FEDERAL UNIVERSITY OF ESPÍRITO SANTO
COMPUTER SCIENCE DEPARTMENT
MASTER IN INFORMATICS

EVELLIN CRISTINE SOUZA CARDOSO

ON THE ALIGNMENT BETWEEN GOAL MODELS AND ENTERPRISE MODELS WITH AN ONTOLOGICAL ACCOUNT

VITÓRIA, DECEMBER 2009

EVELLIN CRISTINE SOUZA CARDOSO

ON THE ALIGNMENT BETWEEN GOAL MODELS AND ENTERPRISE MODELS WITH AN ONTOLOGICAL ACCOUNT

Dissertação submetida ao Programa de Pós-Graduação em Informática da Universidade Federal do Espírito Santo como requisito parcial para a obtenção do grau de Mestre em Informática.

VITÓRIA, DECEMBER 2009

EVELLIN CRISTINE SOUZA CARDOSO

ON THE ALIGNMENT BETWEEN GOAL MODELS AND ENTERPRISE MODELS WITH AN ONTOLOGICAL ACCOUNT

Dissertação submetida ao Programa de Pós-Graduação em Informática da Universidade Federal do Espírito Santo como requisito parcial para a obtenção do grau de Mestre em Informática.

Aprovada em XX de setembro de 2009.

COMISSÃO EXAMINADORA

_____

Prof. João Paulo Andrade Almeida, PhD. Universidade Federal do Espírito Santo (UFES) (Orientador)

_____

Prof. Renata Silva Souza Guizzardi, PhD. Universidade Federal do Espírito Santo (UFES)

_____

Prof. Giancarlo Guizzardi, PhD. Universidade Federal do Espírito Santo (UFES)

VITÓRIA, DECEMBER 2009

ACKNOWLEDGEMENTS

ABSTRACT

Keywords: Goal Analysis, Business Process Modeling, Goal-Process Integration, Goal-driven Business Process Modeling, Goal-based Business Process Modeling, Goal-oriented Business Process Modeling, Tropos, ARIS, Organizational Ontologies.

Business process modelling basically comprises an activity whose main goal is to provide a formalization of business processes in an organization or a set of cooperating organizations (Recker, et al., 2006) (van der Aalst, et al., 2003). By modelling an organization's business processes, it is possible to capture how the organization coordinates the work and resources with the aim of achieving its goals and strategies (Sharp, et al., 2001). Since business processes and goals are intrinsically interdependent, establishing an alignment between the process and the goal domains arises as a natural approach.

This thesis reports on a real-life exploratory case study in which we investigated the relationship between the elements of the enterprise (modeled in the ARIS framework) and the goals (modeled in the Tropos framework and modeling language) which are attained by these elements. The case study has been conducted in the Rheumatology Department of a University Hospital in Brazil. In the course of the case study, we have identified the need of splitting this effort into three phases: the *elicitation phase* (in which goal models and business process models are captured from the organizational domain), the *harmonization phase* (in which the goal domain is structured for alignment according to the business processes structures that will support it) and the *alignment phase* (in which the relationships between the goal domain and the elements of the organizational domain are established).

In order to investigate the relation between goals and enterprise elements, we propose an ontological account for both architectural domains. We recognize the importance in considering the business process as the means for implementing an enterprise's strategy, but we do not exclude the remaining enterprise elements. Furthermore, we are concerned with both the identification of the relationships and with a classification for their nature.

LIST OF FIGURES

LIST OF TABLES

CONTENTS

CHAPTER 1.   INTRODUCTION

1.1   BACKGROUND

The increasing competitiveness drives organizations to promote change in an attempt to improve the quality of the services and products they offer. In recent years, many of the efforts related to managing change in organizations have been conducted in the scope of Business Process Reengineering (BPR) activities (DAVENPORT, 1992) (HAMMER e CHAMPY, 1993) (HAMMER, 1990) (HARRINGTON, 1991). BPR is based on the assumption that change in business processes should generate radical improvements in critical performance measures (such as cost, quality, service and speed) (HAMMER e CHAMPY, 1993).

Predicting how a given enterprise environment should respond to changes by simply adopting a business process centered view is unfeasible since there are a large number of issues to be considered, such as infrastructure, power and politics, managerial control, organizational culture, among others (YU, 1995). In turn, these issues provide potentially conflicting quality criteria whose prioritization (or postponement) impact in the performance of the organization as a whole.

Properly addressing the interconnection among these factors in organizations often requires the utilization of an enterprise architecture. An enterprise architecture consists of "a coherent whole of principles, methods and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure" (LANKHORST, 2005). Thus, the insights provided by enterprise architectures help overcoming the difficulty of managing organizations, allowing the determination of needs and priorities for change in a given business perspective (JONKERS *et al.*, 2006).

Since organizations may become extremely complex, mastering this complexity to accommodate innovations is a recognized necessity. To address this issue, architectures are structured in terms of *architectural domains* or *viewpoints*(IEEE, 2000) (DIJKMAN, 2006) (TELEMATICA INSTITUUT, 2009) which focus on specific concepts of enterprises such as

structural, functional and behavioral domains. Therefore, a good architectural practice not only provides insights for managing separately the architectural domains which compose the enterprise, but also allows balancing quality attributes between these domains.

Among these architectural domains, the domain of "motivation" has been recognized as an important element of enterprise architectures (YU *et al.*, 2006) as highlighted in Zachman framework's motivation column (ZACHMAN, 1987). Goal modeling is the artifact employed for capturing the motivational aspect and strategies behind the organizational practices (YU, 1995), helping in clarifying interests and intentions from different stakeholders (HALLEUX *et al.*, 2008). Moreover, by adopting goal modeling, enterprise architectures can systematically express the choices behind multiple alternatives and explore new possible configurations for an organizational setting. This is essential for business improvement once changes in a company's strategy and business goals have significant consequences within all domains of the enterprise (JONKERS *et al.*, 2004) (JONKERS *et al.*, 2006).

While the goal dimension of enterprise architectures focuses on "*why*" (YU, 1995) (HALLEUX *et al.*, 2008), a behavioural business process dimension also has significant importance in enterprise architectures since it addresses the way the enterprise organizes work and resources to fulfill its strategies (SHARP e MCDERMOTT, 2001), focusing on "*how*" business activities are performed and supported by information systems. Moreover, since business processes are the way in which the strategy and goals are incorporated into the behaviour of the organization, adopting business process modeling can provide high-level insights into general operations of the company to identify organizational structures that better addresses strategic concerns.

This thesis focuses on the association of the goal models and business process models in enterprise architectures. Although our main concerns are directed to these architectural domains, we do not exclude the remaining architectural domains in enterprise architectures, such as the organizational structure, resources and so forth.

1.2 MOTIVATION

Goal modelling explicitly captures the goals of an enterprise, documenting an enterprise's strategy (ANDERSSON *et al.*, 2008). The definition of goals is related with objectives in a

broad scope within the enterprise, i.e., goal statements range from high-level concerns in an enterprise (expressing the vision and mission of the organization) to declarations of the values that must be achieved by business process execution on behalf of stakeholders.

Business process modelling comprises, basically, an activity whose main goal is to provide a formalization of business processes in an organization or a set of cooperating organizations. Modelling an organization's business processes implies in capturing how the organization aims at operationalizing the corporate strategy and how this implementation is constrained by either internal or external drivers.

Since business process and goals are intrinsically interdependent, establishing an alignment between both domains arises as a natural approach. While traditional approaches in business process modelling tend to focus on "how" the business processes are performed (adopting a behavioural description in which business processes are described in terms of procedural aspects), adopting *goal-oriented business process modelling* (KAVAKLI e LOUCOPOULOS, 1999) (YAMAMOTO *et al.*, 2006) (Proceedings of the HCI*02 Workshop on Goal-Oriented Business Process Modeling GBMP'02, 2002) extends the traditional business process methodologies by providing a dimension of intentionality to the business processes (KAVAKLI e LOUCOPOULOS, 2003). The central idea is to create business models that describe not only the entities in a business context, but also include motivations for those entities (ANDERSSON *et al.*, 2007).

The alignment between goals and business processes can be motivated by the following reasons:

(i) To ensure traceability between goal models and business process models (HALLEUX *et al.*, 2008) (ANDERSSON *et al.*, 2008) (ANDERSSON *et al.*, 2007): Given a specific goal at a strategic level, one can find the business processes or activities in business processes which materialize this goal. On the other hand, the results of activities show how organizational goals at the strategic level are fulfilled at lower levels of abstraction. Hence, the existence of goal models reflects the reasons for the existence of each operational activity in business processes, once each of these activities are mapped to goals in the strategic level. Traceability between goal models and enterprise architecture models enables one to locate the set of elements of an

enterprise architecture that are affected by changes to an enterprise's goals. Alternatively, one can assess how changing procedures can impact the achievement of an enterprise's goals.

(ii) To guide business process design (and re-design) from goal models (KUENG e KAWALEK, 1997): Since business processes are responsible for implementing an enterprise's strategy as formulated in goal models, these models can be used to guide business processes design. In this sense, goal models can be understood as requirements for business process design in order to meet business objectives and policies and, thus assure that business processes only include those activities which create value for stakeholders (HAMMER e CHAMPY, 1993). If we consider the evolution of business goals, goal models can guide business process reengineering efforts by generating alternative configurations during the transition from the AS-IS business process models to TO-BE business process models.

(iii) To guide the development of process-oriented systems: The consolidation of the Model-Driven Architecture (MDA) and Model-Driven Engineering (PASTOR e MOLINA, 2007) (FRANKEL, 2003) for software development has increased the importance of the modelling activity. To implement the idea of Model-Driven Development, a software production process must provide not only a precise set of models (representing the different levels of abstraction of a system domain description), but also the corresponding transformations from a higher level of abstraction to the subsequent level (PASTOR e MOLINA, 2007). Thus, these techniques are highly dependent on the definition of business models, i.e., the quality of business models impacts directly the quality of information systems. Goal models play an essential role in increasing the quality of business process models by incorporating the notion of intentionality in these models, allowing one to explicitly capture how such enterprise aims at fulfilling its strategy. Therefore, the alignment between business process models and goal models promotes the development of process-oriented information systems which are fully aligned with enterprise's goals.

Although the benefits from adopting goal modelling for increasing the value of process models have been explored in literature (HALLEUX *et al.*, 2008) (KUENG e KAWALEK, 1997) (MARKOVIC e KOWALKIEWICZ, 2008) (KOLIADIS e GHOSE, 2006) (NEIGER e

CHURILOV, 2004), little attention has been devoted to the association between goal models and other elements of the enterprise architecture in the context of business process modelling. By aligning goal models with other elements in enterprise architectures such as physical or informational resources, one can visualize how the elements of the enterprise architecture are manipulated in business process in order to attain enterprise's goals. Thus, the motivation behind this association can be explained by the necessity of providing a strategic dimension for these elements, acknowledging the fundamental role of the whole set of elements of enterprise architecture in achieving enterprise's goals.

Furthermore, this association between goals and the elements of the enterprise architecture motivates the development of a systematic approach for discovering and modelling goals and other enterprise elements.

1.3   RESEARCH OBJECTIVES

The main objective of this research is to contribute to the area of enterprise architecture by proposing a framework which characterizes the possible relations between the goal domain and other enterprise architecture domains. In order to investigate these relations we propose an ontological account for both architectural domains. Our focus is directed at interpreting our organizational environment through an ontological standpoint with the aim of investigating how an enterprise's goals are achieved. We recognize the importance in considering the business process as the means for implementing an enterprise's strategy, but we do not exclude the remaining enterprise elements. Furthermore, we are concerned with both the identification of the relationships and with a classification for their nature.

1.4   APPROACH

In the scope of this work, we adopt organizational ontologies which provide the concepts for the construction of organizations, i.e., they are used for clarifying the elements which compose the organizations as well as the form with which these elements can be arranged for building a consistent organization (the organizational structure). Some organizational ontologies also provide support for interpreting how these elements are combined for an organization to achieve its goals. We intend to propose a framework which describes how goals models and enterprise models are related using a common ontological foundation for

both models. Ontologies have gained projection in the past decades in computer science due to their importance in the computer science and information systems areas, and more recently in Semantic Web and MDA initiatives (GUIZZARDI, 2007). Since ontologies can be used as reference models in the integration of modeling languages, once they provide a precise specification of the terminology of the organizations, they have been considered in the scope of this dissertation to bridge the gap between different architectural domains.

With the purpose of investigating the potential relationships between both domains in a real world organization, we have conducted an exploratory study in a Rheumatology Department of a Hospital in Brazil. In this sense, we address the alignment problem in a realistic setting based on a sound theoretical foundation.

The development of this framework has been decomposed into the following main phases:

(i) The goal and enterprise elicitation, in which goal models and business process models are captured from the organizational setting through interviews and observation;

(ii) The harmonization phase, in which the goal domain is harmonized, considering that different natures of goals entail in different structures of business processes to support goals;

(iii) The alignment phase, in which the relationships between the goal domain and the elements of the organizational domain are established as well as the semantics of these relationships through an ontological account.

1.5 SCOPE AND NON-OBJECTIVES

We are concerned with the problem of relating goal models and enterprise models in an AS-IS situation (what we call an *analysis approach*).

Despite our efforts in covering all relationships between AS-IS goal models and AS-IS business process models, we do not claim to exhaustively identify these relationships. We believe that the phenomena involved in achieving enterprise goals are complex enough so that the search for the elements responsible for achieving particular goals cannot be covered

by just one case study and is also a matter of subjective considerations which are outside the scope of this thesis (e.g., considerations regarding the human resources policies and other *critical success factors* (*CSF*s) (ROCKART, 1979) (DANIEL, 1961)). Since these phenomena are highly dependent on a large number of (potentially subjective) factors, we explore the alignment between goals and enterprise architecture elements to provide an initial *insight* to explain how organizational goals can be accomplished in practice. We believe that a more complete set of relationships should stem from future research.

It is also outside the scope of this thesis to propose methodologies for designing particular enterprise architecture structures that satisfy particular goals. We thus do not aim at proposing systematic steps for the generation of TO-BE business process models from TO-BE goal models, what we call here a *synthesis approach* (in line with the terminology proposed by (TEKINERDOGAN e AKSIT, 2006) (TEKINERDOGAN, 2000)). A *synthesis approach* would require addressing the aforementioned subjective factors and would also require deep knowledge of both the business domain under consideration and the multitude of operationalization techniques for each kind of goal in that business domain.

1.6   THESIS STRUCTURE

This thesis is structured as follows:

(i) *Chapter 2* (Enterprise Architecture Modelling) describes frameworks for enterprise architecture modelling, focusing on how each framework deals with the goal viewpoint as well as the support for goal modelling provided by these frameworks.

(ii) *Chapter 3* (Goal Modelling) describes the most prominent frameworks for goal modelling and discusses how goals and strategic concerns are aligned with other elements of an enterprise architecture.

(iii)*Chapter 4* (Ontological Foundations for Enterprise Modelling) describes the basic building blocks which define the organizations from an ontological point of view and how these blocks are related with the achievement of goals within organizations.

(iv) *Chapter 5* (Case Study: the Elicitation Phase) presents issues in goal elicitation and modelling and how the elicitation of goals and enterprise models has been conducted in the Rheumatology Department of Cassiano de Moraes University Hospital (HUCAM Hospital) which is part of the Federal University of Espírito Santo in Vitória, Brazil.

(v) *Chapter 6* (Case Study: the Harmonization and Alignment Phase) presents two main contributions: the Harmonization phase required to uniformly treat the goal domain and the Alignment phase in which we build a framework (from the excavation of the case study) for depicting the relations between goals and the enterprise elements used for satisfying these goals as well as the semantics of these relations.

(vi) *Chapter 7* (Final Considerations) concludes by outlining the main contributions of this thesis (contributions for goal elicitation and for architecture alignment) and proposes topics for further research.

CHAPTER 2.   ENTERPRISE MODELING

2.1 INTRODUCTION

The management of organizations involves a high level of complexity since it aggregates several knowledge domains. Each of these domains may be influenced by potentially-conflicting quality factors which affect the organization's overall performance. In order to allow the balancing and/or prioritization of these factors, using an enterprise architecture becomes indispensable.

In this sense, organizations need enterprise architectures as an instrument for operationalizate corporative policies and strategies (LANKHORST, 2005). Furthermore, the enterprise architecture helps providing a common basis for an organization's daily operations, which is useful for determining the needs and priorities for change as well as to determine how the company may benefit from technological operations. Finally, in an increasingly networked world, no enterprise can focus solely on its own operations; it is indispensable to master the difficulties in managing the interconnections with its customers, suppliers, and other partners (JONKERS *et al.*, 2006).

Since enterprise architectures are a powerful mechanism for managing the complexity of organizations, the first step to take the advantages of using some architectural approach is the documentation of key organizational aspects. In this context, modeling languages are employed with the aim of capturing enterprise descriptions for supporting decision-making and communication among stakeholders(TELEMATICA INSTITUUT, 2009). These modeling languages are based on adequate architectural concepts which in turn are represented by notational elements (DIJKMAN, 2006).

Since the importance of the concept of Enterprise Architecture can be acknowledged by many efforts in literature, in this chapter, we present some of current efforts for enterprise modeling. Furthermore, we describe how these efforts propose to align goals with the remaining elements in enterprise architectures (with special attention to the alignment to goals and business processes). Our decision for the selection of these particular enterprise

architecture approaches is based on their wide usage and their association with corresponding enterprise modeling languages.

This chapter provides the description of the following efforts in the enterprise architecture area: DoDAF (section 2.2), ArchiMate (section 2.3) and ARIS (section 2.4) and concludes with some observations about the current support provided by these efforts to the alignment of goals and other enterprise viewpoints (section 2.5).

2.2   DODAF

The Department of Defense Architecture Framework (DoDAF) comprises in a foundational framework to describe enterprise architectures as well as system architecture in a consistent manner (USA DEPARTMENT OF DEFENSE, 2007). It has been initially developed in 1996 by the US Department of Defense to ensure a common basis for the definition of architectures of commands, military services and defense agencies. In 2003, a new version of the framework has been released. Although DoDAF is clearly oriented to military systems, it has a broad applicability in architectures descriptions that are more general (LANKHORST, 2005).

DoDAF provides a set of products which are structured in four main views, namely, *All-View* (AV), *Operational View* (OV), *System View* (SV) and *Technical View* (TV) as mechanism for communicating and visualizing the broad scope of the organizations. Each view depicts certain perspectives of an architecture as described below.

The *All-View* (AV) captures overarching aspects of an enterprise, providing information pertinent to some architecture as a whole, not representing any distinct view of this architecture. The AV products delimit the scope (the subject area and time framing for architecture) and context of this architecture (the conditions in which the architecture exists, including doctrines, scenarios and environmental conditions). Goals, vision statements and tactics are also captured as cross-cutting concerns (global conditions) that compose the context of the architecture within the framework.

The *Operational View* (OV) captures the operational nodes, the tasks or activities performed, and the information that must be exchanged to accomplish DoD missions (including the types

of information exchanged, the frequency of exchange, which tasks and activities are supported by the information exchanges, and the nature of information exchanges).

The *System View* (SV) captures systems and services that are provided for, or supported by operational activities, facilitating the exchange of information among operational nodes. The SV system functions and services resources may be linked to the architecture artifacts in the OV.

The *Technical View* (TV) defines technical standards, implementation conventions, business rules and criteria that can be organized into profile(s) that govern the architecture. The TV products provide the technical systems implementation guidelines upon which engineering specifications are based, common building blocks are established, and product lines are developed. Its purpose is to ensure that a system satisfies a specified set of operational requirements.

In order to successfully implement architectural frameworks, both modeling language standards and tools that implement them are required (KOBRYN e SIBBALD, 2004). In an effort to develop a common modeling language for implementing the DoDAF framework, the OMG defines an industry standard UML representation for DoDAF and MODAF compliant enterprise architectures, the UML Profile for DoDAF/MODAF (UPDM) (OBJECT MANAGEMENT GROUP (OMG), 2009) (ALMEIDA *et al.*, 2010).

The purpose of UPDM is to specify a UML 2 profile to enable practitioners to express DoDAF and MODAF model elements and organize them in a set of specified viewpoints and views that support the specific needs of stakeholders. The standard proposes stereotypes/diagrams for modelling goal-related concepts (some diagrams have the concept of mission) and activities (modelled through the classes activities or operational activities), although the concept of business process is not explicit of the views. Besides, the definition of the standard aims at establishing a common basis for developing DoDAF models, improving tool interoperability, communications between stakeholders and reducing training impacts due to different tool implementations and semantics (OBJECT MANAGEMENT GROUP (OMG), 2009).

2.3 ARCHIMATE

ArchiMate is a modeling language for describing enterprise architectures which presents a well-defined set of concepts and relationships between architectures domains, (THE OPEN GROUP, 2009).

The language has been developed in the ArchiMate Project which lasted from July 2002 until December 2004 in a broad consortium from industry and academia (comprising ABN AMRO, Stichting Pensioenfonds ABP, the Dutch Tax and Customs Administration (Belastingdienst), Telematica Instituut, Ordina, the Centre for Mathematics and Computer Science (CWI), the Leiden Institute for Advanced Computer Science (LIACS), and Radboud University Nijmegen) with the aim of providing a visual design language with adequate concepts for specifying interrelated enterprise architectures.

The design of the language has been guided by the issue that managing the complexity of the organizations requires the description of the language in terms of several domains of knowledge as well as the relations within these domains. Therefore, the main goal of the language is to promote the integration of the several viewpoints of the organization, albeit it is not intended to introduce a language that can replace all existing domain-specific languages.

The central characteristic of the architecture is the service orientation. According to (LANKHORST, 2005), "services are defined as the unit of functionality that some entity (e.g. s system, organization or department) makes available to its environment and which has some value for certain entities in the environment (typically the 'service users')". The service orientation proposed in the ArchiMate enables a layered view of the architectural models, where the concept of the service is one of the main linking between the different layers. Services are made available to higher layers through *service layers* which in turn are interleaved with implementation layers that actually realize these services. Within a layer, there may also be *internal services*.

The language distinguishes three main layers (abstraction levels): the *Business Layer* which offers products and services to external customers realized by business processes executed by actors or roles; the *Application Layer* which supports the business layer with software

applications services; and the *Technology Layer* which offers infrastructural services for software applications (composed by software systems, computer and communication devices). Each of these layers can be decomposed in sub-layers. However, the level of abstraction must be chosen according to stakeholders concerns. The layer distinction is depicted in Figure 2.1.
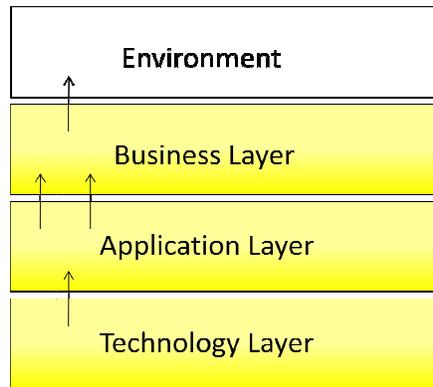
Figure 2.1 Layered View (adpted from (LANKHORST, 2004))

The arrows in the left represent *use* relations which show how the higher layers make use of the services of the lower layers (LANKHORST, 2004). For example, the business layer, where the business processes realize the products of the company, can make use of the generic services offered by supporting applications (in the application layer). These applications in turn can take the advantages of the infrastructural services realized by the lower layer (the technology layer).

Within each layer, the language is structured in three dimensions shown in Figure 2.2 (namely, structural/behavioral, internal/external and individual/collective).
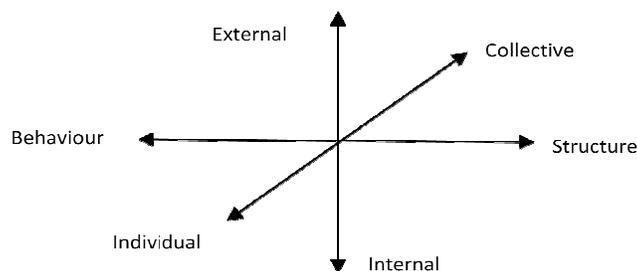
Figure 2.2 Three dimensions of architectural concepts (extracted from (LANKHORST, 2005))

In the structural/behavioral dimension, the behavioral concepts are assigned to structural concepts to show who or what displays the behavior. For instance, in the business layer, roles, interfaces and collaborations (structural concepts) are assigned to business processes, business services and business interactions (behavioral concepts) respectively. The structural concepts are further categorized as *active structural elements* (concepts which display the behavior, e.g., roles, interfaces and collaborations) and *passive structural elements* (objects to which behavior is applied, e.g., information business objects).

Concerning the second dimension, there is a distinction between the external view and internal view. The external view is concerned about the functionality (and its associated non-functional aspects) which are exposed to the environment, whereas the internal view refers to internal realization of the services. In the internal realization of the services, the behavior may be performed by an individual structural element (e.g. actor, role and component) or by a collective structural element (collaborations). From an external perspective, it is usually irrelevant whether a service is realized by individual or collective behavior. Services are accessed through interfaces, which constitute the external view of the structural aspects.

The language puts emphasis on concepts which capture the design and realization of the organization, without however providing concepts for capturing the intentional aspects (goals, strategies, policies and so forth). This "intentional dimension" is indispensable in the sense that it captures the principles which govern the design process for creating the enterprise as well as the translation of the abstract definition to the actual architectural implementation. The absence of this motivational dimension drives the search for modeling languages which are capable of capturing the underlying reasons for design decisions in enterprise architectures. In chapter 3, we survey the literature to show how these languages support the documentation of strategic issues within business contexts.

2.4   ARIS

ARIS (ARchitecture for integrated Information Systems) (SCHEER, 2000) has been developed in Saarbrucken (Germany), in 1992, with the main aim at providing an architectural framework for enterprise description. The framework has been recognized as leader in the business community, having a large market share due to its integration with the SAP suite in the corporate and government sectors (NEIGER e CHURILOV, 2004) (DAVIS, 2001). According to Davis (Business Process Modelling with ARIS - A Practical Guide, 2001), this leadership can be accounted by the fact that it provides support for modeling several aspects of complex business models (including processes, data, organizations, systems and so on), provides support for modeling software systems (using UML) and has some technical advantages (such as rich functionality and configurability for specific user requirements). The aforementioned advantages as well as its wide acceptance motivate the choice of ARIS as the framework for modeling the enterprise architecture of our case study. Furthermore, another interesting aspect is the support provided by the tool to the integration between process models and goals models.

The framework is composed of three abstraction levels (Requirements Definition, Design Specification and Implementation Description) which intend to describe the organization with different levels of detailing and four viewpoints (Organizational, Control, Function and Data) which support the description of different enterprise domains and their relationships. While the division in abstraction levels allows one to capture the information about the enterprise in different granularities, the viewpoints aim at specifying details referring to each organizational aspect.

In the remainder of this section, we intend to present the level of abstraction of Requirements Definition used in our case study for modeling the enterprise architecture. Each viewpoint is presented separately in the sequel. We give a brief introduction to each viewpoint, revealing its main concepts and showing some usage examples (emphasizing that we have selected only the concepts which are relevant for this work).

2.4.1 Organizational View

The Organizational View describes the hierarchical structure of the organization, its units, relationships and responsibilities. The organizational structure defines the competence realms of the organization, indicating its specialty areas and allowing one to identify the hierarchy of roles. The main purpose of this viewpoint is to support strategic decisions, such as how to aggregate similar organizational functions into organizational units and how to aggregate roles in specific units.

Organizational objects represent actors who perform the process tasks represented by ARIS functions and can represent specific people, departments, roles or teams (DAVIS, 2001). Organizational Units represent specific business departments which execute the organizational functions (DAVIS, 2001). Organizational Units can be categorized according to certain characteristics, such as responsibilities and obligations of a set of employers (SANTOS JR. *et al.*, 2009). In this case, an Organizational Unit Type represents the kind of the Organizational Unit. Good examples for Organizational Units Type (whose symbol is depicted in Figure 2.3) are *hospital* and *university* and for Organization Units (whose symbol is depicted in Figure 2.4) are *Cassiano de Moraes University Hospital (HUCAM)* and *UFES*, respectively.
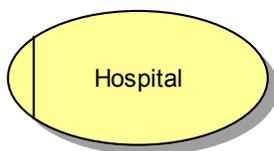
Figure 2.3 Symbol of Organization Unit

Figure 2.4 Symbol of Organization Unit Type

When an Organizational Unit reaches its lower level of decomposition, it is represented by a Position which an individual (Person) can occupy within the organization (SANTOS JR. *et al.*, 2009), i.e., a Position is a role performed by individual people (DAVIS, 2001). Similarly to Organization Units, Positions can be categorized according to their characteristics, justifying the Organizational Unit Type element. Examples of Position, Position Type and Person are depicted in Figure 2.5.

Rheumatologist	Rheumatologist of HUCAM	Valeria
(a) Position	(b) Position Type	(c) Person
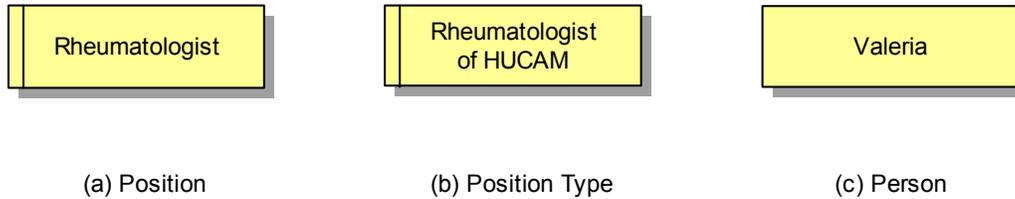
Figure 2.5 Symbols of Position, Position Type and Person

Observe that although Position and Position Type represent different concepts in the ARIS language, the notational elements used for their representation is similar. To properly differentiate the concepts, ARIS allows the creation and assignment of new symbols to the existing objects (thus allowing the differentiation of these concepts). This is done through the mechanism of *Method Filter*.

Method filter is a functionality which allows one to limit the range of model types, object types, relationships and attributes defined by the ARIS method. By limiting this, it is possible to make the tool easier to use, since working with all of these possibilities makes modeling unnecessarily complicated and prone to error. However, the *Method filter* can only be used to constrain the models and objects available, although new symbols can be defined for existing objects, some attributes can be renamed and a limited number of user-defined attributes can be made available (DAVIS, 2001).

2.4.2 Functional View

The Functional View defines the organizational functions which can be described in various aggregation levels in a hierarchical way. Functions designate activities or tasks which must be executed for the production of good or services. The term function is also used synonymously with the terms complex function, process, activity or task (SCHEER, 2000). Figure 2.6 shows the symbol of a function.

Figure 2.6 Symbol of Function

This view captures the static function structure, whereas the Process View (or Control View described in section 2.4.4) reflects the dynamic models that show the behaviour of processes and how they are related to resources, data and functions of the business environment (DAVIS, 2001). Static function structure means that functions are hierarchically organized independently of belonging to specific business process (as opposed to describing the dynamic behaviour of functions).

The language has opted for modeling the relationship between goals and functions in this view since the execution of functions can be seen as operations applied to objects for the purpose of supporting one or more goals (SCHEER, 2000)[1]. This relationship is denominated as "*supports of*" relationship, although its semantics is not clear in the ARIS literature. Figure 2.7 shows the function *Prescribe patient's treatment* which supports the goal Minimize patient's physical suffering and symptoms (it is said that *Prescribe patient's treatment* has a "*supports of*" relationship with the Minimize patient's physical suffering and symptoms).
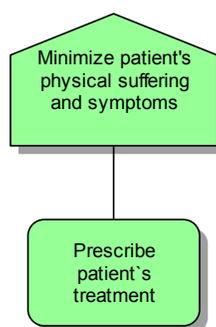
Figure 2.7 Relationship between goals and functions

Goals and their relationships (shown in Figure 2.8) are also modeled in this view. Goals can be linked with one another with a subordinate goal supporting several overriding goals. The

---

[1] Observe that the relationship between goals and the other elements of the enterprise architecture (such as organization units, resources, and so forth) can be indirectly established through functions.

allocation between functions and goals can be inherited by higher levels, i.e., an allocation at a lower level can inherited by the upper levels (SCHEER, 2000). Thus, the function Provide medical care to patient also supports the overriding goal Heal the patient.
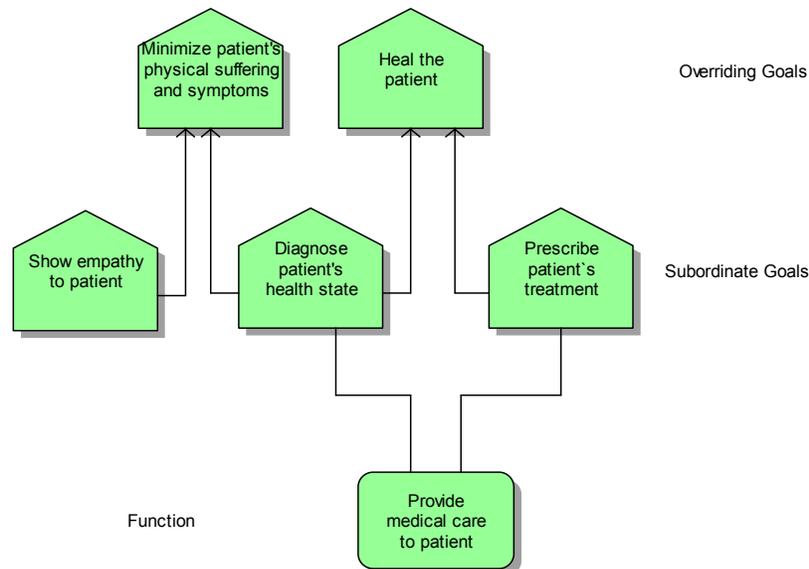
Figure 2.8 Goals and their relationships

Observe that the semantics of the relation among goals are also not clear (denominated as "*belongs to*" relationship). Summing up, it is a N:N relationship among goals, i.e., a (overriding) goal can be overridden by N (subordinate) goals and a (subordinated) goal can override N (overriding) goals. Following with the example, Heal the patient (overriding goal) is overridden by Diagnose patient's health state and Prescribe patient's treatment (subordinate goals).

2.4.3 Data View

This view describes the business information that is manipulated by functions. The informational objects have several roles in the flow of business processes, such as to describe the events and messages which control the flow of business processes, describe the environment status of business process, represent the outputs produced by activities and so forth (DAVIS, 2001).

Figure 2.9 depicts the symbol of the concept (denominated as cluster) which represents a collection of related entity types (entity type is a real-world entity that is described by data attributes, e.g. a customer or an employer) (DAVIS, 2001).
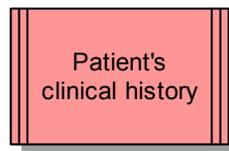
Figure 2.9 Data cluster

2.4.4 Process View (Control View)

The purpose of Control View is to integrate the remaining views of the language (Functional View, Organizational View and Data View) which have been separately modeled. This promotes the description of the state modifications and consequently, the description of dynamic behaviour of processes which manipulate information and other kind of objects previously modeled in other views. Therefore, the Process View provides the linkage among all the enterprise views.

The main models involved in the Process View are: the Value Added Chain (VAC) model, the Event-driven Process Chain (EPC) model and the Function Allocation Diagram (FAD) model. This separation allows one to manage the complexity of modeling as well as the integration among the views.

The business process modeling technique starts with capturing the Value-Added Chain (VAC) which represents all macro-processes which are executed in order to achieve the overall organizational strategies (NEIGER e CHURILOV, 2003) (Figure 2.10).
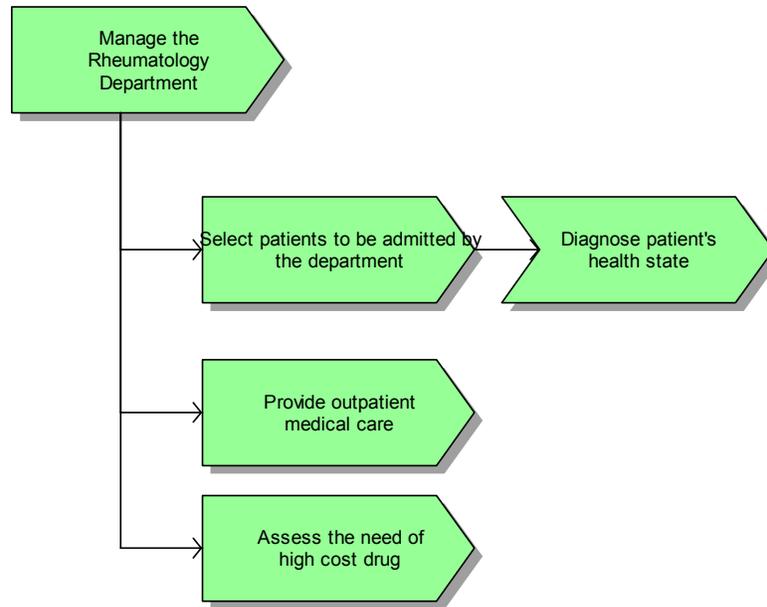
Figure 2.10 A (partial) representation of a value added chain (VAC)

Macro-processes represent bundles of business processes. The refinement of macro-processes produces a chain of processes which represent organizational procedures. A business process is a systematic sequence of related actions which produce measurable results by consuming inputs of varied nature (SHARP e MCDERMOTT, 2001). In the ARIS framework, they are represented in EPC (*Event-driven Process Chain*) models. These models are central for all business modeling in ARIS since it brings together the static resources of the business (systems, organization, data, etc.) and organizes them to deliver a sequence of tasks or activities ("the process") that add business value (DAVIS, 2001).

The EPCs represent business processes in a dynamic form as a combination of activities and events. Events represent the changing of the state of the world as a process proceeds. They can be external changes that trigger the process to start (initial event), an internal changes of state as the process proceeds (intermediate events) or the final outcome having an external effect (end events) (DAVIS, 2001).

The process starts when triggered by some event either internal or external to the organization. As the process proceeds, activities create events and those, in turn, activate other activities, producing a chain of events and functions.

Another important set of objects which are useful for the construction of business process models are *rules*. Rules serve as routing elements within EPCs; functions make decisions (represented by events) and a rule determines the logic of the possible outcomes (DAVIS, 2001). Examples of rules can be seen in Figure 2.11.

Figure 2.11 Rules used in EPCs. The first (from left to right) symbols an "AND rule", the second symbols an "OR rule" and the third symbols an "EXCLUSIVE-OR rule"

Figure 2.12 represents the refinement of the business process *Diagnosis the patient health state* by using an EPC. In these diagrams, there are two notational elements to represent actors who perform some business process: ellipses when actors are organizational units or rectangles when they represent roles performed by human agents in the execution of business process. The activities executed by each actor are placed in his/her respective swimlane and are symbolized by green rectangles while the events are symbolized by pink hexagons. There are also logical operators which determine the flow of execution. For instance, in Figure 2.13, after the execution of the activity *Verify the previous achievement of laboratorial exams*, the flow control can follow only one of the branches associated with either the event *Laboratorial exams not previously achieved* or the event *Laboratorial exams previously achieved* (exclusive-OR logical operator). The event between the activities *ask for laboratorial exams* and *perform required laboratorial exams* has been omitted for the sake of simplicity.
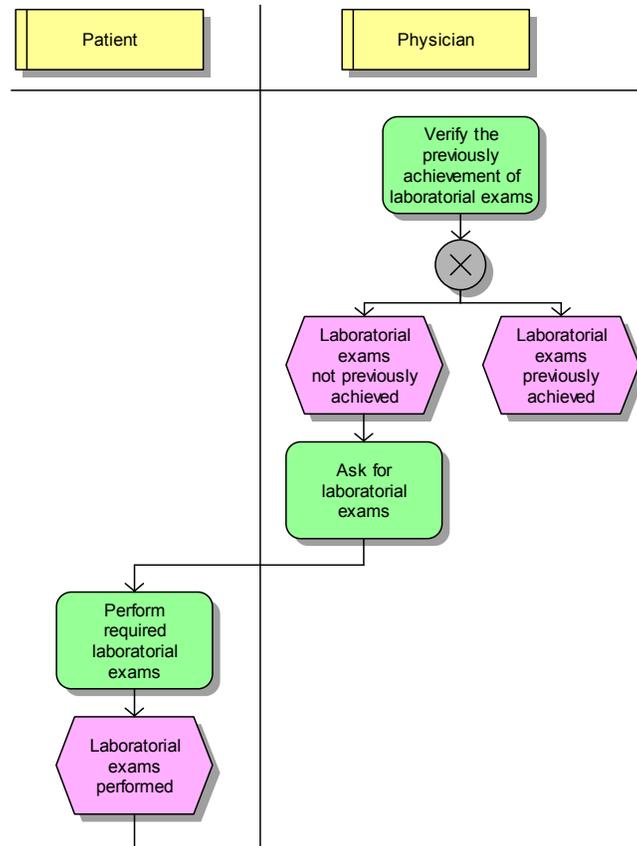
Figure 2.12 A fragment of the Diagnose patients' health state process model

When activities in a business processes can be described as a single action without further decomposition, *Function Allocation Diagrams* (FADs) are created for each activity. In an FAD, one can assign resources to the execution of actions, revealing the organizational units where the activities occur, their executors, the systems which support them, the incoming and outgoing documents and information, business rules, business requirements and risks associated with them. These diagrams are not considered in our modeling approach, due to their detailed nature.

