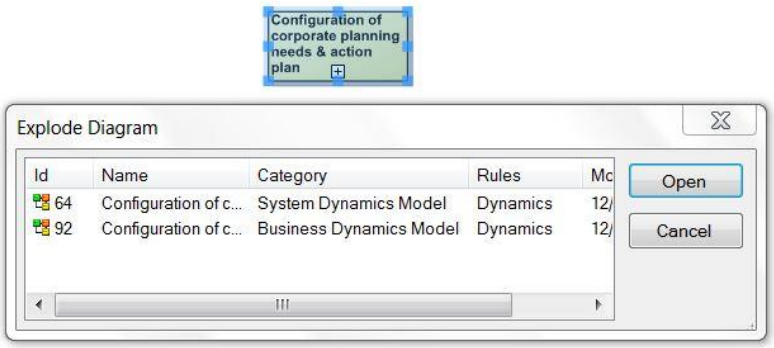


Figure 5.12: Explosion of a 'Business Process'

After selecting which diagram we want to open, a new screen appears in which the selected diagram is shown.

Again we point out that the reason why not all of DEPA's 'Project Management' subsidiary processes have a '+' icon on them, is that we did not focus on 'exploding' each and every process DEPA executes, but we analyzed and developed some of them.

A 'Business Dynamics Model' or BDM, is the highest level diagram category. It shows the scope of the process model and it presents an end – to – end overview of the business. A BDM answers to what the business does. A BDM explodes to a 'System Dynamics Model' which constitutes the next level of diagrams. This 'explosion' increases the level of detail from one diagram to the other. In BDMs it is more common to find process categories like 'Enterprise Area' processes, or 'Business Process', since these two categories indicate high - level processes and represent whole business areas. The BDMs constructed should show the key enterprise 'value chains'. They just show how major process steps link to result events. They do not show how these steps are implemented at locations, by organizations or with technology. In other words, in a BDM the significant 'Events' and 'Results' of the enterprise are being matched with high – level 'Business Processes'.

Examples of BDMs constructed for DEPA's high – level processes follow next.

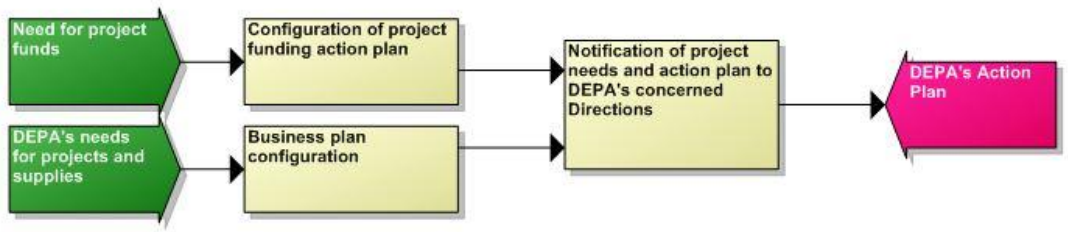


Figure 5.13: BDM for 'Configuration of corporate planning needs & action plan'

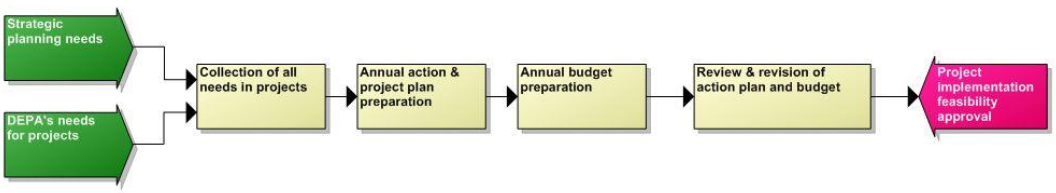


Figure 5.14: BDM for 'Annual scheduling of projects & actions'

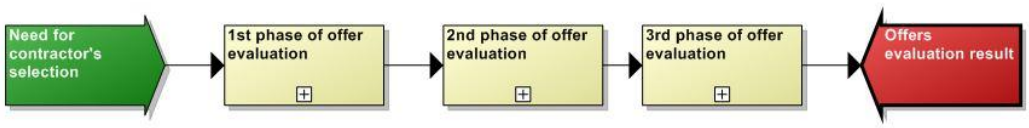


Figure 5.15: BDM for '3 - phase offer evaluation'

In all of the above pictures, one can notice that the objects used are the 'Internal Event' (light green color), the 'External Event' (dark green color), the 'Elementary Business Process' (beige color), the 'Internal Result' (pink color) and the 'External Result' (red color). The 'Internal Event' is an event which causes a process to begin, but which is internal to the business itself. The 'External Event' is an occurrence external to the business which causes the process to begin. The 'Elementary Business Process' indicates that it is a high – level process, which refers a basic business operation. The 'Internal Result' is a result achieved upon completion of a process, but which does not have an effect on the world outside of the business. And finally, the 'External Result' is an occurrence which has some effect outside of the business itself.

3rd row: Designer's view, logical. This cell consists of a list of the enterprise's 'System Dynamics Models' (SDMs). It is a simple list, not a hierarchy diagram, including all business processes that have been "exploded" into an SDM. The object used here is the 'Business Process' and the '+' icon marked on them indicates that they have been "exploded" into another diagram, just like in the BDM list of the 2nd row.

All of DEPA's 'Project Management' subsidiary business processes can be 'exploded' into an SDM. But again, since the aim of this paper is not to fully develop all of DEPA's operation areas, but explore some of them in depth, only some of the subsidiary business processes have been developed and they are presented in the following figure. Again, as in the BDM list, the 'Enterprise Area' on top is 'Project Management' and below follow all the other processes that have been 'exploded' into SDMs.

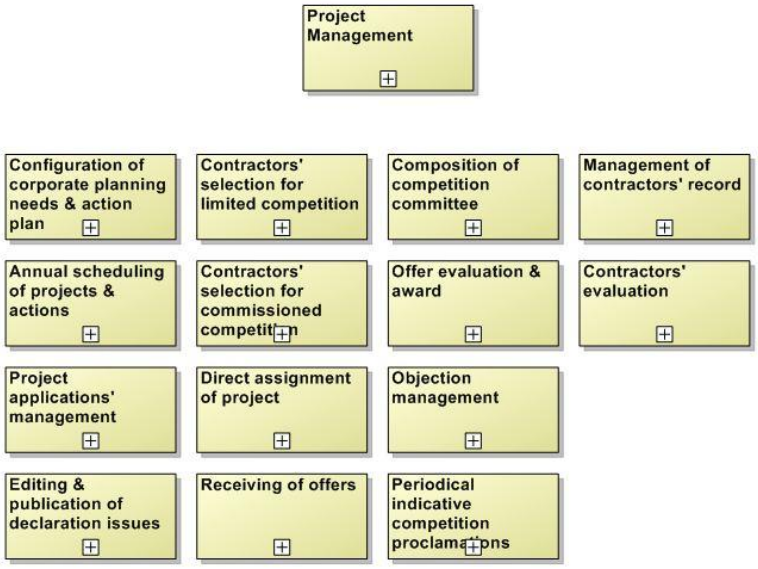


Figure 5.16: List of SDMs

A 'System Dynamics Model' or SDM, is the next level of diagram after the BDM. It explodes a process on the parent BDM and shows the particular process in much more detail and in terms of the real world process flow (for example X department does one thing then Y department does another thing). An SDM answers to who, when and where the required acts are performed. An SDM explodes to a 'Function Dynamics Model' which constitutes the next level of diagrams. This 'explosion' increases the level of detail from one diagram to the other. The most appropriate process category in an SDM is the 'Derived Logical Process', which is carried out by one person or one team at a specific point in time and at a specific location. This kind of process cannot be stopped partway through. Usually one starts with a BDM and then builds up the SDM. The SDM view of the process is constrained, whereas the BDM is not. One may construct multiple SDMs for different system constraints. These constraints refer to location, organization, technology etc. An SDM is used as the starting point for a system specification or procedure manual. It shows the process steps and their dependencies inside the process. It is common to copy a start event or end result from the corresponding BDM and develop the SDM, taking into consideration the 'Organizations' or 'Locations' which are involved in the process. The aim is to analyze the process to a certain level by linking the process steps to the appropriate 'Organizations', 'Locations', 'Applications' and 'Technologies'. Examples of SDMs constructed for DEPA's processes are presented next. The ones that are cited are the ones that contain many different objects, less common, so that they are mentioned and explained.