Figure 2.13 shows the ARIS house with its views and the concepts which pertain to each view.
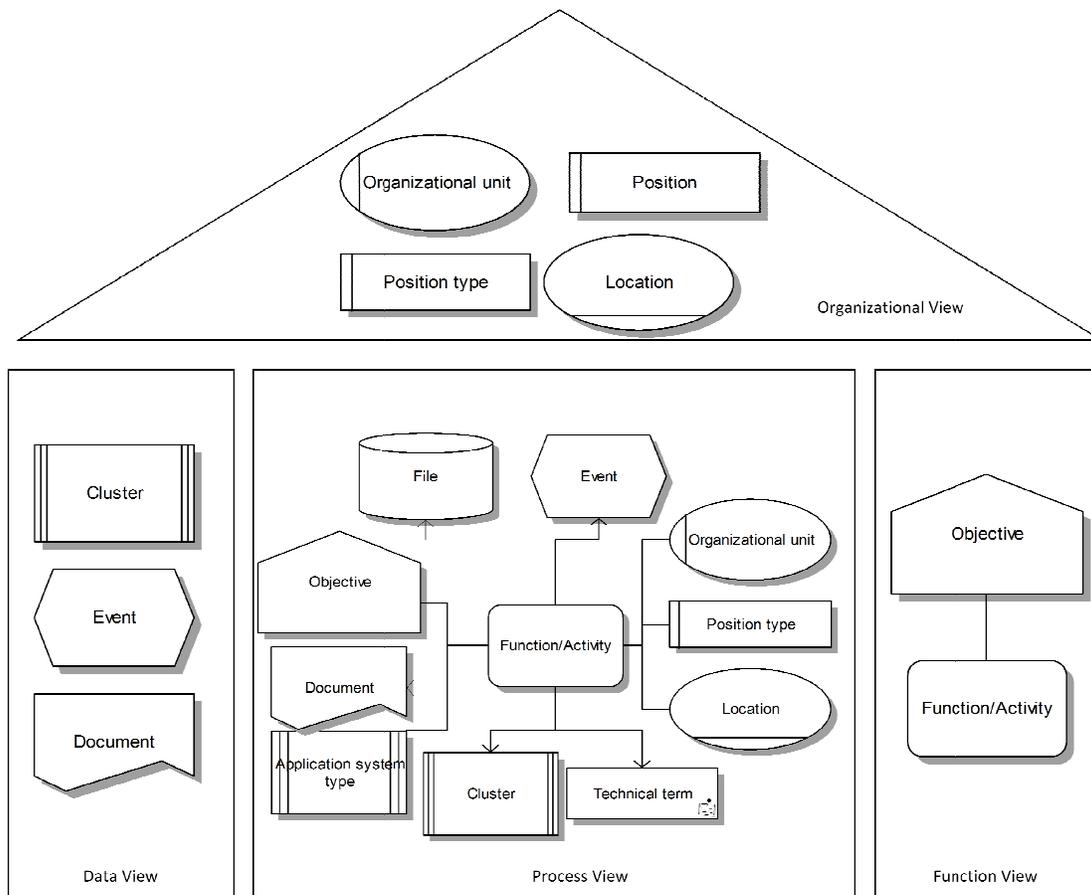
Figure 2.13 Elements of the ARIS house

2.5 CONCLUSION

Methods for enterprise architecture modeling aim at describing organizations to enable an effective guidance both for business managers in mastering the business complexity as well as for supporting common understanding among stakeholders. This guidance refers to the support provided by architectures in the decision-making process which dictates the organizational policies for implementing an enterprise's tactics.

In this chapter, we have surveyed how the current approaches address the issue of providing consistent instruments for enterprise descriptions. Moreover, we intended to investigate how these approaches provide support for the integration of the viewpoint of "motivation" and the other enterprise viewpoints. This integration is useful for providing assistance for business managers to choose among alternative strategies as well as in the translation of this strategy into concrete implementations.

As a general conclusion we can observe that current approaches for enterprise modeling offer rudimentary support for intentional modeling as well as for the incorporation of intentional aspects in the other viewpoints; this conclusion is corroborated with observations by (QUARTEL *et al.*, 2009) and(SOFFER e WAND, 2005). More specifically, we can conclude that the problem of capturing strategic concerns is an issue commonly neglected in the current languages, motivating us to explore methodologies for goal modeling in the next chapter.

With respect to the particular enterprise frameworks surveyed in this chapter, the specific conclusions which can be drawn from our study are presented in the sequel.

With respect to DoDAF, we have observed that the support for the integration of intentional concepts and their correspondent activities is rudimentary, not allowing one to depict complex relationships between goals and activities. The ArchiMate language also does not provide the "motivational" dimension as one of its aspects, although there is a vague idea of intentionality in the current version of the language in linking the concept of value and service[2]. Some recent effort (QUARTEL *et al.*, 2009) presents the motivational aspect of the ArchiMate language and introduces the ARMOR language used to capture goals and intentions of the enterprise. This language is strongly based on i*/Tropos (further explored in the next chapter), with some additional concepts introduced as a means of capturing conflicting relations between goals and goals that a system TO-BE is expected to achieve (denominated as Requirements). Although the ARMOR meta-model inherits most of concepts of i*/Tropos (which suggests that most of the benefits of the usage of this latter methodology can be reproduced with the usage of ARMOR) the suitability of the ARMOR language as well as its expressiveness for modeling real-world organizations remains to be further investigated in future research.

With respect to ARIS, we can observe that it provides two components for creating enterprise descriptions: first, it provides a modeling language to capture enterprise models (including detailed business process models) and second, it provides methodological support for the construction of these models. Nevertheless, despite the aforementioned advantages of ARIS,

---

[2] According to (TELEMATICA INSTITUUT, 2009), "the value of a product or service is that which makes some party appreciate it, possibly in relation to providing it, but more typically to acquiring it". The language allows one to associate values with organizational services and, indirectly, with products.

it lacks a comprehensive goal-modeling framework required for *goal-oriented business process modeling* (NEIGER e CHURILOV, 2004). In this respect, the deficiencies of the ARIS framework includes its limited expressiveness for capturing complex relationships among goals (such as causal, logical and influencing relationships and evaluation mechanisms (NEIGER e CHURILOV, 2004)) and its limited capability in describing the integration between goals and business processes. In particular, the lack of clarity for the semantics of the "*supports of*" relationship in ARIS poses a significant problem for its application. The literature does not specify whether the execution of the function entails goal achievement or just positively contributes to the goal realization. This kind of problem motivates the search for more expressive languages for goal modeling. A deeper discussion of these languages is developed in next chapter.

From this point of view, even with some limitations, the ARIS framework has been chosen to be applied in our case study since it provides the best trade-off among languages and methodologies for modeling the enterprise architecture and the details of a behavioural business process view.Since it offers limited support for capturing the alignment between goals and other views, we intended to associate it with the Tropos language in order to take the benefits from both languages. This approach is similar to the approach followed in the extension of the ArchiMate language with the introduction of ARMOR, although we do not restrict ourselves to the relations between the behavioural and the goal domain as is the case for ARMOR.

CHAPTER 3.   GOAL MODELING

3.1 INTRODUCTION

Goal-oriented approaches for Requirements Engineering (RE) have received increasing attention in recent years (KAVAKLI e LOUCOPOULOS, 2003). The adoption of these approaches has been motivated by the need of overcoming the semantic gap between a software system and the organizational environment in which the system functions. In other words, designers are forced to reconcile requirements arising from the organizational environment with constraints imposed by the technical solution (ISTC-CNR, 2006).

In an attempt to reproduce the benefits obtained from applying goal-oriented approaches to Requirements Engineering, several *goal-oriented approaches for business process modeling* have been proposed recently (NEIGER e CHURILOV, 2004) (YAMAMOTO *et al.*, 2006) (Proceedings of the HCI*02 Workshop on Goal-Oriented Business Process Modeling GBMP'02, 2002). These approaches aim at reducing the semantic gap between the operational business processes and the organizational strategy behind these processes. To properly capture goals and strategies, these approaches commonly borrow methodologies and tools from the RE field. The purpose of this chapter is to present and compare some of the main methodologies/modeling languages for goal modelling which can be employed in our approach.

This chapter is structured as follows: section 3.2 describes the early requirements phase of the Tropos methodology (Castro, et al., 2002) (BRESCIANI *et al.*, 2004), section 3.3 presents the Business Motivation Model (BMM) (OBJECT MANAGEMENT GROUP (OMG), 2008) adopted by OMG and section 3.4 concludes the chapter with a comparison of the approaches and motivates our selection of a particular approach for the remainder of this work.

3.2 i*/TROPOS

The i* modeling framework, first proposed in Yu's PhD thesis (YU, 1995), is an agent-oriented conceptual framework that can be used for requirements engineering, business

process modeling, organizational impact analysis and software process modeling. The i*
framework has been used as a basis for the creation of the Tropos methodology and
modelling language (CASTRO *et al.*, 2002) (BRESCIANI *et al.*, 2004) which in turn, inherits
the i* concepts in its early and late requirements stages and applies these concepts in the
scope of an agent-oriented software development methodology. The differences of Tropos
and i* is that Tropos has been developed with focus on an agent-oriented paradigm for
software development in mind (BRESCIANI *et al.*, 2004), whereas i* has a broader
applicability (as previously cited). Therefore, while Tropos focuses on four phases of
software development (early requirements, late requirements, architectural design and
detailed design), i* solely covers the two initial phases (BRESCIANI *et al.*, 2004).

In the sequel, we describe the early requirements concepts of Tropos methodology.

The framework is structured in terms of two main components: *Actor Diagram* and *Goal
Diagram*. The former describes the organizational context in terms of dependency
relationships between actors, while the latter describes the actors' goals and rationales in
order to justify the actors' relationships.

3.2.1 Actor

Actor is the agent-oriented concept representing an autonomous and social entity. An actor
can represent a physical person, an organization, an organizational role, a type of intentional
entity, a software system or component, or any other entity which has strategic goals and
intentions (ISTC-CNR, 2006). The framework adopts an intentional and strategic view of the
organizational setting, relying on two basic assumptions (YU, 1995):

(i) Actors are intentional entities which accomplish tasks and activities based on
motivations and rationales behind their practices;

(ii) Actors are strategic entities which are concerned about the configuration of
relationships established with other actors, taking into consideration opportunities and
vulnerabilities and measuring impacts in adopting a particular configuration of
relations;

The term **actor** is used for generically designating entities which can participate in intentional dependencies. To model sub-units of actors, there are three types of actors: agents, roles and positions. A **role** is a characterization of a behavior of some actor in a given social domain (it is easily transferable to other individuals). An **agent** is an actor which displays a physical existence, such as human individuals, hardware or software agents (since agents are specific actors, their characteristics are not easily transferable to other individuals). Finally, a **position** comprises in a set of roles which is performed by one agent. We say that an agent occupies a position and a position is said to cover a role (BRESCIANI *et al.*, 2004). A deeper discussion on this issue can be found in (YU, 2002).

3.2.2 Actor Diagram

The Actor Diagram reflects a network of strategic dependencies established between organizational actors, recognizing that actors have freedom of action. This model aims at expressing business models through an intentional perspective instead of capturing non-strategic concerns.

Each node represents an actor and each link represents the dependency between two actors. Dependencies can be characterized as follows: the *depender* is an actor which depends on some other actor (the *dependee*), by an intentional element (the *dependum*). On one hand, by establishing dependencies, the *depender* is able to realize some goal that either it would not be able to accomplish or it would not be able to accomplish optimally. On the other hand, the *depender* becomes vulnerable in the sense that the *dependee* may fail to deliver the *dependum*.

The model has different types of dependencies based on how agents constrain each other's freedoms (i.e., the type of dependency is characterized by who decides how to accomplish the *dependum*) and how vulnerable the agents are according to the type of dependency established. There are four types of dependencies, based on the type of the *dependum*: goal dependency, softgoal dependency, tasks dependency and resource dependency.

A **goal** is a state of affairs desired by some agent. In **goal dependency**, the *depender* depends on the *dependee* to cause a desired state in the world, without prescribing the way in which

the *dependee* must accomplish this state. The *depender* is vulnerable in the sense that the *dependee* can fail to lead the world to that particular state.

A plan represents a specific way of performing something, generally for achieving a goal or softgoal. In **plan dependency**, the *depender* depends on the *dependee*, again to accomplish a goal, but, this time, specifying the way in which the *dependee* must accomplish such goal. Thus, the *dependee* is constrained in its freedom of deciding how to accomplish the goal, i.e., the agent is obligated to adopt the specified plan to achieve the goal.

The difference between goal and plan dependencies is related to what Castelfranchi and Falcone (Towards a Theory of Delegation for Agent-based Systems, 1998) refer to as open and close delegation, respectively. Note that, according to these authors, in both cases, the real dependum is a goal and the differentiation between these two relationships is given by the fact that, while the open delegation leaves the decision regarding the strategy towards goal accomplishment to the depender, the close delegation rather prescribes a specific strategy (i.e. a plan) that the depender should adopt towards achieving the delegated goal.

In **resource dependency**, the *depender* needs the *dependee* to deliver either a physical or informational resource, becoming vulnerable in the case of unavailability of the resource. Resources in the context of the framework must be seen as intentional objects (usually obtained as a finished product from a deliberation process), differing from flow of information which does not depicts intentionality. For example, if a physician does not suffer any harm for the absence of some patient's information or other resource (i.e., the resource can be replaced without damage), then this resource is a flow of information within the process (it is not a strategic resource).

The fourth type of dependency (**softgoal dependency**) borrows from the software engineering the idea of non-functional requirements (CHUNG *et al.*, 2000). Softgoals are goals with no clear-cut criteria for satisfaction and thus, rarely, one can state that a softgoal has been satisfied. Instead, to refer to the satisfaction of a softgoal, one must adopt the notion of partial satisfaction, i.e., the softgoal is satisfied within acceptable limits. In this case, it is said that the softgoal has been "satisficed" (MYLOPOULOS *et al.*, 1992). Softgoals are useful for capturing quality factors for a task or hardgoal, thus guiding the adoption of one alternative solution instead of another when decomposing the hardgoal/task. Although the

concepts of NFRs and softgoals are commonly treated as the same in the literature, we must stress out that the differences between NFRs and softgoals cannot be ignored. On one hand, as explained in (JURETA *et al.*, 2006), NFRs refer to quality attributes that some system is expect to meet while executing a particular service. These services which the system must provide amounts to its set of functional requirements (FRs). NFRs are the opposite of functional requirements (FRs). On the other hand, hardgoals are defined as goals whose satisfaction can be determined by applying formal verification techniques (LAMSWEERDE, 2001) (JURETA *et al.*, 2006). Softgoals are the opposite of hardgoals, since they are "subject to interpretation" (YU, 1995), "imprecise, subjective, context-specific, and ideal" (JURETA *et al.*, 2006). This common association between NFRs and softgoals arises because there is a tendency in specifying quality attributes in an imprecise manner.

Taking these considerations into account, in **softgoal dependency**, the *depender* depends on the *dependee* to meet a softgoal. The softgoal achievement is settled during the trajectory of decomposing the hardgoal/task. The dependency also leads the *depender* to become vulnerable because the *dependee* can fail to bring about the softgoal.

Examples of the four types of dependencies are shown in Figure 3.1.

Depender   Dependum   Dependee
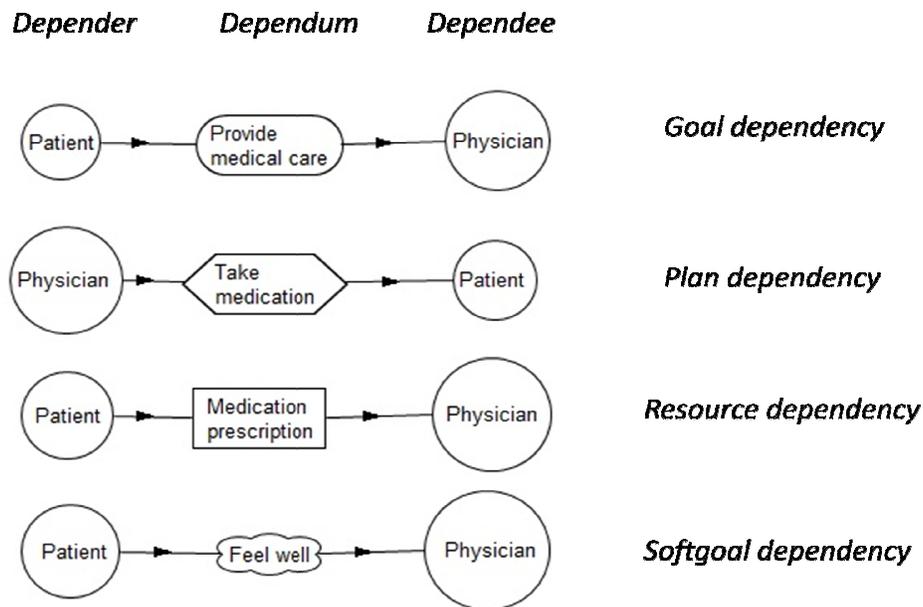
Figure 3.1 Types of dependencies of Tropos methodology

The Actor Diagram is used in this thesis for depicting how actors are related through dependencies relations within an organizational setting. For each business process, we model a corresponding actor diagram which reflects the actors who participate in this process and their dependency relations in that process. Besides, a general Actor Diagram has been developed to depict general dependency relations between the actors within the organization.

3.2.3 The Goal Diagram

The Goal Diagram provides an intentional description of the process in terms of goals and rationales that actors have in each business configuration. The description of these business configurations is elaborated in terms of intentional process elements. This model aims at expressing how actors reason when involved in a process of deliberation for adopting a particular configuration process. Moreover, process alternatives are explicitly expressed, allowing the systematic generation of different process designs based on the prioritization of concerns.

Goal diagrams have four types of nodes based on the same distinctions for *dependum* types (*goals*, *softgoals*, *tasks* and *resources*) and three types of relationships *means-end* link, *contribution* link, and *AND/OR* decomposition.

Means-end analysis aims at capturing plans, resources and softgoals that provide means for achieving a goal. *Contribution* analysis identifies goals that can contribute positively or negatively in the attainment of the goal to be analyzed. An *AND decomposition* supports a goal to be decomposed in a series of sub-goals; while an *OR decomposition* allows modeling of alternative ways of achieving a goal. Additionally, temporal logic specifications can be used to specify constraints on the models.

An example of the aforementioned constructs is depicted in Figure 3.2. The Physician has the goal of providing medical care to patient (Provide medical care to patient goal) which can be realized in two different forms: either via a scheduled medical consultation (Provide medical care in scheduled medical consultation goal) or via an emergency room (ER) (Provide medical care via emergency room (ER) goal). In a scheduled consultation, the Physician initially diagnosis the patient's health state (Diagnose patient's health state goal) and subsequently, prescribe the patient's treatment (Prescribe patient's treatment goal). These goals are respectively attained by the Diagnose patient's health state plan and the Prescribe patient's treatment plan and therefore the goals and plans are linked through a *means-end* relationship. In other words, by performing the plan, this implies in satisfying its respective goal. Observe that in this case, plans and goals have the same name. This can be explaining by the fact that the goal symbolizes a desired state the world (i.e., a state of the world in which the patient's health state is already diagnosed) and the plan corresponds to specific steps necessary for the Physician to achieve the goal (the steps which only the physician knows due to his/her knowledge about the medical domain).

By diagnosing the patient's health state (Diagnose patient's health state goal), the Physician is able to heal the patient (Heal the patient goal), albeit the satisfaction of the former goal is necessary, but not sufficient to achieve the latter goal (and thus the Diagnose patient's health state goal positively contributes to the Heal the patient goal). Diagnosing the patient's health state (Diagnose patient's health state goal) is also a means for the physician to select the most suitable treatment (Select the most suitable treatment goal) once the physician can solely choose the best treatment after having information about the patient's health state.
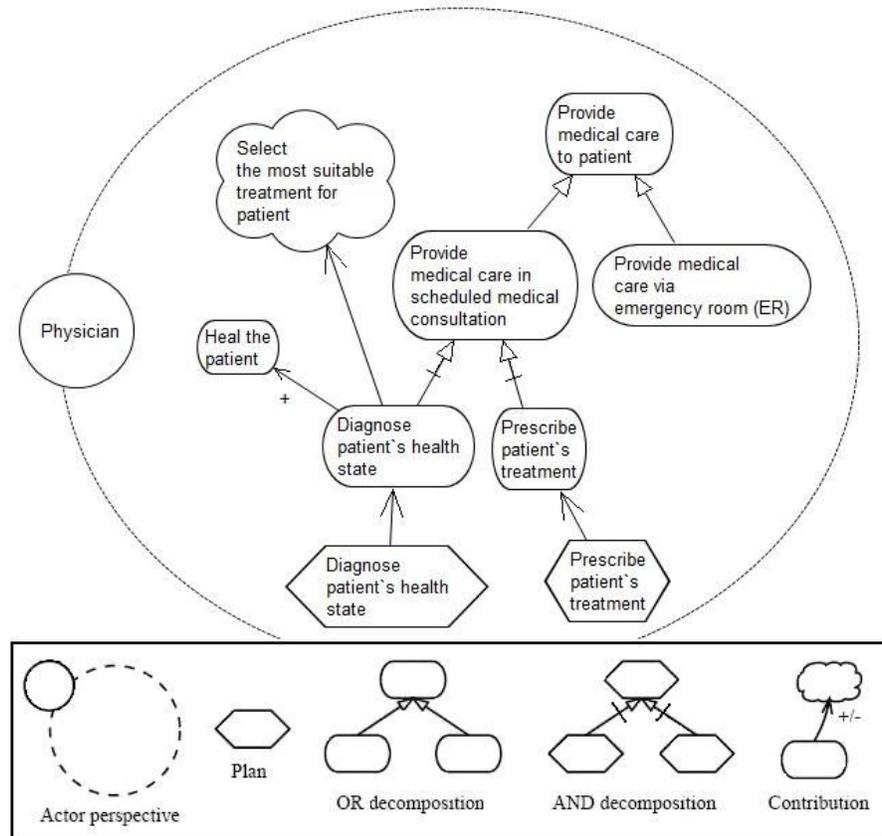
Figure 3.2 Examples of the relationships of the Tropos methodology

Observe that the (soft)goals and the business processes (modeled as plans) responsible for their attainment are linked in this model. By establishing this alignment, a designer is able to analyze how different strategies (represented as different process configurations) contribute to goal achievement. Moreover, he/she is able to relate goals and the other enterprise resources, such as informational resources, physical resources, etc (which are modeled using the concept of resource).

The Goal Diagram is used in this dissertation with the aim of describing each actor in terms of its strategic elements. This diagram reflects the goals, resources, softgoals and plans of each actor in each of the business processes executed by the department under consideration. Moreover, it also supports the capturing of general goals (and issues) which is not related with a specific business process. In each goal diagram, the strategic elements are properly related to show how change in one of them can affect the remaining elements.

Both i*/Tropos have gained considerable attention from researchers and practitioners in the past few years, resulting in an active research community. Consequently, different versions of the language have emerged, each one using slightly different notations. In this dissertation, we chose to use a specific case tool, named TAOM4E(GIORGINI *et al.*, 2005), which efficiently supported our modeling work. For this reason, we adopt the notation applied in this tool throughout this whole work.

3.3 BUSINESS MOTIVATION MODEL

The Business Motivation Model (BMM) (OBJECT MANAGEMENT GROUP (OMG), 2008) is a conceptual specification adopted by the OMG in 2007 for schematizing or structuring the development, communication and management of business plans in enterprises.

The BMM enables one to express the business environment from a strategic perspective, being useful as an instrument in corporative governance, strategic planning and business transformation activities. It points to one of the most important roles of an enterprise architecture: it serves as an instrument in the communication among diverse groups and interests and provides a common ground for discussion and decision-making.

This meta-model comprehends a set of built-in concepts which can capture the factors that motivate the establishing of business plans, the elements which comprise the business plans and the interrelationships between these elements. These built-in concepts define the elements of business plans and are characterized by basic attributes (identifier and text description) and associations (optional and many-to-many). Besides these concepts, there are three concepts (namely, business process, business rule and organization unit[3]) which participate in associations within the Business Motivation Model. These concepts are regarded as references to elements that will be defined and maintained outside the scope of an enterprise's Business Motivation Model.

---

[3] Organization Unit, Business Process and Business Rule are respectively defined and associated with related concepts in the following standards: Organization Structure Meta-model (OSM), Business Process Definition Meta-model (BPDM), and Semantics of Business Vocabulary and Business Rules (SBVR). In practice, enterprises could use alternative external standards.

3.3.1 The BMM Structure

The Business Motivation Model is structured in terms of four essential concepts (built-in concepts), as depicted in Figure 3.3: Means, End, Influencer and Assessment concepts.
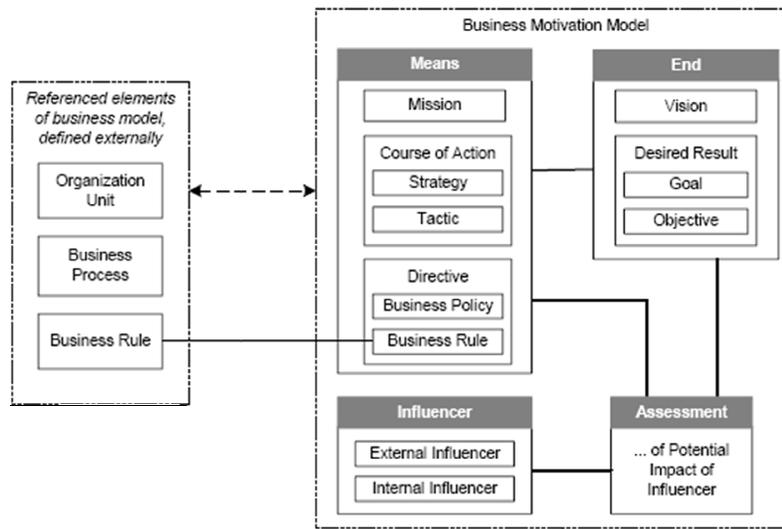
Figure 3.3 The BMM Structure (extracted from (OBJECT MANAGEMENT GROUP (OMG), 2008))

In turn, these concepts are grouped in terms of two major related areas, the Means and Ends; and the Influencers and Assessments. In the first area, Means express the resources employed to reach Ends (for example, strategies, policies and rules). In the second area, Influencers model the elements which underlie the business plans and cause some impact in these plans, and Assessments capture the impacts of such Influencers on Ends and Means (i.e., Strengths, Weaknesses, Opportunities, and Threats).

The left rectangle depicted in this figure (with the following concepts: business process, business rule and organization unit) represents the elements which are referenced in BMM models, but are externally defined.

3.3.1.1 The End Concepts

The Ends aim at expressing what the enterprise desires to reach, either by implementing changes in the current enterprise configuration or by maintaining its current position relative its market and competition.

An End is refined according to Figure 3.4, in Vision and Desired Results. These latter, in turn, are refined in Goals and Objectives. Table 3.1 summarizes the definitions and examples depicted the in BMM standard (OBJECT MANAGEMENT GROUP (OMG), 2008).
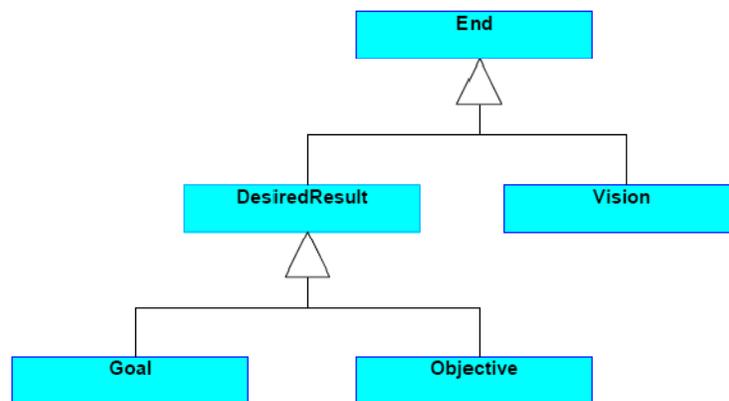
Figure 3.4 The Hierarchy of End concepts

Table 3.1 The description of End concepts (OBJECT MANAGEMENT GROUP (OMG), 2008)

Concept	Description
Vision	Comprises in an overall image of what the organization wants to become in a future state. A Vision is the ultimate, possibly unattainable, state the enterprise would like to achieve. It is broadly defined, rather than focused toward one particular aspect of the business problem. **Organization:** Consulting company **Vision:** Be the premier consulting company in the industry
Goal	A Goal is an attainable statement about a state or condition of the enterprise to be brought about or sustained through appropriate Means. A Goal amplifies a Vision in the sense that a goal indicates what must be satisfied on a continuing basis to effectively attain the Vision. A Goal should be narrow — focused enough that it can be quantified by Objectives. A Vision, in contrast, is too broad or grand for being specifically measured directly by Objectives. However, determining whether a statement is a Vision or a Goal is often impossible without in-depth knowledge of the context and intent of the business planners. **Organization:** Consulting Company **Goal:** To improve customer satisfaction (over the next five years)

Objective	An Objective is a statement of an attainable, time-targeted, and measurable target (explicit criteria to determine satisfaction) that the enterprise seeks to accomplish its Goals. Compared to a Goal, an Objective tends to be short term, quantitative (rather than qualitative), specific (rather than general), and not continuing beyond its time frame. The main difference between Objectives and Goals is that Objectives are always time-targeted and measurable, and Goals, in contrast, are not specific in these ways. **Organization:** Consulting Company **Objective:** By June 30, 2008, an operational customer call center

3.3.1.2 The Means Concepts

A Means represent the instruments that the enterprise intends to adopt to reach its desired results, albeit it neither indicates the steps (business processes and workflows) necessary to accomplish it, nor the responsibility for such tasks. In the Business Motivation Model, Means are organized into Mission, Courses of Action, and Directives (Figure 3.5). Table 3.2 summarizes the definitions and examples depicted the in BMM standard (OBJECT MANAGEMENT GROUP (OMG), 2008).
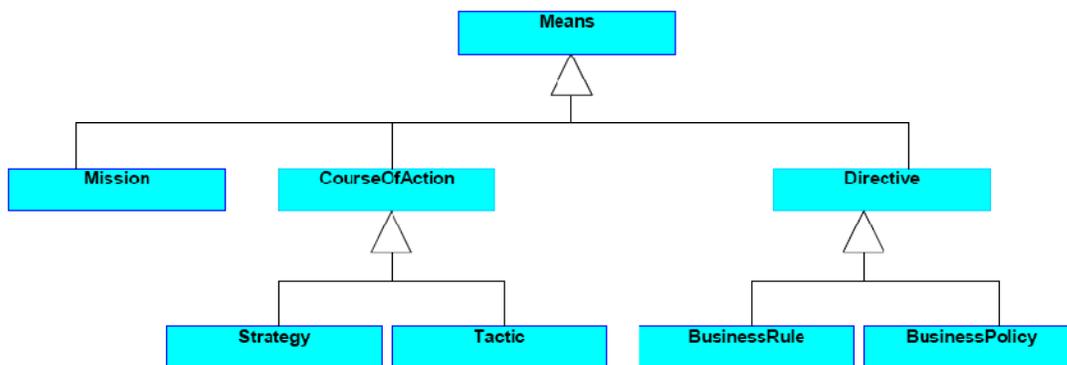
Figure 3.5 The Hierarchy of Means concepts

Table 3.2 The description of Means concepts (OBJECT MANAGEMENT GROUP (OMG), 2008)

Concept	Description
Mission	A Mission indicates the ongoing operational activity of the enterprise, describing what the business is or will be doing on a day-to-day basis. A Mission makes a Vision operative in the sense that it indicates the ongoing activity that makes the Vision a reality through the description of Strategies. The Mission must cover all the Strategies.

	Organization: Consulting Company **Mission:** Provide consulting, outsourcing, and staff augmentation services to companies in North America
Course of Action	A Course of Action comprises in an approach or plan for configuring some aspect of the enterprise undertaken to achieve Desired Results. In other words, they define how resources, skills, or competencies must be employed, but does not specify how well it is employed. The specification of measures of performance is made in terms of the Objectives that are supported by the Courses of Action. It is important to emphasize that Courses of Action are not Business Processes; rather, Courses of Action can be *realized* by Business Processes, that is, they can be made operative by Business Processes. Courses of Action are categorized as Strategies and Tactics. Generally, Goals are supported by Strategies and Objectives are achieved by Tactics, although there is no clear distinction between the two concepts in the specification.
Strategy	A Strategy is one component of the plan for the Mission, representing how resources, skills or competencies are combined to achieve enterprise Goals, given the environmental constraints and risks. Thus, it is said that a Strategy channel efforts towards Goals. Compared to Tactics, Strategies tend to be longer term and broader in scope. A Strategy is implemented by Tactics. However, the model does not make a hard distinction between Strategies and Tactics and the enterprise must define their own criteria. Since the distinction is soft, in fact, an element originally defined as a Tactic may subsequently be elevated to a Strategy. The reverse is also likely to occur. In other words, the business plans will gradually evolve toward greater accuracy in specification, as well as greater coherence and completeness. **Organization:** Consulting Company **Strategy:** Implement a Customer Relationship Management System
Tactics	A Tactic is a Course of Action that represents part of the detailing of Strategies. For example, the Tactic "Call first-time customers personally" implements the Strategy "Increase repeat business." While Strategies usually channel efforts towards Goals, Tactics channel efforts towards Objectives, although this is not mandatory. For example, the Tactic "Ship products for free" channels efforts towards the Objective "Within six months, 10% increase in product sales."
Directives	Directives govern Courses of Action, defining or constraining some aspect of an enterprise. It is stated in the declarative form and intends to assert business structure or to control or influence the behavior of the business. For example, the Business Rule "Pizzas may not be delivered beyond a radius of 30 miles" governs the Strategy "Deliver pizzas to the location of the customer's choice." This governance applies to Tactics as well. For example, the Tactic "Encourage rental extensions" is governed by the Business Policy "Allow extension of rentals by phone." Occasionally a Directive is defined to support the achievement of a Desired Result directly (rather than constraining Courses of Action). In the Business Motivation Model, Directives are categorized as Business Policies and Business Rules.
Business Policy	A Business Policy is a non-actionable Directive whose purpose is to govern or control the Strategies and Tactics. For example, the Business Policy "We will not make on-site visits" governs the Strategy "Encourage repeat business," as well as the specific Tactics that might be selected to implement the Strategy. Compared to a Business Rule, a Business Policy tends to be less formally-structured and usually not atomic (i.e., not focused on a single aspect of governance or guidance) and may be less formally articulated. Business policies are not directly actionable.
Business Rule	Business Rules provide specific, actionable governance or guidance to implement Business Policies, introducing obligations or necessities. 'Actionable' means that a person who understands a Business Rule could

| | observe a relevant situation (including his/her own behavior) and directly decide whether the business was complying with the rule. In contrast to a Business Policy, a Business Rule is highly structured and is carefully expressed in terms of standard vocabulary. In fact, Business Rules are derived from Business Policies. As an example, consider the Business Policy "Rental payments must be guaranteed in advance" from which is derived the following Business Rule "A provisional charge for the estimated cost of the Rental must be made against a valid credit card held by the Renter before the Car is handed over". |
| | Apart from its role in the structure, 'Business Rule' is outside the scope of the BMM and must be defined in another model (it is said that Business Rules are externally-referenced elements). |

3.3.1.3 The Influencers and Assessments

An Influencer comprehends in some factor that has the capability to cause changes that shape the enterprise in its employment of its Means or achievement of its Ends. The main aim of this concept is to allow the indication of the surrounding context in which business plans are formulated, communicating the sufficient background and/or contextual information for other planning participants to make appropriate Assessments.

The BMM provides three Influencers categories: Internal Influencer (from within the enterprise that can impact the employment of Means), External (from outside the enterprise boundary) and a set of general categories to allow enterprises to define their own set. Among the External Influencers, there are competitors, customers, environment, partners, regulations, suppliers and technology and as Internal Influencers, there are assumptions, corporative values, habits, infrastructure, issues, management prerogatives and resources.

Influencers must be formulated in a neutral manner, i.e., devoid from any qualifier. When an Influencer is described in terms of the statements that assess the implications for business plans, they actually are Assessments. Assessments correspond to the judgment of how the Influencers drive the enterprise to articulate its decisions. Since this judgment is to some extent subjective, the model supports a mechanism for recording the responsible for the Assessment as well as when it has been elaborated, providing an audit trail for future reference. The BMM supports a general categorization structure for Assessment, opening up the possibility of the enterprises freely adopt their own instruments for assessing potential impacts that can be identified to support Assessments.

3.4 CONCLUSION

The Tropos methodology provides support for modeling business processes from a strategic perspective differently from other modeling languages which propose to cope with business process models as a collection of ordered activities, not capturing their intentional dimension. In this sense, the methodology provides the concept of goal (either hard or soft) which is useful for capturing that a desired state of the world can be attained by different alternative business processes (modeled as tasks). Besides expressing process models in terms of goals and tasks, it is also important to capture quality factors to characterize the elements of process models and to facilitate and justify the selection of alternatives. Since decisions must be taken during process execution, these quality factors are useful to guide and constrain the selection among alternatives. Commonly, the quality factors are captured as softgoals within the framework since quality aspects tend to be specified in a subjective and context-specific manner.

Other important characteristic of the Tropos methodology is the ability of facilitating goal analysis through a language which is expressive enough to capture complex relationships between goals and dependency relationships among organizational agents (BRESCIANI *et al.*, 2004). Further, Tropos provides sophisticated tools for contribution analysis and formal reasoning for assessing goal satisfaction (GIORGINI *et al.*, 2004).

We argue that one of the main advantages of applying the Tropos methodology in organizational environments is the opportunity of noticing particularities of the environment, such as: (a) the verification of inconsistencies between models elaborated from the point of view of different stakeholders; (b) the detection of tasks performed by multiple organizational actors repeatedly, which suggests that the efficiency of the business process can be improved if the issue is addressed (c) the understanding that little attention is devoted either to collaborative activities or knowledge-intensive activities; (d) the detection of problems related with the lack or inadequacy of policies and/or information systems (e.g. lack of trust among actors, gap between business process and information system, etc.) and (e) the establishment of dependency relationships among actors in the achievement of their goals (this helps the detection of non-reciprocal relationships among actors, revealing actors' vulnerabilities).

Despite these benefits, we can enumerate the following weakenesses in the Tropos approach: (i) the distinction between a means-end relationship and a decomposition relationship in i*/Tropos in terms of semantics may lead to confusion (when should a refinement be considered a decomposition or a means-end relationship?) (QUARTEL *et al.*, 2009) (ii) the complexity of goals models (in terms of scalability, readability, structure, among others) can constrain the usefulness of models (NEIGER e CHURILOV, 2004) (iii) little sophisticated tool support for modeling can limit the large-scale applicability of the framework and (iv) the lack of expressiveness of the language in different domains requires the enlargement of the "core" Tropos meta-model.

Despite these weaknesses, Tropos has been chosen to be applied in our case study since it provides the best compromise in the field of goal-oriented process modeling. Among its advantages (from the designer point of view), we can enumerate: (i) it allows for complex goal classification structures according to goal types (e.g. functionality, verification, temporal, system state and goal level) and (ii) it facilitates the modeling of logical, causal and influencing relationships between goals whilst linking the goals to the activities and functions aimed at their achievement (NEIGER e CHURILOV, 2004).

Differently from Tropos, the BMM does not comprehend a methodology or a language, but rather it is an abstract specification which supports a wide range of approaches for creating and maintaining models for an enterprise. Although providing a conceptual model, BMM does not provide software tools neither for the construction of the deliverables (organized business plans), nor for the management of the process of development. Since BMM is methodology-, tool- and language-neutral, its usage in practical efforts depends on specific languages such as, for example, i*/Tropos.

3.5 CHALLENGES FOR INTEGRATING GOAL AND ENTERPRISE MODELING APPROACHES

As argued in the previous chapters, the advantages of the ARIS framework for modeling complex enterprise architectures as well as the ability of describing the intentional aspects of enterprises provided by the Tropos framework support our selection of both methodologies to be used in our case study. This selection requires coherent integration of ARIS and Tropos,

which is a challenging task, for several reasons. First of all, the languages can use different terminology to denote the same abstract concept. Conversely, distinct concepts can be represented by the same (or similar) notational element within these languages. Additionally, each modeling language focuses on different architectural domains (viewpoints) of the organization (for instance, Tropos is concerned about activities, actors and goals, but it does not devote special attention, for example, to capturing the sequential order between these activities. On the contrary, ARIS commits in capturing business process from a behavioral perspective, neglecting to some extent the intentional dimension of these processes). This characteristic manifests in the existence of different set of concepts in each modeling language which cover different aspects of the organization. To discover the sets of concepts in each language which overlap is an additional difficulty in integration. Finally, when no overlap exists, the gap between the languages has to be bridged. In other words, we could say that there may exist an architectural domain which is not modelled by either languages; this architectural domain concerns the relations between the goal domain and the other enterprise architecture domains.

In the area of semantic integration (NOY, 2004), ontologies are largely recognized as the "link" between modeling languages, providing the semantic foundation to adequately integrate the concepts of different languages since they define these concepts in an unambiguous way. This precise definition enables a subsequent mapping between the common concepts, allowing seamless transition between the domains. The next chapter is aimed at describing organizations from an ontological point of view. In this thesis, the purpose of these ontologies is to allow the integration between the goal domain and other enterprise modelling domains (supporting our integration of Tropos and ARIS).

Note that, at a fist glance, one may regard BMM as a suitable foundational element for integrating these languages since its abstract concepts encompass both the Tropos architectural domain – goals, plans and resources – and the ARIS viewpoints – business process, roles, resources and so forth. However, the lack of a clear semantics for the concepts in the standard (as one example, the OMG specification of BMM emphasizes the absence of hard distinction of strategies and tactics) makes it difficult to apply BMM as a reference model for systematic language integration and analysis. This motivates our enquiry into a semantic basis for goal and enterprise modelling from an ontological point of view as

discussed in the next chapter. This foundation will allow us to discuss the integration between goal models and other enterprise models (in Chapter 6).

CHAPTER 4.   ONTOLOGICAL FOUNDATIONS FOR ENTERPRISE AND GOAL MODELING

4.1   INTRODUCTION

In the past decades there has been growing interest in the subject of ontology in computer and information sciences. In computer science, the term "ontology" has been firstly coined by Mealy in the area of data processing in 1967. Since them, a large number of efforts related to ontology have been put forward ranging from Artificial Intelligence (AI) to Semantic Web, including Model-Driven Architecture (MDA) initiatives (GUIZZARDI, 2007).

Ontology is defined as a theory in philosophy (a branch of metaphysics) concerned with the nature (kinds of existents) and relations of being (GUIZZARDI, 2005). The importance of ontologies for information systems is largely recognized as a means for providing foundations for conceptual modeling. These foundations have the role of capturing the ontological categories (concepts) of such domain, providing real-world semantics for language constructs which represent these concepts (GUIZZARDI, 2005) as well as clarifying the structure of the knowledge (CHANDRASEKARAN *et al.*, 1999).

Analogously, ontological foundations for enterprise modeling are also an essential instrument for providing a common terminology that captures key distinctions within organizational environments. These distinctions must be generic across many domains as well as provide adequate specification of the semantics of the terminology of the enterprise (GRUINGER *et al.*, 2000). Moreover, "an ontological analysis of organizations is the first, fundamental and ineliminable pillar on which to build a precise and rigorous enterprise modeling. An ontological analysis makes explicit the social structure that underlies every organizational setting" (BOTTAZZI e FERRARIO, 2005).

This chapter intends to survey the current literature in ontologies for enterprise modeling, defining the organization in terms of basic concepts. We intend to answer the following questions: "What are organizations from an ontological point of view?", "What are the ontological interpretations for architectural elements which compose organizations?", "How

are goals related with these architectural elements?" and so forth. The purpose of this survey is to lay down a common basis for integrating each architectural domain of our case study. The ontologies can both provide the relevant concepts in each of these domains as well as provide a rigorous semantics for the concepts of each modeling languages employed. With the establishment of a semantic view at the conceptual level, it is possible to devote attention to the relationships necessary to integrate both the architectural domains (and its correspondent modeling languages). After the integration, the ontologies are used as the foundation to explain how the organization of our case study implements its goals.

Furthermore, the usage of ontologies is not useful solely for clarifying the semantics of the modeling constructs of each language for integration purposes, but it has other two associated benefits: first, it can guide one in the usage of the modeling elements of each language and second, one can suggest well-founded improvements in these modeling languages for future reengineering purposes.

The survey of organizational ontologies starts with the concept of organization from an ontological point of view and presents the relationship between goals and the remaining components which form organizations. The chapter is organized as follows: section 4.2 introduces the (ontological) definition of organizations. From this point on, each section describes the relationship between goals and other elements of enterprise architecture. Section 4.3 defines the relation between goals and roles; section 4.4 describes how agents and goals are related; section 4.5 relates actions and plans with goals; section 4.6 describes how collective agents pursue goals through interactions; section 4.7 argues that agents can delegated goals to be achieved and presents the relation between goals and delegations; section 4.8 presents some remarks about the relation of goal realization and objects; and section 4.9 considers rules and norms as mechanisms for enforcing goal realization. Section 4.10 concludes the chapter with some remarks in ontologies of organizations.

4.2 WHAT ARE ORGANIZATIONS?

We start our considerations with the concept of institutional organizations[4]. Despite the large amount of literature devoted to describing organizations, especially in social sciences such as

---

[4] The literature distinguishes among what is called of non-emergent organization (BOTTAZZI *et al.*, 2007) and self-organized or "emergent" organizations (DIGNUM, 2004)(BOTTAZZI *et al.*, 2007). At an intuitive level,

economics or anthropology, organizations are very difficulty to define from an ontological point of view (BOTTAZZI *et al.*, 2007). Some proposals argue that organizations can be social objects (something like a convention or agreement established by humans as an way of coordinate the human behaviour) (BOTTAZZI *et al.*, 2007), artifacts (social objects can be seen as artifacts) which serves to the purpose of orchestrating the collective behaviour (BOTTAZZI *et al.*, 2007) or even intentional agents that emerge from the aggregation of several natural persons[5] (human beings) (BOTTAZZI *et al.*, 2007)(GUIZZARDI *et al.*, 2007). In (BOTTAZZI *et al.*, 2007), Botazzi and colleagues argue that, despite the differences in defining the concept of organizations, at least, there is some agreement (in sociology and philosophy) in facing organizations as a collective of individuals who enacts some roles under some constraints (rules and norms) on behalf of some purpose (goals or ends). This proposal adopts the line which considers organizations as designed agents who act in the physical world with a specific mission. According to this teleological view, organizations are the result of a decision-making process that is necessarily based on goals and on how these goals can be achieved. Dignum (DIGNUM, 2004) moves towards the same direction in affirming that "an organization can be seen as a set of entities and their interactions, which are regulated by mechanisms of social order and created by more or less autonomous actors to achieve common goals". In turn, this proposal admits that organizations are more than the sum of the agents which compose the organization (in fact, roles describe the organizational perspective on individuals, whereas agents represent the perspective and objectives of the individuals themselves). Differently from the previous proposals, in (GUIZZARDI *et al.*, 2007), Guizzardi and colleagues view an organization as an institutional agent constituted by a number of other (physical, artificial or institutional) agents. It is important to emphasize that, according to this point of view; an organization is not separated from the collective body of agents that composes it, but is the aggregation itself. However, it is very relevant to put that this aggregation is not a merealogical sum of the agents. On the contrary, an organization has a functional complex relation with its constituents. According to (GUIZZARDI, 2005),

---

while the former are designed societies, with specific objectives and structures, the latter results from "ad-hoc" interactions of agents (DIGNUM, 2004). We are interested in the non-emergent organizations, since it represents "enterprises" in general and the organization presented in our case study in particular.
[5] Natural person is a concept inherited from Law which states that while human beings are natural persons, juridical persons are abstract entities with juridical existence and responsibility legally authorized (ISTC-CNR).

(functional) complexes are composed by parts that play a multitude of roles in the context of the whole. The parts of a complex have in common that they all posses a functional link with the complex. In other words, they all contribute to the functionality (or the behavior) of the complex. Therefore, if it is generally the case that essential parthood entails dependence (see definition 5.11), in this type of parthood relation, an essential part represents a case of *functional dependence*. To put it more precisely, for all complexes, if x is an essential part of y then y is functionally dependent on x.

Therefore, each (physical, artificial or institutional) agent enacts a different functional role within the scope of the organization.

In the current work, we adopt the concept of organizations as social agents created by human societies to manage the behaviour of agents who act on behalf of some goals (the teleological aspect) (BOTTAZZI *et al.*, 2007) (DIGNUM, 2004)(BOTTAZZI e FERRARIO, 2005)(ISTC-CNR, 2005-2007). Therefore, goals are the drivers for the creation of organizations as the organizational structure which supports the systematic pursuit of goals by autonomous agents.

Since organizations are entities apart from their constituent components, it is important also highlight that the term "organization" refers to the abstract design of the organization (the relations holding among the units of the organization or the "design layer"), rather than the potential realization of some particular organization (instantiation of some organizational environment, the "realization layer") (ISTC-CNR).

Regarding the design of organizations, some proposals (DIGNUM, 2004)(FOX *et al.*, 1998)(USCHOLD *et al.*, 1998) conceive roles as the only structural component in the design of organizations (although they can be hierarchically arranged by dependencies or power relations), not making explicit the underling social structure behind these roles (ISTC-CNR). However, other proposals (ISTC-CNR) describe organizations as being composed by sub-organizations as a mean of explicitly describing the organizational structure. Adopting the concept of sub-organization opens up the opportunity of representing the organizational structure as a set of institutional relationships, i.e., the organization under consideration can be interpreted as being an element of an institutional network of organizations. This kind of representation is useful since internal sub-organizations can interact with external organizations outside the direct influence or control of the organization (ISTC-CNR).

Given this, we take the second approach in which organizations are described as structured in terms of sub-organizations as proposed in (ISTC-CNR). According to the model presented in this proposal, organizations are a 4-tuple composed by a set of objectives, a set of (direct internal) sub-organizations, a set of institutional relationships and a set of external organizations. The internal sub-organizations of an organization are the organizations that are linked by a finite chain of direct internal sub-organization relations. The external organizations of an organization are the organizations that have institutional relations with the organization but are not directly controlled by it. Finally, the set of the direct sub-organizations of an organization is the union of the sets of the internal and external sub-organizations.

Regarding goals, since the top organization is formed with the aim of pursuing some goals, these goals must be refined and assigned to its sub-organizations so that these latter jointly become responsible for attaining the goals of the global organization. Observe that in this process of refinement, the top organization refines the organizational high-level goals into more specific goals and assigns them to its sub-organizations. Moreover, this assignment can also include a specific way about how to pursue these goals (ISTC-CNR, 2005-2007).

Observe that the specification of a particular structure for the sub-organizations can be regarded as a means for the organization to coordinate sub-organizations to achieve its global goals. This specification is made through the imposition on norms to regulate the interaction among these sub-organizations, but the sub-organizations can also decide to autonomously establish additional relationships.

4.3   ROLES

When the refinement of the organization reaches its lowest level, sub-organizations with no further decomposition are denominated as *roles* (BOELLA e VAN DER TORRE, 2006). Roles are social concepts employed for abstracting from specific agents in organizations (BOTTAZZI *et al.*, 2007), representing the part of the organizational design which specifies the activities and services necessary to achieve society objectives (DIGNUM, 2004).

Besides being properly defined by abstract design, organizations need to exist in reality through some physical structure (what one could informally call the "translation" from the

abstract world to the concrete one). This realization is made by assigning individual agents to roles through an enactment relationship, that is, the goals of a role are expected to be executed by the agent(s) enacting that role. Besides the assignment of agents to roles, the satisfaction of the overall organization's goals requires the joint accomplishment of goals of roles as well as the achievement of goals which do not pertain to any particular individual, but are common to many agents (see interactions for a longer discussion about emergent goals).

An obvious problem of goal achievement in organizations is the fact that roles are the design from an organizational point of view, i.e., it is assumed that role playing is predictable, although this is not always true. To regulate the possible deviations from the desired behaviour, organizations rely on norms that fix constraints in the behaviour of agents which enact roles (norms are further explored in section 4.9). These regulative norms are applied to agents as they become affiliated to organizations via agreements or contracts (BOTTAZZI *et al.*, 2007).

4.4 AGENTS

While roles define how the organization aims at implementing its design through the specification of the behaviour of particular individuals, *agents* represent the perspective and objectives of the individuals themselves (agents pertain to the "realization layer"). In dealing with goal attainment issues, it is fundamental to regard the characteristics of agents who enact roles in societies in the sense that this can interfere in the adoption of plans to achieve goals[6].

With that respect, agent-oriented methodologies cope with agents as autonomous and heterogeneous entities that exhibit proactive and flexible behaviour (FERRARIO e OLTRAMARI, 2004) as well as mental states (GUIZZARDI, 2006). In addition, according to Dignum (DIGNUM, 2004), agents are able to interact and cooperate with other agents, since they are socio-cognitive entities, namely, entities endowed with mental attitudes who assumes that other agents also holds the same characteristic. Dignum also defends that, since agents exhibit autonomous and heterogeneous behaviour, they may be more or less

---

[6] In (ISTC-CNR, 2005-2007), the author argues that when an individual agent (e.g. Napolitano) plays a role (e.g. president) within some organization, then a new entity, Napolitano-qua-President arises. Taking this, we can say that goal achievement within organizations is more importantly characterized by the *qua-individuals* which compose the organizations than the (abstract) roles or agents in isolation.

committed with organizational aims and strategies according to the extent to which their own goals are compliant with the organization's goals. In other words, the autonomy of agents may lead to undesirable behaviours from the organizational point of view.

In the sequel, we use the BDI cognitive model (RAO e GEORGEFF, 1991) proposed in the AI literature for describing agents. In this model, agents are characterized by three basic mental components: beliefs, desires and intentions. Further, we also recognize a forth mental state, namely, capability. We use these mental states to explain how agents which enact roles within organizations impact in the organization's goal achievement.

4.4.1 Intentions

Since agents can exhibit undesirable behaviours from the organizational perspective, there is an evident need for some mechanism of enforcement in the organization to guarantee that the agent's participation in the society is compliant with the behaviour which is interesting from the organizational perspective. These enforcement mechanisms are norms and rules and will further explored in section 4.9.

In addition to norms and rules, one may attempt to reach organizational roles by selecting (human) agents who are fully committed with the organizational goals. In this case, the participation (or admission) of the human agent in the organization is conditioned by the compliance of his/her *intentions* with respect to the goals of the organization.

From an ontological point of view, intentionality must be understood as more than an "intention of doing something" in its ordinary sense ((SEARLE, 2000) apud (GUIZZARDI *et al.*, 2008)), as expressed by sentences like "I intend to go to the movies tonight" (the sense of the sentence "intend something" is further explained soonly). Searle (The Construction of Social Reality, 1995) explains that intentionality is the feature of constructing mental representations by which they are about something or directed at something. Intentionality is then the requisite for entertaining intentional mental states (beliefs, desires, fears, or making hypotheses) are different types of intentional states. Therefore, the common characteristic of these mental states is that they refer to possible situations of reality (BOTTAZZI *et al.*, 2006).

In (GUIZZARDI *et al.*, 2008), these individualized properties of some individuals are denominated as mental moments and are existentially dependent on these individuals (observe that the term moment does not bear the temporal notion which is associated in the colloquial language).

Every mental (intentional) moment has a type (belief, desire or intention) and some propositional content. The propositional content of an intention is a goal. An intention is a goal that the agent commits at pursuing (GUIZZARDI *et al.*, 2008), while desires represent the "will" of an agent towards a specific goal, although it might never actually pursue these goals (GUIZZARDI *et al.*, 2007). Actually, the main difference between desires and intentions relies on the association of intentions with the actions, leading agents to be committed in pursuing the goal through the instantiation of some plan (GUIZZARDI *et al.*, 2007). The same idea of intentions is explored by (BOTTAZZI *et al.*, 2006) that affirms that "an agent is considered to be intentional when not only it builds a (mental) representation of the goal, but also a representation of the action necessary to its achievement, and of the resulting consequences" (therefore, "intend something" in its ordinary sense is, in fact, a specific type of intentionality termed as intention).

Despite the importance of intentions to instantiate plans to achieve goals; the mere association of intentions with plans does not entail goal achievement. In other words, as Bernard of Clairvaux (1091-1153) says, "hell is full of good intentions and desires".

4.4.2 Beliefs

As exposed by some authors(FERRARIO e OLTRAMARI, 2004) (GUIZZARDI *et al.*, 2007), beliefs correspond to an external perception of the world, namely, the knowledge about the environment and other agents with whom it interacts, although the origin of these beliefs are slightly different in the proposals.

In (FERRARIO e OLTRAMARI, 2004), the perceptions about the external world may cause the creation of mental objects[7] in the agents. The processing of these perceptions by an agent

---

[7] In fact, mental objects can be defined either as percepts (mental objects which are independent on any other mental object) or computed objects (dependent on at least one another mental object). They are indirect in the

can lead to the creation of beliefs. From these beliefs, desires can be derived. Finally, desires can lead to the creation of intentions. Therefore, intentions are existentially dependent on beliefs to be created. Goals, in turn, are reliant on beliefs to be pursued. In (GUIZZARDI *et al.*, 2008), beliefs are intentional moments of agents created from the perception of the world (this proposal is different from the Ferrario et al's proposal in the sense that the former does not mention the processing from percepts to beliefs as argued by the latter). The concept of belief adopted for our case study is the concept presented by Ferrario et.al.

4.4.3 Capabilities

Although capabilities are not expressed in the BDI model, other models of mental states in agent-oriented theories acknowledge the need of accommodating additional components such as capabilities, as explained in (SHOHAM, 1993).

Botazzi and others (BOTTAZZI *et al.*, 2007) argues that agent's capabilities determine the potential states of the world that the agent can hold in executing actions. In other words, while beliefs influence agents in the choice of some particular strategy to achieve some goal, capabilities determines how effectively the agent will execute the chosen strategy.

Section 4.5 discusses that sometimes, capabilities can be necessary both during a planning process as well as in the instantiation of actions to fullfil goals. Section 4.6 argues that often, a single agent's capabilities are not sufficient to bring about a goal, which leads to agents being engaged in collective actions that involve other agents with complementary capabilities (interactions). Finally, section 4.7 explains when an agent does not possess a required capability to fulfill some goal; it can opt for delegating the goal achievement.

4.5 ACTIONS AND PLANS

In previous sections, we have discussed how mental states affect agents to adopt actions in the pursuit of goals. Although the distinction between goals and actions is quite important as demonstrated in the BDI model, it is not always clear in the existing works (GUIZZARDI *et al.*, 2007). Goals are a set of states of affairs (i.e. a set of world states), whereas actions (or

---

sense that they result of the computational processes that occur every time that an input (external or internal) is processed by the agent.

action events) are events[8] created by agents with the purpose of attaining goals (GUIZZARDI *et al.*, 2007). Therefore, since actions are realized by intentional agents, they are also intentional transformations of reality.

During the process of creation of actions to fulfill goals, agents commonly face different alternative solutions for achieving the same goal. In this decision-making process, there is potential misalignment between the choice of some plan and the satisfaction of the goal associated with this plan. This "misalignment" refers to a possible inadequacy of the plan or due to an intrinsic limitation of the goal to be satisfied in its totality. Therefore, for goals to be achieved, intentions must drive the adoption of "proper" plans.

Concerning this issue, some ontologies (BOTTAZZI *et al.*, 2007)(GUIZZARDI *et al.*, 2007) distinguish between the planning process (in which agents deliberate about which actions must be executed under some constraints) and the instantiation of actions which actually achieve the goal. Planning comprises in decision-making process with the purpose of choosing which actions are better applied to achieve some situation, considering the current constraints to which the agent is subjected. Therefore, in these frameworks, "a plan is an action type that an agent intends to execute (more correctly the agent intends to execute an instance of that action type) to achieve a goal" (GUIZZARDI *et al.*, 2008).

Actions can be atomic (or basic) or complex. In (BOTTAZZI *et al.*, 2007), basic/atomic actions are direct successive transactions between two moments[9] (with their associated preconditions). In (GUIZZARDI *et al.*, 2008), the concepts of atomic action and complex action are not similar to the concepts adopted in (BOTTAZZI *et al.*, 2007). In the former, being atomic and being instantaneous are orthogonal notions in the framework, i.e., atomic actions can be time-extended as well as an instantaneous event can be composed of multiple (instantaneous) participations. In fact, the concept of atomic action in Guizzardi et al. is related with the granularity of the actions: while an atomic action is an action event that is not composed by other action events, a complex action is a composition of at least two basic actions (that can themselves be atomic or complex). Furthermore, in ontologies, the concept of an execution of some business process (or a plan execution) can be understood as the

---

[8] Events are possible alterations of a portion of reality to another state of affairs, i.e., they may change the reality from a pre-state (situation) to a post-state (other situation) (GUIZZARDI *et al.*, 2008).

[9] In this case, moment bear the notion of time instant from the colloquial language.

execution of one or more ordered atomic actions (a complex action in other words), targeting a particular outcome. In fact, a plan execution instantiates a plan (or plan type) through the creation of action events previously specified in the plan (GUIZZARDI *et al.*, 2007). With the purpose of describing the organization of our case study, we adopt the concept of actions as proposed in (GUIZZARDI *et al.*, 2008).

Actions can be coordinated among agents to achieve common goals or goals that require complementary capabilities. Further, if agents cannot independently reach the goal, they can decide to delegate the goal or the plan that is intended to fulfill the goal (notice that even when the goal is independently reachable, an agent may prefer to delegate it to other agents). The issues of interactions and delegations are discussed in sections 4.6 and 4.7.

4.6   INTERACTIONS

As recognized by Dignum in (DIGNUM, 2004), interactions are an important factor in the attainment of organizational goals. She affirms that "interactions occur not just by accident but aim at achieving some desired global goals, and that but participants are autonomous, heterogeneous and not under the control of a single authority". In this proposal, the author considers the concept of interaction as being the joint activity of the participating roles. This concept of interaction is also the one adopted here to be applied in our case study.

An important issue in the topic of interactions is that they can occur to satisfy goals that are either common to agents or global goals which pertain to the society as a whole and lay outside the scope of each individual agent (also denominated as "emergent" goals). If we consider sub-organizations as a kind of structured agents, interactions among the sub-organizations can be faced as a way of realizing the society goals. In this case, the coordination to obtain the global goal is established by the global organization via some constraints/norms that regulate the interactions between the sub-organizations. Note that the interactions imposed by the global organization generally are a vague insight about how to realize the global plan, while additional interactions can be set up by the sub-organizations in order to realize the refinement of their goals (BOTTAZZI *et al.*, 2007).

Not only the pursuit of common goals justify the establishment of interactions. Concerning this issue, Botazzi (BOTTAZZI *et al.*, 2007) introduces the concept of collective capability

which refers that the states of the world an agent is able to attain participating to a collective action that involves the help of other agents. Thus, interactions can be characterized by the notion of common goals that are shared by agents who presents complementary capabilities to attain these goals. In fact, in some cases goal achievement is associated not with an agent who instantiate an action to fulfill the goal, but with two or more agents who separately are not able to accomplish the goal by themselves (since they are not knowledgeable enough or constrained in their resources) and thus, need to interact to achieve the goal.

4.7   DELEGATIONS

As we have discussed earlier, agents may decide to delegate a goal or a plan that is intended to fulfill a goal.

In (GUIZZARDI *et al.*, 2007), Guizzardi et al. define that when an agent A decides to delegate a goal to an agent B through a relationship of delegation, the act of requesting is denominated as social claim and agent A is called the delegator in the relationship of delegation. The act of agent B of assuming the achievement of the goal on behalf of agent A is, in turn, denominated as social commitment (and agent B is called the delegate in the relationship of delegation). The commitment/claim pair entails the creation of a social relator10 (delegatum). There are two types of delegation, according to the delegatum: open delegation and close delegation. In a close delegation, when A performs a delegation action, it delegates not only a goal, but also a way of achieving it (also delegates a plan). This means that the delegator A believes that it is possible that the delegatee accepts and it is able to execute the delegated plan. Instead, in an open delegation, the delegator only delegates the goal to the agent B and the responsibility of finding a strategy to reach the goal relies on B.

Open delegations are often motivated by a lack of competence of the delegator who opts to transfer a specific sub-goal (or sub-plan) to the delegatee. The expertise of the delegatee enables him/her to choose the best alternative under the specific constraints. In some more extreme cases, the delegator gives the power to the delegatee to build the optimal context to execute the delegated sub-plan, i.e. the delegatee has the power of structuring a sub-

---

[10] In section **Erro! Fonte de referência não encontrada.**, we have explained that *moments* are properties from individuals. When these properties are dependent on a plurality of individuals, they are denominated as relators. Thus, a delegation relationship comprises in a property dependent on more than an individual, i.e., they are social relators.

organization (BOTTAZZI *et al.*, 2007). In chapter 6, we demonstrate how this is an important issue in real organizations. Other factors which motivate delegations are: the availability of resources and rights and permissions that limit or empower agents in an environment submitted to regulations (BOTTAZZI *et al.*, 2007).

((PACHECO e SANTOS, 2004) apud (BOTTAZZI *et al.*, 2007)) enumerate different forms of delegation:

(i) Delegation by command (where the delegator has authority over the delegatee and the delegation is immediately turned into a command. The delegatee cannot refuse the command);

(ii) Delegation by joint action (where each agent delegates "a part" of the joint action to the other participating agents)[11];

(iii)Institutional delegation (where there's no direct agreement between the agents but it is institutionally stated that, for instance, in the absence of an agent playing a certain role, another agent, in his/her role, is delegated to act on his/her behalf);

(iv)Informal delegation (not interesting because they are devoid of the normative aspect).

Every form of delegation impacts on how goals may be achieved within the organization. For instance, goal delegation through informal delegation may lead to non-fullfillment since its realization cannot be enforced due to the lack of a normative aspect.

4.8 OBJECTS

In ontologies, objects are endurants, i.e., entities that are in time, like a ball, a pen, or a flower. Endurants are the opposite of perdurants that correspond to entities that happen in time (intuitively speaking, perdurants are events), like a business process, a wedding, etc (GUIZZARDI, 2005)(BOTTAZZI e FERRARIO, 2006).

---

[11] Notice that this comprises in the concept of interaction, previously presented.

In (GUIZZARDI, 2006), the concept of physical object is specialized into physical agent and non-agentive object. The classification in relation to the agentivity refers to the ability of the object of holding intentionality. Physical agents and their relation with goal achievement have already been explored in previous topics. Therefore, here, we refer to non-agentive objects to explain their relation with goal achievement.

Objects can be physical (e.g., an equipment, a device) or social (e.g., money, language and normative descriptions (GUIZZARDI *et al.*, 2008)(BOTTAZZI e FERRARIO, 2006)). Normative descriptions are further explored in next section.

Objects are denominated as resources when they are used by an agent with a specific purpose. In this case, how the resource participates in the action affects how goals are achieved. With that respect, in (GUIZZARDI *et al.*, 2008), authors define that there are four different modes of resource to participate in actions, namely, creation, termination, change and usage.

Informally speaking, a resource creation and termination correspond respectively to the creation and termination of some resource in the organizational environment. A resource change means that some property (moment) of the resource has been altered by an action and finally, a resource usage is a kind of participation which is not any of the three aforementioned modes. Sometimes, the way how the resource participates in the action is determinant for goals to be achieved. An example of how a resource participation impacts some goal to be fulfilled is when some agent has to access to the resource to achieve a goal or the way that some agent manipulates a resource previously accessed to achieve a goal (in this latter, highlighting the role of agent's capabilities in manipulating certain resources to attain organizational goals).

4.9   RULES AND NORMS

Organizations are entities that strongly depend on norms; i.e., they are completely made up of norms (ISTC-CNR). The proposals in (BOTTAZZI e FERRARIO, 2006) (GUIZZARDI *et al.*, 2008) (BOELLA e VAN DER TORRE, 2006) view rules and norms as a *collectively recognized descriptions* which act as enforcement mechanisms to restrain the individual behaviour of agents, regulating all sort of organizational interactions among them, including

delegations, relationships with internal/external organizational entities as well as defining concepts within the organizational setting.

Botazzi (BOTTAZZI e FERRARIO, 2006) and Searle (SEARLE, 1995) suggest three different kinds of norms based on the different functions they have; constitutive norms, deontic norms and technical norms:

4.9.1 Constitutive Norms

Searle (SEARLE, 1995) argues that the social reality is constructed by this kind of norms which create new institutional concepts. In fact, they are responsible for defining the institution itself, since the organization comprehend a social concept defined by norms and collectively accepted by a human community. In (GUIZZARDI *et al.*, 2008), social concepts are created by normative descriptions. Among the social concepts that authors cite, we have social objects (such as the crown of the king of Spain), social roles (such as president or pedestrian) and social commitments (such as social contracts).

This kind of norms is responsible for the creation of social concepts which make feasible for goals to be attained within the organizational context. For example, it creates social objects which may be indispensable for the realization of some action to fulfill a goal. Furthermore, they describe the activities and services that must be executed by roles to achieve society goals. In this sense, norms are responsible for providing the linkage between organizational goals and roles (BOTTAZZI *et al.*, 2007) since the definition of roles assigns obligations to specific roles to achieve organizational goals.

4.9.2 Deontic Norms

Searle in its construction of social reality (SEARLE, 1995) discusses the distinction between the nature of constitutive and deontic norms. He explains that constitutive norms have the function of creating concepts, whereas deontic norms constrain the existence of pre-existing concepts.

He uses two examples for illustrating the difference between the constitutive and the deontic norms (respectively): the act of playing chess and the act of eating. On one hand, the act of

playing chess is created by the constitutive norms, i.e., the activity of playing chess just exist whether the actions performed by players are in accordance to these rules (in other words, playing chess is defined by the norms). On the other hand, the act of eating is a concept which exists independently of the (deontic) rules which state what is polite or not. In this sense, the constitutive norms create the possibility of the existence of an activity denominated as playing chess.

Therefore, deontic norms in this sense have a regulatory function within organizations. With respect to roles, while constitutive norms are responsible for creating roles, deontic norms have the function of avoiding a potential deviation of agents' behaviour while pursuing organizational goals. Notice that this possible deviation refers to the fact that agents have their own goals which can be non-compliant with organization's expectation (DIGNUM, 2004). Since agents are relatively free for adopting the strategies (actions and plans) for attaining organizational goals, norms not only provide the link between an agent and its goals through roles, but also can dictate the plans to be executed to achieve these goals. Moreover, norms can even constrain the way how plans must be executed (please, refer to technical norms).

When goals are collectively pursued, a social contract is a mean of coordinating roles through the description of conditions, rules and agreements applied to an agent while enacting roles (DIGNUM, 2004). Contracts are valuable instruments for specifying the commitments of participants in relation to each other, i.e., under which terms they interact, the responsibility over the acts, the power of each participant in the interaction and so forth.

Finally, with respect to resources, norms can regulate the possession/access of certain objects. In some cases, permissions and rights are similar to physical resources in a system governed by laws (BOTTAZZI e FERRARIO, 2006).

4.9.3 Technical Norms

Technical norms describe the correct procedure to do something, i.e., they specify how a plan should be executed. They are different from deontic norms in the sense that deontic norms are assertive (prescriptive) and technical norms are like suggestions (BOTTAZZI e FERRARIO, 2006). Therefore, technical norms basically present the same relation with goals that the

deontic norms, i.e., while deontic norms regulate the behaviour of agents in pursuing goals within the organization, the technical noms also provide guidelines for governing the agent's behaviour in goals' realization.

Further, a last distinction that could be made about norms is based on their origin. They can be institutionally created by an authority and thus explicitly encoded on some physical artifact, or they can emerge from social practices. In this latter case they can still remain implicit, or later evolve in institutional when their usefulness is recognized by someone in the organization who decides to encode them (BOTTAZZI e FERRARIO, 2006).

4.10 CONCLUSION

Enterprise ontologies are particular kind of ontologies employed in clarifying the domain of enterprises and organizations. They have the purpose of capturing what organizations are as well as of characterizing organizations through a set of basic building blocks. In this chapter, we have used ontologies to provide real-world semantics for the relationships between organizational goals and the building blocks used to achieve organizational goals.

We have started with the vision that organizations do not merely consist in the plurality of the individuals that compose them; rather, organizations consist of social (designed) agents organized to support the collective pursuit of goals by the roles which compose the organization. These social roles are the concepts used to abstract from specific agent and to reason in general about goals and plans (BOTTAZZI *et al.*, 2007). This opens up the possibility of the agents who instantiate the organizational setting to "realize" the organization according to their point of view, deviating from the intended design. This definition highlights the importance of agents in being self-committed in adopting organizational goals (the intentionality aspect), as well as having the abilities for achieving these goals (capabilities).

Since agents have freedom of action, norms are an attempt of organizations to enforce its goal-pursuit by agents (BOTTAZZI *et al.*, 2007). They have a meta-role in the achievement of organizational goals in the sense that they regulate all sort of organizational aspects; they prescribe which goals agents must adopt through the definition of roles, they guide the action

of agents in the course of pursuing these goals (including interactions and delegations), they create the social concepts that are necessary to fulfill organizational goals and so forth.

As argued in chapter 3, BMM could be thought as the foundation for integration of language purposes. Establishing a parallel with organizational ontologies, on one hand, BMM is not intended to capture the organization in its totality, such as its business processes, business rules and organizational structure. For this reason, these elements are referenced in BMM models, but externally defined by other standards. Organizational ontologies, on the contrary, have the purpose of providing rigorous semantics to enterprise modeling. This is a disadvantage of using BMM as the foundationa element since its application must be associated with the usage of other standards, what represents an additional cost in the modeling activity.

Furthermore, although the set of concepts provided by BMM to capture the motivational aspect within the organization is very expressive, the lack of sharp distinction of some concepts also represents a disadvantage. In the counterpart, organizational ontologies can express the same concepts provided by the BMM through the articulation of their basic building blocks.

These two aforementioned characteristics of ontologies made its applicability more interesting from our point of view. In chapter 6, we use this theoretical foundations discussed in this chapter to demonstrate how a real-world organization aims at satisfying its goals.

CHAPTER 5.   CASE   STUDY: GOAL   AND   ENTERPRISE MODELLING IN A HEALTHCARE INSTITUTION

5.1 INTRODUCTION

Business process modelling basically comprises an activity whose main goal is to provide a formalization of business processes in an organization or a set of cooperating organizations (RECKER *et al.*, 2006)(VAN DER AALST *et al.*, 2003). By modelling an organization's business processes, it is possible to capture how the organization organizes the work and resources with the aim of achieving its goals and strategies (SHARP e MCDERMOTT, 2001). Since business processes and goals are intrinsically interdependent, establishing an alignment between the process and the goal domains arises as a natural approach. While the goal domain copes with selecting and prioritizing organizational strategies, the business process domain addresses the execution of organizational activities, possibly revealing the computational support provided by information systems to these activities.

The main benefit of the alignment between the goal and the business process domains relates to traceability between goals and business process models (HALLEUX *et al.*, 2008)(KUENG e KAWALEK, 1997), i.e., our ability to account for how strategies are operationalized into business processes, and to account for how business processes impact the achievement of goals. Traceability between goal models and business process models is particularly important for business process reengineering to support the selection between alternative process changes, since the strategies that must be achieved in TO-BE business processes may be documented in goal models (YU, 1995)(HALLEUX *et al.*, 2008)(KAVAKLI e LOUCOPOULOS, 1999). Further, if business process models are to be used as a starting point for the definition of process-oriented information systems (CARDOSO *et al.*, 2008), then the alignment between goals and business process directly affects the alignment of information systems and organizational goals and strategies. In other words, goal models play an essential role in increasing the quality of business process models by incorporating the notion of intentionality in these models. Therefore, the alignment between business process models and goal models promotes the development of process-oriented information systems which are fully aligned with enterprise's goals.

In this and in the next chapter, we intend to report a real-life case study in which we have investigated the relationship between business processes and the goals which are attained by these processes. In the course of the case study, we have identified the need of splitting this effort into three phases: the *elicitation phase* (in which goal models and business process models are captured from the organizational domain), the *harmonization phase* (in which the goal domain is structured for alignment according to the business processes structures that will support it) and the *alignment phase* (in which the relationships between the goal domain and the elements of the organizational domain are established as well as the semantics of these relationships). The *elicitation phase* is addressed in the current chapter and the *harmonization* and *alignment phases* in the subsequent chapter.

The case study has been conducted in the Rheumatology Department of Cassiano de Moraes University Hospital (HUCAM Hospital) which is part of the Federal University of Espírito Santo in Vitória, Brazil. The Rheumatology Department has the following functions: provide educational training to form specialists in rheumatology, provide outpatient medical care, provide medical reports confirming the need of the administration of high cost drugs in either inpatients and outpatients (also denominated as High-Cost Drug Assessment Commission) and develop research to investigate the incidence of rheumatologic conditions in population. It employs six specialists in rheumatology, two nurses and two physiotherapists, among other professionals for hosting patients. The department performs 15 business processes (in the scope of outpatient medical care functions), such as outpatient care, drugs infusion, among others, and performs an average rate of 5700 outpatient medical care per year.

In the scope of this study, we have focused on 7 business processes related with outpatient medical care functions and 1 business process referring to the High Cost Drug Assessment Commission (8 business processes selected among a total of 15 business processes). We have produced 8 goal models (represented in the Tropos modeling language and methodology) and their respective business processes (represented in the ARIS methodology). An additional goal model has been developed to capture organizational issues which are not related with a specific business process (but with a set of business processes) or with other organizational concerns, such as infrastructure, policies, management, among others.

For the sake of brevity, we focus on the goal model of the diagnosis process in the course of this chapter, although a complete set of the business processes and goal models can be found as an Annex to this dissertation.

This chapter is structured as follows: section 5.2 concerns about the goal modeling phase (section 5.2.1 surveys some current approaches for goal elicitation and section 5.2.2 reports the goal elicitation in the case study), section 5.3 describes the enterprise architecture elicitation phase, section 5.4 presents some theoretical issues in conducting case studies. Section 5.55.4 concludes the chapter with the benefits and limitations of the proposed approach for goal elicitation.

5.2   GOAL MODELING

5.2.1 Approaches for Goal Elicitation

As we discussed in chapter 2, goal-oriented techniques arose in the requirements engineering field due to the difficulties presented by traditional systems analysis approaches when dealing with increasingly complex software systems (LAPOUCHNIAN, 2005). This issue led practitioners and researches to move their focus to methods and techniques for developing systems which are better aligned with the organizational strategy, introducing some notion of intentionally in these methods and techniques.

In the context of the requirements engineering, requirements elicitation is concerned with "understanding the organisational situation that the system under consideration aims to improve and describing the needs and constraints concerning the system under development" (KAVAKLI e LOUCOPOULOS, 2003). In the context of business process modeling, goal modeling is extended not only to capture concerns and motivations of the stakeholders in the achievement of business processes, but to incorporate issues related to the strategy of the enterprise as a whole. In a parallel between requirements engineering and business process modeling, a business process is analogous to the "system under development" whose system requirements are equivalent to the goals in business process modeling. As well as the system requirements guide the design of the target system, the goals guide the creation of business processes structures.

Although goal modeling provides a more intentional view for business processes, little attention is devoted to explicitly modelling goals as well as using the concept of goal to increase the value of the process modelling techniques (SOFFER e WAND, 2005). To articulate an organization's business processes in terms of the enterprise's strategic goals, the first problem to be addressed is how to elicitate goals from the organization context since goal identification is not an easy task (LAMSWEERDE, 2001). Problems related to goal elicitation are firstly addressed by the requirements engineering (RE) literature, but essentially the same problems arise in the area of business process modelling, such as:

(i)   Goals are difficult to formulate (often these formulations become vague and highly abstract) (HALLEUX *et al.*, 2008);

(ii)   The approaches for goal elicitation lacks detailed systematic structures (SINGH e WOO, 2008), besides being high level and abstract in nature (e.g. asking how, why and how else questions),

(iii)   The involved parties are unable to explicitly state their views (DARDENNE *et al.*, 1993);

(iv)   Even when the stakeholders are capable of, the elicited goals can be conflicting (even when goals are drawn from the same individual) (ALEXANDER, 2002);

(v)   Analysts have limited knowledge about the environment (DARDENNE *et al.*, 1993);

(vi)   Stakeholders do not know how to set tactical and operational goals that accurately reflect the strategic goals (SINGH e WOO, 2008);

(vii)   Although stakeholders know about their individual obligations, they are seldom aware of how their role contributes to the realization of business-wide objectives (KAVAKLI, 2004);

(viii) Stakeholders do not know how to define goal attributes (for example specificity, difficulty, acceptance, and commitment) (SINGH e WOO, 2008);

(ix)   Often there is a confusion about the fundamental distinction between what to achieve (the goal) and the manner to achieve it (the strategy) what makes it more difficult to discover alternative ways of achieving a goal (NURCAN *et al.*, 2005), among others.