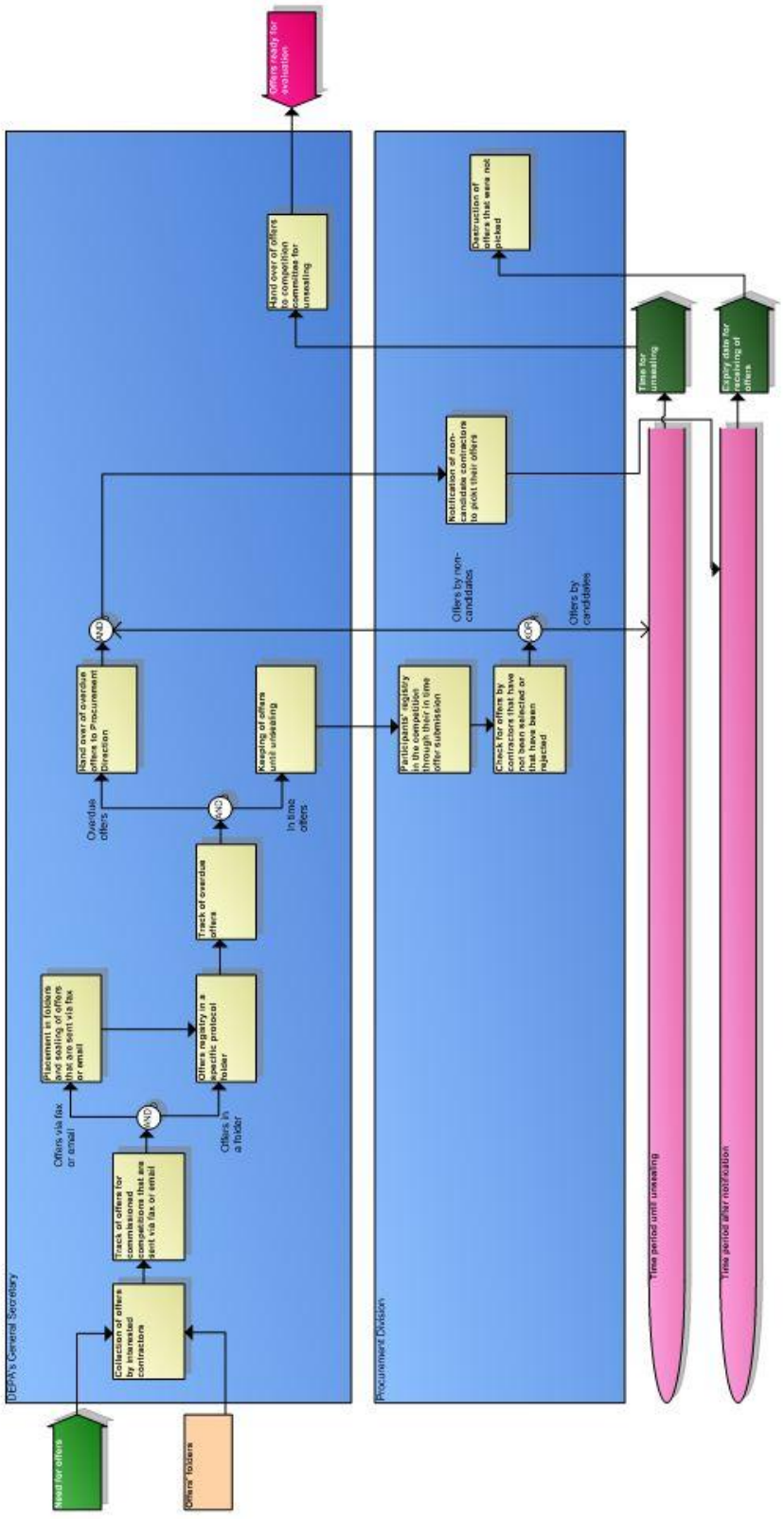


Figure 5.17: SDM of 'Receiving of offers'

In the picture above one can see many of the objects that are commonly used in an SDM diagram. Apart from the 'Event', 'Result' and 'Derived Logical Process' that have already been discussed earlier in the paper, other important objects are the 'Connector Sets', the 'Process Break', the 'Documentation' and the 'Swim Lanes', all of which appear in this diagram.

The 'Connector Set' is used to model a complex flow of information or data, where a decision is involved. There are three types of 'Connector Sets': 'XOR', 'OR' and 'AND'. For the 'AND' set there are two options, the 'Input AND' and the 'Output AND', according to whether the "Connector Set' reaches or leaves a process. The 'XOR' (Exclusive OR) 'Connector Set' describes a path where only one of several alternative exit routes is followed. The 'OR' 'Connector Set' describes a path where either one of several alternative exit routes is followed. The 'AND' 'Connector Set' describes a path where all of the several alternative exit routes are followed, or a path where all of the routes leading to a following process must be complete in order for the process to be triggered. The 'Connectors' (the lines connecting two or more objects) following an 'XOR' or 'OR' are 'optional', whereas the 'Connectors' linking an 'AND' are 'mandatory'.

The 'Process Break' (the pink long object in the diagram) is an object that defines delay in a process while it is waiting for an event of some kind. The properties that have to be declared for a 'Process Break' are its 'name' and the 'delay', the amount of time the pause is going to last. In our case DEPA has some ground rules regarding the time period that has to pass during which non – successful candidates have the opportunity to take back their offers' folders. After this period has passed, the folders are destroyed by DEPA. This whole sequence is represented using a "Process Break', which gets triggered by a 'Process' but always leads to an 'Event' (one cannot connect the output end of a 'Process Break' to another 'Process' or 'Result').

The 'Documentation' (beige object) can represent written information for any read, projection or technical performing, data media of any format and for any reproduction, quick – reference guidelines, that is either on paper or distributed via websites or on – line applications. In DEPA's case, and specifically in the diagram we are examining, the 'Documentation' used is the 'Offers' folders', which is actually a file containing all offers from candidate contractors.

A very important element in an SDM diagram is the 'Swim Lane'. The term 'Swim Lane' is used by Business Analysts to describe how 'Process' mapping often appears on diagrams. 'Processes' are placed inside 'Location' or 'Organization' objects to show that they either occur at the 'Location' they lie within, or are the responsibility of the 'Organization' they lie within. So in the following diagram, object A is an 'Organization' that is responsible for performing 'Process' C, and object B is a 'Location' where 'Processes' D and E occur. The term 'Swim Lane' is used because the objects are typically represented as elongated rectangles, which look like the lanes in a swimming pool, as it is clear in the picture.

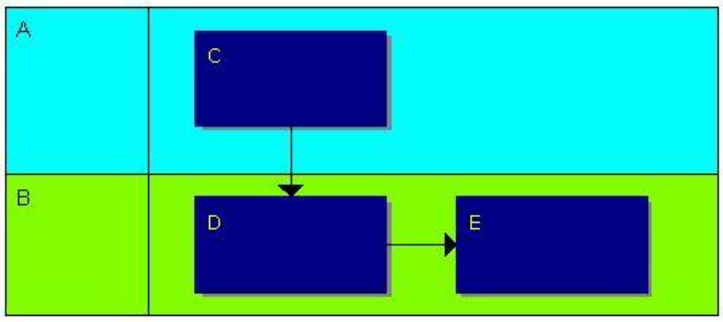


Figure 5.18: 'Swim lanes'

A 'Swim Lane' is therefore used to make associations on diagrams. The way to achieve this is to simply drag the 'Process' into a 'Swim Lane' object. When this is done, an association between these two objects is created automatically. Alternatively one can create the association by defining a new link in the 'Properties' dialog box of a 'Process', following the steps shown in the pictures. Obviously when one creates an association this way, the association is valid for both objects (both the 'Process' and the 'Organization') and it can also be done the other way around (defining the association in the 'Properties' dialog box of the 'Organization').

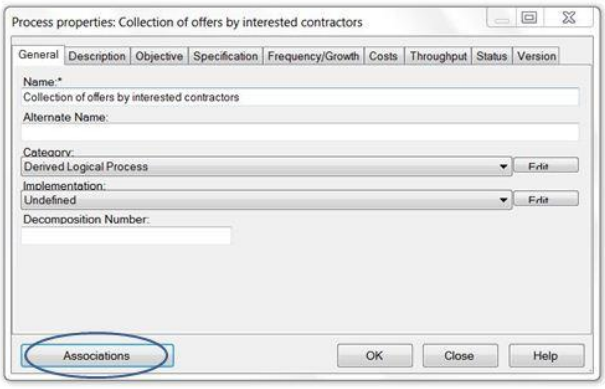


Figure 5.19: First step of the creation of an 'association' between a 'Process' and an 'Organization'

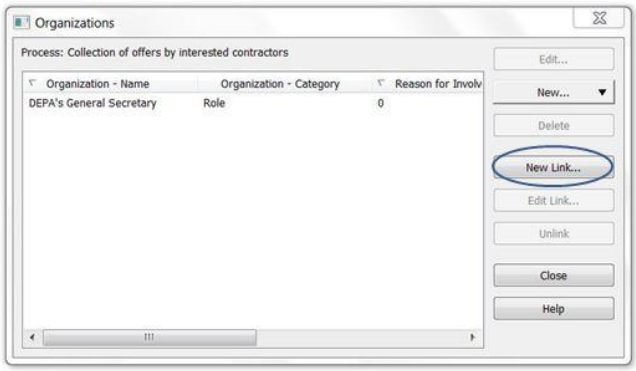


Figure 5.10: Second step of the creation of an 'association' between a 'Process' and an 'Organization'

In DEPA's case, we see in Figure 5.2.11 that the 'Swim Lanes' used in the particular diagram are the 'Organization' units 'DEPA's General Secretary' and the 'Procurement Division'. The first is a 'Role', whereas the second is a 'Division'. It is not obvious that they are 'Swim Lanes' due to their rectangular shape.

Another example of an SDM is the following.