Given this difficulty in eliciting goals from the organizational setting, we survey the state-of-art in the area of RE for goal discovery. Among the sources which could potentially provide

goals for analysts, the literature in goal-oriented requirements engineering cites (i) the stakeholders who can explicitly state them; (ii) preliminary material about the organization (iii) preliminary analysis of the current system (in this case, preliminary analysis of the current organizational setting) with the identification of problems and deficiencies which represent goals to be achieved in a future organization configuration (LAMSWEERDE, 2001)(LAPOUCHNIAN, 2005) (iv) policies, strategies, products, processes, models of the organization (BASILI *et al.*, 1994) and mission statements (KOUBARAKIS e PLEXOUSAKIS, 2000).

5.2.1.1 Scenarios

More sophisticated techniques for goal identification and abstraction include scenarios. In (ROLLAND *et al.*, 1998), authors use them to discover goals, interleaving goal modeling and scenario authoring. The discovery process is centered around the notion of a requirement chunk (RC) which is a pair <Goal, Scenario> and rules to support the discovery of RCs. Other works, such as (LAMSWEERDE *et al.*, 1998)(ANTON e POTTS, 1998)(DARDENNE *et al.*, 1993) also concentrate on linking goals and scenarios. The large amount of works on this topic can be explained by the complementary characteristics of scenarios and goals; while the former are concrete, narrative, procedural, and leave intended properties implicit; the latter are abstract, declarative, and make intended properties explicit (LAMSWEERDE, 2001). Furthermore, scenarios are useful means for communicating with stakeholders, offering a natural way to illustrate how their needs may be satisfied or hindered in a given situation (KAVAKLI, 2004).

Scenarios are strongly related with other technique for goal discovery, namely, the identification of obstacles for goal achievement and the posterior resolution of conflicts among goals. According to (KAVAKLI, 2004) (LAMSWEERDE, 2001), analysis of 'problematic' scenarios that describe the circunstances in which a business goal may fail or be blocked are also shown to be a good vehicle in order to identify change goals. Obstacles to goal achievement and negative interactions among goals are also useful for the detection of unachievable goals. In this case, during the process of refinement, unachievable goals need to be substituted by weaker ones that are actually achievable (KOUBARAKIS e PLEXOUSAKIS, 2000).

5.2.1.2 Refinement/Abstraction Techniques

Once a preliminary set of goals have been identified, *refinement* and *abstraction* techniques can be applied to generate other goals. With the *refinement technique* one can find out subgoals of the parent goal by asking "HOW questions" about the goals already identified (LAMSWEERDE, 2001). With the *abstraction technique*, more abstract goals can be identified by asking "WHY questions" about the goals previously modelled (LAMSWEERDE, 2001)(KOUBARAKIS e PLEXOUSAKIS, 2000).

In the *refinement strategy*, some of the general goals of the organization are select and the subset of subgoals that permit their satisfaction are determined. This top-down goal analysis is useful in the cases where the analyst elicits the goal of the organizational managers, who tend to express high-level goals. In the *abstraction strategy*, the actors that participate in the organization are detected and their goals and operations are elicited. This bottom-up goal analysis is useful in the case where the analyst elicits the goal of the organizational actors who tend to express low-level goals.

5.2.1.3 Singh et al.

In (SINGH e WOO, 2008), authors prefer using three approaches for discovering goals at different organizational levels (namely, the operational, tactical, and strategic levels) and integrate them into a single approach, which spans the entire organization. The method is grounded on the premise that different disciplines focus on different organizational levels, and a combination of these disciplines provide richer context than a single discipline when trying to understand the complexities at all levels.

In the operational level, authors propose the Requirements Engineering (RE) discipline for the discovery of operational activities through a formal modeling approach (the proposal uses the Object Oriented Enterprise Modeling (OOEM) which represents interactions between objects/agents in form of requests/response (services)). Goals are elicited by analyzing every service in every object and subsequently formalized for consistency in representation by using the Rolland et al. approach (ROLLAND *et al.*, 1998).

The Management Information Systems (MIS) discipline is proposed to elicit tactical goals. The method starts with the identification of the overall tactical goals and categorization of the operational levels goals (OG) based on pre-determined criteria. For each criterion, a set of key performance indicators (PI) are identified and used to classify each OG. Following the classification, and based on the context of goals in each category, emergent goals (tactical goals) are defined, which are relative to the strategic level goals.

Finally, with respect to the strategic level, the proposal presents a set of guidelines (in the form of a questionnaire using the Boardman Comprehensive Strategic Analysis Framework (BOARDMAN e SHAPIRO, 2004)), which system analysts can use for discovering, verifying, and validating goals.

The unified approach is noted for encompassing bidirectional mapping, which allows for discovering strategic goals through a top-down approach, operational goals through a bottom-up approach, and tactical goals through a combination of top-down and bottom-up methods. Discovering tactical level goals through the hybrid approach and using PIs as guidance create the opportunity for detecting alignment/misalignment between assigned goals and interpreted goals.

The approach offers the following main contributions: (i) a systematic bidirectional process of discovering goals at different organizational levels; (ii) a means (through structure and rich context) of understanding and explaining discovered goals and (iii) instruments for business managers to define specific tactical goals that relate to information systems (this can be valuable in the creation of measurements for assessing information systems factors).

Among the disadvantages of the approach, there is the fact that the research regarding the unified approach was limited to only one case study in an academic environment, what can lead to losses of industrial insights. Secondly, the approach focused primarily on goals elicited from the system analysts' perspective and validated from the business executives and managers perspective, thus missing the points-of-view of people involved in the operational activities of the organization. For this reason, the elicited goals may lack pragmatism of the actual organizational processes.

5.2.1.4 Estrada et al.

In (ESTRADA *et al.*, 2003), Estrada and colleagues define a goal-based methodological approach for the generation of business models to be used subsequently as the starting point of the requirements specification process of the information system. Initially, the business models (also designated as organizational models) are generated through the *goal-based elicitation method* (step 1). These models (which are deployed in a tree structure denominated as Goal-Refinement Tree (GRT)) reflect the goals of each actor as well as the general goals of the organization. From the GRT, strategic models of i* framework are generated with the aim of being used to perform business improvement analysis (step 2). Later, system requirements models (represented through the uses cases and their corresponding scenarios) are derived from the business model (step 3).

The first step is the stage which the goal elicitation indeed is performed through the execution of the *goal-based elicitation method* for the construction of the GRT. The root the GRT represents one of the general goals of the organization. The intermediate nodes represent the groups of low-level goals for the satisfaction of a more general goal. Finally, all the leaves represent operational goals that satisfy the low-level goals. The tree is constructed using *refinement* and *abstraction strategies* for goal elicitation.

The contribution of the proposal is the fact that the method allows requirements engineers to carry out an antecedent business analysis (business process reengineering analysis, dependency analysis, workflow analysis, task analysis) which are fundamental to obtaining requirements that reflect the functionality expected by the users of the information system. A more strategic perspective for the generation of business models has been suggested in this proposal, even considering issues concerning the organizational aspect regardless of the support provided by computational tools. Although the work presents a clear contribution for the goal-oriented requirements engineering, the *refinement* and *abstraction strategies* are little discussed in the paper. In fact, no techniques for goal elicitation are provided in the description of these strategies neither for acquiring an initial version of goal models, nor for refining the previous elicited goals or abstracting from goals of particular agents.

5.2.1.5 GBRAM

The Goal-Based Requirements Analysis Method (GBRAM) (ANTÓN, 1997) is a methodology for initial identification and abstraction of goals from various sources of information, assuming that no goals have been elicited before. The method differentiates between two activities: goal analysis and goal refinement.

Goal analysis comprehends the exploration of information sources for goal identification followed by organization and classification of goals. This activity is further divided into four types of sub-activities, namely: *explore activities* (which refers to the exploration of the available information, such as interviews, policies, requirements, transcripts, workflow diagrams, corporate goals and mission statements); *identify activities* that are about identifying and extracting goals, identifying stakeholders, identifying agents[12] and their responsibilities from the information provided by the previous explore activities; and *organize activities* that classify and organize the goals according to goal dependency relations.

Goal refinement concerns the evolution of goals from the moment they are first identified to the moment they are translated into operational requirements for the system specification. Goal refinement activities can be summarized as follows: *refine activities* (involve the pruning of the goal set), *elaborate activities* (refer to the process of analyzing the goal set by considering possible goal obstacles and constructing scenarios to uncover hidden goals and *requirements and operationalize activities* (represent the translation of goals into operational requirements). The output of the GBRAM is always a software requirements document (SRD) with the functional and nonfunctional requirements.

GBRAM defines agents as entities or processes that strive to achieve goals within an organization or system, based on the assumed responsibility of achieving specific goals.

---

[12] For clarification purposes, the difference between an agent and a stakeholder in GBRAM must be noted. A stakeholder is anyone who claims an interest in the enterprise or system; he/she can be a customer, an actor or an owner. An agent is responsible for the completion and/or satisfaction of goals within an organization or system; it can be a system or a human agent who interacts with the system. By the examples, it is possible to verify that some agents are stakeholders and some stakeholders are agents. The stakeholders (which are also agents) are not simply a system "user" in the classical sense, but rather, they are any representative affected by the achievement or prevention of a particular goal. The agents that lie outside of the intersection of agents and stakeholders are not stakeholders; instead, they are system-specific agents.

Representing stakeholders as agents within the system is a useful vehicle for system analysis, since it considers multiple viewpoints and potentially afftected parties for various goals, which provides coherence for goal formulations. The approach also helps in goal elicitation and refinement by providing guidelines regarding the format of standard questions in each of the activities (these questions include the treatment of goal obstacles and scenarios which denote the reasons why these goals have not been obtained).

An important characteristic of GBRAM is the fact that goals, agents, stakeholders, etc. are specified in natural textual form in goal schemas (allowing the representation of precedence relationships among goals), not relying on formal or mathematical notations. Further, the method does not provide a graphical notation for representing goals, goal refinements, agents, etc. An obvious advantage of this characteristic is the accessibility by non-expert users, which encourages active involvement of the stakeholders throughout the process. On the other hand, this results in the loss of the ability to perform certain analyses associated with formal representation of constructs, such as verification of the consistency and satisfiability of goal structures, goal correctness, etc.

5.2.1.6 NFR Framework

The Non-Functional Requirements (NFR) framework (CHUNG *et al.*, 2000) addresses the problem of dealing with the representation of non-functional requirements in the system development life-cycle. The framework is composed by catalogues that accumulate knowledge about specifying and operationalizing NFRs, offering guidelines for prioritization and decomposition during the design process.

The knowledge about NFRs is represented in graph structures denominated as SIGs (*Softgoal Interdependency Graphs*) which document particular kinds of NFRs, their decomposition structures and possible design alternatives to embody a requirement in a target system. Further, the interdependencies between the NFRs and their operationalizations are represented.

There are three kinds of catalogs used: the first kind (called *NFR type catalog*) contains particular types of NFRs, such as security or performance, and their associated terminology. The second type (called *methods catalogs*) represents development techniques for the system

to meet a particular requirement and finally, the third type (*correlation catalogs*) shows the correlation and tradeoffs among softgoals.

Figure 5.1 depicts a catalogue of some NFR types, where a NFR can be "performance", "security", "cost" and "user-friendliness" (CHUNG *et al.*, 2000).
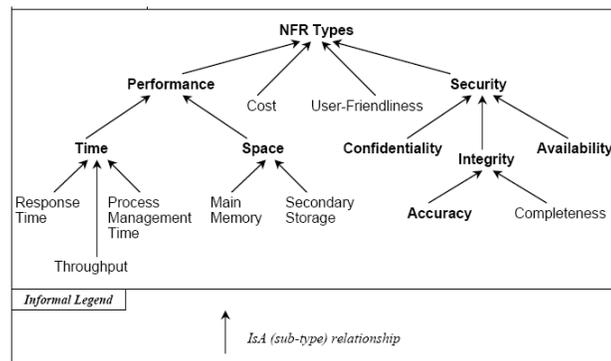
Figure 5.1 A catalogue of some NFR types (Chung, et al., 2000)

There are three types of goals in SIGs: *NFR goals* (which represent particular kinds of NFRs), *satisfacing goals* (which represent design decisions which implement some softgoal within the future system) and *claim goals* (which represent arguments to adopt a particular solution instead of another). The main requirements (the NFR types) are shown in the top of the graphs and are connected by interdependency links (shown as lines with arrowheads). Interdependencies show refinements of "parent" NFR types downwards into other, more specific, "offspring" NFR types. In fact, this refinement (or operationalization) corresponds to breaking down the NFR types into smaller components so that effective design solutions can be found.

The main requirements in the NFR framework (NFR types) are also denominated as softgoals (modelled as clouds). An example of an application within a real example is also demonstrated in (CHUNG *et al.*, 2000). In this example, security is the NFR considered for developing a credit card system. Figure 5.2 shows that to incorporate security in a given account, three subtypes of NFRs are necessary: integrity, confidentiality and availability. In turn, to incorporate integrity on credit card accounts, two additional NFRs are needed: completeness and accuracy. This example depicts that the process of decomposing some NFR

is guided (and thus facilitated) by adopting these catalogues since they are helpful in reasoning about what qualities the system to-be is expected to meet.
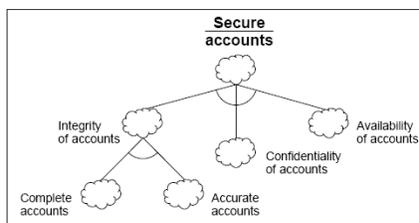
Figure 5.2 Further decomposition of a security softgoal (adapted from (CHUNG et al.*, 2000))*

The SIGs also show the contribution (impact) of offspring softgoals upon the meeting of other (parent) softgoals (claim goals are used to capture statements used to argue about the priorization of some softgoal. By using the claim goals, it it possible to rationalize trade-offs). To reason about goal satisfaction during design, the framework adopts the concept of *satisfacing* (MYLOPOULOS *et al.*, 1992). The notion of *satisfacing* states that a NFR rarely can be said to be fully satisfied. Instead, softgoals are *satisficed* if the solution used is expected to satisfy it within acceptable limits. Thus, the softgoals have associated labels (values representing the degree to which a softgoal is achieved) and an evaluation procedure (labeling algorithm) which considers labels, contributions, and, important decisions by the developer to verify whether softgoals are achieved.

NFR catalogues are used in the scope of this work for tackling the problem of identifying goals in the context of BPM activities. The NFR type catalogues provide NFR types which can be faced as (soft)goals. These (soft)goals can be subsequently adapted for representing organizational issues in the context of the business processes of our case study.

In the context of software development, current approaches to system design comprise in a decision-making process driven by functional requirements, in which the decisions about how to embedded functionalities in the target system are the main driving force to design the system. Although designers take non-functional requirements into consideration to some extent, this attributes are commonly seen as consequences of the decisions about functional requirements and not addressed in a systematic fashion. The construction of catalogues in NFR framework allowed not only the documentation of NFRs, but also provided a systematic

treatment to incorporate them in the system development through methodological steps for decomposition, prioritization and implementation.

The same line of reasoning could be reproduced in the context of business process modeling in the sense that NFR catalogues would help analysts to identify softgoals for business process, operationalize them through a trade-off analysis to prioritize/postpone among the many alternative operationalizations. Our work provides some insights in this direction (see chapter 5) in the identification of softgoals in the context of business process.

5.2.1.7 Bittencourt et al.

Before passing to the description of the method for elicitation, we must mention that the usage of NFR catalogues as tool in identification of quality attributes is little explored in the literature. As far as we know, only the work presented in (BITTENCOURT e ARAUJO, 2008) explores the idea of NFR catalogues for a systematic identification of NFRs in the course of the development of information systems. The approach uses two conjugated artefacts for the identification of system requirements: the Business Models (BM) and the NFR catalogues.

The BMs are used as instruments for identifying the system requirements which support the activities' execution, anticipating the identification of the functional requirements in the system development. BMs have what the proposal identifies as business elements which comprehend the actors, the artifacts and the activites. The NFR type catalogues help the analyst to assess the quality required for the business process, helping in the identification of the quality aspects and in the translation of these quality aspects to NFRs in a high level of abstraction.

The analyst examines the BMs (and the processes' documentation) and with the support of the NFR catalogues, he/she assigns quality attributes which are deemed necessary to the business process as a whole as well as for each identified business element. After this assignment, these suggestions are discussed and validated by the stakeholders (a step for decomposing the NFRs can be necessary in some cases). The final product is a document which describes the business elements (actors, artifacts and activities), the quality attributes

of these business elements and the justification for these quality attributes. The method has been tested in real case in the system development for an industry of nuclear energy.

This work has the advantage of using the NFR catalogues for supporting the elicitation of quality aspects for business process, although the identification is oriented to the system development area. Compared to the method proposed in our work, the NFR catalogues play the same role (i.e., in the identification of quality attributes for business process) with the difference that our proposal focuses on quality aspects of the organization from a strategical point of view (not focusing in the development of information systems).

5.2.2 Goal Elicitation in a Healthcare Organization

This section describes the goal elicitation phase of our case study conducted in the Rheumatology Department of the Cassiano de Moraes University Hospital, which is part of the Federal University of Espírito Santo in Vitória, Brazil.

According to a survey in the current literature in goal elicitation and modeling, we have found that the support for goal elicitation in the context of BPM is almost inexistent. Current literature focus on goal elicitation for requirements engineering and few works approach the problem from the BPM point of view. This deficiency has motivated us to propose the method for goal elicitation which we believe may be used to conduct the phase of elicitation of similar case studies.

The goal elicitation activity has been carried out in two stages, namely Preliminary Goal Elicitation and Goal Elicitation with Catalogues. The preliminary goal elicitation has been acomplished for collecting an initial version of goal models. After this phase, we noticed that the goals captured in this preliminary phase have the characteristic of being much focused on operational aspects of the medical domain and failed in reflecting the managerial dimension of the organization. This characteristic would impact in the subsequent phase of the alignment, producing goal models depicted in low level of abstraction, which would invalidate strategic analysis due to the absence of strategical and tactical aspects. The adoption of NFR catalogues had the purpose of tackling this issue. Since the catalogues address quality attributes in the system development activity, their adoption could help us to raise details related with the quality aspects of the organization and its business processes.

Fortunately, this insight has been confirmed after the application of the catalogues in the goal elicitation activity. Consequently, after the Preliminary Goal Elicitation phase, we carried out a second step (named as Goal Elicitation with Catalogues) in which we have obtained a second version of the goal models by using the NFR catalogues as a tool in goal elicitation. Figure 5.3 depicts the steps of the suggested method for goal elicitation.
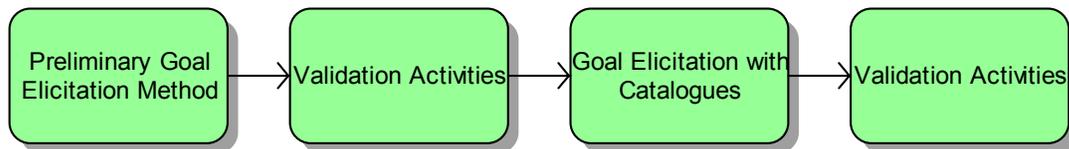
Figure 5.3The methodological steps of the Goal Elicitation Method

In the remainder of this section, we report the method for goal elicitation as well as the results of its application in the case study.

5.2.2.1 Preliminary Goal Elicitation Method

This preliminary goal elicitation and modelling effort was divided in four stages according to the source of information and technique used to interact with the process stakeholders. In the first and second stages, we have captured only hardgoals. From the second stage on, our goal models were composed by hardgoals and softgoals.

In a *first stage*, the available documentation about the organizational processes was assessed. This revealed some organizational characteristics such as: organizational structure and human resources, routines, business processes (with a brief textual explanation in natural language about these processes) and physical space. From the organization structure, we could infer internal actors and the business process they carry out. This documentation also provided goals previously achieved by the department (along with their impacts) and goals which were yet to be achieved by the department, giving us some insight about the nature of the business processes under consideration and about some relevant goals (stated in natural language). Further, a first interview was undertaken with a physician (who does not belong to the organization) for understanding general concepts about the medical domain. Additionally, concepts related with rheumatology (diseases, medicines and other technical terms) were briefly surveyed in online information sources.

In a *second stage*, we obtained a preliminary goal model along with a preliminary business process model. The approach used here consisted in observing the process performers during business process execution, i.e., we observed the daily routine of the organization and captured goals for each stakeholder involved in the business process. While this approach allowed us to understand how actors interact and how actor dependency relationships are established in practice, the actors' focus on getting the work done prevents one from revealing most of the intention and motivation behind their practices.

A *third stage* focused on eliciting requirements by observation of how the work is done in practice. This included interviewing the organizational actors during business process execution to reveal the goals of specific activities as well as goals related with a process as a whole. Thus, the model generated in previous stages could be incremented through *refinement/abstraction techniques*. This enabled us to capture the rationale (more general goals) behind more specific goals. Although the interviews during the process execution provided a more strategic dimension (in the sense that they have captured details related with the organization's strategy in a lower level of abstraction), the goal models obtained were strongly related to the business process models, not capturing knowledge about the enterprise setting as a whole. This deficiency was addressed in *fourth stage*.

In a *fourth stage*, we concentrated in dedicated interviews not only with the business process actors but also with the department manager (by "dedicated interviews" we mean that the interviewees devoted all attention to the elicitation process as opposed to being fully involved in activity execution). The elicitation interviews in this stage focused on raising internal problems of the organization, as well as problems associated with the relationship between the department and external organizations, highlighting all kinds of conflicting interests. The problems and deficiencies that the stakeholders believed to exist in the organization provided not just additional goals to enrich the models, but also some obstacles for goal realization, reasons for non-achievement of goals and possible solutions for these obstacles.

Observe that the previous stages were mainly concerned about capturing goals, i.e., desired states of the world. Differently, this phase focused on the understanding problems and deficiencies, i. e., the phase concerned about capturing undesired situations of world, as we designate as "negative goals". Since the core Tropos language is not expressive enough to

capture undesired situations (the "negative goals")[13], we coped with this problem by introducing the negative forms in the name of goals, such as Do not grant privileges to internal patients in the assessment of high cost drug goal or by using verbs which denote the minimization of likelihood of occurrence of these undesirable situations, such as Avoid conflicts of interests goal and Decrease differences with State Health Department in the high cost drug assessment goal (these goals are not depicted in the models presented in this chapter, since they do not refer to the process of diagnosis).

Furthermore, the obstacles for goal realization, the reasons for the existence of these obstacles as well as the solutions for them were captured in textual form in the Annex of this thesis. In one hand, the decision of transferring the undesired situations to the goals' description as well as capturing other issues in textual format indeed tackles the problem of the lack of expressivity of the Tropos language. On the other hand, this solution can bring about a rigor loss in the description of goal models and can potentially affect our ability to simulate and evaluate important properties of goals models through formal reasoning.

5.2.2.1.1 *Results of the Preliminary Elicitation Activities*

Figure 5.4[14] exhibits a Tropos diagram which shows the goals of a physician who conducts the diagnosis business process.

---

[13]With that respect, the Asnar's work (ASNAR *et al.*, 2007) introduces the Tropos Goal-Risk framework. This proposal comprehends a formal framework for modeling, assessing, and treating the risks of the occurrence of potential undesired situations. This treatment is made on the basis of the likelihood of occurrence of these situations and on the severity of failures.

[14] Goal models depicted in this chapter are only small portions of a complete model. For the complete version, refer to the annex 1 of this dissertation.
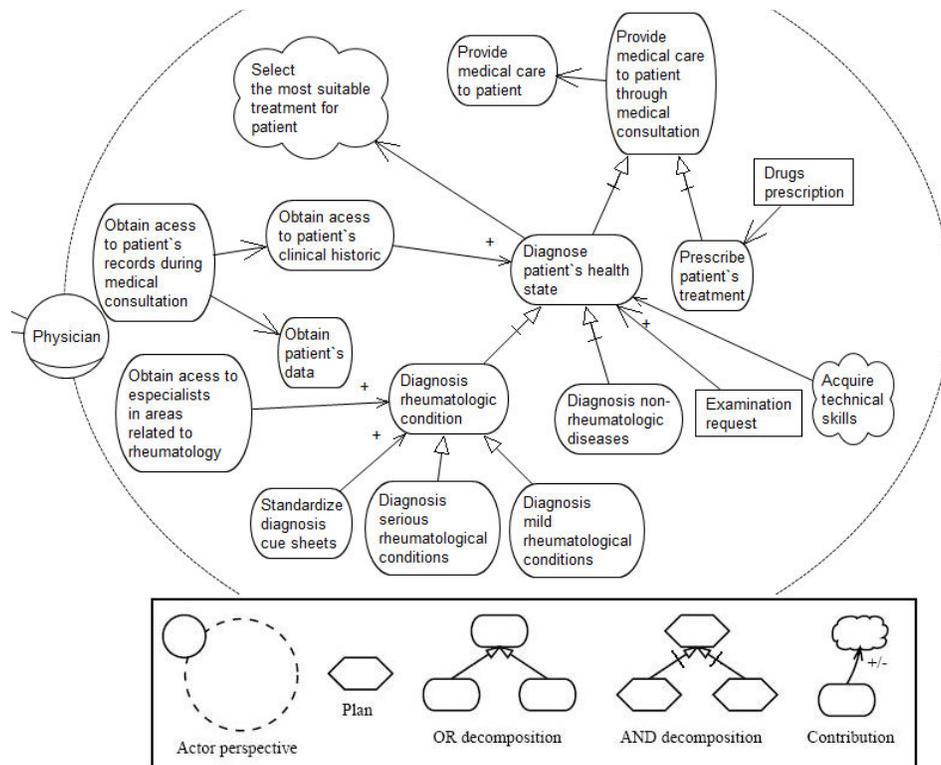
Figure 5.4 Goal model resulted from the preliminary goal elicitation activities

In Tropos diagrams, actors are represented as circles, goals as oval shapes and softgoals as cloud shapes. (Soft)goals can be related with three kinds of relationships: *means-end analysis*, *contribution analysis* and *AND/OR decomposition*.[15]

The physician provides medical care to a patient (Provide medical care to patient goal) through a medical consultation (Provide medical care through medical consultation goal). During consultation, the physician diagnoses the patient's health state (Diagnose health state goal) and prescribes the treatment (Prescribe patient's treatment goal which uses, in turn, a Drugs prescription).

The main goal of the physician is to Diagnose patient's health state. During the process of diagnosis, the physician can find either rheumatologic or non-rheumatologic conditions (Diagnose rheumatologic conditions goal and Diagnose non-rheumatologic conditions goal). After diagnosing the patient's heath state, the physician is able to select the most suitable treatment for the disease (Select the most suitable treatment for patient

---

[15] The AND/OR decomposition can be made by using the "HOW questions" previously mentioned.

softgoal). For this reason, Diagnose patient's health state is a mean for Select the most suitable treatment for patient.

The physician must have accurate knowledge for being able to discover the presence/absence of diseases (Acquire technical skills softgoal). He/she must also access the patient's data (Obtain patient's data goal) for being able to determine how the patient health condition is evolving along the time (Obtain access to patient's clinical historic goal). One of the means for accessing the patient's data and thus to know its clinical history is to obtaining access to patient's records (Obtain access to patient's records during medical consultation goal). Finally, the rheumatologist must confirm the diagnosis with other specialists in order to interpret the evidences in the whole clinical context (Obtain access to specialists in areas related to rheumatology goal).

5.2.2.1.2 Goal Elicitation with Catalogues

Although we found it hard to deepen the goal analysis in the preliminary phase, during the four stages we have reported in the previous sub-section, we had the opportunity to understand the organization's context, its problems, deficiencies and so forth. By observing the execution of the business process, interviewing the stakeholders and observing the organizational setting, we could keep direct contact with implicit factors that underlie the organizational context. These previous stages were crucial to provide *insights* about new concerns that could be added. These *insights* guided us to suggest which NFR types could be extracted from NFR catalogues (CHUNG *et al.*, 2000)(CYSNEIROS, 2009)(RILSTON e CASTRO, 2002)(O'SULLIVAN *et al.*, 2002) and subsequently adapted to the organizational context. According the NFR types catalogues, we have formulated additional goals for the business process, initially without participation of the stakeholders. The translation from NFR types in the catalogues to goals was highly related to the knowledge acquired in previous stages, i.e., to adequately refine the NFRs we had to consider the meaning of the NFRs' refinement in the context of the domain under consideration. After incorporating these additional goals into the model, we have applied the same techniques of abstraction/refinement previously applied for identifying additional goals without the participation of the stakeholders. For the sake of brevity, we concentrate here on some relevant portions of the resulting goal models.

5.2.2.1.3 Results of the Goal Elicitation with Catalogues

Before discussing the outcomes related with the utilization of the catalogues with the stakeholders, we have translated the NFR types to (soft)goals in the context of the domain under consideration. This translation is necessary since the NFR types suggested by the catalogues are highly generic (even in the context of systems development) and an adaptation is required to express the meaning of each NFR type in terms of the context of the domain.

In catalogues, softgoals have an NFR type, which indicates the particular NFR, such as security or performance, addressed by the softgoal. The softgoals also have a subject matter or topic which represents the object which the NFR type refers to. Then, in one step of the NFR framework (step 2.4 of the NFR framework (CHUNG *et al.*, 2000)), to specify some softgoal, the analyst must specify the NFR type and its "topic". For example, in the "good performance for account" softgoal, the NFR type is "performance" and the topic is "account".

Similarly, in our case, the translation step follows the same rationale. For instance, if we consider the NFR type "confidentiality", we must also regard what represents "confidentiality" in the health-care domain (in particular, in the health-care domain of our organization). To properly specify what represents "confidentiality" in this domain, then we must specify the topic which this NFR type refers to. In our case, we have identified the need of confidentiality for the patient's information. Once specified the NFR type and the topic, we have the Maintain healthcare information private softgoal.

After we have applied the translation step for all the chosen NFR types of our case study, the NFR types originated the following goals:

(i) **Accessibility** (RILSTON e CASTRO, 2002). Access patient's data records;

(ii) **Confidentiality** (RILSTON e CASTRO, 2002). Maintain healthcare information private;

(iii) **Completeness** (RILSTON e CASTRO, 2002). Obtain complete information about patient's treatment;

(iv) **Accuracy** (RILSTON e CASTRO, 2002). Obtain accurate information about patient's treatment;

(v) **Traceability** (process and data) (RILSTON e CASTRO, 2002)(CYSNEIROS, 2009). Obtain traceability for information in patient's treatment refined into Obtain traceability in investigation of patient's condition, Obtain traceability in relation to treatment administered to patient and Obtain traceability in relation to physicians who prescribed patient's treatment.

(vi) **Integrability** (RILSTON e CASTRO, 2002). Integrate service with other hospital departments, Integrate service with municipal and state health services (to obtain what is called "integrated treatment" exploring the benefits of information integration) and Integrate service with specialists in areas related to rheumatology.

(vii) **Trust and confidence to the provider** (assurance)(O'SULLIVAN *et al.*, 2002). Trust physician (not shown in the figures since this goal belongs to the patient's perspective.)

(viii) **Empathy** (level of caring and personalized attention provided to the requestor)(O'SULLIVAN *et al.*, 2002). Show empathy to patient.

The use of NFR catalogues is a technique generally applied in the elicitation of non-functional requirements (thus, represented as softgoals in i*/Tropos). However, in our case, focusing on the NFR types led us to elicit goals which could be objectively evaluated, i.e. hardgoals instead of softgoals. For instance, the requirement of **Accessibility** has led to the identification of the hardgoal Access patient's records. Besides, the translation seems to be highly domain-dependent. For example, traceability refers to the capacity of tracing patient's data along the treatment. Another particularity concerned with the translation is that different NFR types are mapped to the same goal in the organization. **Distributivity** (capacity of reaching all decision-makers (RILSTON e CASTRO, 2002)) and **integrability** (capacity of adequately and efficiently integrating operational information (RILSTON e CASTRO, 2002)) mean the same in this context (in the sense that both mean the information must be integrated

so as to reach all decision-makers caring about that information). **Privacy** and **confidentiality** are also mapped to the same goal.

With respect to the goals added, we were able to identify goals which had remained implicit in the preliminary study (Figure 5.5). Most of these goals were either associated with quality aspects of the previously modelled goals (Obtain complete information about patient's treatment softgoal and Obtain accurate information about patient's treatment softgoal) or with quality aspects for the service as a whole (Integrate service with all stakeholders softgoal and the softgoals originated from its refinements). We also have noticed that some of the elicited (soft)goals address exceptional situations, for example, the softgoal Integrate services with specialists in areas related to rheumatology is relevant only in the case the rheumatologist needs to clarify further details about the diagnosis with other specialists (for example, a dermatologist or ophthalmologist) in the hospital.
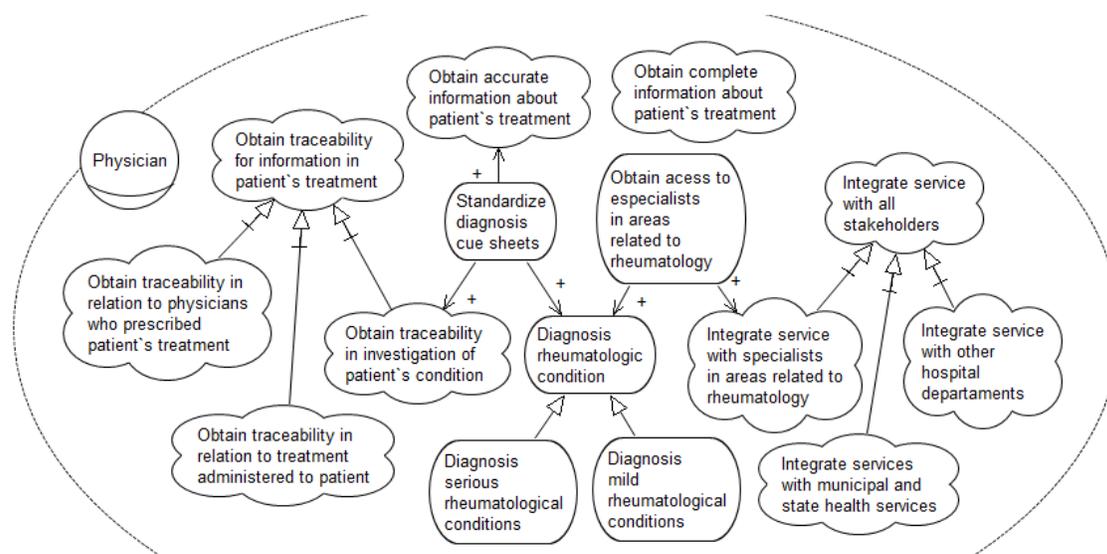
Figure 5.5 Portion of the goal model obtained in goal elicitation activities with catalogues (1)

Another interesting aspect in the elicitation with catalogues was the fact that we could notice that some of the goals spontaneously mentioned are actually goals for implementing mechanisms for the attainment of more abstract goals, which remained implicit when applying the abstraction technique, but that could be revealed through the use of the catalogues. For instance, in Fig. 4, we have suggested three types of traceability: Obtain traceability in relation to treatment administered to patient softgoal (obtain information about the drugs prescribed along the treatment), Obtain traceability in relation to

physicians who prescribed patient's treatment softgoal (obtain information about the physicians who had already prescribed treatment to the patient) and Obtain traceability in investigation of patient's condition softgoal (obtain information about the conditions which had already been investigated previously by the physician). Actually, this last goal was the motivation for the standardization of diagnosis cue sheets (previously modelled). The standardization of diagnosis cue sheets was one of many means towards achieving traceability in the investigation of diseases.

Finally, all goals suggested through the use of catalogues were validated by the stakeholders in a validation interview. They acknowledged the need of these goals and were also able to spontaneously mention other goals (for example the refinements of the goal Provide medical care to patient goal, shown in Figure 5.6). The goal Provide medical care to patient can be achieved in three forms: by achieving a consultation appointment (in this consultation, the physician examines the patient and prescribes the treatment); by providing attendance for assessment of high cost drug (the physician examines the patient and in the case of the need of a high cost drug, he/she issues an certificate) and by an informal meeting (the goals which denote these situations are, respectively: Provide medical care in scheduled medical consultation goal, Provide attendance for assessment of high cost drug goal and Provide informal meeting goal). In these informal meetings, the physician can examine a patient who reports the presence of symptoms, or the physician just issues some document required by the patient (a medical certificate, a medical report or a prescription of drugs). The goals which denote these situations are, respectively: Provide attendance for assessment of symptoms goal, Provide attendance for elaboration of medical certificate goal, Provide attendance for elaboration of medical report goal and Provide attendance for elaboration of prescription of drugs goal.
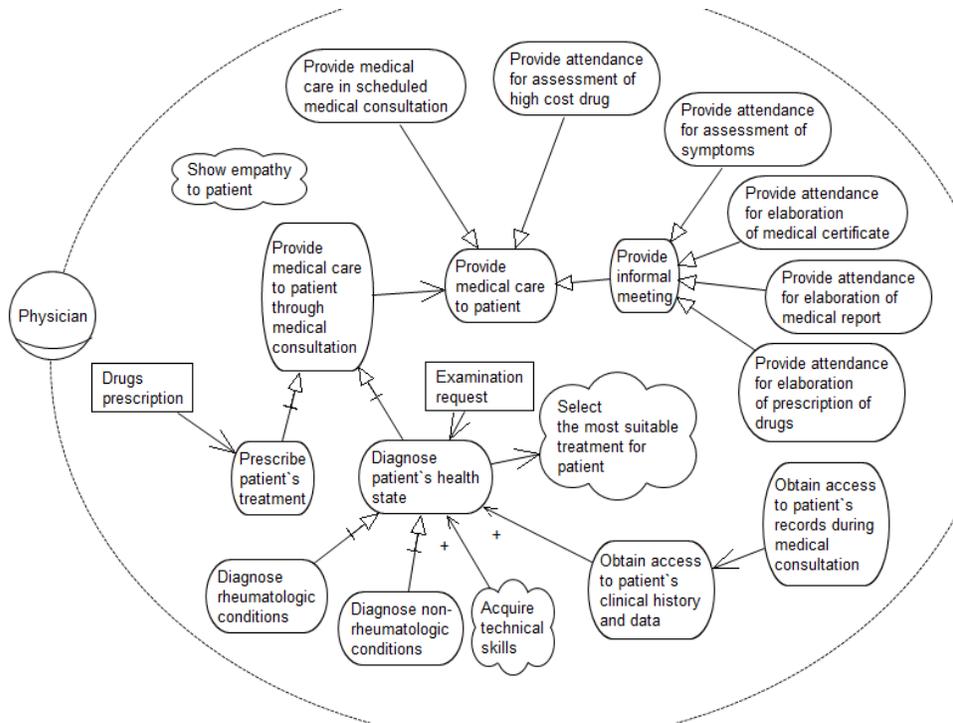
Figure 5.6 Portion of goal model obtained in goal elicitation activities with catalogues (2)

5.3   ENTERPRISE ARCHITECTURE MODELING

5.3.1 Enterprise Architecture Elicitation in a Healthcare Institution

The enterprise architecture elicitation and modelling effort has been divided in the same stages as the goal modeling phase, namely into four stages according to the source of information and technique used to interact with the process performers. Furthermore, the enterprise architecture elicitation (and modeling) has been carried out iteratively with respect to the goal elicitation (and modeling) phase.

The effort started with the analysis of the existing documentation about the organizational processes. From this documentation, we were able to delimit the business processes to be modeled as well as their scope. Following, we have identified the roles which participate of each of the business processes as well as their respective assignments.

The identification and delimitation of the scope of the business processes of the organization allow us to produce the Value Added-Chain (VAC) which corresponds to the actions

responsible for the realization of organizational vision and mission. As we have cited before, although the department executes 15 business processes, we have limited our scope to model only 9 business processes.

In a second *stage* (in which we observed the process performers during business process execution), we were able to model the business process during the observation of the actors executing them. As we argued before, this method of capturing organizational practices cannot bridge the gap of providing strategic issues to business process.

To overcome this dificultty, a third and fourth stages (characterized by interviews with stakeholders) addressed the need of searching for intentions for the organizational practices. These stages were also very valuable in clarifying the relationships between the business processes and the goals of the organization. Moreover, it demonstrated how the organization interacts with the external organizations in order to fulfill its goals.

Although the ARIS methodology includes the modeling of Function-Allocation Diagrams (FADs, our approach does not encompass this kind of models. In FAD diagrams, the activities of business processes are described as atomic actions with no further decomposition and the resources manipulated by these activities are also depicted.

It is also important to highlight that although this activity has been primarily concentrated in capturing business process models, the other elements of the enterprise (e.g. resources, organizational actors) have also been considered.

5.3.2 Results of the Enterprise Architecture Elicitation

The process of Diagnose patient's health state has been modelled in an EPC diagram. In Figure 5.7, the activities are arranged in swimlanes according to the actors who perform them. We omit events between sequential activities.

The business process starts when the need for diagnosis is identified in the business process for selecting patients to be admitted by the department. The patient reports the current symptoms, the physician, in turn, investigates the patient's clinical, personal and family history, and performs physical examination. These initial activities aim at diagnosing the

patient's health state. According to what is reported by the patient, the physician decides whether laboratorial exams are required to formulate a diagnostic hypothesis or to confirm a diagnosis. In case exams are indeed required, the physician verifies whether they have already been requested in a previous consultation. If not, the patient is referred to a laboratory for examination. The patient is responsible for undergoing examination and forwarding the results of laboratorial exams to the physician. Eventually, the physician elaborates a diagnostic hypothesis. At this point, the physician identifies: (i) the existence of a serious rheumatologic condition; (ii) the existence of a mild rheumatologic condition (low complexity rheumatologic condition); or (iii) the absence of rheumatologic conditions. In the latter two cases, the physician releases the patient immediately. In the case of a serious rheumatologic condition, the physician explains the diagnostic hypothesis to the patient and decides whether the patient requires rheumatologic treatment. If not, then the physician releases the patient. Otherwise, he/she starts elaborating the therapeutic treatment, deciding about the most appropriate procedure to treat the patient and, finally, sending the patient to the proper clinic. We must highlight that due to capacity constraints, the department only admits patients with serious rheumatologic conditions. Patients with mild rheumatologic conditions are referred to the municipal health service for follow-up in basic health care units.

Patient

Physician

Select patients to be admitted by department

Need of diagnosis identified in the process of selection

Report current symptoms

Investigate patient's clinic history

Investigate patient's personal history

Investigate patient's familiar history

Perform physical examination

Decide about the necessity of laboratorial exams to confirm the diagnostic

Need of laboratorial exams detected

Need of laboratorial exams not detected

Verify if laboratorial exams previously made

Laboratorial exams not previously made

Laboratorial exams previously made

Ask for laboratorial exams

Figure 5.7 The Diagnose patient's health state *process model*

5.4 THEORETICAL ISSUES IN CONDUCTING CASE STUDIES

Before proceeding with the presentation of our case study, we have deemed necessary the introduction of some methodological aspects related to type of research conducted along this thesis. The reason for these considerations is to clarify the nature of the contributions of our work as well as to provide guidelines for future investigation. In particular, we discuss the methodological issues regarding the use of case studies in research methods, since this is an important aspect of the work reported here.

A "case study research method" is defined by (YIN, 2008) as "all empirical inquiry that investigates a contemporary phenomenon and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". Using case studies for research purposes arises out of the desire to understand complex social phenomena, allowing investigators to retain the meaningful characteristics of real-life events (YIN, 2008). Therefore, our choice of selecting a case study as the instrument of our research is motivated by the need of capturing the alignment of goal models and enterprise models in a real realm, in this case, in a University Hospital.

Our case study is positioned as an exploratory case study. According to (KOTLER *et al.*, 2006), the objective of an exploratory case study is to gather preliminary information that will help to define problems and to suggest hypotheses, providing insights into and comprehension of an issue or situation. This kind of research is conducted when a problem is not clearly defined *a priori* and the researcher begins with the observation of the social setting and subsequent explanation for the phenomenon under consideration. Rather than testing a preformulated hypothesis, the research aims at developing general principles to account for the previous observations. The idea is to let questions emerge from the situation itself (SCHUTT, 1999).

Yin (YIN, 2008) also enforces this idea of lack of an earlier model as a basis of study for exploratory case studies. He argues that propositions are one of the fundamental components in case studies as a means of directing the attention to something that should be examined within the scope of study. Nevertheless, when the available literature does not provide any conceptual framework or hypotheses (or the existing knowledge is incipient), the new

empirical studies assume the characteristic of an exploratory study. In our case, the decision for adopting an exploratory case study has been motivated by the small amount of works in the literature of enterprise modeling that investigate the alignment of goals models and enterprise models from a real-world perspective. In other words, the lack of an estabilished body of initial propositions for the problem in a concrete scenario motivates the exploratory case study as a research method.

Since the exploratory case study does not start with pre-conceived ideas, it is very difficulty to make a detailed work plan in advance. This work plan is also denominated as research design and refers to the logic which governs the research from the initial questions of the study to data acquisition and conclusions (YIN, 2008). In fact, the research starts with a preliminary notion of your object of study and its context; as it evolves, the logical structure of the project gradually gains precision. Therefore, because the research design of an exploratory case study is also unclear beforehand, we believe that the need of splitting our case study into three phases can be considered as the first contribution of this thesis. The steps suggested in this work can be replicated in similar case studies as means of driving the entire research project. Nevertheless, we do not claim that this logical structure is the only research design admitted to conduct all case studies in the area of enterprise architecture alignment, recognizing that future research is required to validate these steps. For instance, in a future effort, additional steps can be added as necessary.

The second contribution refers to the methodologies used inside each phase. We believe that the same methods can be applied in similar cases, i.e., the elicitation approach with catalogues can be reproduced (described in section 5.2.2) as well as the goal taxonomy and the ontological analysis for the alignment (described in section 6.3.1 and section 6.3.2, respectively). Again, we should note that the general applicability of the particular techniques employed requires validation in future efforts.

With respect to the contributions of the results of the case study, a discussion which naturally arises refers to the generability of results found in such case study, i.e., the establishment of the domain to which a study's findings can be generalized. As argued by (YIN, 2008), "theory development is not only an immense aid in defining the appropriate research design and data collection but also becomes the main vehicle for generalizing the results of the case study". The role of the theory is summarized as the blueprint for the study, determining the

strategies for collecting and analyzing the data. During this analysis, the researcher attempts to verify whether the collected material conforms to the model or the model must be corrected to become more suitable to reflect the situation.

Nevertheless, even with the absence of the theoretical framework, since the goal of the exploratory case study is to develop an explanation for a previous observed phenomenon, exploratory case studies are also characterized by the goal of developing pertinent hypotheses and propositions to be reinforced in future case studies. (SEALE *et al.*, 2004) and (YIN, 2008) argue that the results of case studies (either multiple- or single-case studies) are generalizable to the theoretical propositions (they are useful for both generating and testing hypothesis), through a process of "analytical generalization" (YIN, 2008). The author explains that in "statistical generalization", an inference is made about a population (or universe) on the basis of empirical data collected about a sample (this is the most common way of generalizing when doing surveys or analyzing archival data). A fatal flaw in doing case studies is to conceive of statistical generalization as the method of generalizing the results of the case study. Rather, case studies are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study does not represent a "sample," and in doing a case study, the goal is to expand and generalize theories (analytical generalization) and not to enumerate frequencies (statistical generalization). Analytic generalization can be used whether the case study involves one (single-case) or several (multiple-case) cases.

Therefore, the exploratory case study also contributes to the development of a reasonable model for theory of some subject (the hypothesis or propositions). Hence, the third contribution of this thesis is the enrichment of the theory in enterprise modeling with relations among some of its architectural domains (our hypothesis), based on the relations proposed by enterprise ontologies. In this sense, the enterprise ontologies are used here as an instrument for clarifying the architectural concepts to be related, providing guidelines in the linkage of the goal domain and other architectural domains. The organizational ontologies are not considered our antecedent hypothesis; instead, the incipiency of the current literature in approaching this problem of architecture alignment systematically is a good motivator for the establishment of these initial propositions.

Summing up, we have used an exploratory case study motivated by the absence of initial propositions in the area of goal and enterprise architecture alignment using organizational ontologies as an instrument of analysis. In the course of developing the research, we provided three contributions: (i) the suggestion of how to conduct similar case studies (the division into three phases), (ii) the methods to be applied in each of these phases (the elicitation and alignment methods) and (iii) the provision of relations between the goal domain and the enterprise domain. Besides, our goal is not to conclude a study but to develop propositions for further study. This need of further investigation leads us to face our case study as a pilot case (first case study) of a series of multiple future case studies.

5.5   CONCLUSION

5.5.1 Benefits of the Proposed Approach

In relation to our method, we have found the preliminary goal elicitation activities useful in addressing our need to understand the organizational setting. This has enabled us not only to capture details about the enterprise and its business processes, but also to provide us with proper understanding about the domain under consideration. However, we have found the preliminary stages to be deficient in the identification of strategic concerns related to the organization's goals since the focus was concentrated on operational activities. This difficulty was partly addressed through stakeholder interviews. Although these interviews addressed many organizational issues, much knowledge still remained implicit. With respect to that, the

catalogues provided by the NFR framework have shown to be useful as a complementary tool to elicit goals.

Before discussing the nature of the additional goals identified with the support of catalogues, we must highlight some particularities about translating NFR types to goals. We have observed that the translation is highly domain-dependent, i.e., one must take into account how a NFR must be mapped to some goal in the organization domain such that this goal makes sense regarding the organizational context, as we have illustrated in section 5.2.2.1.3. Further, one must define whether a NFR type should be represented as a soft or hard goal. As observed in (DANEVA *et al.*, 2007), there is a tendency in treating NFRs as softgoals, however, as demonstrated in the case study, some NFRs could be objectively specified in the context of the domain.

In relation to the goals uncovered with the help of catalogues, we believe that goals have enabled us to reason about the organization from a more strategic point of view. This can be confirmed by the fact that some additional goals referred to quality attributes; either for specifying qualitatively a hardgoal or for specifying quality metrics for the business process as a whole. We have observed in this case study that stakeholders have difficulties in explicitly stating quality attributes for business processes (the same difficulty is often reported to elicit requirements in system development (CYSNEIROS, 2007)). In that respect, the catalogues employed in this case study provided guidelines for identifying these attributes in a systematic way.

We have observed that, in certain cases, stakeholders formulate goals which are highly dependent on the current operationalization of the organization's objectives, i.e., much emphasis is given to the goal of applying successfully a particular solution for a problem. Catalogues partially helped to overcome this issue, revealing higher level goals not easily identified by the abstraction technique. Further, some of the goals uncovered through catalogues had initially been deemed an inherent organizational characteristic by stakeholders, and thus had not been spontaneously mentioned.

At first sight, the technique we have employed seems highly dependent on the experience of analysts in conducting the elicitation effort (experience in the sense that analysts must have broad knowledge about the domain). This issue (of acquiring the knowledge about domain)

has been addressed in the preliminary stages with the immersion inside the organization. We believe this is the case partly because of the need to translate NFRs into goals which are specific to the organization's domain. Further investigation in NFR type catalogues for business process in a particular business domain may prove to be fruitful to reduce the dependency on analyst experience and improve goal elicitation in general. In this sense, NFR type catalogues can be seen as design patterns in goal modelling. The compilation of these catalogues in a format of design patterns would allow one to reuse the knowledge by making available methodological connections which are tacit in an experienced modeller's mind and which are not typically available to the novice.

With respect to the elicitation of the business process models, we felt that observing the business process execution allowed a straightforward identification of the organizational practices. Moreover, it served as support for the identification of points of improvement, bottlenecks as well as to clarify the logistics of the business processes and how they are related to providing what the customer perceives as the service provided by the organization. This identification of the organizational practices has been fruitful for the goal elicitation activities, since the observation of actions led to the identification of uncovered goals. On the other hand, the elicitation of goals has also been useful for the identification of organizational practices. Hence, the elicitation process should be iterative, with the models being refined at each elicitation/modeling cycle.

5.5.2 Limitations of the Proposed Approach

We have faced two main difficulties with respect to the elicitation activities reported here. The first one concerns the knowledge-intensive characteristic of the health care domain. Some incorrect details of business process have been identified since these details are specific to medical business processes. This issue has been mastered in the *third* and *forth* stages with the support of the interviews.

The second difficulty seems to be an inherent challenge for elicitation activities in most realistic settings, and relates to the limited access of the analysts to stakeholders and the bounded resources allocated for elicitation. In our study in particular, we have not been able to access all the stakeholders of the chain who are indeed interested in the elicited goals. For example, the Rheumatology Department is inserted into a very complex structure in which

the department itself is solely one of many "leaf nodes" (in chapter 6, we present a sketch of this structure). The stakeholders at higher levels, such as the public administrators, the physicians of other public health services have not been covered, limiting the identification of higher-level goals of the whole system. Such higher-level goals were only inferred by an indirect analysis (i.e., by analyzing the goals which we were able to capture and inferring how the higher-level goals from the whole system might be related with lower-level goals).

5.5.3 Future Work

Further work will be necessary to associate particular goals with guidelines for business process (re-)design. Additionally, in our future work, we intend to investigate suitable representation and semantics to relate goal models and business process models (especially in the presence of softgoals). Moreover, we aim at investigating the impact this approach of eliciting additional goals through the use of NFR catalogues shall have in business process structures as well as in the systematic redesign of business processes.

CHAPTER 6.   IDENTIFYING THE ALIGNMENT BETWEEN GOAL MODELS AND ENTERPRISE MODELS

6.1 THE ALIGNMENT BETWEEN INFORMATION SYSTEMS AND BUSINESS CONTEXTS

The problem of "alignment" has been recognized as an important issue by a vast amount of literature in the area of information systems. The central motivation which drives the development of this topic in research relies on attempts to promote synergy business and information technology (IT), since this kind of synergy is highly recognized as an instrument to realize controlled changes in an organization. Generally, the proposals implicitly assume that the IT policy and the other organizational domains must be driven by strategic concerns, i.e., business strategy must be regarded as the fundamental enabler to guide the decision making-process within the organization. Further, proposals are usually guided by the overarching principle that "(organizational) effectiveness is driven by the relationships between components rather than by the detailed specification of each individual component" (LANKHORST *et al.*, 2005). In this section, we review some representative studies in the area of alignment, focusing on the alignment of business with IT.

In (LANKHORST *et al.*, 2005) (application) architecture alignment can be defined as "the problem of designing architectures at the infrastructure, application, and business levels such that each fits optimally with the other architectures". This work defends the adoption of enterprise architecture models to manage the organizational complexity and to promote alignment between organizational structures. Furthermore, ArchiMate focuses on the relations different architectural domains without capturing too many details in each domain of the enterprise architecture.
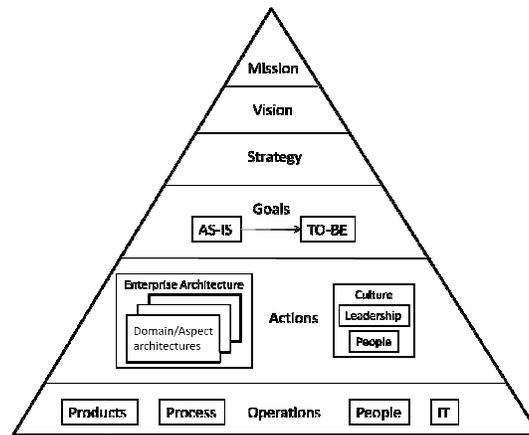
Figure 6.1 Enterprise architecture as a management instrument (LANKHORST et al*., 2005)*

Figure 6.1 illustrates schematically the hierarchical relations in the implementation of an enterprise's mission, vision, strategy and goals. An organization's mission states the reason for the existence of the organization, basically describing why it exists and what it does to achieve its vision, while the "vision states its "image of the future" and the values that the enterprise holds" (LANKHORST *et al.*, 2005). The strategy, in turn, is translated into goals which give direction to implementing changes. These goals are then translated to a level of abstraction until reach the concrete daily operations of the organization. It is important to notice that organizational culture is an important driver in the process of refinement. Besides, the alignment of the levels of this architecture is an indispensable instrument to help managers to identify necessary changes (as well as their priorities), to evaluate these needs against the existing business context and to innovate with stability and flexibility. To promote the alignment (between business and IT), Lankhorst and colleagues (Enterprise Architecture at Work - Modelling, Communication, and Analysis, 2005) present a language for enterprise description (the ArchiMate language presented in chapter 3). With respect to methodological guidelines, it provides tecniques for quantitative and qualitative architecture analysis and the GRAAL framework (VAN ECK *et al.*, 2004) which comprises in a set of operational guidelines for aligning IT architecture with business architecture. Although the concept of alignment is diffusely treated in the proposal, the tecniques and framework can be regarded as tools to suggesting architectural adjustments to reach the architectural (business-IT) alignment. With respect to the alignment between goals and business process (as well other operational elements), the proposal does not provide us with architectural architectural concepts, languages nor methodological guidelines.

Another important well-known work which addresses the problem of the alignment between business and IT is proposed in (HENDERSON e VENKATRAMAN, 1993). They propose what is denominated as the Strategic Alignment Model which is defined in terms of four fundamental domains: business strategy, information technology strategy, organizational infrastructure and processes; and information technology infrastructure and processes.
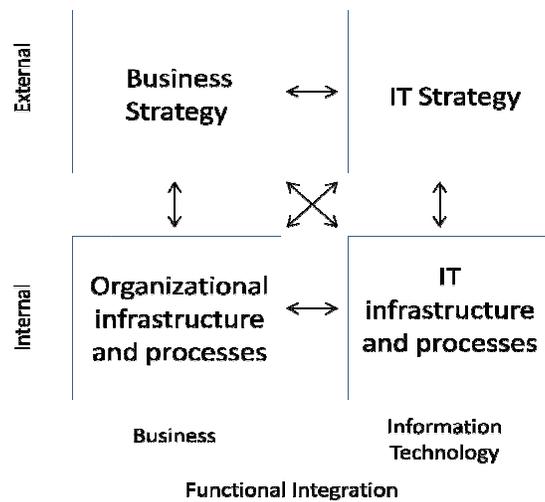
Figure 6.2 Strategic Alignment model (Henderson, et al., 1993)

These perspectives are complementary in the sense that starting in one of them, it is possible to derive one of the three remaining perspectives. For example, in Figure 6.2, starting in Business Strategy, it is possible to reach the IT infrastructure and processes via an IT Strategy. The concept of strategic alignment is based on two fundamental concepts: strategic fit (considers the necessity for any strategy to address both external and internal domains) and functional integration. While the internal domain concerns about rationales pertaining to the logic of administrative structure, the external domain focuses on how an organization reacts in face of competitors and partners. The functional dimensions consider how choices made in the IT domain impact those made in the business domain and vice versa.

It is important to highlight that the proposal is strategic in the sense that the construction of the framework is motivated by strategic issues. However, although admitting the articulation of the business strategy as a driving force within the organizational setting, this articulation aims at directing design choices only in the scope of the IT domain (to guide IT investments (external domain) and to guide choices in defining information systems (IS) architectures

(internal domain)), ignoring the impacts of strategy in the selecting alternatives which encompass the whole organizational scope (not prescribing actions for addressing business processes, human resources, among others). Furthermore, the proposal does not make explicit the concept of goal to guide IT decisions, but the concept of strategy instead. Observe that the concept of strategy of this proposal differs from the concept adopted in (LANKHORST *et al.*, 2005). A clear disadvantage of this choice is the fact that when a manager assumes a particular strategy to reach some goal in the decision-making process, generally, he/she ignores the existence of different alternative solutions to the same problem (goal) as well as the trade-offs associated with these alternatives.

Another important issue concerning the proposal refers to the absence of methodological guidelines to guide managers in making decisions with respect to the IT policy. In this sense, the proposal establishes the cross-domain relationships among the four perspectives, but does not prescribe how to implement these relationships through operational policies.

Another well-known framework (possibly the best known framework) for enterprise architecture has been introduced in 1987 by John Zachman (ZACHMAN, 1987). The framework comprises in a descriptive structure for classifying the relevant aspects (areas) which must be considered in the management of an enterprise as well as for guiding the process of selection of enterprise systems.
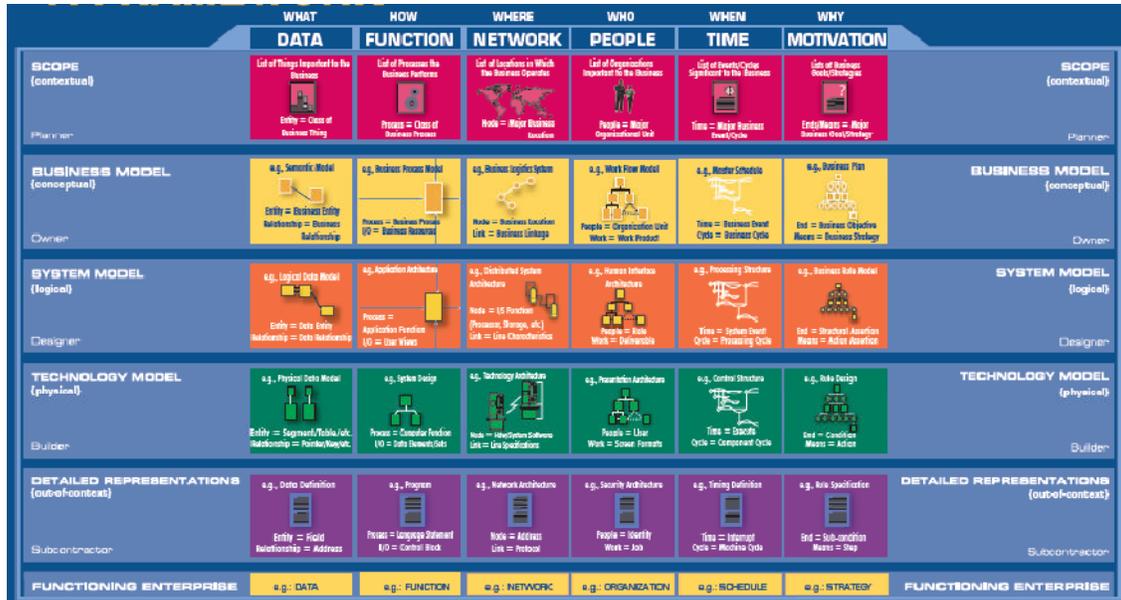
Figure 6.3 The Zachman Framework

In Figure 6.3, the framework depicts the intersection between aspects of the enterprise architecture. These aspects can be summarized as the roles who participate in the process (represented in the vertical axis) and the product abstractions (represented in the horizontal axis). The roles corresponds to the *planner*, *owner*, *designer*, *builder* and *subcontractor* and the product abstractions corresponds to *what* (material), *how* (process for product production or processing), *where* (corresponds to the geometry that components are deployed in relation to each other). More recently, the need for including additional product abstractions, namely, *who* (who executes the work?), *when* (when are the products processed?) and *why* (what motivates the work?) has been identified.

Perhaps, the main benefit of this logical scheme is to enable focused concentration on selected aspects of an enterprise architecture without losing the sense of the contextual analysis (in fact, there is a high amount of details and relatioships to be considered simultaneously). Observe that Zachman addresses the framework as a unified whole (e.g. recognizing "motivation" as an important enabler) and conceding no special focus to any particular aspect of the enterprise. However,(LANKHORST *et al.*, 2005) argues that *the number of cells inhibits the pratical applicability* of the framework in real enterprises. Besides, this same author claims the *semantics of the cells are not well-established* (LANKHORST *et al.*, 2005). And, in addition to that, the framework is totally *independent of*

tools or methodologies (ZACHMAN, 2003). These three italicized characteristics implie this framework provides little assistance in creating real architectural artefacts.

As we have noticed, the proposals for alignment were firstly addressed in the context of aligning a business setting with system architectures. Some recent works have acknowledged the need of focusing on the problem of the alignment of the goal domain with the other elements of the enterprise architecture. Considering this, this chapter is divided as follows: section 6.2 describes some of the existing approaches of aligning goal models with business process models; section 6.3 introduces our solution for the alignment between enterprise models and goals models in the healthcare organization of our case study. This solution is divided into two stages: the harmonization phase (section 6.3.1) and the alignment phase (section 6.3.2). Section 6.4 presents some conclusions of the case study with respect to the method employed as well as the results obtained and section 6.5 presents our research agenda for the future.

6.2 THE ALIGNMENT BETWEEN ENTERPRISE MODELS AND GOAL MODELS: A COMPARATIVE PERSPECTIVE

A specific problem within the problem of aligning domains comprises in the issue of aligning organizational goals with enterprise architectures. The importance of this issue in areas in computing such as requirements engineering and business process management drove the research community to devote considerable attention in recent years to the topic, evidenced by some recent works presented in (NURCAN *et al.*, 2005)(GONZÁLEZ e DÍAZ, 2007)(KUENG e KAWALEK, 1997)(KOLIADIS *et al.*, 2006)(SAMAVI *et al.*, 2008)(YU *et al.*, 2006)(SOFFER e WAND, 2005) (MARKOVIC e KOWALKIEWICZ, 2008)(HALLEUX *et al.*, 2008)(KOLIADIS e GHOSE, 2006)(ANDERSSON *et al.*, 2008)(LOUCOPOULOS, 2001). These proposals (denominated as *goal-oriented* methodologies) are mainly laid on the notion that the enterprise modeling methodologies can be extended through an alignment with goal/strategic/intentional models. This extension provides an intentionality dimensionto the organization, emphasizing the distinction between goals (what is to be achieved) from the strategy to achieve this (how it is supposed to be achieved). Moreover, this kind of alignment allows synchronized movements between the goal domain and other organizational viewpoints as they evolve throughout time.

In order to obtain the benefits from adopting the alignment between the goal domain and the remaining viewpoints in enterprise architectures, researchers must rely on two main components (BUBENKO *et al.*, 2001):

(i) A meta-model for defining the modeling language for goals and enterprise models, i.e., a meta-model for defining the modeling constructs syntax, semantics and graphical notation used to create models. This meta-model comprises in a number of inter-related sub-model types, each focusing on one perspective.

(ii) A systematic methodology for creating aligned models. During this process different ways of working are applied in order to elicit and develop the knowledge of business stakeholders or domain experts.

The first component has already been explored in chapter 2 and 3 with the presentation of the languages for goal and enterprise modeling, respectively. In chapter we discuss how approaches in the literature address the second component. We also explore (from a methodological point of view) how the goal models are aligned with enterprise models in the context of the case study, through an ontological account.

This approach has been explored in a previous work by (GUIZZARDI, 2006), where she proposed the alignment of two agent-oriented notations (namely Tropos's language and AORML) for the purpose of creating a methodology to develop Knowledge Management Systems. This methodology is named ARKnowD (read Arnold), and guides analysts and designers since the early stages of system development towards the detailed design of the proposed solution. In fact, this early work has been the main inspiration for the development of the case study presented in this work.

Although our objective has somehow been changed, we decided, from the start, to follow the same alignment methodology as in ARKnowD, since this methodology had already proven fruitful. More about the Tropos+AORML alignment may be found in a series of publications, such as (GUIZZARDI *et al.*, 2005) (GUIZZARDI, 2006) (GUIZZARDI *et al.*, 2007) (GUIZZARDI *et al.*, 2008).

After this brief digression to explain some historical background, we now go back to the current alignment problem. The fact is that promoting this alignment from a methodological point of view is not an easy task. An analyst must deal with a multitude of issues in the course of solving this problem. Some (not exhaustive) list of questions which commonly arise are:

(i) How can one bridge the gap between these models, once the abstraction level considered in each one is different? (goal statements range from high-level strategic concerns to lower level aspects);

(ii) How can one relate both domains given that goal models and business process models are based on different concepts? (while goals present some relationships such as contribution, priorities, among others, business processes reflect sequential relationships among activities);

(iii) Since goal models and business process models are differently structured, what are the basic relationships between them? (One goal always leads to the adoption of a corresponding business process, or one goal can entail the adoption of many business processes? These business processes satisfy the goal in a total or partial manner?).

These questions are just a few examples about how mastering the problem of the alignment must address a high number of aspects. These will serve us as guidelines for comparing the existing approaches. The remainder of this section explores how the current proposals approach the problem.

6.2.1 Existing Approaches for the Alignment of Goals and BPM

In this sub-section, we explore several approaches for tackling the problem of aligning goal models and business process models. Our intention is to provide a comparative analysis of the concepts that the proposals strive to provide for enabling the alignment between enterprise models.

The concept of goal (or objectives, as treated in some proposals) is, not surprisingly, central in the approaches we have surveyed. In this context, goal statements declare desired states for

the enterprise setting as well as the reasons and motivations (i.e., rationale) for the existence of the components in the other viewpoints (BUBENKO *et al.*, 2001).

The goal-driven modeling perspectives adopted by these proposals strive to address many important problems in a large number of areas. Some methodologies appear in the context of business process management to promote semantic interoperability and integration of business processes at the conceptual level. Furthermore, these works integrate business process within several cross-organizational solutions (cross-organizational information systems) which are used in enterprise cooperation and business exchange (MARKOVIC e KOWALKIEWICZ, 2008) (LIN, 2008) (SOFFER e WAND, 2005). Other approaches are intended to provide additional support in business process reengineering activities (NURCAN *et al.*, 2005)(NEIGER e CHURILOV, 2004)(HALLEUX *et al.*, 2008)(KOLIADIS *et al.*, 2006), assuring that business processes are fully compliant with business strategies. In the same vein, the use of business models in requirements engineering (GONZÁLEZ e DÍAZ, 2007)(ESTRADA *et al.*, 2003) strives to increase the value of the activity, by assuring "sufficient completeness of a requirements specification", "avoiding irrelevant requirements", providing "a natural mechanism for structuring complex requirements documents", among others as mentioned in (LAMSWEERDE, 2001). As a consequence of the different contexts of these proposals, goal models are employed with different purposes.

In addition, goal models are defined with different levels of rigour or formalism. Concerning that, the proposals can be said to enable *informal* (MENDES *et al.*, 2001), *semi-formal* (BUBENKO *et al.*, 2001)(ANTÓN, 1997) and *formal representations of goals* (KOLIADIS e GHOSE, 2006)(NURCAN *et al.*, 2005) (NEIGER e CHURILOV, 2004)(KOUBARAKIS e PLEXOUSAKIS, 2000). In addition, we highlight those approaches which use ontologies: (MARKOVIC e KOWALKIEWICZ, 2008) (LIN, 2008)(SOFFER e WAND, 2005)(KOLIADIS *et al.*, 2006)). According to (KAVAKLI e LOUCOPOULOS, 2003), informal approaches generally express goals in natural language; semi-formal use mostly box and arrow diagrams; and formal approaches express goals as logical assertions in some formal specification language or formal system (including formal ontologies).

The concept of business process also plays an important role in the literature on enterprise alignment. This importance can be justified by the fact that while goal models focus on the essence of the business (capturing "what" is necessary to be achieved regardless of "how" to

achieve it), business processes represent how the enterprise aims at fulfilling its goals by adopting particular strategies incorporated to daily operations. Thus, the relationship between goal models and business process models is the most explored relationship in literature (NURCAN *et al.*, 2005) (HALLEUX *et al.*, 2008)(KOLIADIS e GHOSE, 2006)(KUENG e KAWALEK, 1997)(KOLIADIS *et al.*, 2006)(NEIGER e CHURILOV, 2004). Moreover, commonly, the proposals just extend business process languages by increasing their semantics with the adoption of a notion of goal (Koliadis, et al., 2006) (NEIGER e CHURILOV, 2004) (SOFFER e WAND, 2005)(BIRGIT e LIST, 2007).

Differently, other approaches encompass the remaining viewpoints which pertain to enterprise languages (such as organizational structures and rules). However, although the remaining viewpoints are taken into account, the relationships between these viewpoints and goal models are often implicitly made (MARKOVIC e KOWALKIEWICZ, 2008)(NURCAN *et al.*, 2005)(SOFFER e WAND, 2005)(KOLIADIS e GHOSE, 2006). It is assumed that the elements of these viewpoints present some correlation with business processes, which are, in turn, related with goal models. Among these correlations, we emphasize the following: (i) agents play some roles in the organization and are responsible for carrying out activities (business processes are compounded by activities); (ii) agents access all kinds of resources when performing activities, such as informational resources; and finally, (iii) all these elements (agents, activities, resources, business processes) are either governed or constrained by rules. Not establishing direct connections between goals and other elements of enterprise architectures can be considered a disadvantage to some extent, since indirect correlation can add difficulties to the task of architectural analysis and to the decision-making process. Differently, in (HALLEUX *et al.*, 2008), goal models are defined in terms of economic resources (resources that are of economic value for agents) and agents who participate in the achievement of the goal. Making direct connections enables a deeper analysis about how all elements in organizational architectures impact goal fulfillment.

With respect to the utilization of ontologies in the scope of BPM, we must highlight the SUPER Project (Semantics for Utilized Process Management within and between enterprises) (SUPER CONSORTIUM, 2009) which comprehends one of the initiatives of the European Semantic Systems Initiative (ESSI) for semantic annotation of business processes. The project consortium is a blend of software vendors, service providers and research teams from all over Europe.

The main objective of the project is to raise Business Process Management (BPM) to the business level, where it belongs, from the IT level where it mostly resides now. This objective requires that BPM is accessible at the level of semantics by business experts. Acknowledging that the current degree of mechanization in BPM is very limited, what does not support the machine reasoning, the project aims at providing scalable methods and tools for the machine-readable representation of knowledge. For doing so, Semantic Web technologies are used to support the automated discovery, substitution, composition, and execution of software components (Web Services).

The combination of SWS (Semantic Web Services) and BPM leads to the development of ontologies which describe business processes and their underlying domains such as organizational structure, goals and information systems. Therefore, these ontologies support the alignment of the goal domain and the business process domain for business process management purposes.

6.3 THE ALIGNMENT BETWEEN ENTERPRISE MODELS IN A HEALTHCARE ORGANIZATION

In chapter 5, we discussed the problem of discovering goals from a given organizational context and presented the results of the elicitation phase: separate goal models and enterprise architecture models (including business process models). This chapter discusses the alignment of these models and reports on our investigation into how an organization employs its resources, for instance, how the organizations organizes its employees, process, systems, among others with the aim of satisfying its goals.

The discussion is structured into two phases: the harmonization phase and the alignment phases. The activities in each of these phases are justified based on the observations that establishing the relations between goals and business process models is far from straightforward. This can be accounted by the fact that goals may be formulated in various levels of abstraction (NEIGER e CHURILOV, 2004) and precision (JURETA *et al.*, 2006) and, further, that goals may refer to various aspects of an organization and its processes. Our approach to address the alignment is based on *harmonizing* goal models such that they can be subsequently *aligned* with business process models (and other elements of the organization).

Thus, in the harmonization phase, we propose a goal taxonomy to classify the goal domain according to some criteria and report on the implications of this classification in establishing the relationships with business processes. In the alignment phase, the focus is concentrated on developing a framework which describes the relationships between goals and the other elements of the organization.

6.3.1 The Harmonization Phase

We have already discussed the main benefits of adopting the alignment between business process models and goal models in chapter 5 (section 5.1). Since goal statements are not uniform, goals require to be classified according to some of their characteristics before being aligned with process models. This classification is important because the goals' characteristics impact in the structures of business processes which support them. Therefore, the goal taxonomy represents each of the characterists that we have found relevant. The aim of this phase can be summarized in two main topics:

- To address the different characteristics of goals in the goal domain;
- To discuss how the different natures of goals impact the structures of the business processes which support them.

In the remainder of this section, we propose the goal taxonomy, the concepts involved in each of the categories of the taxonomy and, finally, the implications in the business processes structures which support these goals.

In chapter 5, we have provided the goal model of the diagnosis process. In this chapter, we extend that model with additional goals which are necessary for proposing our goal taxonomy as well as introduce the relationships among the organizational actors within the department with the purpose of demonstrating how the organizational setting is configured.

6.3.1.1 Rheumatology Department Goals (an extension of the models presented in chapter 2)

As can be seen in Figure 6.4, the Rheumatology Department has three main actors: the Patient, the Resident in Rheumatology and the Rheumatologist Physician (which are

referred to as Patient, Resident and Physician, respectively in the remainder). The Patient has two main goals: Get healed and Feel well. These goals exemplify the distinction between hardgoal and softgoal. While one can objectively infer whether the patient is healed (from a physiological perspective through exams analysis), it is not possible to accurately determine what characterizes the patient's well-being. The Resident and the Physician aim at healing the patient (Heal the patient goal) and when this is not feasible, at least minimizing patient's physical suffering (Minimize patient's physical suffering and symptoms goal). This softgoal is important in this particular case, since in Rheumatology, in most of cases, the conditions are chronic and incurable, which implies in adopting a treatment which focuses on minimizing the condition effects.

In the scenario analyzed, in most of cases (but not in all cases), the medical consultation is not directly executed by the Physician, but by the Resident. This is captured by the dependency between the Patient and the Resident/Physician to obtain a medical consultation. In counterpart, the Resident/Physician depends on the Patient to acquire technical skills (Acquire technical skills goal dependency). Although the resident and physician have the same goal of acquiring technical knowledge in treating the patient, this goal has a different meaning for each actor. The Physician is interested in acquiring technical knowledge for becoming more experienced (Become more experienced goal) to treat the future cases in the course of his/her professional exercise. The Resident besides considering this issue is also concerned about being approved in an exam after concluding the residence to be acknowledged as a Rheumatology Specialist (the Acquire technical skills goal is also refined in Resident's perspective, not shown in this figure). In this sense, the Resident's dependency on providing a medical care to patient is more critic than the Physician's dependency on the Patient.

To satisfy legal requirements, after the Resident has analyzed the patient's case, he/she contacts the Physician to approve the diagnosis and proposed treatment. The Approve the treatment proposed by the resident goal dependency from the Resident towards the Physician captures this practice. The Physician in turn, depends on the Resident to Treat more patients. This is a matter of scaling up the service provided to patients. While there is just one physician in each shift, there are usually four residents.

This diagram enables us to consider the balance in the relationships between pairs of actors. This is relevant because mutual dependency leads to greater motivation for cooperation when compared to the cases that dependencies occur just in one direction (YU, 1995) (GUIZZARDI e PERINI, 2005). In the first case, both actors act towards establishing commitments which lead to adopting the goals of each other.
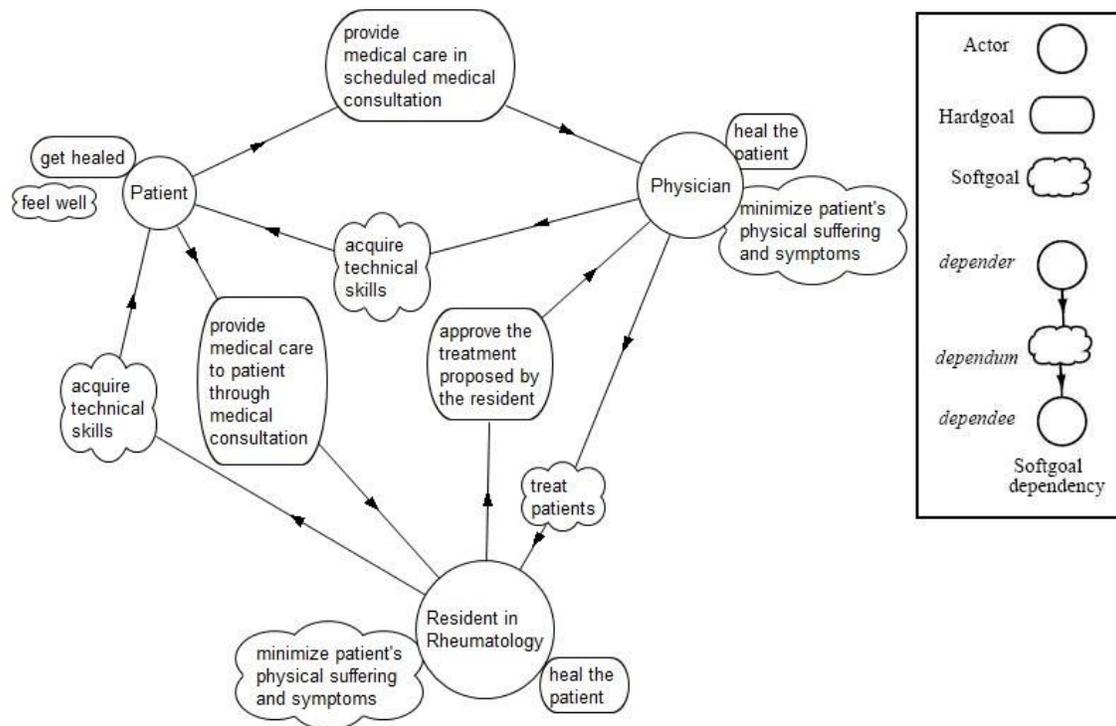
Figure 6.4 An actor diagram in Tropos, depicting a global vision of the organizational scenario

The documentation of some unbalance (which does not occur here) in an AS-IS model open up the possibility of improvements to the generation of a TO-BE model. In other words, the analysis allows one to identify the cases in which it is necessary to modify organizational practices so that mutual dependencies are established.