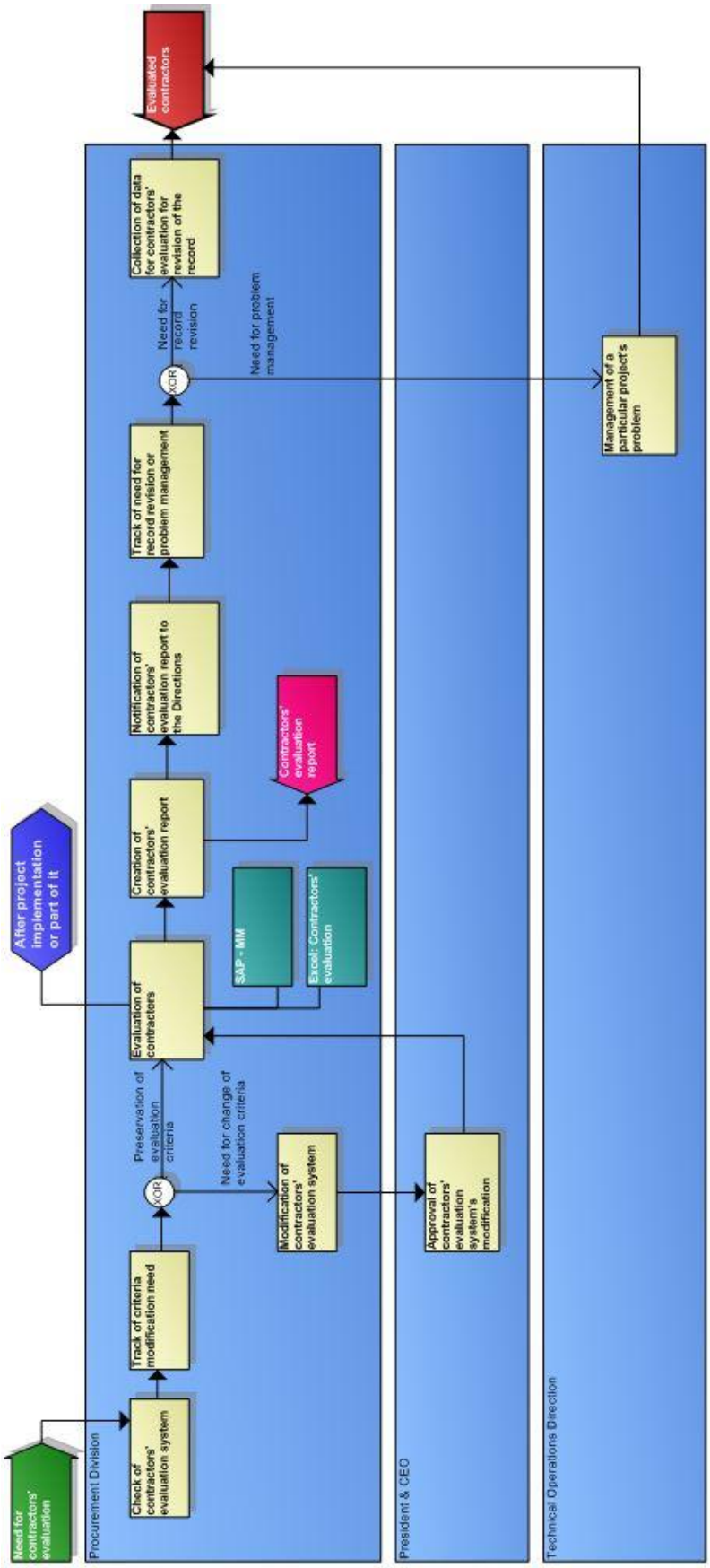


Figure 5.11: SDM of 'Contractors' evaluation'

In this diagram we see all of the main objects of an SDM diagram, plus some others, which will be explained next. These are: the 'Application' and the 'Issue'.

The 'Application' (the two ciel objects) represents a program or group of programs used by the 'Organization' for the execution of a 'Process'. Such examples are: an operating system, any software or its applications etc. The 'Applications' used in the above diagram are the 'SAP – MM' and the 'Excel: Contractors' Evaluation'. The first refers to the famous business management software package (and more specifically to the Materials' Management module) and the second to the Excel file created after the evaluation of the contractors. Both 'Applications' are linked to the 'Evaluation of contractors' process, which means that 'SAP – MM' was used during the execution of the particular 'Process' and the 'Excel: Contractors' Evaluation' was produced as a result of the 'Process'. The 'Application' object is linked to a 'Process' by using a special line, the 'Process – Applications' connector.

Lastly, the 'Issue' (blue polygon object) is some text which identifies important questions to be raised and solved for an object. One can create an 'Issue' while a model is under development. Typically it is used to keep track of outstanding issues and other supplementary information. 'Issues' can be associated to specific objects or whole diagrams. In our case it is used to stress the timing of the 'Process' it is associated to.

4th row: Builder's view, physical. This cell consists of a list of the enterprise's 'Function Dynamics Models' (FDMs). It is a simple list, not a hierarchy diagram, including all business processes that have been "exploded" into an FDM. The object used here is the 'Business Processes' and the '+' icon marked on them indicates that they have been "exploded" into another diagram, just like in the BDMs and SDMs.

Normally all of DEPA's 'Project Management' subsidiary business processes could be 'exploded' into an FDM. But in our case, due to lack of available data, only three of these processes have been developed, and they are presented in the next picture. These 'Processes' describe the offers' evaluation procedure and are part of the '3 – phase offer evaluation' SDM. That is why the '3 – phase offer evaluation' process is on the top of the list and below are the three subsidiary processes that have been 'exploded' into an FDM.

Figure 5.12: List of FDMs

A 'Function Dynamics Model' or FDM, is the lowest level of diagram and therefore shows the most detail. It explodes a process on the parent SDM and shows the particular process in much more detail describing the exact processes required to complete an activity in the SDM. This type of diagram is said to present information at 'task level'; this is because it describes each task a member of staff will have to perform to complete the process. An FDM answers to how each specific act is actually performed.

The most appropriate process category in an FDM is the 'User Request', which is a step of a 'Derived Logical Process' which involves some human interaction to be completed; it is a 'task'. It shows the detailed physical workings of a 'Derived Logical Process' and it should be suitable to define a workflow or computer program. Usually one decomposes each bottom – level SDM from the 3rd row into one or more levels of FDM. The FDM can be used to give detailed specifications and test scripts for developers, as an instruction manual for end users, and to configure and build actual applications. FDMs can be converted into other useful system development objects with interfaces.

An example of an FDM constructed for DEPA is presented next.

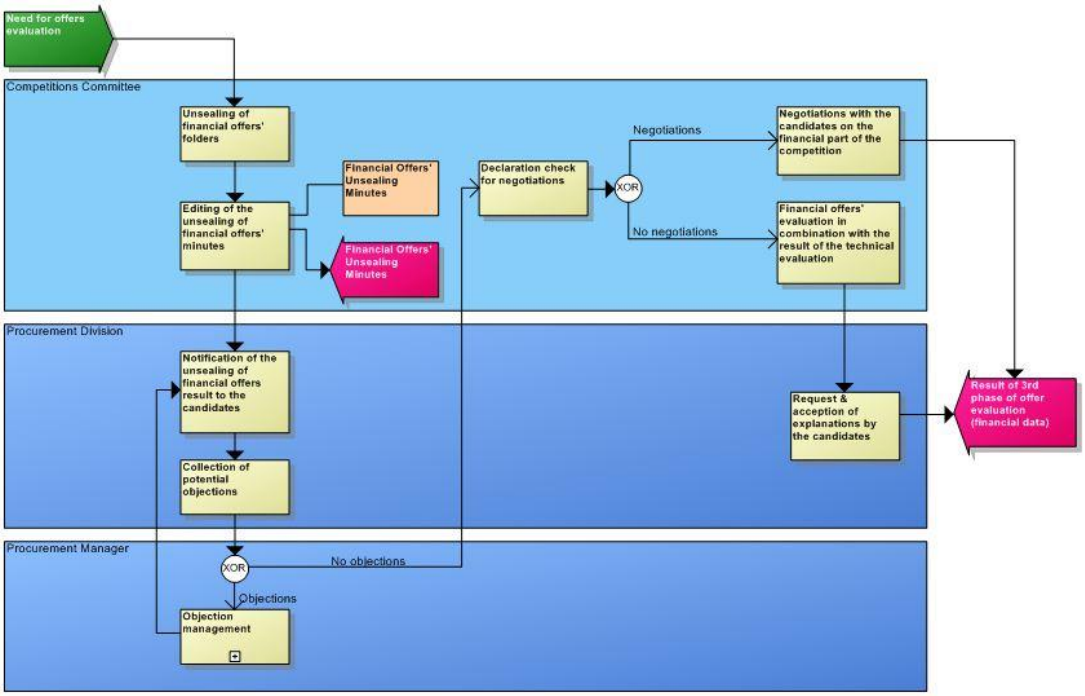


Figure 5. 13: FDM of '3rd phase of offer evaluation'

5.2.1. Entities

It was mentioned earlier in the paper that a 'Committee' in DEPA is a team of people with a particular task. The 'Competitions Committee' is responsible for the conduct of the competition, the control and security of the procedures and so on. This organizational unit of DEPA is represented by a 'Body' object, which is actually an 'Organization' under the category 'Body'. A 'Competitions Committee' however is temporary, which means that it doesn't exist permanently, but is composed for the time period of the competition and is decomposed afterwards. This means that every time a 'Competitions Committee' is composed, it is made up by different people (although in reality most times the people participating in a committee are the same because of their experience in such procedures). The fact that for example, a member of the 'Competitions Committee' might not always be the same physical person, but is represented by an 'Entity', which is actually a concept that might exist for just some time, is depicted in an 'Entity Model'. An 'Entity Model' is used to draw 'Entities' and the relationships between them. All 'Entities' should have at least one relationship. At this point it is important to mention that in the Corporate Modeler Suite a relationship describes how two instances of type 'Entity' are related. The two Entities typically represent items in the real world whose relationship one needs to understand and

model. By convention one of the Entities in the relationship is deemed the parent and the other is the child.