After an abstract vision of the scenario under consideration, we focus on the particular goals of actors, deepening the analysis about their intentions, choices and strategies to reach a specific goal. This analysis can be conducted using an actor diagram which shows the goals of a physician who conducts the business process of diagnosis, as exemplified in Figure 6.5.

The first step in the analysis is to internalize the goals of the actor. We notice that the main goals of the Physician (Heal the patient and Minimize patient's physical suffering and symptoms) are internal to his/her perspective. Besides the actor's individual goals, it is necessary to internalize those goals which had been delegated from the dependencies established with other actors as shown in the actor diagram. Thus, the Provide medical care to patient through medical consultation goal delegated by the Patient is now represented inside the Physician's perspective. In the same way, the Physician assumes the Approve the treatment proposed by the resident goal, delegated by the Resident.

From this point on, we can identify how goals are interrelated. For example, one of the alternatives when a physician needs to provide medical care to a patient (Provide medical care to patient goal) is scheduling a medical consultation (Provide medical care in a scheduled medical consultation goal). This is captured by an OR-decomposition, in which the other alternative consists on the goal Provide medical care via ER. Providing medical care to patient contributes positively to minimize patient's physical suffering and symptoms (Minimize patient's physical suffering and symptoms goal).

In the remainder of the section, we describe the goals with respect to a specific medical consultation. During consultation, the physician diagnoses the patient's health state (Diagnose health state goal) and prescribes the treatment (Prescribe patient's treatment goal which uses, in turn, a Drugs prescription).

The main goal of the physician is to Diagnose patient's health state. During the process of diagnosis, the physician can find either rheumatologic or non-rheumatologic conditions (Diagnose rheumatologic conditions goal and Diagnose non-rheumatologic conditions goal). Rheumatologic conditions can be, in turn, classified as mild conditions (Diagnose mild rheumatologic conditions goal) or serious conditions (Diagnose serious rheumatologic conditions goal). If a mild rheumatologic condition has been identified, the patient receives treatment for a short period of time and is soon released. This justifies the existence of the Release patients with mild rheumatologic conditions after no more than 3 consultations goal.

Figure 6.5 Goal diagram in Tropos which focuses on the Physician's perspective

After diagnosing the patient's heath state, the physician is able to select the most suitable treatment for the condition (Select the most suitable treatment for patient softgoal). For this reason, Diagnose patient's health state is a means for Select the most suitable treatment for patient. With respect to the diagnosis, the physician is also interested in obtaining information about all the conditions which had already been previously investigated (Obtain traceability in investigation of patient's condition softgoal). One of many means towards achieving traceability in the investigation of diseases is to Standardize diagnosis cue sheets.

The physician must have accurate knowledge for being able to discover the presence/absence of conditions (Acquire technical skills softgoal), i.e., to become more experienced so as to discover conditions in future cases (Become more experienced goal). He/she must also access the patient's data for achieving the current medical consultation (Obtain access to patient's records during medical consultation goal). In the case which the physician is not able to access the patient's records, he/she has the legal right to deny providing assistance to patient. After analyzing this data, the physician is able to determine how the patient's health condition has evolved in time (Obtain access to patient's clinical history and data goal), which positively contributes to establishment of the diagnosis.

Another common technique in Tropos is denominated contribution analysis (BRESCIANI e SANNICOLÒ, 2003). This technique highlights important social and/or ethical issues which are rarely captured by other kinds of analysis. For instance, Figure 6.5 documents a relevant issue that the physician takes into account when prescribing a drug. One of his/her softgoals refers to prescribing the most effective drug to treat a certain case (Prescribe the most effective drug goal). We have noticed that commonly the most effective drug is also the drug which causes multiple collateral effects (negative contribution of Prescribe the most effective goal towards Minimize collateral effects goal). Thus, when prescribing the treatment, the physician encounters these particular issues, requiring that he/she decides according to each case based on his/her self judgment and contact with the patient. When minimizing the patient's physical suffering (Minimize patient's physical suffering and symptoms goal) and the collateral effects, the physician positively contributes to the patient well-being (Guarantee patient well-being goal).

 In the pursuit of the patient's health and well-being, there is also a need to integrate the department's service with other health care providers (Coordinate patient care with other healthcare providers goal). These involved providers are classified according to three types: other Hospital departments, such as laboratories or administrative departments (Coordinate patient care with other hospital departments goal), municipal and state health services (Coordinate patient care with municipal and state health services goal) and specialists in areas related to rheumatology (Coordinate patient care with specialists in areas related to rheumatology goal). The integration of information between the rheumatology department and other departments which compose the public health care

service is a fundamental quality factor for the success of the treatment, since the information must reach all decision-makers who care about that information. From this point of view, being integrated with laboratories allows the physician to have updated information for selecting the proper treatment. Sharing information with municipal and state health services, on its turn, allows the physician to understand how the patient's health state is evolving along the time (to obtain what is called "integrated treatment"). And finally, coordinating the treatment with specialists in areas related to rheumatology allows the physician to clarify further details about the diagnosis with other specialists (for example, a dermatologist or ophthalmologist) in the Hospital. To have integrated information helps to reduce uncertainty during the process of diagnosis (Eliminate all uncertainty during the process of diagnosis goal), helping the physician to deliberate about the treatment (although the access to information has a weak impact on reducing these uncertainties, as we explain latter).

Finally, with respect to the development of research achieved by the department, i.e. to investigate the incidence of rheumatologic conditions in population, the physician also has the Collect data for epidemiological analysis goal.

6.3.1.2 The Goal Taxonomy

Having analyzed this more complete model of the studied setting, we were able to note a number of dimensions that characterize goals, which may be used either to differentiate a goal from another or, at times, to identify a group of goals with similar characteristics. The six dimensions to classify goals are the following: level of abstraction, functional/non-functional aspect, hardgoal/softgoal, scope aspect, temporal aspect and desires.

The first dimension refers to the **level of abstraction**. Goals formulations range from highly abstract statements, such as "Provide the best treatment possible" to low level propositions such as "Medical reports must be issued within five days of frequency". The classification proposed in (NEIGER e CHURILOV, 2004) and (KEENEY, 1994) categorizes goals (or objectives, as denominated in the proposal) according to: (i) **fundamental objectives**, which "describe business values" (NEIGER e CHURILOV, 2004) and "concern the ends that decision makers value in a specific decision context" (KEENEY, 1994); (ii) **means-ends objectives, i.e.** "means to achieve ends" (NEIGER e CHURILOV, 2004) and "methods to achieve ends" (KEENEY, 1994); and (iii) **process objectives** which are a subset of means

objectives, i.e., "process objectives are ends towards achieving overall business objectives, as are the means objectives." (NEIGER e CHURILOV, 2004). Top-level means-ends objectives are refined until the lower-level means-ends objectives can be assigned to process objectives which implement them.

Here, we consider the same taxonomy (namely, **fundamental goals**[16], **means-ends goals** and **process goals**), although our approach introduces some differences in relation to this classification.

First, this proposal assumes that means-ends goals do not have to be linked to individual fundamental goals as long as it is assumed that means-ends goals *together* are sufficient to achieve fundamental goals (NEIGER e CHURILOV, 2004). Instead, we regard that the relationships between means-ends goals and fundamental goals can be captured by the relations expressed in the Tropos metamodel (means-ends links, contribution links and AND/OR decomposition). Second, we introduce an additional kind of goal, namely, **activity goals** which we define as a desired state of the world which must be reached after the execution of the activity responsible for attaining this state.

As an example of these categories consider the following goals: Provide medical care to patient (fundamental goal), Provide medical care in scheduled medical consultation (means-ends goal), Diagnose patient's health state (process goal) and Prescribe patient's treatment (activity goal). We regard Provide medical care to patient as a fundamental goal since the main value considered by the organization during the decision making process is the provision of medical care. In this context, we regard fundamental goals as guidelines for driving the decision making process in the organization and, moreover, we introduce the notion that agents who are affiliated to the organization are always committed with a fundamental goal during the period of time which the agent belongs to this organization[17]. Provide medical care through consultation is a means-end goal because consultation is a particular means to Provide medical care to patient. Since ends can be implemented by alternative means, in this case, an alternative solution to provide medical care is via

---

[16] Notice that the terms goal and objective are interchangeably used here.
[17] Observe that this definition opens up the discussion about the adoption of organizational goals by agents. In fact, we intend to address this issue in our future work. We aim at discussing the role of norms and rules as a regulator mechanism to enforce the agents' behaviour with the respect of which goals the agents adopt as well as how agents are constrained in the selection of the alternatives to attain these goals.

emergency room (ER) (Provide medical care is via emergency room (ER) goal). Actually, although the ER is a feasible mean for providing medical care, physicians try to avoid this alternative at all costs, since providing medical care to patient via ER means that the patient's health state is so critic that the patient cannot wait until the next medical consultation, i.e. he/she must immediately receive medical care. Diagnose patient's health state is a process goal since there are multiple activities in the business process which contribute to achieving this goal (for example, the activities *Investigate patient's clinical history*, *Investigate patient's personal history*, *Investigate patient's family history* and *Perform physical examination*). It is also relevant to highlight that process goals sometimes can either be associated with a specific business process (for instance, the Diagnose patient's health state goal which is associated with the process of diagnosis) or can be partially satisfied within several business process simultaneously. For example, the Acquire technical skills goal is attained in various different business processes at the same time. While a diagnosis is obtained through several activities, prescribing treatment (Prescribe patient's treatment) is a goal of a specific activity in the business process (*Start elaborating the therapeutic treatment* activity). In the process of diagnosis, after the condition has been diagnosed, the physician starts elaborating the therapeutic treatment. At this point, the patient is forwarded to some specific clinic, where treatment will actually be elaborated and refined.

The second dimension has been identified in the software engineering domain in (JURETA *et al.*, 2006) and refers to the distinctions between **functional and non-functional goals**. **Functional goals** refer to services that the organization environment is expected to deliver (i.e., *what* is achieved in fact), whereas **non-functional goals** refer to quality attributes that the organizational environment needs to satisfy while delivering the services (i.e., *how* the organization provides the services). In the case study, Diagnose rheumatologic conditions is a functional goal since it refers to what the business process is supposed to deliver (the patient's health state diagnosed), while Release patients with mild rheumatologic conditions after no more than 3 consultations is a non-functional goal since it refers to a quality attribute of the process (performance in terms of physician and patient resources which are allocated to a consultation).

The third dimension is also relevant in requirements engineering and is already supported by the Tropos metamodel. In this dimension, goals are categorized as either **hardgoals or softgoals**. Commonly, NFRs and softgoals are interchangeably treated as the same concepts

(albeit the distinction is clear according to the definition of the concepts). This association arises because there is a tendency in specifying quality attributes in an imprecise manner. As examples of hardgoals/softgoals in the context of the case study, we have the Diagnose patient's health state goal and Select the most suitable treatment for patient goal, respectively. While Diagnose patient's health state is objectively defined in the context of the domain, Select the most suitable treatment for patient is not clear-cut defined *a priori*; it depends on how the condition is responding to the prescribed treatment along the time as well as the acceptance of the treatment by the patient. The meaning of what is the most suitable treatment is specified in terms of the results obtained in the course of pursuing the goal.

The fourth dimension refers to what we call the **scope aspect**. In this dimension, goals are categorized according to the scope in which a goal may be fulfilled. A **restricted-scope goal** is a goal which should be achieved in a single execution of a business processes. A **broad-scope goal** is a goal which is attained after several executions of a business process. Notice that while fundamental and means-ends goals are always broad scope goals, activity goals are always restricted scope goals. Thus, this dimension is particularly relevant for process goals. Another important remark about this dimension is the fact that the multiple executions of the same business processes can be regarded by the customer as the service provided by the organization. To illustrate this distinction, consider the Approve the treatment proposed by the resident goal which is an example of a restricted scope goal. This goal is attained in multiple business processes in the organization, however, each process execution is independent; and for each patient, the physician has to validate the diagnosis issued by the resident, thus justifying the classification as a restricted scope goal. In constrast, Collect data for epidemiological analysis is an example of broad scope goal. An analysis of the incidence of rheumatologic conditions in population needs sufficient data to facilitate decision-making in public policies for health care services. This amount of data is solely collected after a sufficient number of patients have been treated.

During the goal elicitation phase, the stakeholders commonly state strategies and motivations for the current business process. However, besides describing the current motivations, they also provide the motivations for altering the current organizational context as well as the motivations for a future organizational setting. Thus, the fifth dimension addresses **temporal aspects**. In the context of *goal-oriented requirements engineering*, (KAVAKLI, 2002)

proposes four types of goals with respect to the temporal dimension: AS-IS goals, change goals, TO-BE goals and evaluation goals. We adopt the same classification, but we leave out evaluation goals (since these kind of goals are not relevant for our purposes). Then, we adapt these types of goals for the business process context. **AS-IS goals** concern the current organisational situation and how current organisational goals are realised in existing business processes (they provide motivations for the current business processes). **TO-BE goals** focus on statements that propose motivations and intentions in a future business context (the business processes which will exist in a future environment). **Change goals** refer to the reasons (the need) for altering the existing situation through the reengineering of current organizational setting. Although this kind of goal exists in a current business setting, driving the adoption of changes, they disappear as long as they are fulfilled.

As an example, consider the Approve the treatment proposed by the resident goal (classified as AS-IS goal). This goal is justified by a current organisational situation (the fact that resident's are still under training and are not legally responsible for treatment. The Coordinate patient care with other healthcare providers goal can be classified as a TO-BE goal[18]. This goal states that higher information integration among the involved stakeholders must be reached so that overall patient care becomes more efficient and effective. Finally, as a change goal, we have identified the Standardize diagnosis cue sheets goal which comprises an intention which is present in the current setting and the agents strives towards transforming the current situation. Thus, in a future situation, the cue sheets will be standardized and the need does not belong as a motivation for any action in a future setting, which leads to the disappearance of the goal. The difference between **AS-IS goals** and **change goals** is that the latter lead to alterations within the organization (which cannot be said about the former). The difference between **TO-BE goals** and **change goals** is that change goals are not present in the future setting (but in the current situation, instead) and disappear as they are attained.

Finally, the sixth and last distinction we propose refers to the (often elusive) separation between **goals** and **desires** (GUIZZARDI *et al.*, 2007). A **desire** "refers to the 'will' of an agent towards a specific goal, although he/she might never actually pursue these goals". This has shown to be very relevant in addressing issues which exceed the boundaries of action of

---

[18] Although this goal is a TO-BE goal, it is shown in Figure 6.5. In fact, we have decided to maintain the goal to illustrate its correlation with the Eliminate all uncertainty during the process of diagnosis goal.

the actors within the organization. For instance, issues (goals) related with competitors or external partners cannot be controlled and thus, no action is available to achieve the goal. Another situation in which the concept of desire is valuable is related with the treatment of uncertainties in some organizational environment. In the case study, we have found that the Eliminate all uncertainty during the process of diagnosis is a desire of the physician. Rheumatology is an investigative speciality in which evidences must be considered in a whole clinic context. Thus, this "goal" denotes a desire of the physician to have the ability to cope with the subjectivity of evidences used to establish and validate a hypothesis of diagnostic. Although physicians would like to eliminate all uncertainty, there is no feasible plan to fulfil this goal.

We must also emphasize that classifying an objective either as a goal or as a desire is a subjective issue. This classification must be driven by a number of issues, such as: the possibility of establishing commitments so that other agents pursue the goal, the possibility of associating concrete actions; or when there are no concrete actions, the possibility of establishing strong correlations with plans and goals, among others. In this sense, although the goal Coordinate patient care with municipal and state health services to some extent impacts in the reduction of uncertainties during the process of diagnosis, this impact reveals to be so weak that we found relevant to classify the goal as a desire.

Table 6.1 summarizes the proposed goal taxonomy and the examples as identified in the case study.

Table 6.1 Goal Taxonomy

Dimension	Classification	Example
Level of Abstraction	**Fundamental**	Provide medical care to patient
	Means-ends	Provide medical care in scheduled medical consultation
	Process (associated with a specific business process)	Diagnose patient's health state
	Process (partially satisfied within multiple business process)	Acquire technical skills
	Activity	Prescribe patient's treatment
Functional/Non-functional	**Functional**	Diagnose rheumatologic conditions
	Non-functional	Release patients with mild rheumatologic conditions after no more than 3 consultations
Hardgoals/Softgoals	**Hardgoal**	Diagnose patient's health state
	Softgoal	Select the most suitable treatment for patient
Scope aspect	**Restricted scope**	Approve the treatment proposed by the resident

	goal	
	Broad scope goal	Collect data for epidemiological analysis
Temporal aspect	**AS-IS goal**	Approve the treatment proposed by the resident
	Change goal	Standardize diagnosis cue sheets
	TO-BE goal	Coordinate patient care with other healthcare providers
Desire		Eliminate all uncertainty during the process of diagnosis

6.3.1.3 Consequences of the Classification of Goals for the Issue of Alignment

As we argued in section 6.3.1, the proposed goal taxonomy is intended to represent a classification for harmonizing the goal domain. This classification brings about consequences for the relation between goals and business process structures. In this section, we present the consequences of our classification for the issue of the alignment between business process and goals.

With respect to first dimension for goal classification, the **level of abstraction** of goals has a deep impact in the business processes structures that support them. In that respect, fundamental goals are not directly related with business process, instead, they are connected to means-ends goals and these, in turn, are connected with processes. The assignment of means-ends goals and process goals to process depends on the *granularity* of processes available in the organization. Means-ends goals are decomposed in a finer goal structure until they can be assigned to process goals. Finally, as denoted by the name, activity goals are connected with activities within the processes.

With respect to the second dimension (**functional/non-functional**), while functional goals specify "*what*" must be achieved, leading to the adoption of actions (activities or business processes), commonly, non-functional goals guides the implementations of functional goals in organizational environments. Therefore, non-functional goals are not directly related with business processes; rather, they serve as *guidelines* or *constraints* during the implementation of functional goals, which in turn are associated with actions. As an example, we have the functional goal Prescribe patient's treatment which is associated with a specific activity and is characterized by the non-functional goal Select the most suitable treatment for patient. This latter constrains the treatment to be the best treatment possible, but is not associated with any specific activity.

In relation to the third dimension (**hardgoal/softgoal**), the categorization of either hard or soft only refers to the specification of the goal (whether it is possible to formulate the goal with a clear-cut distinction or attainment criterion). This imprecision in the definition of the softgoal cannot reveal *a priori* the structures which will support the goal, i.e., whether the goal will be attained by an activity, business process or a set of business processes. In fact, the solutions for attaining the softgoals are defined in the course of pursuing them (LAMSWEERDE, 2001). For example, with respect to the Acquire technical skills softgoal, the physician is not capable of defining how (s)he will acquire the knowledge *a priori*, this is defined as the physician provides attendance.

In relation to the fourth dimension (**restricted/broad scope**), on one hand, since a restricted scope goal is directly related with one execution of some business process, by definition, this business process must be *specific* (and thus it is not possible to be attained by a set of business processes at the same time). On the other hand, a broad scope goal can be either achieved by one business process after it has executed for *several times* (e.g. Diagnose patient's health state goal) or by multiple business process after they have executed for several times (e.g. Acquire technical skills goal).

With respect to fifth dimension, the **temporal aspects** also highly impact business process structures. They drive the creation, modification and extinction of organizational structures (in which business processes can be included). AS-IS goals present motivations for the existence of current elements of the enterprise architecture. Change goals formulate intentions which drive the organization towards reengineering. Thus, change goals can lead to the generation of new activities or business processes. Finally, TO-BE goals state about strategies in a future organizational context. Examples of these types of goals have been provided in the previous subsection.

At last, in the sixth dimension, the **desires** play an essential role in organizational modelling since they do not cause the creation of activities (or business processes) to be adopted by agents either to promote some positive impact in the achievement of some goal or to directly materialize the goal. In other words, whether one decides to include desires in goal model, then they do not establish relations with any element of the enterprise architecture. This absence of relations can be due to a broad number of reasons, such as: agents deem not

relevant to pursue the goal when they have the opportunity, or the solution adopted to attain the goal is prohibitively costly or even due to the inexistence of actions to fulfil the goal.

6.3.2 The Alignment Phase

6.3.2.1 The Method

This phase concerns the development of a framework which establishes the relationships between goals and the elements of the enterprise architecture employed to achieve these goals through the examples found in the case study.

Before developing our framework, some important considerations must be mentioned in order to justify the solution we have proposed. Initially, we aimed at comprehending how goals are satisfied by the adoption of actions (business process) to attain them. However, as we have noticed in the course of our case study, adopting a *process-centered* view to clarify the alignment was insufficient, since goal achievement is related with a multitude of issues. For instance, the Obtain fair remuneration goal of physician is not related with a behavioral aspect of the organization, but with organizational policies for human resources. Therefore, instead of concentrating in the role enacted by business processes in achieving the corporative strategy, our focus has been directed to comprehend how the alignment is achieved taking into consideration several elements of the enterprise architecture.

A second methodological aspect while developing the framework refers to the inherent complexity for establishing relationships (with their semantics) between goals and the elements of the enterprise architecture. For example, the notion of partial satisfaction of goals and the relation among many enterprise elements simultaneously employed for the satisfaction of some goal are some of these complex aspects.

To master this complexity and inspired by previous work, we have decided to provide an ontological account for the alignment. Ontologies are the conceptual tools used for describing our organization as well as for describing how goal achievement relies on the basic building blocks which form organizations. The adoption of this solution is motivated by the fact that foundational ontologies are committed to explaining the world based on philosophical and cognitive principles which is indispensable for coping with the complexity of realistic scenarios. Therefore, our choices are grounded on these aspects, overcoming the more

traditional view which considers a business process as the only component to achieve goals. To the best of our knowledge, this is the first initiative offering foundations in terms of an ontological account for the alignment between goals and elements of an enterprise architecture.

We develop our framework through careful examination of the models produced in the case study with the aim of identifying which elements within the organizational setting are employed for achieving goals. Our proposal is to analyze how each AS-IS goal of our case study is related with each element of the enterprise architecture through some sort of satisfaction relationship. Besides enumerating these elements, we intend to understand the semantics of the relationships which they establish with goals. We must emphasize that we are not concerned with the TO-BE and change goals and the elements which might be employed for their satisfaction since the task of operationalizing goals is related with domain-specific knowledge and therefore, relies on the specialists of the domain. Hence, our work proposes an *analysis approach* for understanding how the goal domain (*problem-domain*) is satisfied by the employment of the elements of the enterprise architecture (*solution-domain*) which satisfy them; instead of a *synthesis approach* which reaches the *solution-domain* from the *problem-domain* by finding suitable operationalizations for goals.

Since we iteratively develop this framework through examples extracted from the case study, we do not claim exhaustiveness in covering all the potential relationships, although we believe that the chosen case study is rich enough to cover a large number of relationships. After identifying the aspects which enable each goal of the case study to be achieved, we have mapped the factor to its ontological category. In our example, *organizational policies* are classified as **deontic norms**, the *physician's capability* is faced as an **agent's capability** and the *physician's commitment* is mapped into a **social commitment**, created by **constitutive norms**.

6.3.2.2 What Impacts Goal Achievement?

Figure 6.6 depicts all elements we have found in the case study which impact goal fulfillment in organizations. These aspects have already been mapped to their ontological categories. The choice of categories can be accounted by the fact that the literature in organizational ontologies acknowledges these building blocks as the components which form organizations.

Moreover, we observed that the case study corroborates the considerations of the organizational ontologies with respect to the entities which are relevant for considering goal achievement within our organization as well as the relationships with these entities with goals.
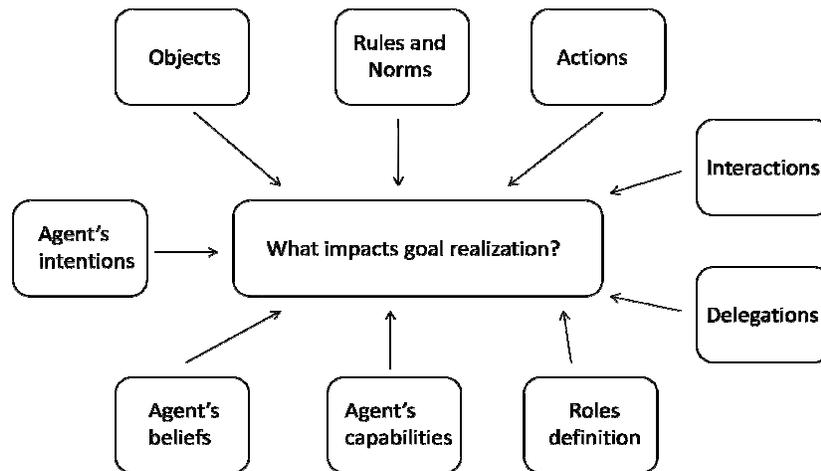
Figure 6.6 What impacts goal achievement?

In the sequel, each section is devoted to describing through examples of the case study how each of the element impacts goal achievement. In the end, we summarize the results with a table which depicts the relations between goals and the elements as well as the characterization of these relations.

6.3.2.3 Results: The Rheumatology Department Interpreted within an Ontological Point of View

Before starting our considerations about the case study, we dedicate a few words in order to describe the Unified Public Brazilian Health Service (in Portuguese *Sistema Único de Saúde* – SUS)

SUS is structured in three service levels to provide health: the primary, secondary and tertiary health services:

- The primary health service corresponds to basic health care services, being the main contact point between the user and the public health service;

- The secondary health service is composed by the services aimed at treating health problems which demand the availability of specialized professionals and technological resources;

- The tertiary health service, also denominated as high complexity service, is concerned with hospital-based health care.

The primary, secondary and tertiary health services are respectively administered by the Municipal, State and Federal Governments. The analyzed Rheumatology Department is an exception; although it is a secondary health service, it is controlled by the Federal Government (since the department is a part of a Hospital which in turn is controlled by the Federal Government) (MINISTÉRIO DA SAÚDE, 2009).

Given this, we may situate the organization which is the subject of our analysis. In chapter 4, we argued that the internal sub-organizations of an organization are those organizations that are linked by a finite chain of direct internal sub-organization relations. In our case study, we consider the Cassiano de Moraes University Hospital (HUCAM) as our organization with the Rheumatology Department being one of its internal sub-organizations. Our choice has been made on the basis of the existent institutional relationship of control between the Hospital and the Department (the Hospital controls the Department). Other sub-organizations of the Hospital are: the Dermatology Department, the Ophthalmology Department, among others.

Further, in chapter 4 we have defined external organizations as the organizations that have institutional relations with the organization under consideration but are not directly controlled by it. Taking this into account, we define the external sub-organizations as being the primary and secondary health services since the Hospital (also representing the terciary health services) has institutional relations which both, although not having the power over them (these institutional relations between the Hospital and the other health care services are established through the Rheumatology Department). Other external sub-organization is the State Health Department [19] and some of its internal sub-organizations.

---

[19] The State Health Department is the state government entity which aims at managing a particular amount of public resources with the aim of assuring health care acess to population **Fonte bibliográfica inválida especificada.**.

Figure 6.7 depicts schematically how SUS is organized in terms of its primary, secondary and tertiary health services. The curved arrows show the organizations with which the Rheumatology Department interacts with. For the sake of brevity, we omit other sub-organizations of SUS and HUCAM.
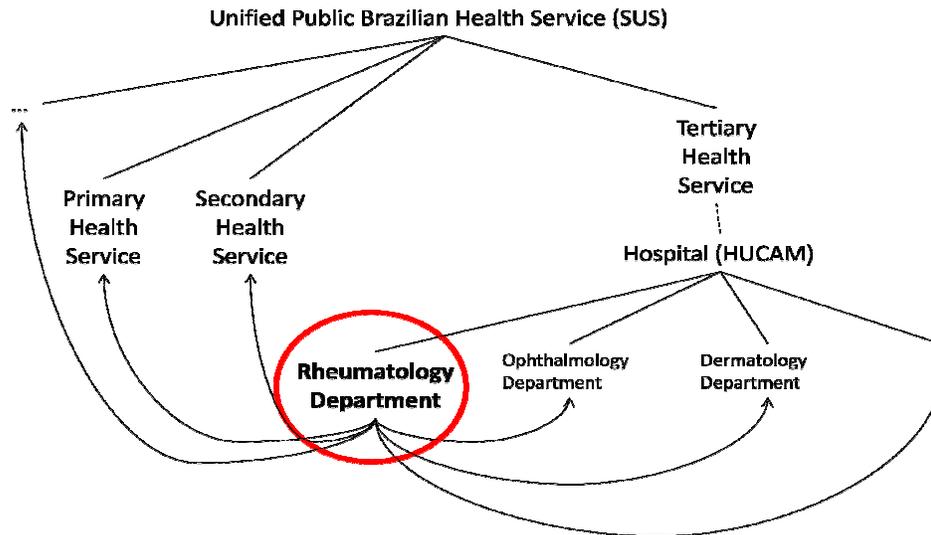
Figure 6.7 Structure of Unified Public Brazilian Health Service

Taking goals[20], the Hospital is the global organization which is responsible for refining its goals and delegating them to its different sub-organizations (including the Rheumatology Department). According to the structure of this organization, the Rheumatology Department is administered by specialists in Rheumatology who simultaneously provide medical care to population and perform administration functions.

A consequence of this particularity is the existence of a goal delegation relationship between the top organization and the department. In other words, the Hospital does not care how these goals are indeed implemented as long as they get achieved. In fact, administrators (from the Rheumatology department) are responsible for establishing the department's goals, as well as the best strategies to attain these goals.

---

[20] From this point on, with the purpose of describing the results of our case study, ther term Goal is the ontological concept introduced in section 4.4.1.

Now, we are ready to proceed to the analysis of the relations that organizations have with their goals. In each section, the examples are summarized in tables in the end of example. The tables depict the element of the enterprise architecture which relates with the goal, their corresponding relationship and the situation in the case study which exemplifies this relation. In section 6.3.2.13, the tables are joined in a *traceability matrix* (Table 6.20) with the purpose of summarizing all the relationships. Furthermore, an additional table (Table 6.19) for depicting the goal satisfaction with different intensities is provided.

6.3.2.4 Relations between Society Goals and Role Goals

In the discussion of roles presented in section 4.3, we argue that roles represent the design which specifies how individual agents must achieve goals from the organizational point of view. This section is intended to describe how the transition from the organizational goals to the roles' goals occurs and how this assignment relationship impacts in goal achievement.

Roles within the case study have been modeled based on the ontological concept of Role presented in section 4.3. The Rheumatology Department has five main roles, namely the Physician (who provides the medical care), the Resident (which is a student which has the same assignments of the physician and is supervised by him/her), the Patient, the Receptionist and the Nurse (among other secondary roles, such as the Physician of High-Cost Drug Assessment Commission). Some roles captured within the case study in fact are roles which pertain to the external organizations, such as the Physician of the primary health care service. This decision is accounted by the need of capturing how the roles depend on the external organizations to achieve their own goals.

Considering that roles specify how abstract agents must achieve society goals, roles definition comprehends the transitional step in which the organization transfers its goals to individual actors (through assignment). In the case study, these roles are very well-defined based on the capabilities required for the agents to perform them, i.e., since the Rheumatology Department is a health care organization, roles are organized in terms of the academic formation as a requirement for role playing. This definition for roles is advantageous because goal assignment is straightforward: it does not open the possibility for goals to remain without being assigned to any role since their achievement is strongly related with domain-specific knowledge. Table 6.2 depicts this relation.

In goal elicitation phase, we assumed that the department has already refined and assigned its goals to each corresponding role. With respect to the possible misalignment between the organizational assignment of goals and the adoption of goals by agents, we also assumed that the assignment/adoption issue has already been resolved, and our models are the final outcome of this decision-process. Furthermore, we also have interpreted that the *society goals* are modeled as being composed by *the sum of goals of all organizational roles* (and their goal dependencies). This fact is opposite to the idea that the organizational goals are formed by the composition of goals of roles and global goals which pertain to many individuals. When it has been necessary to depict the goals which are common to many individuals, we have opted to capture them inside the perspective of the actor who is more interested in that goal (generally, the administrators of the rheumatology department, but other agents have also been included when necessary).

Therefore, the joint satisfaction of goals of roles implies in satisfying the society goals. Conversely, not satisfying a goal of some role also impacts the achievement of the overall organizational goals. As an example of this, consider in the scope of the *Select patients to be admitted by the department* business process, the Increase the efficiency of the process of selection of patients goal. This is a change goal according to the classification proposed in section 6.3.1.2 and consequently, it is not fulfilled in the current situation. This non-achievement of the goal of one single role impacts in a hazardous way the entire organization to reach its goals (since an inefficient business process of admission causes a delay for the patient to receive proper treatment). Further, the provision of treatment constitutes in one of the fundamental goals of the Department (Provide medical care to patient goal).

Table 6.2 Relation of Society Goals and Role Goals

Element	Relationships	Example
Roles	Organizational goals must be assigned to roles (roles must be defined)	Roles are defined through academic formation (capability-definition).

Language support: In the scope of the i*/Tropos modeling language, we adopt the concept of Role for modeling the ontological concept of roles of our case study. In section 3.2.1, we provide the description of three other concepts (i.e. actor, position and agent). However, as discussed in (GUIZZARDI, 2006), the original i*/Tropos language does not provide a clear

semantic distinction between these four concepts, making them confuse and, at times, unnecessary.

Goals of the roles of the case study have been modeled into the perpective of the actor who holds that goal (in the Goal Diagrams as exposed in section 3.2.3). Nevertheless, representing society goals is not allowed in the language, since Tropos does not possess any construct to represent goals assigned to many agents. To tackle this deficiency, we have opted for modeling the society goals as the aggregation of the roles' goals.

With respect to the ARIS framework, we have used the concept of Position to model the the ontological concept of role. This decision has been made on the basis of the work developed in (ALMEIDA *et al.*, 2010). In this paper, the authors map the concept of Position (from ARIS) to the concept of (social) Role (ontological concept).

6.3.2.5 Relations between Role Goals and Agents' Goals

After the assignment of goals from the organizational perspective to roles, for goals to be achieved, it is necessary that the agents who occupy the roles assume their goals (from this point on, Agent is the concept described in section 4.4). Therefore, this is the way how the organization relies on particular agents to achieve its own goals: through an indirect assignment/adoption relationship from organizational goals to roles and then, from the adoption by agents of the goals of their roles.

In our case study, we assume that the agent's goals are compliant with the organizational goals (although the way how they decide to attain the goal can diverge). This can be accounted by the fact that the professionals assume the goals of roles in their admission in the organization (this admission is regulated by norms and rules exposed in section 6.3.2.12). After the adoption of role goals, agents may suggest additional goals during their role playing which were not directly originated from the organizational perspective, but which are aligned to to those prescribed by the organization.

The first factor (maybe the most important one) to consider when dealing with the adoption of organizational goals by agents is the fact that the instantiation of the organization through the signing of a contract is a sort of goal delegation of the organization (*delegator*) to the

agents (*delegatee*) who accept to join this organization. In (DIGNUM, 2004), the author argues that agents assume the roles (and consequently its goals) whose objectives somehow contribute to their own goals, trying to achieve an as optimal as possible solution for their own goals. In the Rheumatology department, for example, the agents (physicians, residents, receptionists and so forth) accept the goal delegation of the department in exchange of fulfilling its own goals; e.g., the Obtain fair remuneration for the exercise of professional activity goal (Physician).

Furthermore, another important issue to take into account when considering the relation between roles and goals is the compliance of agents' goals and the goals prescribed by the organization. We have assumed this compliance in our experience motivated by the observation that actors are fully committed with the organizational goals. I.e., when admitted in the Rheumatology Department, the agents assume the organizational goals as being their own because they believe that these professionals play an essential role in promoting the health and wellness of population, especially those who belong to the tertiary sector (hospitals) (the issue of adoption of organizational goals based on beliefs is further explained in section 6.3.2.7). The third sector is even more strategic than the primary and secondary sectors in the sense that they deal with high complexity treatments. To adopt the organizational goals (and evidently to pursue these goals) consequently, as believed by these professionals, can positively contribute to directly save human lives (this topic of beliefs is further explored in section 6.3.2.7). These relations are depicted below (Table 6.3):

Table 6.3 First Relation between Role Goals and Agent's Goals

Element	Relationships	Example
Agents' Goals	Organizational goals are assigned to roles. Agents must assume goals of roles.	Agents assume roles whose objectives somehow contribute to its own goals. This assumption is a kind of delegation from the Rheumatology Department to the agents. **Delegator:** Rheumatology Department **Delegatee:** Health professionals from department Agents assume goals of roles due to a belief. This assumption is a kind of social commitment. **Belief:** Health professionals believe that they play an essential role in promoting the health and wellness of population.

Since agents are relatively free within the organizational setting, a discussion which naturally arises with respect to the assignment of the organizational goals is the limits of which goals are imposed by the organization and which goals are suggested by the agents in enacting their roles. In our case, goals are suggested by agents in three situations: (i) the first one occurs

when the goals prescribed by the organization are high-level specifications and agents need to refine them in terms of sub-goals and; (ii) the second case refers to situations when the agents suggest additional goals (in relation the ones prescribed by the organization) whose achievement represent positive contributions for the achievement of the existent ones and (iii) the third situation refers to the suggestion of additional goals based on beliefs.

An example of the first situation concerns the following goals (suggested by the receptionist): Manage the medical attendance on behalf of patients, Manage the medical attendance on behalf of internal patients and Manage the medical attendance on behalf of external patients. The management of the patient's access to the service is prescribed by the organization to the receptionist who, in turn, refines this goal (and thus creates new sub-goals) on the basis of the guidelines prescribed by physicians (see the section 6.3.2.12). The second case of suggestion of additional goals in relation to those prescribed by the organization occurs when agents suggest goals whose realization contributes to the realization of the antecedent goals. This situation is exemplified by the Have more physical space for selecting patients to be admitted by the department goal (from receptionist). The achievement of this goal contributes positively to the Manage the medical attendance on behalf of patients goal since more physical space brings about better work conditions for the receptionists.

The third case in which agents suggest additional goals to the organization is based on beliefs. Here, we have opted for describing the example in section 6.3.2.7 which refines the relation between goals and beliefs. It is important to mention that in this case, as in the second case, the attainment of the suggested goals represents a positive contribution to the satisfaction of the existent goals. We have separated this example from the second case with the purpose of emphasizing the role of beliefs within the organizational environment. Table 6.4 depicts this second relation between role goals and agent's goals.

We also assumed that some personal goals of agents (suggested goals) are incorporated into the role perspective. Agents have a high amount of goals in the course of their professional activity within the organization since the actors of our case study are human agents. Obviously, the incorporation of these additional goals has been guided by their relevance to the organization. Moreover, we have modeled only the goals which present some sort of impact in the goals of the roles. These impacts can be positive contributions to the existing

goals, refinement of high-level goals and goals whose satisfaction contributes to the personal goals of agents (for instance, increase the level of personal satisfaction in participating in the organization as in Obtain fair remuneration for the exercise of professional activity goal).

In the case of a potential misalignment between agents' goals and roles' goals, norms appear as a mechanism of correction. In that respect, norms are originated from the top organization (Hospital), from the Department itself and even from external organizations, such as the National Medical Board[21].

Table 6.4 Second Relation between Role Goals and Agent's Goals

Element	Relationships		Example
Agent's Goals	Agents suggest additional goals (in relation to those goals prescribed by the organization)	Agents refine high-level goals	**Goal prescribed by the organization (Role Goal):** Manage the medical attendance on behalf of patients goal (from the receptionist) **Goals suggested by the agent:** Manage the medical attendance on behalf of internal patients goal and Manage the medical attendance on behalf of external patients goal
		Agents suggest additional goals whose achievement represents positive contribution for the achievement of the existent ones	**Goal prescribed by the organization (Role Goal):** Manage the medical attendance on behalf of patients goal (from receptionist) **Goal suggested by the agent:** Have more physical space for selecting patients to be admitted by the department goal (from receptionist)
		Agents suggest additional goals based on beliefs.	**Please, refer to section 6.3.2.7, Table 6.9**

6.3.2.6 Relations between Goals and Plans

In the previous section, we argued that in the process of assuming goals of their roles, agents may suggest additional goals. After the whole process of deciding which goals each agent is responsible to pursue, agents thus have their respective goals. Therefore, agents must find suitable strategies to attain these goals. This section is aimed at describing the characteristics

---

[21] The National Medical Board is an agency which licenses and disciplines physicians and surgeons in Brazil. The Board accredits professional through the concession of licenses/professional registers for the professionals after the application (and approval) of an exam. The existence of this organization aims at restricting the legal authority of the medical exercise only to the physicians that are trained and qualified by accredited medical schools.

of the relations between goals and plans. The concept of plans/actions used to describe these associations is the one presented in section 4.5.

We first start our considerations with the vision that the mere association with goals and plans are not sufficient to achieve goals (which means that goals can be partially satisfied depending on a number of issues related to plan selection and execution). After, we argue that in this process of finding strategies to achieve goals (i.e. the process of finding strategies which maximize the level of goal satisfaction), agents are influenced by their beliefs about the world as well as their constraints. Furthermore, in some cases, another important concern to be considered the granularity of actions to fulfill goals. Finally, this section ends with some remarks about the cardinality of the association of goals and actions.

The association between goals and plans is the most direct relationship between goals and all the remaining enterprise elements which are relevant for considering goal satisfaction. Actions are performed by agents with the purpose of achieving goals. However, even when an intention to achieve some goal and plans are associated, this association seems not to be sufficient for goals to be completely satisfied. With that respect, there are two situations in which goals can be satisfied within acceptable limits: in the first one, the chosen plan is not the best one for achieving the goal, i.e., another plan could be suitable or even better; in the second situation, the chosen plan is the only alternative to achieve the goal (or the most suitable alternative to achieve the goal if it is possible to determine in the moment of the choice), although the goal is not completely achieved (or not achieved) due to uncontrollable factors, such as environmental constraints.

The first situation in which goals can be satisfied within acceptable limits refers to the case in which the chosen plan may not be the most appropriate for achieving the goal, i.e., possibly there is a plan which better achieves the goal. Therefore, before performing actions, agents have to select among different alternatives based on constraints imposed on them (what is denominated as planning process). This first situation is exemplified with some goals of the physician in the scope of the business process *Realize procedures.* In this process, the confirmation of the diagnosis can be established through two alternatives procedures, namely, via biopsy or salivary flux exam (and the two alternatives indeed achieve the goal). Then, the Confirm clinical suspect of Sjögren syndrome goal is refined into two alternatives goals, namely, Confirm clinical suspect of Sjögren syndrome via salivary flow exam goal and

Confirm clinical suspect of Sjögren syndrome through biopsy goal. The biopsy of the salivary gland is the most effective exam which can be chosen to achieve the goal since it confirms the clinical suspect of the condition (Sjögren syndrome) with one hundred percent of certainty. In contrast, the salivary flow exam only provides some insights for the physician. Nevertheless, the first exam applied to verify diagnosis is always the salivary flux exam (the method which "worst" achieve the goal). This is due to the complexity, risk and knowledge required in a biopsy exam. In other words, the biopsy exam is the best plan to be applied since it (completely) satisfies the goal (in opposition to the salivary flow exam which satisfies the goal within certain limits), but it is only applied when the first solution has failed in achieving its goal.

In the second situation, we consider the case in which the mere execution of a plan does not guarantee (total) goal satisfaction. This example refers to the situation in which although the goal is associated with a plan, it is not completely achieved due to intrinsic characteristics of that goal, such as uncontrollable factors. We have extracted our examples from the *Conduct pulsotherapy* business process. This business process refers to the intravenous administration of high complexity drugs (intravenous drug administration is also designated as pulsotherapy) in internal patients (only in those patients). The administration of drugs requires that the patient presents a stable clinical health state before administration as well as in the course of administration. We take the Stabilize the patient's clinical health state for drug administration goal and Avoid the occurrence of complications during drug administration goal of the *Conduct pulsotherapy* business process to exemplify the limited goal satisfaction. The chosen plan for achieving both goals relies on the technical knowledge from the physician. For example, for the physician to stabilize the patient's health state, he/she performs some preemptive actions, e.g. to administrate a drug for controlling the blood pressure. Nevertheless, the successful achievement of the goal is not related only with these preemptive actions since it depends on factors that are outside the control of the physician, in this case, it depends on the response of the patient to these preemptive actions. Even if the physician adopts all the relevant solutions for achieving the goal, it may not be attained or may be attained partially. In the second case, the stabilization of the patient's health state positively contributes to avoid the occurrence of complications, although it is totally out of control of the physician the occurrence of these complications.

In other situations, the mere association of goals with plans is sufficient to achieve the goal. Consider the Evaluate the presence of contraindications for drug administration goal (from physician) in the same business process. The mere act of investigating the existence of contraindications by the physician achieves the goal in its totality (namely, the execution of the following activities: *Interrogate the patient about impediments for drug administration* and *Verify the existence of impediments for drug administration*). Table 6.5 summarizes the first association between goals and plans.

Table 6.5 First Relation between Goals and Plans

Element	Relationships		Example
Actions and Plans	Agent's intentions lead the adoption of plans based on beliefs and constraints (goals can be either partially or totally satisfied)	The chosen plan is not the best one for achieving the goal (partial satisfaction)	**Agent's Goal:** Confirm clinical suspect of Sjögren syndrome goal. **Plans:** biopsy of the salivary gland (the best one) and salivary flow exam (the worst one). The first is adopted due to complexity and monetary constraints.
		The chosen plan is the only alternative to achieve the goal, but the goal is not completely achieved due to uncontrollable factors (partial satisfaction)	**Goal:** Stabilize the patient's clinical health state for drug administration goal **Plan:** administrate a drug for controlling the blood pressure (contributes positively) **Goal:** Avoid the occurrence of complications during the drug administration goal **Plan:** administrate a drug for controlling the blood pressure (contributes positively).
		The chosen plan is the best one for achieving the goal (total satisfaction)	**Goal:** Evaluate the presence of contraindications for drug administration goal **Plans:** Interrogate the patient about impediments for drug administration and Verify the existence of impediments for drug administration.

In the previous examples about the association with goals and plans, we argued that as agents adopt organizational goals, intentions drive them towards finding rationales and strategies (actions) for reaching their goals either in isolation or with the participation of other agents (through interactions or delegations). This process of finding suitable actions to achieve goals is based on beliefs about the world and constraints (sometimes prescribed as norms or even environmental constraints) which the agent is subject to.

The example of this process of selection is extracted from the *High-Cost Drug Assessment Commission*) business process. As we have exposed in chapter 4, besides providing medical care to the population, an important service provided to the population is the *High-Cost Drug Assessment Commission*. This commission is composed by some physicians who pertain to

the department and are responsible for assessing the need of administration of high cost drugs in patients. The high cost drug is financed by a state government entity denominated as State Health Department and the aim of the assessment is select the patients who indeed the high need cost drug to be financed by it. Since the cost of the drug is prohibitive, it cannot be indiscriminately granted to all patients with rheumatologic conditions; but only for those patients who the cost-benefit is acceptable.

The assessment of the commission is based on the scientific evidences about the need of the drug for controlling the condition in either internal or external patients to the department. While internal patients are those who receive outpatient medical care in the department, the external ones are those who receive outpatient medical care in particular clinics or in the secondary service.

Along the process (there is one business process corresponding to the assessment of a high cost drug), the commission interacts with the external prescribers physicians (physicians from the particular clinics or secondary service who indicates the drug), the internal prescribers physicians (physicians who pertain to the department, but does compose the commission), the patient and the State Health Department.

This interaction between the department and the external entities correspond to the assessment of high cost drug provided by the commission to patients. External prescribers believe that physicians from commission favour internal patients. Physicians from commission in turn argue that although this belief is unjustified, they adopt clinical protocols in their assessment as a means of having a common basis in which external prescribers and commission can be grounded their analysis. This example highlights that physicians from commission have a (general) goal of assessing the need of high cost drug for patients, but adopt a particular strategy for achieving the goal based on beliefs of other agents (external prescribers). This particular strategy corresponds to the adoption of clinical protocols in their assessment (Assess the indication of high cost drug based on clinical protocols goal). Table 6.6 depicts how goals and plans are related.

Table 6.6 Second Relation between Goals and Plans

Element	Relationships	Example
Actions and Plans	Organizational goals are achieved by plans.	**Goal:** Assess the indication of high cost drug goal **Plan:** *Assess the indication of high cost drug based on clinical protocols*

	Beliefs conduct the choice of alternative plans to fulfil some goal	**Agent:** Physicians from commission of high cost drug **Agent's belief:** the commission believes that external prescribers believe that the commission favours internal patients.

Other important distinction (which is orthogonal to the distinction previously mentioned) regarding the association between goals and plans is the granularity of the chosen plans to achieve goals. The concept of actions and plans adopted here is presented in section 4.5. In that section, it is argued that actions have different granularities, that is, actions can be either atomic or complex. In this section, we have opted to use interchangeably the terms "complex action", "plans" and "business process". Therefore, the concepts of "execution of some business process", "execution of some complex action" and "plan execution" are also used interchangeably to denote that one execution of some specific business process.

We have noticed that for goals to be achieved, they can be associated with the execution of one atomic action, with the execution of some business process (one plan execution) or even with multiple executions of the same business process (multiple plan executions). Observe that, according to our goal taxonomy provided in section 6.3.1.2 some of the goals suggested within the taxonomy are achieved by the type of actions above mentioned. Namely, by definition, activity goals are achieved through the execution of atomic action, restricted scope goals are achieved through the execution of some plan and broad scope goals are achieved through multiple executions the same plan. Examples of these categories can be obtained in section 6.3.1.2. Other examples in the context of the *Infuse High-Cost Drug* business process for the goals above mentioned are: Assess the clinical patient's health state in the moment of the administration of the drug goal (activity goal), Prescribe high cost drug ((process) restricted scope goal) and Induce the remission of the condition ((process) broad scope goal) all from physician's perspective.

The first goal (Assess the clinical patient's health state in the moment of the administration of the drug) is achieved when the physician interrogates the patient with the aim of verifying the existence of impediments for the drug administration (the execution of the *Verify the existence of impediments for the drug administration* activity depicted in its correspondent business process model in the physician swimlane). The second goal (Prescribe high cost drug) is achieved by one execution of its respective business process (*Infuse High-Cost Drug* business process) since the main goal of this process is to prescribe

the high cost drug for each patient through the elaboration of a medical receipt in the moment of the drug administration (each process execution is assigned to each patient). Several activities (such as *Verify the existence of impediments for drug administration* activity) contribute to the achievement of this goal, which justifies its classification as a (process) restricted scope goal. Finally, the administration of the high cost drug by the physician has a long-term purpose to reduce the manifestations of the condition as well as to improve the patient's well-being. Multiple administrations of the drug are able to promote the remission of the condition and therefore, Induce the remission of the condition goal has been classified as a (process) broad scope goal since it requires multiple executions of the same business process to be reached. Table 6.7 shows how different granularities of actions impact in goal achievement.

Table 6.7 Third Relation between Goals and Plans

Element	Relationships	Example
Actions and Plans	The activity execution satisfies the goal	**(Activity) Goal:** Assess the clinical patient's health state in the moment of the administration of the drug goal **Activity:** *Verify the existence of impediments for the drug administration*
	One execution of some business process satisfies the (restricted scope) goal	**(Restricted scope) Goal:** Prescribe high cost drug goal **Business process:** one execution of the *Infuse High-Cost Drug* business process
	Multiple executions of some business process satisfies the (broad scope) goal	**(Broad scope) Goal:** Induce the remission of the condition goal **Business process:** multiple executions of the *Infuse High-Cost Drug* business process

Finally, a third orthogonal distinction refers to a cardinality of the relation of association between goals and the execution of actions (in this case, actions can be either atomic actions or one business process (one complex action) or several business processes (several complex actions)). In other words, one goal may be associated with the execution of multiple actions; conversely, multiple goals may be associated with the execution of one action. Finally, multiple goals may be associated with the execution of multiple actions.

Concerning the first situation (one goal to multiple actions execution), the execution of different actions in several business processes of our case study represents an (indirect) positive contribution to the achievement of the Employ the organizational resources in a rational manner goal. Some of these (atomic) actions are: the *Assess the need of*

administration of high cost drug (in the scope of *High-Cost Drug Assessment Commission* business process), *Administer drug in the patient* (in the scope of *Infuse High-Cost Drug* business process and *Conduct pulsotherapy* business process), *Realize infiltration of drug in the patient's articulations* and *Realize biopsy of salivary gland* (both in the scope of *Realize Procedures* business process). If these activities are executed by experienced agents (in the two former activities, by experienced nurses and in the two latter by experienced physicians), this avoids the waste of organizational resources (positively contributing to the Avoid the waste of resources goal in the scope of each of the aforementioned business processes). A positive contribution to this goal entails a positive contribution to the Employ the organizational resources in a rational manner goal.

In the second situation (in which we have one action to multiple goals), the execution of the same set of actions in different business process (namely, *Investigates the patient's clinical*, *personal* and *family history* and *performs physical examination* activities) positively contributes to the satisfaction of different goals depending on the business processes in which these activities occur. In other words, the set of activities have different goals depending on the context in which they are executed. E.g., in the scope of *Diagnose patient's health state* business process, the execution of these activities aims at providing information for the physician to diagnose the patient's health state (Diagnose patient's health state goal), whereas in the scope of *High-Cost Drug Assessment Commission* business process, they are intended to provide information for the physician evaluate the need of a high cost drug by the patient (Assess the indication of high cost drug based on clinical protocols goal). Table 6.8 shows the forth relation between goals and plans.

Table 6.8 Fourth Relation between Goals and Plans

Element	Relationship	Example
Actions and Plans	The execution of very different actions (actions can be activities or one business process or several business processes) satisfies a specific goal (one goal to one or more executions of multiple actions)	**Goal:** Employ the organizational resources in a rational manner goal **Activities:** *Assess the need of administration of high cost drug* (in the scope of High cost drug assessment business process), *Administer drug in the patient* (in the scope of *Infuse High-Cost Drug* business process and Conduct pulsotherapy), *Realize infiltration of drug in the patient's articulations* and *Realize biopsy of salivary gland* (both in the scope of Realize Procedures)
	The execution of a specific action (actions can be activities or one	**Goal:** Assess the indication of high cost drug based on clinical protocols goal (in the scope

	business process or several business processes) simulteneously satifies several goals (multiple goals to one or more executions of one action)	of High cost drug assessment business process) **Goal:** Diagnose patient's health state goal (in the scope of Diagnose patient's health state business process) **Activities:** *Investigates the patient's clinical, personal and family history* and *performs physical examination* (the execution of this set of activities represents a positive contribution for the goal satisfaction)

Language support: The Tropos language allows to associate the concepts of (soft)goals to the plans (modeled as tasks) which achieve these goals in the Actor Diagrams. However, due to the limited support for modeling business process in the framework, the ARIS framework has been adopted as a solution. Although the relation between goals and the other entities in enterprises has been established in the case study, no graphical representation has been used to link goals from Tropos models with the business processes from ARIS.

With respect to the ARIS language, the ontological concept of actions has been modeled as functions since these functions are performed with the aim of producing some good or service (according to section 2.4.2). Furthermore, the association with goals and actions in the framework, as argued in section 2.4.2, is made in the functional view. However, due to the limited ability of capturing the relationships between business process and goals, we have opted for integrating ARIS and Tropos.

6.3.2.7 Relations between Goals and Beliefs

An interesting result obtained from our case study is the important role that *beliefs* enact in organizational settings. The ontological concept of Belief (explored in section 4.4.2) guides the discussion of how beliefs contribute to guide goal-pursuit. Basically, this discussion emphasizes aspects which have previously presented in the adoption of organizational goals by agents (Table 6.3 in section 6.3.2.5), the suggestion of additional goals by agents during their role-playing (Table 6.4 in section 6.3.2.5) as well as in the decision-process of selecting alternative strategies to achieve goals (Table 6.6 in section 6.3.2.6).

The first aspect concerns the adoption of organizational goals by agents based on beliefs that they hold about the world. In the discussion of roles (Table 6.3 of section 6.3.2.5), we argued that agents adopt the organizational goals based on the belief that the service provided by the professionals of the department is essential for society. In this case, beliefs are fundamental

for the organization to successfully deliver its services since it leads to the adoption of its goals by agents. Otherwise, even if the department would have adequately assigned its goals to roles, the organization would fail to provide its services since agents would not concerned about pursuing them.

Another situation in which beliefs impact organizational goals refers to the derivation of intentions from beliefs. As exposed in section 4.4.2, intentions are indirectly originated from beliefs by mechanisms of mental processing realized by agents. Although Ferrario et. al.'s proposal defines intentions as historically (indirect) dependent entities on beliefs, the authors do not explore the reasons which actually lead to this derivation (since there is the possibility of a belief never becoming an intention), nor the mechanisms through which this is achieved. Although discussing these mechanisms is outside the scope of our text, some results of our case study provided us insights about the reasons which lead from beliefs to intentions.

As we have noticed, after agents have adopted the goals of their roles, a belief shapes the strength of the motivation for the agents to suggest additional goals in relation to those prescribed by the organization (previously discussed in section 6.3.2.5, Table 6.4). For explaining our considerations about the derivation of intentions from beliefs, regard the following situation: the physicians' internal belief states that physicians play an essential role in promoting the health and wellness of population (especially those who belong to the third sector). Now, suppose that the physicians have adopted the following organizational goals due to this belief: Provide medical care to patient goal and Diagnose patient`s health state goal.

Notice that the physicians have these goals assigned by the organization, but their internal belief of providing the best treatment (not saving resources, if they deemed necessary) can lead them to elaborate additional goals which are related (or not) with the goals prescribed by the organization. In our context, these additional goals are: Minimize patient's physical suffering and symptoms goal and Guarantee patient well-being goal. While the goals assigned by the organization concerns about the service that must be provided to patients, these additional goals refer to the quality of this provision. Table 6.9 sums up the discussion of the relation between role goals and agent's goals based on beliefs.

Table 6.9 Second Relation between Role Goals and Agent's Goals (with the addition of Beliefs)

Element	Relationships		Example
Agents' Goals	Agents suggest additional goals (in relation to those goals prescribed by the organization)	Agents suggest additional goals based on beliefs. The Agent's beliefs shapes the strength to find suitable plans	A belief drives the suggestion of additional goals (and adoption of suitable strategies) to achieve the goal of providing the best possible treatment (prescribed by the organization). **Goal prescribed by the organization:** Provide medical care to patient goal **Goal suggested by the agent (due to a internal belief):** Minimize patient's physical suffering and symptoms goal and Guarantee patient well-being goal **Belief:** Health professionals believe that they play an essential role in promoting the health and wellness of population.

Summing up, this example highlights that the stronger a belief ("we have a moral mission of providing health and wellness for population") is grounded in agent's mind, the higher is the probability for this belief to influence an intention and therefore, the agent becomes more motivated to find suitable strategies for reaching this goal (i.e., to adopt the goal). A last remark about this belief refers to the fact that differently from other organizations, to provide the best service is not solely related with the need of increasing the organizational reputation in the customer's perception, but it is also motivated by a moral commitment of the agents.

The third case in which is relevant to consider the role of beliefs within the organizational environment refers to choice of alternative strategies (actions to achieve goals) based on beliefs. This situation is further explained in Table 6.6 in section 6.3.2.6.

6.3.2.8 Relations between Goals and Interactions

Essentially, interactions present the same relation with goals as actions; the only difference is that while one agent performs actions with the aim of satisfying some goal, in interactions, collective agents share the responsibility of instantiating plans. This section is aimed at describing how agents engage in collective actions with the purpose of pursuing goals. The ontological concept of Interactions used here is presented in section 4.6.

Interactions are a crucial aspect for achieving common/emergent goals within the Rheumatology Department. As we have noticed, in a general sense, interactions among agents who are internal to the department (such as physicians, nurses, receptionists and residents) are very well-established based on the obligations, rights and duties from each role.

Moreover, among the agents who enact the roles, there is a general agreement that agents have the "moral mission" of providing the best service to population (informally speaking, agents' expectations are "inline" with the behaviour prescribed by their respective roles) and therefore, interactions within the agents in department are governed by this principle (including the most important relation of department, namely, the relation between physicians and patients). Relations with other Hospital Departments, such as the Hospital Laboratory and Dermatology Department are also well-established, possibly by the fact that these sub-organizations are under the control of a central authority (Hospital).

Within the department, we also have other many examples of goals which require interactions to be attained. Good examples of goals are the Report symptoms and Acquire technical skills goal dependency relations between the patient and the physician, respectively. These goals require an interaction between these both agents (physician and patient) in order to be achieved. Interestingly, while the Report symptoms goal is aimed by physician and patient who jointly perform an activity to achieve it (presenting a notion of shared goal), in the Acquire technical skills goal, the physician depends on the patient to achieve this, even if the latter is unaware of this need.

Another aspect of the establishment of interactions is motivated by the issue that sometimes agents cannot find solutions separately for achieving their goals due to capabilities and resources constraints. In the case study, sometimes Rheumatologists are not able to diagnose the condition by themselves (Help in the differential diagnosis goal dependency relation from rheumatologist towards a specialist from other department) since there are symptoms and other evidences which they cannot interpret (these evidences are outside of his/her field of competence). To overcome this issue, Rheumatologists must interact with specialists from other areas such as dermatologists and ophthalmologists in order to clarify further details and thus, jointly establish the diagnosis of the condition. It is also from the interest of the other specialists to diagnose the condition since symptoms and complications arising from rheumatologic conditions impacts the patient's health state in his/her field of competence.

Observe that when the Rheumatologist cannot access the specialists, the Obtain access to specialists in areas related to rheumatology goal cannot be fulfilled and the diagnosis cannot be either established or is established, but not in a feasible time.

Differently, relationships with the external services, for instance, the relationships between the department and the primary/secondary health services, are problematic. In this case, the problems associated with these relations are due to fact that the organizational polices implemented by the primary/secondary health services are different from the policies implemented by the Rheumatology Department.

In the former relationship, physicians (from the Rheumatology Department) are interested in the (re)absorption of patients by the primary and secondary health services after the patients have received health care in the department (in the cases which the conditions are not too serious and patients have to be followed in the primary/secondary service). Thus, the satisfaction of the Reabsorb patients goal who are discharged from the department goal is associated with the actions executed by the Rheumatology department as well as the actions executed by the primary/secondary health services. However, the problem in this relation is that this goal is not completely achieved currently. The reason is that, although the patient discharged from the department is indeed absorbed in the primary/secondary services, after some time, commonly, he/she has to return to the department due to a worsening in his/her health state. This worsening can be explained by the failure of these health services to offer the proper treatment. The most interesting aspect from this deficiency is that no period follow-up is performed due to an organizational norm which states that "immediately after a consultation, it is not allowed to schedule the next consultation". This norm introduces difficulties in periodic follow-up which may lead to worsening the patient's health state and consequently, leading to the reintroduction of the patient in the Rheumatology department.

Observe that the failure to satisfy this (common) goal (Reabsorb patients who are discharged from the department goal) negatively contributes to the satisfaction of the Provide health and wellness for population goal. This goal is a highly abstract goal from the whole health care system (SUS) that is not depicted in any model, since we focused on a small organization within this system, not capturing highly abstract goals from the whole system. Table 6.10 relates goals and interactions between the organizational agents to achieve goals.

Table 6.10 Relation between Goals and Interactions

Element	Relationships	Example
Interactions	(internal) Interactions must be established to achieve the goal	**Goal:** Report symptoms goal and Acquire technical skills goal

		Agents who interact: Patient and Physician
	(external) Interactions must be established to achieve the goal	**Goal:** Reabsorb patients who are discharged from the department goal
		Agents who interact: Rheumatology Department and Primary/Secondary health services
	Interactions must be established to achieve the goal due to complementary capabilities of agents	**Goal:** Help in the differential diagnosis (dependency relation)
		Agents who interact: Rheumatologist and Specialist from other department

Language support: The Tropos language offer the concept of dependency in actor diagrams in order to capture interactions (dependencies) among actors, although the semantics of this concept is slightly ambiguous in the language; it can be interchangeably used for capturing relationships of dependency and delegation[22]. In fact, along the case study, we have been constrained by this aspect of the language; and interactions and delegations have been modeled using the same concept of the Tropos language.

6.3.2.9 Relations between Goals and Delegations

Delegations determine which agents will pursue goals, i.e., since goals depend on agents to instantiate plans to fulfill them, the agent who possess the goal can decide to delegate this goal to other agents, based on some factors, such as the availability of resources, expertise or rights and obligations. Section 4.7 presents the ontological concept of Delegation to be used in this section.

Delegations within the case study are institutional accounted by the fact that the service is not hierarchically structured. The health professionals (physicians, nurses, residents) join the public service and when they come into the organization, they commit in providing health services to the population, although there is no hierarchy structure among these professionals. Differently, receptionists are not employed via the public service; instead, they join a particular firm contracted by the Hospital. Receptionists are also not hierarchically subordinated to the professionals employed via Hospital. This organization structure entails that no authority relations are established among the agents in the organization and thus, goal/plan delegations by command are not made. Roles are very well-defined based on capabilities and consequently, agents know in advance which goals they have to assume to be

---

[22] For a deeper discussion about the ontological distinction between the concepts of delegation and dependency as well as a proposal for disambiguating the concept of dependency in the Tropos language, please refer to (Guizzardi, et al., 2007).

pursued (through a delegation relationship), without being necessary a direct agreement among them.

The design of the goals of the department and their implementation are examples of an open delegation from the Hospital to the Rheumatology Department. This delegation is classified as open since it relies on administrators to deliberate how goals must be implemented based on his/her competencies. In this case, the top organization does not possess the required knowledge to determinate the department goals' and the delegation can be seen as fruitful, since the delegation enables not only the definition of the goals as well as solutions to attain them.

Although goals are delegated through an institutional relationship, sometimes, physicians dictate rules which specify the way to how achieve them. For example, physicians depend on receptionists to manage the medical attendance on behalf of patients (Manage the medical attendance on behalf of patients goal). This management is not imposed by physicians through a command, but institutionally encoded in the specification of the receptionist role. Although the goal is institutionally delegated, the physician prescribes to the receptionist the criterion (rules) for granting access to patients.

The most important example of the delegation concept in the case study is the goal delegation of the rheumatologist towards the resident in providing attendance for patients. In most of cases (but not in all cases), the medical consultation is not directly executed by the rheumatologist, but by the resident. This is captured by the (open) dependency relationship Treat patients between the rheumatologist and resident. The main aim of this delegation is to open up the opportunity for the resident in applying his/her theoretical knowledge in practical cases (this kind of experience is formally required by laws for the resident to be acknowledged as rheumatologist). Furthermore, this practice assures efficency in attending all patients in the department, since while one rheumatologist attend a patient, other four residents also attend patients. In counterpart, the resident delegates to the rheumatologist the responsibility of validating the medical diagnosis and treatment proposed by the resident, i. e., the rheumatologist is the legal responsible for the treatment. In this case, the advantages of this schema is twofold: first, it enables the resident to keep contact with the professional activity in the real world (contribution to the satisfaction of other organzational goals, namely the To be approved as specialist goal of the resident) and it enables to increase the efficiency

in attendances with no penalty to the quality of the service provided since the diagnosis is supervised by the rheumatologist. Table 6.11 depicts the relation between goals and delegations.

Table 6.11 Relation between Goals and Delegations

Element	Relationships	Example
Delegations	Delegations determine which agents will pursue goals	**Goal:** Treat patients (close delegation) **Delegator:** Physician **Delegatee:** Resident **Goal:** The design of the goals of the department and their implementation are examples of an open delegation from the Hospital to the Rheumatology Department. **Delegator:** Hospital **Delegatee:** Rheumatology Department

Language support: Delegations within the case study have been modeled as Tropos dependencies in actor diagrams, as exposed in the previous section (section 6.3.2.9).

6.3.2.10 Relations between Goals and Capabilities

As we intend to demonstrate, capabilities have shown to be a very important and recurring issue in the case study since the medical domain is strongly based on knowledge. In a general sense, the satisfaction of the majority of goals within the department rely on the knowledge about the medical domain (since they depend on the agents with knowledge in this domain in order to propose solutions for attaining them), including even the own design of the goals of the department as well as the management of its resources. This section explores how agents' capabilities influence in goals satisfaction. The ontological concept of Capability as used here is described in section 4.4.3.

Some goals which require roles with specific knowledge are: Diagnose patient`s health state goal and Diagnose rheumatologic conditions. These goals require agents with knowledge in medicine (rheumatologists) to perform business processes to fulfill them. It is also important to stress out that the higher the physician's knowledge and experience, the higher the level of satisfaction of the goal. In other words, a diagnosis is reached faster when performed by an experienced physician. Table 6.12 shows the first relation between goals and agent's capabilities.

Table 6.12 First Relation between Goals and Agent's Capabilities

Element	Relationships	Example
Agent's capabilities	Organizational goals are assigned to roles. Capabilities required to play a certain role allow agents playing these roles to pursue domain-specific goals	**Goal:** Diagnose patient's health state goal and Diagnose rheumatologic conditions goal **Role:** Physician

Considering the design of the department's goals, the Hospital assigns goals to the department (in a high level of abstraction, such as Provide medical care to patient in rheumatology goal), while the physicians who manage the department are responsible for refining the Hospital's goals and converting them to a finer-grained structure. Furthermore, the Hospital also concedes a certain amount of resources to the department. Administrators refine goals and find solutions based on: constraints imposed by the Hospital, constraints imposed by the relationships with other internal sub-organizations of the Hospital (such as the Ophthalmology Department or Dermatology Department), among others. For example, the administrators are responsible for defining how many and which clinics the department has (the clinics are divided by types of conditions) based on some factors, such as the incidence of the conditions in the population, the number of physicians, among others.

In the case of the Rheumatology department, this power of deliberating about the management of the organization is decisive to the successful achievement of the organizational goals, since these agents hold the required knowledge about the best way of applying health policies to population.

In other situations, capabilities are required not only for agents to occupy roles, but present a stronger relationship with goals in the sense that some goals require specific agents (with specific capabilities) to be attained (i.e., roles are not sufficient to attain goals, but specific agents instead). In our case study, there exists two business processes for selecting patients to be admitted in the service provided by the department, namely the *Select patients to be admitted by the department* business process and the *Elaborate report* business process. They differ in that (i) the former is performed by all the physicians of the department, whereas the latter is conducted by just one specific physician and (ii) the patients who receive medical in the former have been referred from the municipal/state health services, whereas the patients from the latter are referred from another department of the Hospital.

The separation of the process for selection of patients in two distinct business processes can be accounted by a problem in the municipal and state health services. The general physicians who pertain to these services have a deficiency in their medical formation with respect to the identification and treatment of rheumatologic conditions. Therefore, the patients which are referred from these services commonly present symptoms of rheumatologic conditions, despite they actually do not possess them. These misinterpretations impacts the efficiency of the business process for selecting patients since the rheumatologists must provide medical care to a high number to patients of which few actually have rheumatologic conditions. This also affects the efficacy of the process; a great number of patients imposes on the physicians the need of fast screening, which leads to the occurrence of unidentified cases of rheumatologic conditions. Due to these problems, the department has created two business processes for selecting the patients to ingress in the service: while the first (*Select patients to be admitted by the department*) receives only the patients from the primary and secondary health services, the second (*Elaborate report*) only receives patients from other internal departments.

These patients referred from another department of the Hospital are proner to possess rheumatologic conditions since they have already passed by the inspection of other specialists. The process of diagnosis in these patients requires high technical experience to be successfully achieved. Therefore, the satisfaction of goals of the *Elaborate report* business process is associated with a specific agent who pertains to the department who had amounted great experience along her professional carrier in diagnosing difficult cases in rheumatology. Thus, the creation of this business process had with the purpose of speeding up the selection of patients. Among the goals associated with the *Elaborate report* business process, we have: **Provide medical care to patients referred from other internal departments** and **Identify the existence of rheumatologic conditions**.

We must emphasize that although the department has a set of rheumatologists who are responsible for providing treatment for the general public, in the case of another physician issue the medical report, the goal of this business process either would not be attained or would be attained, but not as well as it would be in the case which that specific agent performs the business process. Table 6.13 shows the second relation between goals and agent's capabilities.

Table 6.13 Second Relation between Goals and Agent's Capabilities

Element	Relationships	Example
Agent's capabilities	Specific capabilities of specific agents are required to pursue domain-specific goals (agents define operationalizations based on capabilities)	**Goal:** Provide medical care to patients referred from other internal departments goal and Identify the existence of rheumatologic conditions goal. **Agent:** Specific agent which has experience in diagnosing

6.3.2.11   Relations between Goals and Objects

Objects are used in ontologies to represent the resources employed within organizations. An extended discussion of objects from an ontological standpoint is presented in section 4.8. Here, we intend to use the concept of Object to explain how agents use objects within the organizational environment to attain their goals.

The first dimension to distinguish objects is to classify them as social or physical resources. In the case study, as physical objects, we have the exams and the high cost drug. As the social ones, good examples found in the case study are the patients' records and the medical certificates. In the sequel, we demonstrate how goal achievement is related with these resources.

An interesting aspect of the case study with respect to objects is the fact that the patient's records are one of the most important (probably the most important) social object within the medical domain created and regulated by the Medical Board. It serves as a mechanism of communication among physicians, i.e., physicians have the obligation of elaborating the description of the patient's health state and the treatment prescribed as refined and detailed as possible. This rigor has the purpose of improving the general understanding of the evolution of the condition (and the treatment) by all physicians who provide medical care to some patient (also denominated as traceability of the investigation of the condition).

Considering the kind of participation of the resource in actions performed by agents, generally, goals are stated in terms of the access of some strategic resource, either a social or a physical object. In the scope of the *High-Cost Drug Assessment Commission* business process, goals are stated in terms of the communication among the participants (since the most of the entities which interacts in the service does not belong to the same organization) as well as in terms of the access to the high cost drug (a valuable and strategic resource).

Examples of goals which are fulfilled by accessing some resource in the scope of this business process are: Obtain high cost drug with no monetary charge goal (patient) and Access clinical protocols for assessment of need of high cost drug goal (commission).

The first goal refers to need of the patient to freely access the high cost drug with the aim of reducing the manifestation of the condition (in order to obtain all the benefits from some medical treatment, such as minimize the physical suffering, promote quality of life, heal the condition, among others). The second goal refers to the need of the commission for accessing protocols for assessing the need of high cost drug. Since the State Health Department uses some criteria for financing the high cost drug, protocols are social objects which represent these criteria.

In the previous examples, to access some resource entails in the goal realization. Other times, the access to some object represents a positive contribution for the goal realization (considering that the goal can be satisfied within certain limits, the access increases the level of satisfaction of the goal). Consider for example the goal Diagnose rheumatologic condition. In some cases, diagnosis is either speed (in the sense that physicians are able to deliberate in advance about the diagnosis) or improved (in the sense that the diagnosis is more precise) in the case they are able to access some kinds of exams (i.e., if the resource is created in the organization). Observe that the physicians are able to diagnose the condition without any further assistance of exams in some cases, but the provision of this exams improves the process of diagnose. In other cases, this access is not only related with the level of satisfaction of the goal, but is indispensable to the realization of diagnosis in fact.

Other times, not the object creation is relevant for goal achievement, but the object usage instead. In the business process of *Realize procedures*, the goal Relieve crisis[23] can be achieved by the activity *Realize infiltration*[24]. However, the goal achievement is impact by the ability/experience of the physician in manipulating the resources (the better the physician can guide the injection of the drugs within the affected areas, higher is the relief felt by the patient). Furthermore, the goal satisfaction is not causal in the sense that although the physician who performs the procedure is very experienced, the patient can not fell no

---

[23] These crises refer to the manifestation of painful or bothering symptoms, generally caused by high activity of the rheumatologic condition.
[24] Infiltration is a type of procedure in which the physician injects drugs in articulations of patient (commonly the knees or ankles).

meaningful improvement in his/her heath state (in this case, this can be assigned to a bad response of the condition to the treatment). This example is a case in which the goal satisfaction is associated with the ability of the agent (capacity) in manipulating some resource (object usage).

Following with the types of resource participation, the way in which the object is changed has important implications in the goal realization. As an example of how a resource change affects goals, consider the manipulation of patient's records by the physician during a medical consultation and two goals which refer to this manipulation (Maintain healthcare information private goal and Keep patient's records completely and correctly updated goal). The first goal refers to the confidential change of the patient's clinical history (healthcare information) by those (physicians and nurses) who register any kind of healthcare information in the patient's records. A confidential change of the patient's records is covered by law and thus, the agents who violate the rule are subject to legal implications (sanctions). The second goal refers to the manner how healthcare information is registered in the patient's records; i.e., agents must be committed to writing all the relevant information in a complete and precise way. Table 6.14 sums up the first relation between goals and objects.

Table 6.14 First Relation between Goals and Objects

Element	Relationships	Example
Objects	The access to the (social or physical) resource satisfies the goal	**Goal:** Obtain high cost drug with no monetary charge goal (patient) **(Physical) Object:** High cost drug **Goal:** Access clinical protocols for assessment of need of high cost drug goal (commission) **(Social) Object:** Clinical protocols
	The usage of the (social or physical) resource satisfies the goal	**Goal:** Relieve crisis goal **(Physical) Object:** Injection of drugs
	The change of the (social or physical) resource satisfies the goal	**Goal:** Maintain healthcare information private goal **(Social) Object:** Patient's records **Goal:** Keep patient's records completely and correctly updated goal **(Social) Object:** Patient's records

Interestingly, some (social or physical) objects in the context of the domain are used as mechanisms for implementing goals which are generally declared. As some examples of these goals, we have: the Provide security for drug administration goal (from physician in the scope of *Conduct pulsotherapy* business process) and the Obtain access to patient`s clinical history and data goal (from the physician in all business processes). In the first

goal, the security is implemented through devices for measuring the patient's blood pressure (physical objects). A high blood pressure represents a complication during the drug administration which must be avoided at all costs (the drug administration must be interrupted in the case of an occurrence of an elevation of the blood pressure). The adoption of devices for monitoring the infusion aggregates security to this process (i.e. *implements* security) in the sense that triggers an alarm which allows the physician to halt the process of drug infusion. In relation to the other goal, the patient's records are a means for recording the patient's clinical history; then accessing the patient's records implies in accessing the patient's clinical history since the patient's records "implement" the patient's clinical history. Table 6.15 shows the second relation between goals and objects.

Table 6.15 Second Relation between Goals and Objects

Element	Relationships	Example
Objects	Objects can be used as mechanisms for implementing goals	**Goal:** Provide security for drug administration goal (physician) **Physical object:** Devices for measuring the patient's blood pressure **Goal:** Obtain access to patient's clinical history and data goal (physician) **Social Object:** Patient's records

6.3.2.12   Relations between Goals and Rules

The last concept in ontologies which is relevant for considering goal achievement is norms and rules (these concepts have been described in section 4.9). Norms have a meta-role in allowing goals to be achieved in the organization in the sense that they allow goals to be satisfied in multiple levels. First, they are responsible for defining why the organization has been formed, i.e., to set (and refine) the organizational goals, defining the social concepts used for the organization to define their operations (and thus achieve its goals). Following, they affect the satisfaction of all goals within the organization in the sense that they: (i) create the social roles, (ii) assign these social roles to particular agents and, (iii) regulate the (either collective or not) pursuit of goals in the organization, regulating also the relationships with external partners. Some goals are even completely reliant on norms to be achieved. In this section, we aim at providing some examples how goals are forced through the application of norms, emphasizing that these relations are just a glimpse for the innumerous relations which can exist.

Norms within the Rheumatology Department come from a high number of sources, including either internal or external ones. Among these sources, we have: the top organization (Hospital), the own department, the State Health Department, the Medical/Nursery Board, the Department of Education, the National Agency of Health Surveillance) and so forth. Each of these external organizations has some kind of relationship with the department and the rules stated by them affects the behaviour of the agents in achieving the department's goals.

6.3.2.12.1   Constitutive Norms

In the context of the department, a (non-exhaustive) list of some of objects which are created by social norms (and affects the organization to achieve its goals) are the patient's records, medical reports, medical certificates and the physicians' and nurses' stamps. Among the social commitments, we have the commitment assumed by the physicians in providing regular attendance for patients who pertain to the service, the commitment of the physician in satisfying legal requirements and the commitment of the commission of high cost drug in not granting privileges to internal patients in its assessment.

The first commitment is signed in the moment the physician is hired by the organization (thus the legal norm in this case is the contract between the physician and the Hospital). The second one is also the contract of admission of the physician in the organization since when an agent decides to join an organization, this entails in an acceptation of these agents in being under all the legal sanctions imposed by this organization. Finally, the third commitment is not regulated by any legal contract, instead, it is more than a moral commitment assumed by the physicians of commission.

As exposed in previous sections, the patient's records are a social object which is responsible for attaining many goals in the department. Medical reports and medical certificates are also socially created and recognized by law (federal law). The act of issuing these resources by the physician (the object creation) is one of the reasons why the physician aims at providing attendance for the patient (Provide attendance for elaboration of medical certificate goal and Provide medical care for elaboration of medical report goal). In other words, the act of creating the object in the organization is a mean for attaining a goal.

The physicians' and nurses' registry are the social objects created and recognized, respectively, by the Medical Board and Nursery Board. This registry is the legal license which enables an agent to occupy the role of physician or nurse (in fact, the registry in its respective council is the first legal requirement which enables the health professional to occupy the role in the organization, but other requirements are also necessary for the professional to join the organization). Therefore, professional registries define the social roles and thus, also assign organizational goals to agents who enact these roles.