The types of relationships that exist in the Corporate Modeler Suite are shown in the following picture along with their explanation.

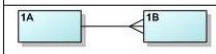
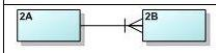
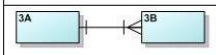
How the relationship and Entities appear on the canvas	How the relationship appears on the diagram palette	How the parent Entity is related to the child	How the child Entity is related to the parent
		For each parent Entity 1A there are zero or more child Entities 1B. Example: A **customer** places zero or more **customer orders**	For each child Entity 1B there can only be at most one parent Entity 1A. Example: Each **sales person** can only have at most one **sales manager**
		For each parent Entity 2A there are one or more child Entities 2B Example: A **customer order** consists of one or more **order lines**	For each child Entity 2B there can only be at most one parent Entity 2A
		For each parent Entity 3A there are one or more child Entities 3B	For each child Entity 3B there must only be one parent Entity 3A Example: each **order line** belongs to just one **customer order**
		For each parent Entity 4A there are zero or more child Entities 4B	For each child Entity 4B there must only be one parent Entity 4A

Figure 5.14: Relationship types

The 'Entity Model' constructed for DEPA's 'Competitions Committee' is presented and discussed next.

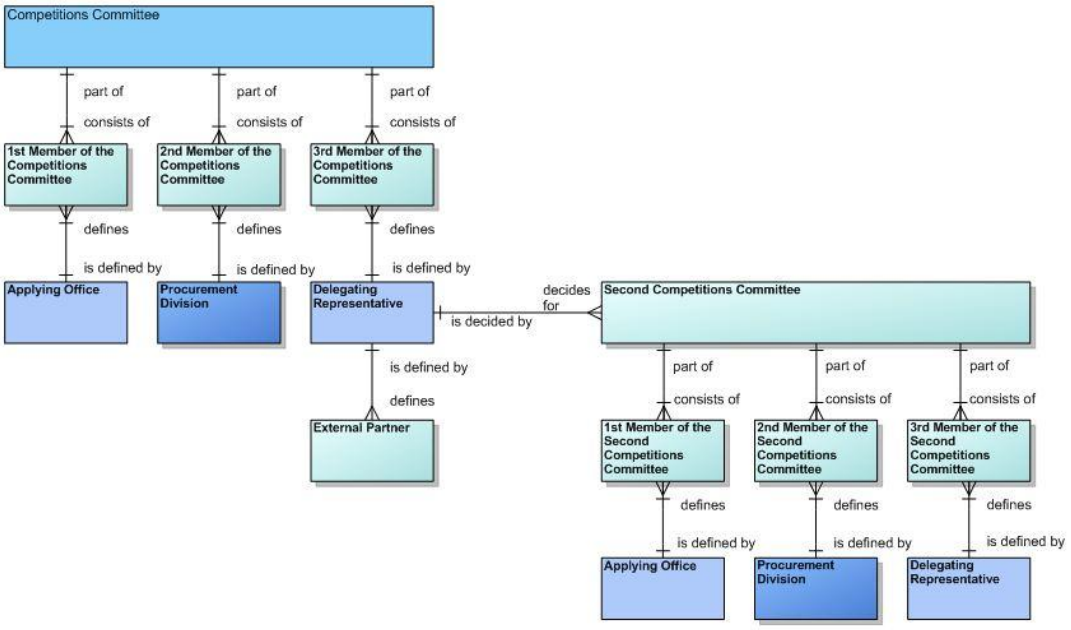


Figure 5.15: Entity model for 'Competitions Committee'

In the diagram above one can see that not all objects are 'Entities' (the turquoise colored objects), whereas in an 'Entity Model' all objects should be. The reason this was done, is because we wanted to relate the 'Competitions Committee' 'Entities' to the already existing 'Organizations'. The fact is that the selection of committee members is done by existing 'Roles' or 'Divisions' of the company, and that is what we wanted to show in the diagram. It would be wrong to define new 'Entities' for the already existing 'Organizations', so we related the new 'Entities' to the already existing 'Organizations'. The main reason for doing that – apart from the avoidance of the mismatch with the program- is so that when someone wants to get a complete report from the program about the Organizations' associations, relationships or tasks, they can. Otherwise the relationships shown in this 'Entity Model' would not be visible in such a report and so the Organization's profile would be incomplete.

Another issue about the diagram is the fact that relationship links only apply to 'Entity' objects. This means that a relationship cannot link an 'Entity' with an 'Organization'. That's why another type of connection has been used in the particular diagram, to show this exact link. It is not obvious in the picture, because it is just a line, but all the connections between 'Entities' and 'Organizations' have been created using the 'Entity – Organizations' association. It is an already existing option in the program's repository (but even if it wasn't one could easily create it). By defining the association between each 'Entity' and its corresponding 'Organization' we have a fully developed diagram, with all existing relationships among its objects, which helps us draw any necessary information.

5.3. The 'Motivation' column

The 'Motivation' column is the least developed column in terms of recommended models. The program offers a model only in the 1st row and gives no further guidance for the rest of them. Consequently, it is up to the architect to choose which models he is going to use or create new ones that depict the enterprise's needs. This can be very difficult for the architect, since the freedom he has can lead him to confusion or ignorance. However this is the one of the program's biggest challenges· to expand and develop new ideas and models that correspond to each different case.

1st row: Planner's view, contextual. This cell actually encloses the company's mission and vision, expressed by concepts like 'Business Goals', 'Critical Success Factors' (CSFs) and 'Key Performance Indicators' (KPIs).

A 'Critical Success Factor' is a very important factor or activity required for the success of the company. It is a critical factor on which the company should focus in order to achieve its goals. As a definition, CSFs refer to the "limited number of areas in which satisfactory results will ensure successful competitive performance for the organization" [Morrison Mike, 2007]. Setting the right CSFs helps the company focus on the necessary capabilities to meet its CSFs and thereafter its goals.

Whereas a CSF is an element vital for a strategy to be successful, a 'Key Performance Indicator' is the measure that quantifies business objectives and goals and enables the measurement of strategic performance. In a way a KPI is the measure of how well the company is doing in achieving its CSFs (and furthermore realizing its goals).

The diagram in this cell is a list of 'Business Goals' and 'CSFs' as one can see in the following picture (the purple objects being the CSFs and the blue ones the business goals).

At this point it is important to point out that all of this column's data is collected from the available literature, and is not provided by DEPA. However it is all information that regards a company like DEPA, and was used to explore this column a little further.

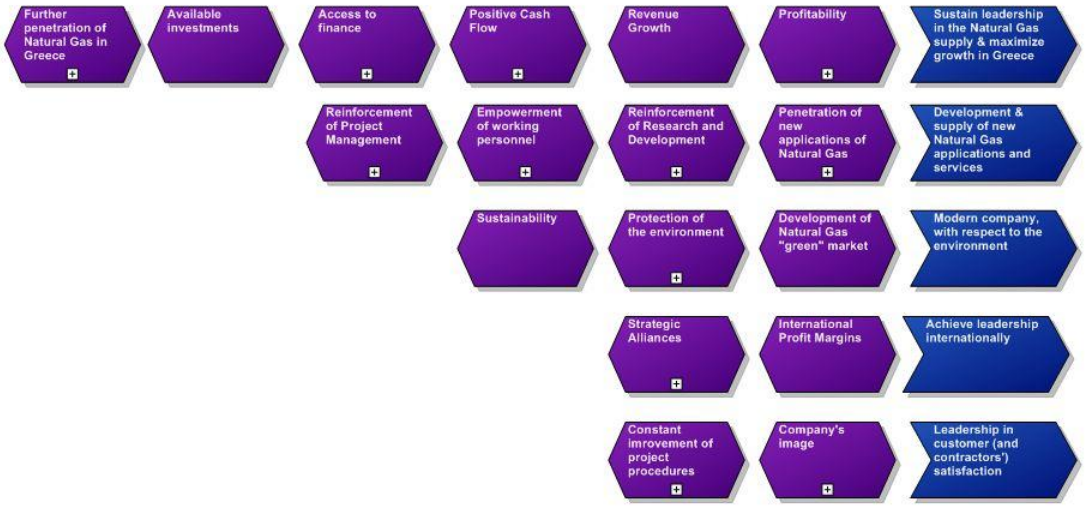


Figure 5.16: List of Business Goals and CSFs

As one can notice, some of the CSFs have a '+' sign, which means they have been 'exploded' into another diagram. This other diagram is a 'Hierarchy' diagram, which represents how a CSF is broken down into KPIs. In other words this diagram shows which indicators are used

to measure the effort to achieve the corresponding CSF. Next is an example of this (the grey object is obviously the KPI).

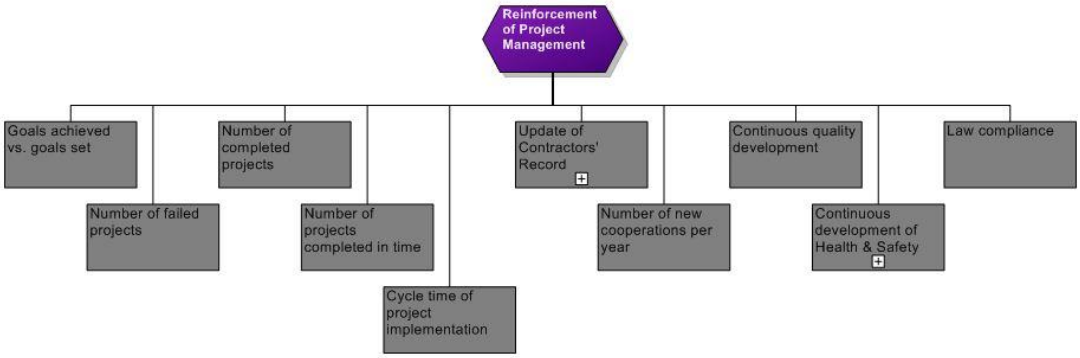


Figure 5.17: Explosion of CSF 'Reinforcement of Project Management' into KPIs

The CSF is an already existing object in the Corporate Modeler, whereas the KPI is not. Therefore we have to create a new object, under the name 'KPI' and with certain properties. This is done in Model Explorer, where one can also define the associations between KPIs and other objects. For example, a KPI is associated with a specific (one or probably more) 'Organization', which means that this 'Organization' is responsible for achieving the desired result described by the KPI. Furthermore, a KPI is connected to a 'Process', meaning that the outcome of the 'Process' should be of a certain (desired) level (again depicted by the KPI). The definition of these associations is shown in the following picture.

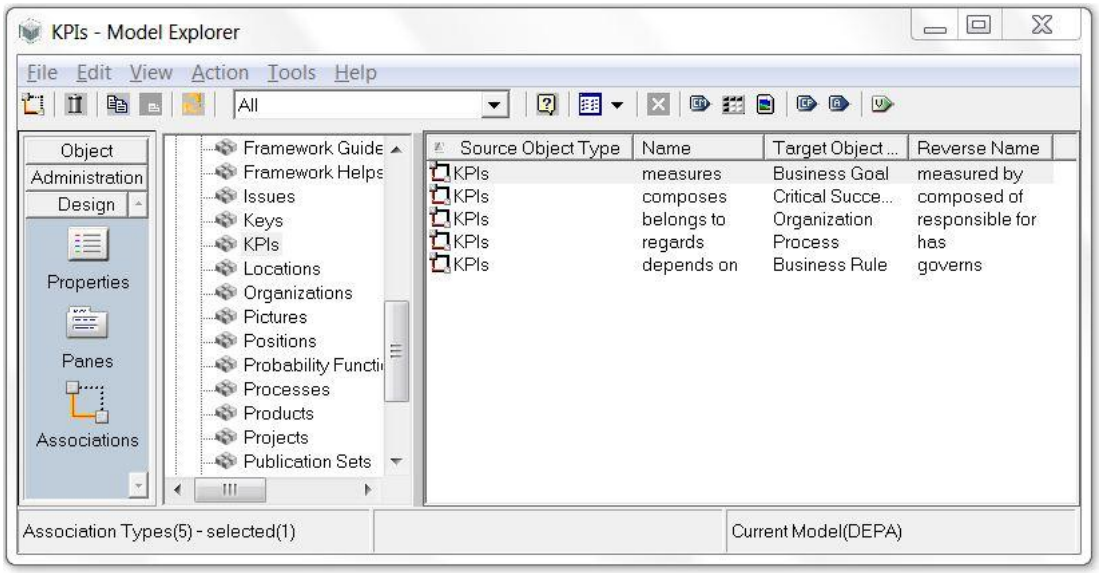


Figure 5.28: KPIs' associations

Some of the KPIs in Figure 5.3.2 have been exploded into more detailed – Derived – KPIs, which are more specific or focused measures.

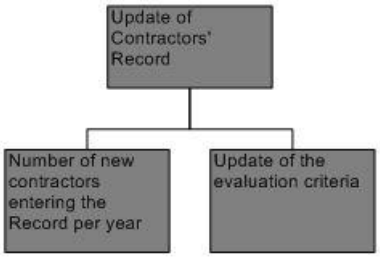


Figure 5.29: Explosion of KPI 'Update of Contractors' Record' into Derived KPIs

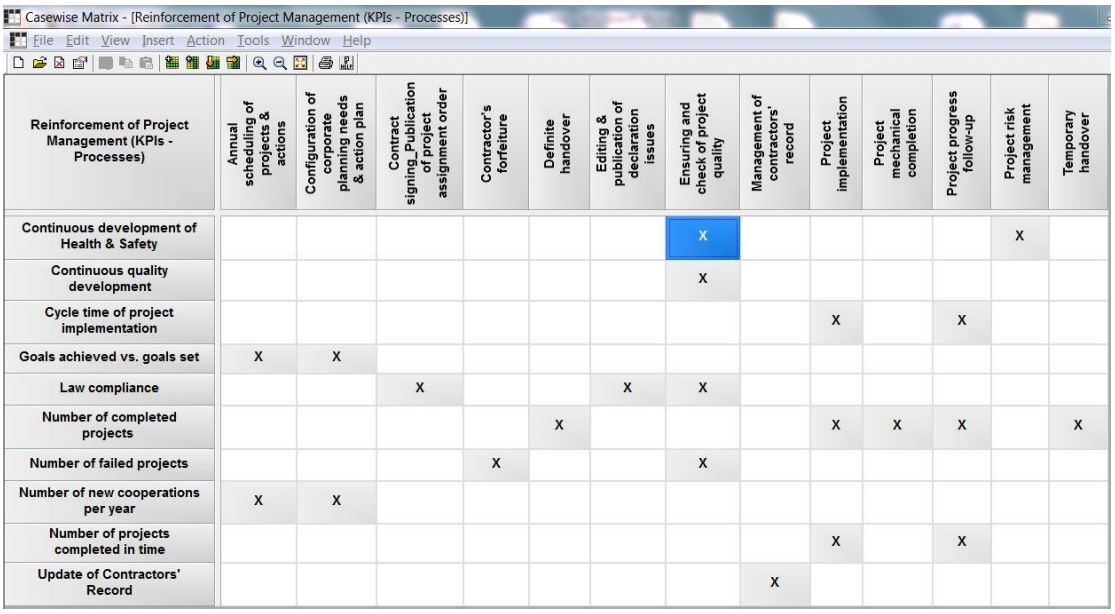
The associations between KPIs and other objects can be depicted in 'Matrices'. The 'X' shows that there is a connection between the two objects. Examples of such matrices follow next.

Casewise Matrix - [KPIs - Organizations]

File Edit View Insert Action Tools Window Help

KPIs - Organizations	Corporate & Communication Affairs Direction	Finance & Administration Direction	Human Resources Direction	Information Technology & Corporate Procedures Direction	Legal Affairs Direction	Natural Gas Commercial Direction	Natural Gas Distribution Direction	President & CEO	Strategy & Corporate Development Direction	Technical Operations Direction
% of new personnel			X							
% of new technology equipment										X
% usage in air conditioning & cooling machines						X	X		X	
% usage in automobiles						X	X		X	
% usage in cooking & professional furnaces						X	X		X	
% usage in electric energy production						X	X		X	
% usage in professional drycleaning machines						X	X		X	
% usage in the industrial sector (energy & heat production)						X	X		X	
Cash Ratio		X								
Competitive pricing policy						X				
Continuous development of Health & Safety										X
Continuous quality development										X
Contractors' opinion	X									X

Figure 5.30: Matrix with company's 'KPIs – Organizations' associations



Reinforcement of Project Management (KPIs - Processes)	Annual scheduling of projects & actions	Configuration of corporate planning needs & action plan	Contract signing_Publication of project assignment order	Contractor's forfeiture	Definite handover	Editing & publication of declaration issues	Ensuring and check of project quality	Management of contractors' record	Project implementation	Project mechanical completion	Project progress follow-up	Project risk management	Temporary handover
Continuous development of Health & Safety							X					X	
Continuous quality development							X						
Cycle time of project implementation									X		X		
Goals achieved vs. goals set	X	X											
Law compliance			X			X	X						
Number of completed projects					X				X	X	X		X
Number of failed projects				X			X						
Number of new cooperations per year	X	X											
Number of projects completed in time									X		X		
Update of Contractors' Record								X					

Figure 5.31: Matrix with 'KPIs – Processes' associations (includes only 'Reinforcement of Project Management' KPIs)

2nd row: Owner's view, conceptual. In this cell Corporate Modeler includes the company's 'Business Plan' but just as a guideline, not as a specific model. Because this is very vague (a 'Business Plan' includes so many things, like procedures, policies, standards, constraints etc.) we chose to focus on some 'Business Rules' which govern the company's strategy and operation. Of course in this row, we refer to high – level business rules, which apply to the business' CSF and goals.

'A business rule is a criterion used to guide day-to-day business activity, shape operational business judgments, or make operational business decisions. Business rules have definite form, and are very specific. Each business rule gives well-formed, practicable guidance. Each uses terms and wordings about operational business things that should based on a structured business vocabulary (fact model). Each expression is declarative, rather than procedural. Business rules need to be managed and single-sourced. They represent a form of business communication and must make sense (communicate) to business people. They can be technical, but only in terms of the company's know-how or specialized product/service, not in terms of IT designs or platforms' [Object Management Group (OMG), 2007, 'Semantics of Business Vocabularies and Business Rules'].

The aim however was not to simply quote some 'Business Rules' but explore how these are connected and associated to the other objects used in this column. So, we represented this relationship in a 'Generic' diagram, in which it is shown that 'CSFs' are 'based on' 'Business

Rules' and the latter 'lead to' 'Results' important for the company. The following picture shows the concept used in this diagram.

Figure 5.32: The concept for connecting CSFs and Business Rules

According to this concept we stated some basic, high – level 'Business Rules' which govern DEPA's operation (and more specifically its 'Project Management' area) and associated them with the 'CSFs' they regard and the 'Results' they produce. An example is shown in the following picture.

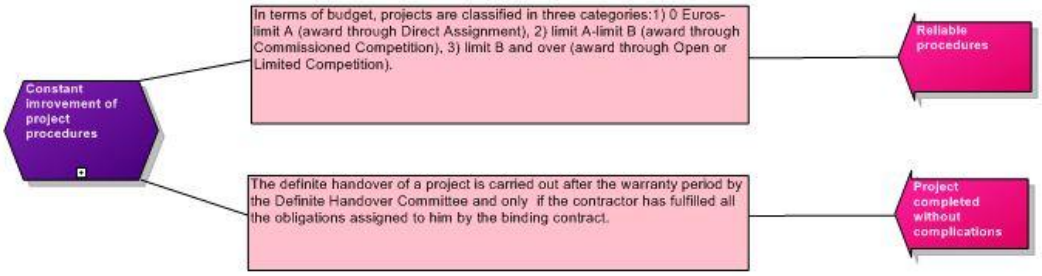


Figure 5.33: High – level Business Rules, CSFs and Results

3rd row: Designer's view, logical. In this cell the business rules included regard lower – level business structure and process. In other words, they refer to SDM level of operation, which is more detailed and specific than the one in the 2nd row. Here, in analogy to the concept mentioned above, which associates 'CSFs', 'Business Rules' and 'Results', we associate some lower – level 'Business Rules' with the 'KPIs' and the 'Results' they are related to. The example shown in the picture regards the time period needed for the award of a project to a contractor. Note that the 'KPI' and the 'Result' refer to SDM level processes.

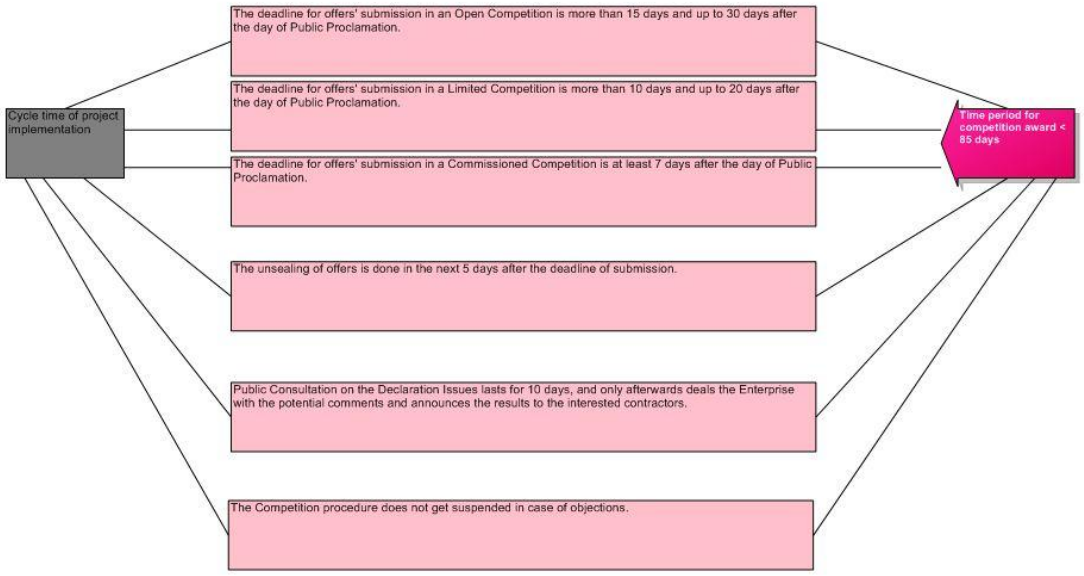


Figure 5.34: Lower – level Business Rules, KPIs and Results

6. Simulation

A very interesting application of the Corporate Modeler Suite is the 'Simulator'. The Simulator allows one to animate business processes. That is, to see what would happen if the processes one has drawn as diagrams are actually performed. Simulating process diagrams is a powerful way of understanding and analyzing the effectiveness of one's business processes. One can see if there are any bottlenecks in the processes (caused by lack of resources), or if one is running processes which do not help them achieve their business goals.

The Simulator takes the business process diagrams and creates an animation describing how those processes would behave in the real world (how long each process would take to perform, what costs would be incurred as a result of performing it etc.). This animation - and the output simulation report - allows one to see what would have happened had the business processes actually been performed. Simulating processes allows one to see how effective they are and to analyze the impact changes to those processes (increasing staff numbers, automating systems etc.) would have, without adversely impacting one's actual business. Overall simulating helps identify and eliminate bottlenecks and unacceptable delays, identify ways to process in parallel where possible, identify, assess and replace inefficient activities, analyze the impact of change, communicate process knowledge. Simulating gives people the opportunity to avoid the cost of the implementation of a wrong

solution and the chance to try many solutions, without actually implementing them. If the simulation is based on correct input data, then it is able to lead to the increase of service level and throughput, and to the decrease of total process cycle time, waiting time, inventory cost and activity cost. A simulation can only run on 'Dynamic' diagrams, like BDMs, SDMs etc.

After having constructed the dynamic diagram and before starting the simulation, one must give the objects on the diagram simulation properties. That is, each object's properties should contain enough information to be able to simulate how it will behave over time. Next we are going to mention which properties should be configurated for each object.

- 'Event': The properties that have to be set for an 'Event' are:
  - Frequency: determines how many 'Events' or jobs will be created over the defined time period, or in other words the rate at which jobs are passed to the process being simulated. The number of jobs can be varied by selecting a distribution from the drop – down list in the 'Properties' dialog box.
  - Growth: it is used to specify the rate at which the 'Frequency' changes.

- 'Process': The properties that have to be set for a 'Process' are:

  In the 'Throughput' tab:
  - 'Service Time': defines the amount of time it takes for resources to complete the process.
  - 'Min/Max. Batch': determines how many jobs must be in the process queue before the process starts.
  - 'Resources/Batch': defines the number of personnel required to fulfill the task (that is the number of people needed to complete the process once).
  - 'Concurrency': determines how many jobs can be done simultaneously.

  In the 'Costs' tab:
  - 'Direct Cost': any expense directly related to a product or service.
  - 'Indirect Cost': is shared and therefore cannot be directly related to a single product or service.

  In the 'Frequency/Growth' tab:
  - 'Frequency': how often the process occurs within a defined time period.
  - 'Growth': the rate of change of the 'Frequency'.
  - 'Repeats': how many times a process is repeated.

- 'Connector': The properties that have to be set for a 'Connector' are:
  - 'Delay': represents how long it takes for control of a job to pass from one end of the 'Connector' to the other end, and simulates the period of time to pass a job between two processes.
  - 'Percent split': is the percentage of jobs emerging from an activity that go down this 'Connector'. If there is a 'Connector Set' in the diagram, the sum of all percent splits must be 100%.

- 'Organization': The properties that have to be set for an 'Organization' are:
  - 'Direct Cost': it is accumulated when the resource is actively performing work that is directly attributable to the job performed by that resource.
  - 'Indirect Cost': it is accumulated when the resource is actively performing work that is not directly attributable to the job performed by that resource.
  - 'Resources': the number of personnel that are available to perform any 'Process' that the 'Organization' is associated with. It is possible that a waiting queue is created due to lack of resources or due to wrong mistaken allocation.

Other additional information that can be defined in a simulation process is:

- 'Time Period': the duration in minutes of a familiar interval of time (Day, Week, Month, and so on). Some 'Time Periods' already exist in the program's repository, but one can create a new one according to their business needs.
- 'Calendar': a sequence of sample points which indicate that some activity turns on and off during the 'Time Period' specified.
- 'Break Point': defines when the simulation will stop. If there is no 'Break Point' set, the simulation will run indefinitely until manually stopped.
- 'Probability Function': is used to statistically calculate the likelihood of something occurring over a given time. The 'Probability Functions' that already exist in the program's repository are the 'Flat', the 'Normal', the 'Poisson' and the 'Triangle', but one can also define a new one.

In this paper we cover the simulation aspects that were used in the case we examined. There is no reason to fully analyze the simulation process since our approach is not educational but result – oriented· we wanted to run a simulation example and interpret the results.

After having set all of the above necessary properties, one can continue to the actual simulation process. By clicking on the 'Simulator' icon on the 'Toolbar', the 'Simulator' window opens, giving the user some more options. In order for everything to work fine and for the results to be complete and accurate, one must 'Validate' the diagram, so that any errors or warnings that may exist are corrected. Apart from that one can at this point define a 'Calendar' for the whole diagram, or a 'Break Point', so that the simulation stops at some point. Then, by clicking on the 'Start' icon on the 'Toolbar' a new dialog box opens, where the user must define a 'Simulation Run'. In it the user can define elements like:

- 'Times Control', which includes the 'Start Time' and the 'Warm up Time' and the
- 'Animation Control', which includes the 'Animation Level', the 'Animation Speed' and the 'Seed'.

'Start Time' can either be the actual current time, or any other given time in the past or in the future. If one selects 'Animated' for the 'Animation Level' it means that there will be an animation during the simulation run, which will show the flow of the process. One can chose from a variety of images for the animation, or even insert a new picture that best represents their case. 'The Animation Speed' determines how quickly the simulation runs. A value of 1 means that it runs at real time, a value of 10 means it runs at 10 times real time speed etc. Obviously if the time period of a simulation is short (e.g. minutes) it wouldn't be wise to set a high 'Animation Speed', because one would not realize or see anything (and of course the other way around). On the other hand, the 'Animation Speed' depends on the computer's CPU (how active it is). Lastly, by giving the 'Seed' a value different from 1, it means that a different generation algorithm will be used during the simulation every time it runs, producing of course different results.

The SDM simulated in this paper describes the process 'Limited Competitions Management'. It actually describes the steps DEPA follows in order to award a competition to a contractor. These steps are in short: configuration of technical specifications, publication of declaration issues, request for interest, request for proposal, receiving of offers, unsealing of offers, evaluation of legal, technical and financial data of the offers and finally award of the competition to the selected contractor. Between most of the steps there is an 'Objections Management' procedure, where all possible objections are gathered, examined and resolved and the decision is announced to the interested contractors. The entire diagram along with

the results report is included in the attached CD. Where there was no available information, we made some assumptions based on experience and logic.

At this point we would like to point out that the type of process simulated here is not a "perfect example" for the simulation process (a "perfect example" being an assembly line process, or a production process) · however we decided to go through with it, so that we explored the whole 'Simulation' and observe how it would work in this kind of a process.

In the following pictures we explain the features that appear during the simulation.

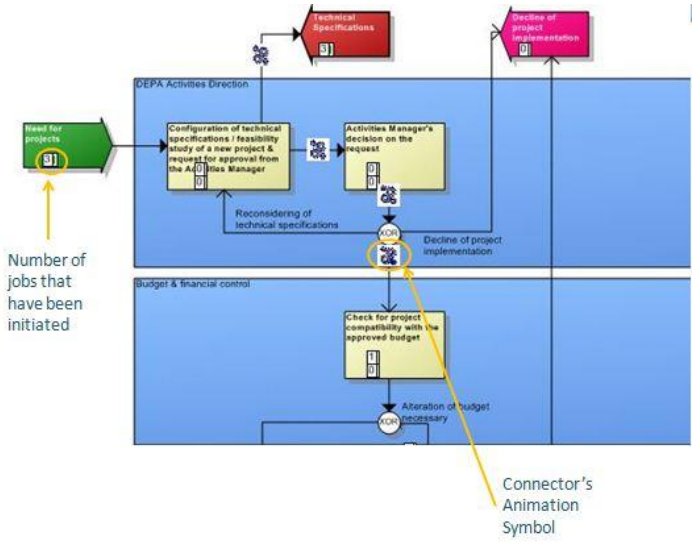


Figure 6.1: Explanation of simulation features - 1

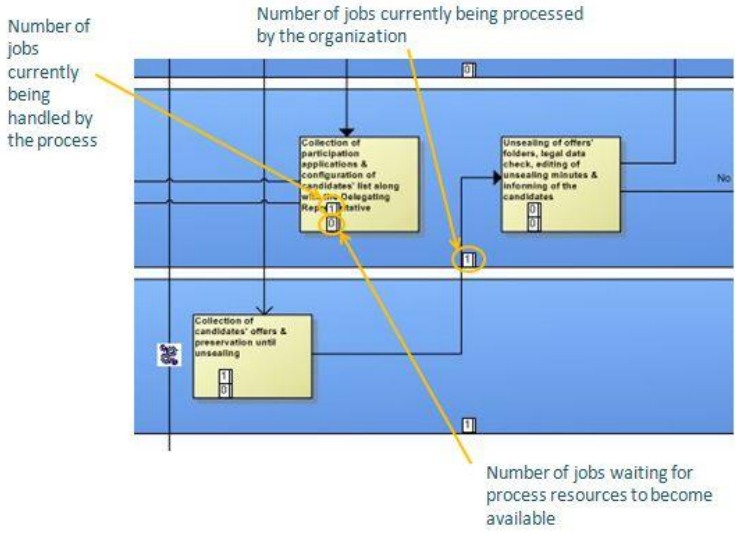


Figure 6.2: Explanation of simulation features - 2

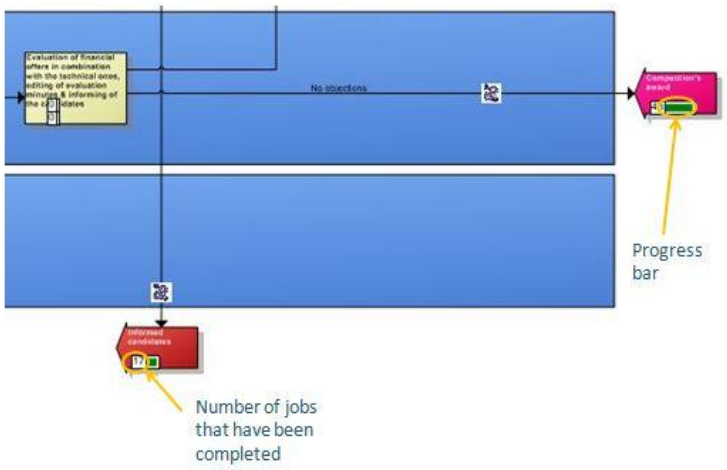
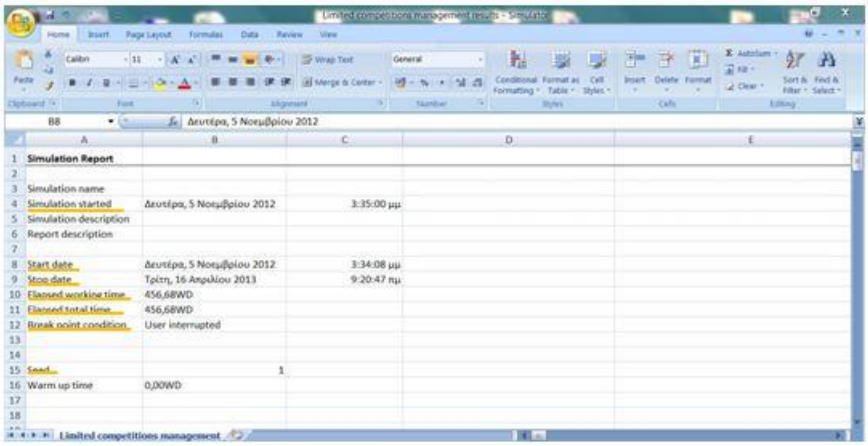


Figure 6.3: Explanation of simulation features - 3

At any time during the simulation, the user has the opportunity to get a results report in the form of an Excel file. It contains information concerning the simulation itself and all its contents (objects, connectors etc.). In the following pictures we are going to present the simulation's results and explain when needed.



	A	B	C
1	**Simulation Report**		
2			
3	Simulation name		
4	Simulation started	Δευτέρα, 5 Νοεμβρίου 2012	3:35:00 μμ
5	Simulation description		
6	Report description		
7			
8	Start date	Δευτέρα, 5 Νοεμβρίου 2012	3:34:08 μμ
9	Stop date	Τρίτη, 16 Απριλίου 2013	9:20:47 πμ
10	Elapsed working time	456,68WD	
11	Elapsed total time	456,68WD	
12	Break point condition	User interrupted	
13			
14			
15	Seed	1	
16	Warm up time	0,00WD	
17			
18			

Figure 6.4: Explanation of simulation results - 1

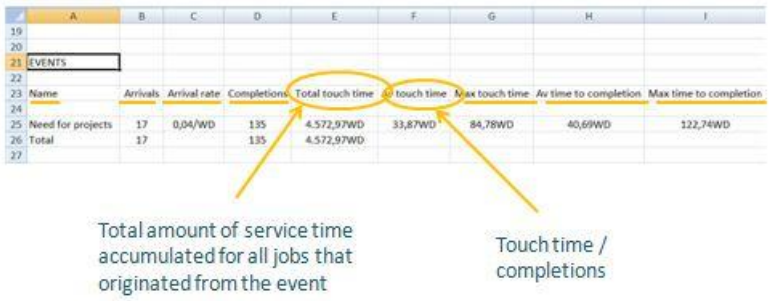


Figure 6.5: Explanation of simulation results – 2

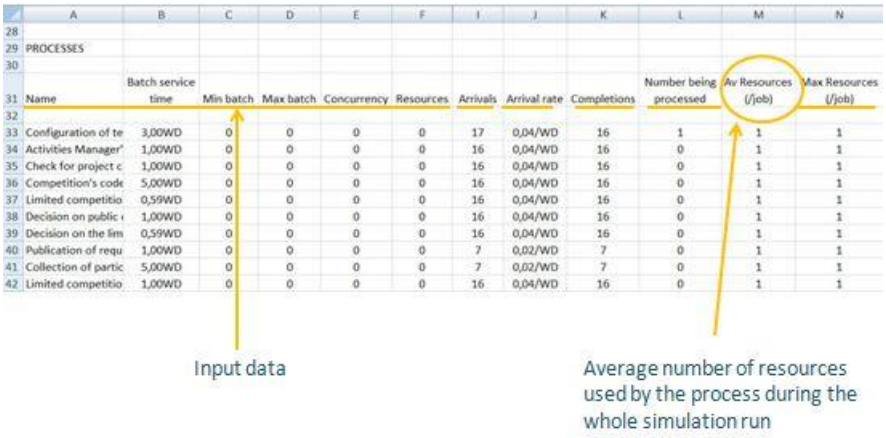


Figure 6.6: Explanation of simulation results - 3

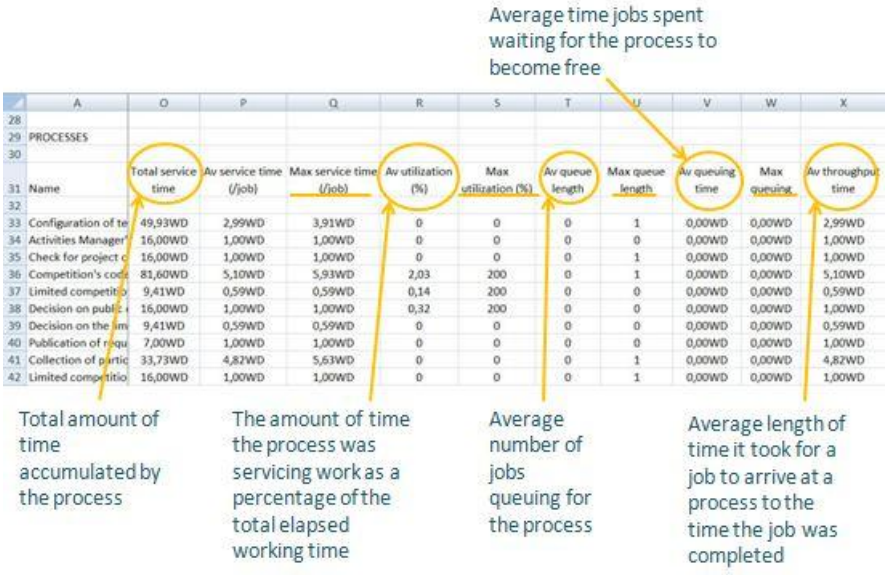


Figure 6.7: Explanation of simulation results - 4

Similar results are produced also for the 'Connectors', the 'Results', the 'Organizations' and the other objects used in the diagram. The important thing here is to interpret the results. For example, the queue length or the utilization percentage can indicate problems in the process and the use of resources. In DEPA's case, we mention again that since this simulation is almost "experimental", the aim is not to figure out the changes that need to be applied, especially since some of the input data result from personal assumptions. However after the simulation, it turned out that the average duration for the award of a limited competition is 59 days, given that the management of objections does not interfere or stop in any way the flow of the competition and that the probability function for 'External Events' such as 'Objections' or 'Need for projects', is the Poisson distribution (it is the most suitable probability function for the "birth" of external, unpredictable events). Of course the program doesn't take into consideration that the weekends are non–working days· as a result the competition's calendar duration reaches 75 days.

7. Conclusions

After having completed the research on the 'Zachman Framework' and the development of DEPA's modeling using the Corporate Modeler, we reached some conclusions.

The most valuable advantage of the 'Zachman Framework' is its holistic perspective of an enterprise. It is true that it covers every possible aspect or point of view from any party (stakeholders, owner, employees etc.) involved in a company. It also takes into consideration all possible elements regarding the company (time, data, location etc.), thus making it a complete framework and an excellent guideline for Enterprise Architecture. However despite of all its complete structure, it still grants the architect with a great deal of freedom when it comes to developing models. This means that the architect can judge and choose the way he wants to approach the framework, the type of models he is going to use and the quality and quantity of information he is going to insert in these models. This is a great advantage, given the fact that each enterprise is unique, with different needs and goals. On the other hand this can be a serious drawback for the modeling process, because all this freedom can be overwhelming and confusing. Sometimes it is much easier for people to just follow precise instructions, than to be left alone to think and decide. All this freedom can lead to bad decisions and results, and to possible de-normalization of the framework, causing it to lose its unique advantage.

The situation described above is also found in Corporate Modeler. The program has many different options for models, diagrams, objects etc. and gives the user the freedom to choose between them or edit them. It has a large repository, which can be easily replenished. However it is a bit weak when it comes to the 'Motivation' column. As we already mentioned when we examined this column, the program suggests a model only for the 1st row, whereas the user / architect is obliged to come up with models of their own for the rest of the rows. This lack of guidance for the three other rows is quite frustrating, given that the Corporate Modeler is supposed to be a complete modeling package, available to every enterprise that might need it. To be fair though, there is not much material on the 'Motivation' column's models in the international literature either (this is the least developed column in general).

A more practical weakness of the program is its inability to define different types of resources for an 'Organization' or a 'Process'. In the 'Properties' dialog box, there is an option for the user to define a number of resources for example for a 'Process'. However this includes only one type of resources, whereas in a 'Process' multiple types of resources may be necessary (people, machines, computers etc.). The program doesn't distinguish the types of resources. Of course this may not be an issue for some enterprises, or it may never cause a problem, but still, since the aim is a precise modeling of the company, it would be best if a distinction between resources existed. Furthermore, this can cause misleading results in a simulation process, since it could indicate a surplus or contrary cover a lack of resources and so alter the true result.

Another imperfection of the program is the fact that 'Relationships' can only connect 'Entities' with each other. It is not such a big problem, because one can apply other types of associations between 'Entities' and other types of objects (like 'Organizations'), but it is more practical and more user – friendly when a certain type of connection is used thoughout the whole diagram. If a 'Relationship' could be used to connect 'Entities' with other objects, then the user would not be obliged to create new associations, and it would give the whole framework a more complete perspective· one could see the actual 'Relationships' of the objects they are interested in and get all relevant information at once.

The 'Simulator' is an "extra" application of the Corporate Modeler, meaning that it is not its main focus (the modeling based on the framework is its main focus), but it is an additional, very helpful application. However it has some deficiencies that make it quite primitive. For one, there is no option for programming, so that one can set more parameters in the

simulation process. For example, in DEPA's case, one could take into consideration during the simulation the existence of more than one external events, such as 'Objections' or 'Offers', that would only be triggered at some specific point of the whole process. In other words, when the time was right (meaning that the Declaration Issues have been published to the candidate contractors), then the 'Offers' Event would be triggered, feeding the system with offers for a specific time period. Neither the frequency of the received offers, nor the time period for offers' collection can be set as an additional variable now.

Also, the Simulator's 'Calendar' is not very flexible. Although it gives the user the opportunity to "program" each process or the whole diagram, this can be done only in terms of actual time. In other words the 'Calendar' is set according to real time (specific days and hours), whereas it could be parametric, and relate objects to one another (for example one process starts when a particular event happens, or one event is triggered when a particular process comes to end). However, we stress again, that the 'Simulator' is just an additional application in the Corporate Modeler (and not its primary focus), very helpful in cases such as an assembly line or production company, where one can insert all necessary data and get some reliable results, and also have the chance to try alternative scenarios by changing the input data, observing the differences and thus being driven to important conclusions about their company.

Of course the Corporate Modeler has some very strong advantages that make it a powerful Enterprise Architecture tool. First of all, it offers a large repository of objects, diagrams etc. but at the same time it gives the user the freedom to expand it by adding user – defined objects or other types of necessary elements or by editing the already existing ones (their properties, associations etc.). Also it offers many different diagram templates, which can be used in modeling. This way it is easier for the user to understand and use the program (and the Zachman Framework) better. It offers good guidance and support to the user, as far as modeling is concerned (of course with the exceptions mentioned above).

It is also quite easy and user – friendly in terms of design techniques (it is a modeling program but it is mostly based on design). The drawing techniques it uses are quite simple and common to other design programs' techniques, making it easy for users acquainted to design, to adjust to the Corporate Modeler quickly and with great ease. The 'explode' option is a really amazing one, because it automatically connects diagrams and matrices and gives them a hierarchical relationship, which depicts the actual relationships of the enterprise's elements.

It includes many different applications (the 'Simulator', the 'Publisher', the 'Automodeler' etc.) which give the user the opportunity to extract information, create reports, discover 'what – if' scenarios and many other alternative options, thus satisfying most (if not all) important needs of a company. Due to its compatibility with Microsoft Office programs, it is very handy and practical when it comes to exchanging data. It offers easy data recovery and automatic creation of reports, which is really useful to managers who are interested in high – level information.

In conclusion, the Corporate Modeler fulfills its purpose, which is to create a complete and organized database for the company's information, where all interested parties can refer to, in order to find the knowledge they need for their working tasks. It is safe to say that it would be a very useful tool for DEPA's case, because it would offer the company great flexibility in modeling its elements and adjusting the program to its needs.

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