Among the social commitments, in a general sense, the agents compromise with adopting the organizational goals (and pursuing them) in the moment they are hired by the organization. Other times, the goal realization is only possible whether the agent have a moral commitment to find some solution to achieve the goal (commonly grounded in a belief or a percept from reality). Notice that in the first situation, the commitment is formally established through a social contract between the agents and the organization. In the second case, however, the agreements are commonly set up through an informal convention among the agents.

The first statement can be exemplified by the commitment assumed by physicians in providing regular attendance for patients who pertain to the service. For example, the **Provide medical care to patient** goal (and its refinements) is solely achieved in the case of the physician/resident compromise in using its knowledge (capability) to reach the organizational goals.

The second example of commitments has already been explored in the section about beliefs. Beliefs are the main driving factor which motivates the establishment of commitments in our case study. For example, in the scope of the high cost drug assessment business process, the **Do not grant privileges to internal patients in the assessment of high cost drug** goal is only possible if the commission is committed with not making any difference between the internal patients and the external ones in its assessment. Since the level of bias of some patient is subjective, to apply regulatory rules in this case is impossible and the only aspect which affects the satisfaction of this goal is the commission's moral commitment (in fact, to reduce the level of bias, the involved parties have adopted clinical protocols which represent the criteria used by the State Health Department for financing the high cost drug. Adopting a common criterion for the assessment helps the commission to provide a uniform assessment).

The **Satisfy legal requirements** goal (from the physician) is also related with the commitment of the physician (on his/her admittance of the organization) in being subject to regulatory impositions during the pursuit of the organizational goals. Observe that this goal is a commitment of the physician in achieving the other organizational goals under the constraints imposed by the regulatory entities. This commitment is very important in the organization: it represents a stronger relationship between agents and roles than the relationship of "adoption" previously presented; namely, besides the agents adopt the organizational goals, they also accept to pursue them based on the required constraints. Table 6.16 depicts the relation between goals and constitutive norms.

Table 6.16 Relation between Goals and Constitutive Norms

Element	Relationships	Example
Rules and Norms	Constitutive norms define the social concepts used for the organization to define their operations to achieve its goals	**Social Objects:** patient's records, medical reports, medical certificates, diagnose cue sheets and the physicians' and nurses' stamps.
		Social Commitments: the commitments assumed by the physicians in providing regular attendance for patients who pertain to the service, the commitments of the physician in satisfying legal requirements and the commitment of the commission of high cost drug in not granting privileges to internal patients in its assessment.
		Rules: Contract of admission of physicians by the Hospital

6.3.2.12.2 Deontic Norms

Generally, deontic norms have the role of constraining the agent's behaviour in the pursuit of organizational goals, regulating the possible implementations of goals and restraining the space of alternative solutions. For example, the **Handle the medical access to the patient's records** goal (receptionist) is guided by some rules either determined by the Hospital or by the own department. The Hospital rule states that the patients' records must be sent to the department one day before the medical consultation (since they are stored in another physical place in the Hospital) and restored after the day. The department rule states that the patients' records must be grouped per physician as they come in the department. Notice that these rules are responsible for leaving little alternative solutions to the management of the patients' records by the receptionists (namely, the receptionists are constrained in their freedom of action by the norms in instantiating plans to achieve the goal). A freer schema for coordinating the behaviour of the receptionists in this case would possibly lead to different implementations for the goal. These differences could impact in the level of

satisfaction of this goal and moreover, could impact in the satisfaction of those goals which present some relations with the former goal. E.g., the Handle the medical access to the patient's records goal positively contributes to the Manage the medical attendance on behalf of internal patients goals and Manage the medical attendance on behalf of external patients goal. An ineffective management of the medical access by the receptionist could bring about failures in the access of the patient to the medical care, impacting in the central function of the organization, that is, the core goal of providing medical care to patients.

Besides, the organization has specific goals related with the prescription of rules by agents to guide the pursuit of goals by other agents. The Establish clear criteria to grant medical attendance for patients by receptionists goal (from receptionist) when achieved by physicians, produces a written document (or another kind of artifact) with norms which prescribe how receptionists must manage access to physicians by patients. This artifact serves to guide receptionists to attain the Handle the medical attendance to patients goal according to the criteria established by physicians, constraining the way how this handling is actually achieved.

Contracts also play an important role in the coordination of the collective pursuit of goals, either when goals are jointly achieved through interactions or delegations. In the former case, the normative aspect of the Update patient's records with all relevant information goal is covered by the laws from the Medical Board which regulates the relationship between physician-patient. Taking into account that several physicians provide treatment for the same patient in the course of his/her treatment, this rule must be strictly followed by all physicians, since the lack of information can imply in an ineffective treatment (once the physicians cannot access all the relevant information, they cannot also take the better decisions about the treatment), besides being a potential source of medical errors (in a extreme situation).

Delegated goals are also regulated by legal norms. The physician delegates the attendance of patients to the resident (Treat patients goal dependency from physician towards resident) and in counterpart, he/she has to approve the treatment proposed by the resident (Approve the treatment proposed by the resident goal dependency relation from resident towards physician). In this case, the law states that to every attendance provided by some resident, a physician must approve the treatment in return. This specie of validation is legally required

by the Department of Education, being mandatory for: (i) the prescribed treatment to be legally recognized and (ii) as one of the academic courses required to the whole course of residence.

Since the sub-organization relies on other sub-organizations to achieve its own goals, norms intend to control the relationships between the department and these organizations, mediating all the conflicts interests which can arise among them. A good example of goal which arises in the cross-borders of organizations is the Attend patients forwarded from the municipal (primary) health service goal of the rheumatologist (from the rheumatology department). This relationship between the rheumatology department and the primary health service is intermediated by the rules of the SUS. SUS delimitates the scope of competency of each health service, namely, the municipal health service is concerned about providing basic attention to patients; the state health service addresses the middle complexity health services and the third sector addresses the high complexity services. This goal refers to situation which the rheumatology department must receive patients from the basic health services, namely, the goal delegation of the primary health service (stated and regulated by SUS) for the rheumatology department to treat patients who require specialized professionals. The norms of SUS act as enforcement mechanisms between the two organizations, functioning as the social link between these organizations. Observe that the delimitation of the scope of competency of each organization by norms defines the responsibilities and tasks of each of them, assigning specific attributions to these organizations in the collective pursuit of common goals.

The last aspect regulated by norms is the resource participation within organizations. For example, considering the resource creation, the Obtain high cost drug with no monetary charge goal (patient) is regulated by a law from the state which addresses the financing of some high cost drugs by the state government (the law states that some high cost drugs must be covered with public money). In this case, the rule is responsible for the creation of the resource within the organizational environment.

Regarding a resource change, the manipulation of the patient's records is regulated by rules from the Medical/Nursery Board. These rules aim at better satisfying the organizational goals in the sense they prescribe constraints which regulate how well the resource is manipulated.

Finally, it is important to emphasize that some goals are completely reliant on rules and norms to be attained (namely, rules are the only entity in the organizations to be employed in the goal satisfaction), highlighting the fundamental role of these concepts within organizational environments. Some examples of these goals are: Obtain fair remuneration for the exercise of professional activity goal and Have flexibility and autonomy in the management of organizational resources goal (both from physician). Both goals are solely related with the organizational policies implemented through norms; while the former is associated with a human resource policy (from the Hospital) in promoting proper job conditions to its employers, the latter is related with the power of the department (delegated by the Hospital) in generating its policies with the purpose of implementing its goals.

Some relationships with other organizations (to achieve internal goals) are also only enforceable through norms. The Obtain traceability with the remaining parties involved in the high cost business process goal (in the scope of high cost drug assessment business process) is only achieved whether the external organizations respect the rule of implementing mechanisms to promote traceability. Table 6.17 depicts the relation between goals and deontic norms.

Table 6.17 Relation between Goals and Deontic Norms

Element	Relationships		Example
Rules and Norms	Deontic norms restrain the behaviour exhibited by the agents in the pursuit of goals	Rules restrain the space of alternative solutions for achieve goals (the differences could impact in the level of satisfaction of the goal or in the satisfaction of goals which present some relations with the former goal)	**Goals:** Handle the medical access to the patient's records goal **Rules:** The Hospital rule states that the patients' records must be sent to the department one day before the medical consultation (since they are stored in another physical place in the Hospital) and restored after the day. The department rule states that the patients' records must be grouped per physician as they come in the department. **Associated goals (which could be impacted):** Manage the medical attendance on behalf of internal patients goal and Manage the medical attendance on behalf of external patients goal.
		Contracts specifies how collective goals are pursued (either internally or externally)	**(Internal) Goals:** Update patient's records with all relevant information goal **Rules:** Laws from the Medical Board which regulates the relationship between physician-patient
			(External) Goals: Attend patients forwarded from the municipal (primary) health service goal **Rules:** Rules dictated by SUS which delimitate

			the scope of competency of each health service.
		Rules regulate delegations	**Goals:** Treat patients goal (Resident) and Approve the treatment proposed by the resident goal (Physician) **Rules:** Laws from the Department of Education
		Rules regulate the access to resource	**Goal:** Obtain high cost drug with no monetary charge goal (patient) **(Physical) Object:** High cost drug **Rule:** The obtaining of the high cost drug is regulated by laws from the State Health Department which addresses the financing of some high cost drugs by the state government
		Rules regulate the change of the resource	**Goal:** Update patient's records with all relevant information goal and Maintain healthcare information private goal **Rules:** Laws from the Medical Board which regulates the relationship between physician-patient
		Rules implements organizational policies which allows goals to be achieved	**Goal:** Obtain fair remuneration for the exercise of professional activity goal and **Goal:** Have flexibility and autonomy in the management of organizational resources goal **Rules:** Goals are related with the organizational policies implemented through norms. The former: human resource policy (from the Hospital). The latter: the power of the department (delegated by the Hospital) in generating its policies with the purpose of creating and implementing its goals.

6.3.2.12.3   Technical Norms

The medical domain has the particularity of being highly related with domain-specific knowledge, what implies that technical norms are also strongly employed for agents to achieve goals. These norms are applied in the realization of goals which require capabilities and knowledge of the medical domain.

In the business process of *Realize procedures*, (more experienced) physicians prescribe technical suggestions about how to infiltrate the drug (to achieve the Realize infiltration goal) as well as guidelines about how to conduct a biopsy (to achieve the Confirm clinical suspect of Sjögren syndrome through biopsy goal). Other examples are the Obtain traceability in investigation of patient`s condition goal and Obtain accurate information about patient`s treatment goal. More experience physicians prescribe rules about how to use the diagnose cue sheets can be employed in the capturing of patient's information. The level of adherence of physicians (and residents) in following these rules determines the level

of satisfaction of the goals, namely, the more the physicians follow these rules, the goals for traceability and completeness about patient's information are better achieved.

Furthermore, norms (contracts) which control interactions among organizations can also be domain-specific. In the scope of the high cost assessment commission, clinical protocols are specie of "technical contract" which specifies the patients who are able to receive the high cost drug, guiding the decision making of the commission. Since the high cost drug is financed by the State Health Department, this entity must issue the criteria for this financing (the rule to approve the financing). This rule serves to control the decisions of the commission, and therefore serves to control the pursuit of the goals in the scope of this service. Examples of goals which are coordinated by protocols are: Assess the indication of high cost drug based on clinical protocols goal and Elaborate the indication of high cost drug based on clinical protocols goal. While the physician of the commission must evaluate the indication of high cost drug, the physician who prescribers must elaborate the indication based on the same protocols. Observe that the protocols act as a contract which guides the behaviour of agents, specifying constraints in the pursuit of goals. Table 6.18 sums up the discussion about the relation between goals and technical norms.

Table 6.18 Relation between Goals and Technical Norms

Element	Relationships		Example
Rules and Norms	Technical norms regulates the employment of domain-specific capabilities to achieve goals	Technical norms regulate how agents perform plans to achieve goals	**Agent:** (more experienced) Physicians **Goal:** Realize infiltration goal **Rules:** Technical suggestions about how to infiltrate the drug **Agent:** (more experienced) Physicians **Goal:** Confirm clinical suspect of Sjögren syndrome through biopsy goal **Rules:** Technical guidelines about how to conduct a biopsy **Agents:** (more experienced) Physicians **Goals:** Obtain traceability in investigation of patient's condition goal and Obtain accurate information about patient's treatment goal **Rules:** Technical guidelines about how to use the diagnose cue sheets
		Technical norms specifies how collective goals are pursued (either internally or externally)	**Agents:** State Health Department **Goals:** Assess the indication of high cost drug based on clinical protocols goal and Elaborate the indication of high cost drug based on clinical protocols goal. **Rule:** Clinical protocols are a kind of "technical contract", i.e., domain-specific contracts which

			specify the criteria for financing the high cost drug

6.3.2.13   *Goal achievement: traceability matrix*

This section summarizes the results found along the case study with the purpose of graphically showing the relations between goals and the other elements. The *traceability matrix* depicts the element of the enterprise architecture which relates with the goal, their corresponding relationship and the situation in the case study which exemplifies this relation. These enterprise elements have been acquired in a survey in enterprise ontologies as being the components which form organizations. Therefore, since organizations rely on the definition of these elements, it is also natural that goal achievement is impacted by their interrelationships.

Before presenting what we denominate as *traceability matrix*, we have to clarify some important characteristics of the relationships found along the case study. The first characteristic refers to the fact that the relations between goals and enterprise elements seem not to be causal. In other words, we mean that even when an enterprise is provided, for instance, an activity is executed; this does not entail the satisfaction of its associated goal in many cases, not depicting a causality relation between the enterprise element and the goal. Other situation to exemplify this characteristic is the fact that merely assigning organizational goals to roles is necessary, but not sufficient for these goals to be achieved. Besides, the association of the enterprise element with some goal can also entail the satisfaction of this goal in certain limits. Non-functional goals generally state about this level of satisfaction. For instance, the Obtain access to patient`s records during medical consultation goal declares a function to be achieved. As explained before, the patient's records implement the patient's information. Therefore, the Obtain accurate information about patient's treatment goal declares a specific metric which specify how well the first goal has to be satisfied.

In the remaining of this section, we provide three *traceability matrixes*. The first one (Table 6.19) reflects the intensity of satisfaction of goals (with softgoals capturing the degree of satisfaction). Observe that this partialitiy of goal achievement can also be applied in the

subsequent matrix. The second matrix (Table 6.20) indeed describes how goals are satisfied with the employment of the elements of the enterprise architecture.

Differently from the previous example in which the level of satisfaction of some goal is affected by the strategy used for attaining it, other goals are totally achieved by the execution of their respective plans. For instance, the Provide medical care in scheduled medical consultation goal is totally achieved with the realization of a medical consultation previously scheduled.

Table 6.19 Examples of goal satisfaction in different intensities

Intensity of relationships		
Element	Relationships	Example
Actions and Plans	The action execution satisfies the goal (partially - within acceptable limits)	**Goal:** Confirm clinical suspect of Sjögren syndrome goal **Plans:** Collect saliva in a time period of 15 minutes, Verify the salivary flux acquired from patient through weighing and Conduct questionnaire to investigate the presence of other criteria for Sjögren syndrome activities.
	The action execution satisfies the goal (totally)	**Goal:** Provide medical care in scheduled medical consultation **Softgoal:** Provide quality medical care **Plan:** The execution of the diagnosis business process.
Objects	The access to the (social or physical) resource satisfies the goal (partially or totally)	**Goal:** Obtain access to patient's records during medical consultation **Softgoal:** Obtain accurate information about patient's treatment **(Physical) Object:** patient's records

Table 6.20 Examples of direct relations between goals and enterprise elements

Element	Relationships	Example
Roles	Organizational goals must be assigned to roles (roles must be defined)	Roles are defined through academic formation (capability-definition).
Agents' Goals	Organizational goals are assigned to roles. Agents must assume goals of roles.	Agents assume roles whose objectives somehow contribute to its own goals. This assumption is a kind of delegation from the Rheumatology Department to the agents. Delegator: Rheumatology Department Delegatee: Health professionals from department

			Agents assume goals of roles due to a belief. This assumption is a kind of social commitment. Belief: Health professionals believe that they play an essential role in promoting the health and wellness of population.
	Agents suggest additional goals (in relation to those goals prescribed by the organization)	Agents refine high-level goals	**Goal prescribed by the organization (Role Goal):** Manage the medical attendance on behalf of patients goal (from the receptionist) **Goals suggested by the agent:** Manage the medical attendance on behalf of internal patients goal and Manage the medical attendance on behalf of external patients goal
		Agents suggest additional goals whose achievement represents positive contribution for the achievement of the existent ones	**Goal prescribed by the organization (Role Goal):** Manage the medical attendance on behalf of patients goal (from receptionist) **Goal suggested by the agent:** Have more physical space for selecting patients to be admitted by the department goal (from receptionist)
		Agents suggest additional goals based on beliefs. The Agent's beliefs shapes the strength to find suitable plans.	A belief drives the suggestion of additional goals (and adoption of suitable strategies) to achieve the goal of providing the best possible treatment (prescribed by the organization). **Goal prescribed by the organization:** Provide medical care to patient goal **Goal suggested by the agent (due to a internal belief):** Minimize patient's physical suffering and symptoms goal and Guarantee patient well-being goal **Belief:** Health professionals believe that they play an essential role in promoting the health and wellness of population.
Actions and Plans	Agent's intentions lead the adoption of plans based on beliefs and constraints (goals can be either partially or totally satisfied)	The chosen plan is not the best one for achieving the goal (partial satisfaction)	**Agent's Goal:** Confirm clinical suspect of Sjögren syndrome goal. **Plans:** biopsy of the salivary gland (the best one) and salivary flow exam (the worst one). The first is adopted due to complexity and monetary constraints.
		The chosen plan is the only alternative to achieve the goal, but the goal is not completely achieved due to uncontrollable factors (partial satisfaction)	**Goal:** Stabilize the patient's clinical health state for drug administration goal **Plan:** administrate a drug for controlling the blood pressure (contributes positively) **Goal:** Avoid the occurrence of complications during the drug administration goal **Plan:** administrate a drug for controlling the blood pressure (contributes positively).
		The chosen plan is the best one for achieving the goal (total satisfaction)	**Goal:** Evaluate the presence of contraindications for drug administration goal **Plans:** Interrogate the patient about impediments for drug administration and Verify the existence of impediments for drug administration.
	Organizational goals are achieved by plans.		**Goal:** Assess the indication of high cost drug goal **Plan:** *Assess the indication of high cost*

	Beliefs conduct the choice of alternative plans to fulfil some goal	*drug based on clinical protocols* **Agent:** Physicians from commission of high cost drug **Agent's belief:** the commission believes that external prescribers believe that the commission favours internal patients.
	The activity execution satisfies the goal	**(Activity) Goal:** Assess the clinical patient's health state in the moment of the administration of the drug goal **Activity:** *Verify the existence of impediments for the drug administration*
	One execution of some business process satisfies the (restricted scope) goal	**(Restricted scope) Goal:** Prescribe high cost drug goal **Business process:** one execution of the *Infuse High-Cost Drug* business process
	Multiple executions of some business process satisfies the (broad scope) goal	**(Broad scope) Goal:** Induce the remission of the condition goal **Business process:** multiple executions of the *Infuse High-Cost Drug* business process
	The execution of very different actions (actions can be activities or one business process or several business processes) satisfies a specific goal (one goal to one or more executions of multiple actions)	**Goal:** Employ the organizational resources in a rational manner goal **Activities:** *Assess the need of administration of high cost drug* (in the scope of High cost drug assessment business process), *Administer drug in the patient* (in the scope of *Infuse High-Cost Drug* business process and Conduct pulsotherapy), *Realize infiltration of drug in the patient's articulations* and *Realize biopsy of salivary gland* (both in the scope of Realize Procedures)
	The execution of a specific action (actions can be activities or one business process or several business processes) simultaneously satifies several goals (multiple goals to one or more executions of one action)	**Goal:** Assess the indication of high cost drug based on clinical protocols goal (in the scope of High cost drug assessment business process) **Goal:** Diagnose patient's health state goal (in the scope of Diagnose patient's health state business process) **Activities:** *Investigates the patient's clinical, personal and family history* and *performs physical examination* (the execution of this set of activities represents a positive contribution for the goal satisfaction)
Interactions	(internal) Interactions must be established to achieve the goal	**Goal:** Report symptoms goal and Acquire technical skills goal **Agents who interact:** Patient and Physician
	(external) Interactions must be established to achieve the goal	**Goal:** Reabsorb patients who are discharged from the department goal **Agents who interact:** Rheumatology Department and Primary/Secondary health services
	Interactions must be established to achieve the goal due to complementary capabilities of agents	**Goal:** Help in the differential diagnosis (dependency relation) **Agents who interact:** Rheumatologist and Specialist from other department

Delegations	Delegations determine which agents will pursue goals		**Goal:** Treat patients (close delegation) **Delegator:** Physician **Delegatee:** Resident **Goal:** The design of the goals of the department and their implementation are examples of an open delegation from the Hospital to the Rheumatology Department. **Delegator:** Hospital **Delegatee:** Rheumatology Department
Agent's capabilities	Organizational goals are assigned to roles. Capabilities required to play a certain role allow agents playing these roles to pursue domain-specific goals		**Goal:** Diagnose patient's health state goal and Diagnose rheumatologic conditions goal **Role:** Physician
	Specific capabilities of specific agents are required to pursue domain-specific goals (agents define operationalizations based on capabilities)		**Goal:** Provide medical care to patients referred from other internal departments goal and Identify the existence of rheumatologic conditions goal. **Agent:** Specific agent which has experience in diagnosing
Objects	The access to the (social or physical) resource satisfies the goal		**Goal:** Obtain high cost drug with no monetary charge goal (patient) **(Physical) Object:** High cost drug **Goal:** Access clinical protocols for assessment of need of high cost drug goal (commission) **(Social) Object:** Clinical protocols
	The usage of the (social or physical) resource satisfies the goal		**Goal:** Relieve crisis goal **(Physical) Object:** Injection of drugs
	The change of the (social or physical) resource satisfies the goal		**Goal:** Maintain healthcare information private goal **(Social) Object:** Patient's records **Goal:** Keep patient's records completely and correctly updated goal **(Social) Object:** Patient's records
	Objects can be used as mechanisms for implementing goals		**Goal:** Provide security for drug administration goal (physician) **Physical object:** Devices for measuring the patient's blood pressure **Goal:** Obtain access to patient's clinical history and data goal (physician) **Social Object:** Patient's records
Rules and Norms	Constitutive norms define the social concepts used for the organization to define their operations to achieve its goals		**Social Objects:** patient's records, medical reports, medical certificates, diagnose cue sheets and the physicians' and nurses' stamps.
			Social Commitments: the commitments assumed by the physicians in providing regular attendance for patients who pertain to the service, the commitments of the physician in satisfying legal requirements and the commitment of the commission of high cost drug in not granting privileges to internal patients in its assessment. **Rules:** Contract of admission of physicians by the Hospital
Rules and	Deontic norms	Rules restrain the	**Goals:** Handle the medical access to the patient's

Norms	restrain the behaviour exhibited by the agents in the pursuit of goals	space of alternative solutions for achieve goals (the differences could impact in the level of satisfaction of the goal or in the satisfaction of goals which present some relations with the former goal)	records goal **Rules:** The Hospital rule states that the patients' records must be sent to the department one day before the medical consultation (since they are stored in another physical place in the Hospital) and restored after the day. The department rule states that the patients' records must be grouped per physician as they come in the department. **Associated goals (which could be impacted):** Manage the medical attendance on behalf of internal patients goal and Manage the medical attendance on behalf of external patients goal.
		Contracts specifies how collective goals are pursued (either internally or externally)	**(Internal) Goals:** Update patient's records with all relevant information goal **Rules:** Laws from the Medical Board which regulates the relationship between physician-patient
			(External) Goals: Attend patients forwarded from the municipal (primary) health service goal **Rules:** Rules dictated by SUS which delimitate the scope of competency of each health service.
		Rules regulate delegations	**Goals:** Treat patients goal (Resident) and Approve the treatment proposed by the resident goal (Physician) **Rules:** Laws from the Department of Education
		Rules regulate the access to resource	**Goal:** Obtain high cost drug with no monetary charge goal (patient) **(Physical) Object:** High cost drug **Rule:** The obtaining of the high cost drug is regulated by laws from the State Health Department which addresses the financing of some high cost drugs by the state government
		Rules regulate the change of the resource	**Goal:** Update patient's records with all relevant information goal and Maintain healthcare information private goal **Rules:** Laws from the Medical Board which regulates the relationship between physician-patient
		Rules implements organizational policies which allows goals to be achieved	**Goal:** Obtain fair remuneration for the exercise of professional activity goal and **Goal:** Have flexibility and autonomy in the management of organizational resources goal **Rules:** Goals are related with the organizational policies implemented through norms. The former: human resource policy (from the Hospital). The latter: the power of the department (delegated by the Hospital) in generating its policies with the purpose of creating and implementing its goals.

| Rules and Norms | Technical norms regulates the employment of domain-specific capabilities to achieve goals | Technical norms regulate how agents perform plans to achieve goals | **Agent:** (more experienced) Physicians
Goal: Realize infiltration goal
Rules: Technical suggestions about how to infiltrate the drug

Agent: (more experienced) Physicians
Goal: Confirm clinical suspect of Sjögren syndrome through biopsy goal
Rules: Technical guidelines about how to conduct a biopsy

Agents: (more experienced) Physicians
Goals: Obtain traceability in investigation of patient's condition goal and Obtain accurate information about patient's treatment goal
Rules: Technical guidelines about how to use the diagnose cue sheets |
| | | Technical norms specifies how collective goals are pursued (either internally or externally) | **Agents:** State Health Department
Goals: Assess the indication of high cost drug based on clinical protocols goal and Elaborate the indication of high cost drug based on clinical protocols goal.
Rule: Clinical protocols are a kind of "technical contract", i.e., domain-specific contracts which specify the criteria for financing the high cost drug |

6.4 CONCLUSION

The first problem of alignment has originated in the area of information systems with the alignment of application systems and business contexts. An underlying problem is to align the business processes (which are supported by applications) with the enablers which drive the design of these processes (goals models).

Current approaches in *goal-oriented business process modeling* are totally focused on aligning business process models and goal models through a prescription of some methodological guidelines for the alignment, i.e., they prescribe guidelines with which the goal models and business process models must be initially modelled so that they can fit subsequently. This approach ignores the different natures of goals (for instance, they can be strategic or operational, hard or soft, among others) as well as the relevance of the other elements of the enterprise architecture in goal achievement.

We have observed that aligning process models and goal models is not straightforward. In the course of the case study, we have identified the need to split this effort into three phases: the elicitation phase (in which goal models and business process models are captured through

interviews and observation), the harmonization phase (in which the goal domain is structured for alignment according to the business processes structures that will support it) and the alignment phase (in which the relationships between the goal domain and the elements of the organizational domain are established and in which the semantics of these relationships are elaborated). The first phase has been addressed in chapter 5; the harmonization and alignment phase are treated in this chapter.

In the harmonization phase, we propose a goal taxonomy to harmonize the goal domain to be subsequently aligned with business processes. Furthermore, we discuss the implications of this classification in establishing the relationships of the goal domain with the business processes domain. This alignment with goals models extends traditional business process methodologies by providing a dimension of intentionality to the business processes (KAVAKLI e LOUCOPOULOS, 2003). This contrasts with several approaches in business process modelling which focus on "*how*" business processes are performed (adopting a behavioural description in which business processes are solely described in terms of their procedural aspects).

We have demonstrated the need for harmonizing the goal domain since different natures of goals impacts in the business processes structures which support these goals. In this sense, we have proposed five dimensions to classify goals (referring to level of abstraction, functional/non-functional aspect, hardgoal/softgoal, scope aspect, temporal aspect and desires). Moreover, we have provided a discussion about how each of these dimensions impact on the (re)design of business processes. Our main observation regarding goal harmonization is that different natures entails in different business process structures which support the goal domain. As some examples of these structures, we have shown that some kinds of goals do not lead to the generation of business process to support them (such as fundamental goals and desires). Other types of goals cope with a number of issues, such as the scope in which it must be fulfilled (if it sums up to a specific execution of the business process or the goal attainment is associated with the service provided by the organization as a whole), whether the goal refers to a current or future organizational situation, among others.

With respect to the alignment phase, we have developed an ontological framework for explaining the phenomena of the alignment through the examples found in the case study. This framework is grounded in two central aspects, namely: (i) it presents an ontological

account for the alignment and (ii) it addresses all the elements in the enterprise architecture (in opposition to consider business processes as the solely component). We consider that these aspects represent important differences from our proposal in relation to the existent *goal-oriented business process modeling* approaches in literature. Although the current proposals address the problem with solutions which resemble our work to some extent, we have not found approaches which jointly regard all the enterprise elements in the goal achievement as well as ontologies as the conceptual instrument for establishing the connections between the goal domain and these elements.

The decision of using organizational ontologies for providing real world semantics for the rheumatology department has driven us to analyze this organizational from a teleological standpoint, i.e., to characterize the relations which holds among the fundamental entities of the social domain and the relations that these entities have with their goals. This teleological analysis can be considered complementary to the theoretical literature of ontologies of organizations in the sense that it has provided some important relationships which have not been covered by the previous proposals. On the other hand, exploring the literature in ontologies has opened the possibility for us to apply a theoretical basis in a practical scenario, helping in clarifying the structure and relationships of the organization.

Some important issues that had passed unnoticed in our previous considerations and that have been ignored by other proposals in the literature have been now clarified with the use of ontologies. These issues fall into two broad categories, namely, which are the organizational concepts relevant for considering the alignment between goal and enterprise models and how these concepts are interrelated to attain goals. With respect to the first issue, the fundamental entities used for considering goal realization have been provided by a survey in the literature of organizational ontologies which agree in a common line of thought that these entities are the building blocks which form organizations. Concerning the relations holding among the entities, possibly it has been one of the most interesting conclusions found in the case study: (i) the fact that goals have to establish multiple simultaneous connections with enterprise elements to be satisfied and (ii) the fact that these connections are not causal in the sense that even if the necessary enterprise elements have been provided, goals can or cannot be satisfied.

With respect to our method, our main purpose is to establish the connection among the AS-IS goals and the enterprise elements which are employed for achieving these goals. The choice of the rows of the matrix (the organizational entities) has been made based on the literature of organizational ontologies which describes the organizations in terms of these elements. Furthermore, concerning the mapping process between goals and enterprise elements, we believe that discovering the elements which impact some goal to be achieved is in some cases straightforward as in the Diagnose patient's health state goal which requires a (experienced in some cases) rheumatologist. In other cases, it can require deep knowledge about the specificities of the domain under consideration. For instance, "security" in the context of medical domain (drug infusion) (Provide security for drug administration goal) is implemented through devices for measuring the patient's blood pressure. For this reason, we believe that the experience conducted inside the daily operation of the department as well as the interviews with the administrators were also a valuable instrument in the alignment phase. They were decisive in this phase in the sense that the domain-specific goals could only be mapped to its elements of the enterprise due to the explanations provided by them.

A second issue in relation to the mapping process refers to the completeness of the enterprise elements assigned to the satisfaction of each goal. We believe that for each AS-IS goals, it is highly probable that all the elements of the enterprise architecture have been covered since these goals have already been implemented (and thus it is already known how they can be affected). For the change and TO-BE goals, it is more probable that some of their relations have remained unidentified since the domain-dependent goals can be implemented through some particular mechanisms which have passed unnoticed (what is not actually a problem since domain-specific relations have limited usefulness). Even if we consider general relations, we do not aim at being exhaustive in demonstrating all the possible relationships between goals and the other enterprise entities with the investigation of only one case study. However, we believe that this initial exploration can clarify in a real world case how an organization aims at achieving its goals, providing useful guidelines for future efforts in this line of research.

In relation to the results found, we have provided three broad categories of results: a matrix that exemplifies the intensity of satisfaction of goals, a matrix which depicts meta-relations that affects the satisfaction of all goals and a third matrix which shows the relations (patterns) between the elements of the enterprise architecture and goals. The relations in this latter

matrix also fall into three broad categories: (i) the potential (mis)alignment between the agents' expectations and roles' goals; (ii) the role of actions to realize goals as well as the issue of which agents must perform these actions (i.e., in which situations agents need to interact or delegate goals) and (iii) the role of the legal regulators, such as norms, rules, social contracts as mechanisms of imposing the pursuit of goals to agents.

In the first category, we have the rheumatology department being a low-level organization which pertains to a high-level organization (The Hospital) and establishes relations with internal sub-organizations (Dermatology Department and Ophthalmology Department) and external sub-organizations (primary and secondary health services). The Department is administered by rheumatologists who receive high-level goals from the Hospital and set the department's goals and their operationalizations.

The design of goals by the administrators has important implications in the delimitation of organizational goals and the personal goals of these agents. In this sense, to make more accurate delimitation, we believe that our observation of the behaviour of agents in their work and the interviews with the other performers of the organization has contributed to delineate these differences. Besides, the design is not made by single agents; instead, the decision-making process is conducted by a group of physicians, which also reduces the possibilities of capturing goals from a single standpoint.

In a general sense, the designer of goals relies on the translation from the goals prescribed by roles to the goals adopted by the agents. In other words, the adoption is as essential to the attainment of goals as the design is, since it does not make much sense that the organization prescribes goals which are never adopted by the agents who populate it. In our case, goals have been assigned by the organization to roles and adopted by agents (through a social commitment) due to the acceptance of the goal delegation from the Hospital in exchange of the satisfaction of its own goals. The adoption of goals by agents has taken into account that the goal interpreted by the agent can diverge from the goal prescribed to the role. We have assumed that this kind of problem does not occur since the prescribers and the performers are the same agents.

On one hand, the definition and assignment of organizational goals per role has been a decision which had resulted from a limitation of the Tropos language. On the other hand, this

definition of roles allows that the satisfaction of goals of all roles entails the satisfaction of the overall organizational goals.

Once assumed by agents, goals are reliant on agent's intentions to handle these goals, to prioritize them as well as to elaborate plans (or strategies) which lead to their achievement, despite the mere association with plans does not guarantee goals to be totally achieved. Sometimes, during this decision-making process, agents' beliefs are important issues to be considered in the sense that they guide agents to choose some alternative strategies (plans) to fulfill the goals. An example of the selection of strategies based on beliefs has been provided in the scope of the High-Cost Drug Assessment Commission in which the physician adopt clinical protocols in their assessment as a particular solution due to the external prescribers' belief that the commission favors internal patients. Beliefs are also important for the organizations in the sense that they can bring about the generation of intentions.

Capabilities are also important factors in goal achievement in the sense that some goals require the instantiation of domain-specific plans to be satisfied. Commonly, this domain-specific knowledge is the main motivator for the establishment of interactions and delegations. Within the case study, capabilities have motivated the establishment of the interaction between the rheumatologist and the other specialists of the Hospital (such as dermatologists and ophthalmologists) in order to jointly diagnose the patient's conditions in some cases. Delegations based on capabilities have also been encountered within the case study as the goal delegation of the Hospital to the rheumatology department to set its own goals and operationalizations. With that respect, we emphasize the relevance of specialists of the domain (rheumatologists) as department's administrators. As noticed in the case study, the existence of goals relies on the agent's capabilities to exist, what in a last instance means that the existence of the department also depends on these capabilities. Moreover, organizational policies to implement goals are also set up based on agent's capabilities.

In the second category, goals within the case study are achieved by the execution of some action, one execution of some plan, or by several executions of the same plan. While interactions within the department for fulfilling internal goals are well-established, internal goals that require interactions with external sub-organizations (such as primary and secondary health services) to be achieved are problematic. As interactions, delegations for achieving goals within the department are also well-established taking into account that they

are institutionally defined according to the organizational structure implemented by the department (a "flat" hierarchical structure).

Finally, the third set of results found within the case study refers to the role of social contracts and norms in creating social concepts, such as social objects and social commitments as well as regulating the agents' behaviour. Norms within the case study are originated from a high amount of sources, including the Hospital as well as the own department.

Resources in the context of the case study are widely employed in the goal achievement. Goals are commonly stated in terms of the resource participation (namely, access, usage and change) in actions performed by agents, putting emphasis on the own resource and not in the action. Examples of these objects are: the patient's records, medical certificates, medical reports, high cost drugs, among others. It is also important to mention that objects are used as mechanisms for implementing operationalizations as in the case of the patient's records which implements traceability. Besides the social objects, norms also creates the social commitments, such as the commitment of the physician in accepting norms and rules in his/her pursuit of organizational goals.

With respect to the regulatory aspect of norms, since agents which compose the organization have freedom of action, there must be some mechanism to regulate their behaviour in the pursuit of goals. The deontic norms have the role of setting constraints not only on what must be achieved (the goals itself), but in other cases it does not leave to the initiative of the agents neither the goals to be pursued, nor the procedure to obtain the goal.

Deontic norms serve to control the behavior exhibited by agents in the relationships within the department (interactions and delegations) and in the relationships with external organizations. As we have noticed, while the former are well-established, the latter are problematic and the roles of norms become more important in this case. Other conclusion provided by the case study is the insight that organizations does not exist in isolation, instead, the successful attainment of its internal goals equally depends on the establishment of successful relationships with external partners. A second interesting result is that, sometimes goals are completely reliant on norms to be achieved and no other element of the enterprise is related with the implementation of some solution to achieve the goal.

Therefore, since norms (i) control the behaviour of agents in the pursuit of goals, (ii) control the interactions (either internal or external to the organization), (iii) create the relevant objects, roles and commitments for goals to be implemented, (iv) enforce the achievement of other goals, and so forth, goals must be the main driving force in the design of organizational norms. This can be evidenced by this general role of norms in guaranteeing the satisfaction of goals.

6.5 FUTURE WORK

This chapter addresses the issue of presenting the basic entities and relations of the domain of organizations in a real world and complex case study and how these entities are interrelated with the realization of the organizational goals. As a further step, we envision contributions into two main directions, namely, with respect to the activity of harmonizing the goal domain and with respect to the activity of aligning two distinct domains (the goal domain and the enterprise).

With respect to the activity of harmonizing the goal domain, we have identified the following issues:

(i) In the harmonization phase, we intended to depict that goals have different natures, although the relations which hold among goals have not been explored. We have noticed that these relations are much more complex than the relations provided by the majority of existing frameworks in goal modeling.

(ii) The need to extend the Tropos meta-model to accommodate the proposed goal taxonomy. If we consider new relations among goals, then additional goal relations must be also accommodated in the meta-model extension.

With respect of the alignment of both domains, we have as future research:

(i) The adoption of specific (ontological) models of organizations may be used to formally represent the design of the organization of our case study. This ontological formalization can be considered the first requirement to build a rigorous representation of the organizational setting since it captures the ontological

distinctions which are relevant to explain the alignment. Observe that the usage of the formal model of the Rheumatology department in other applications must take into account the notion of *qua-individuals* (see chapter 4 for a brief definition of this concept) since goals are much more related with the particular realization of the organization than its actual design as depicted in the case study. Nevertheless, every potential axiomatization of organizations faces the problem of an incipient state-of-the-art in ontologies of organizations: the current proposals present many interesting insights into the formalization of organizations, but much work still remain to be done until a stable version of the concepts and relations which form organizations is established.

(ii) Our method to search for the relationships between goals and enterprise elements presupposes the existence of no system to automate the department in its functioning. We believe that the introduction of computational systems in the department (such as workflow systems, medical billing software, systems for implementing the eletronical medical records (EMR), telemedicine systems, among others) can radically change the relations among the human actors, introducing new issues in these relations (especially in the medical-patient relation). These new questions will dramatically impact in the relations between the organizational goals and the elements of the enterprise architecture employed in their satisfaction.

(iii) Business process models allow the identification of which business process can be supported by information systems. In particular, two lines of research have shown to be promising: (i) the development (or acquisition) of workflow management systems (from the business process models) which manage the flow of documents in the department and (ii) the development (or acquisition) of knowledge management systems to promote the use and sharing of knowledge in health care institutions.

(iv) The investigation of suitable modelling notation and semantics to relate goal models and business process models have shown to be a very relevant issue, since the ontological alignment proposed here is not graphically represented.

We also believe that goal models can be used to support formal reasoning during the selection of which strategy will be adopted to attain a specific goal. This should be fruitful in the systematization of business process reengineering.

CHAPTER 7.   CONCLUSIONS AND FUTURE WORK

7.1 CONCLUSIONS

Business objectives and goals have been considered as one of three basic pilars to drive changes in the process life-cycle according to (NURCAN *et al.*, 2009). The evolution of business processes can be driven by attempts to either improve the achievement of business objectives (based on their measurement) or by the need to adapt to changes in these objectives, focusing on what is essential to be achieved, regardless the particular strategies adopted to achieve it.

As argued in (NEIGER e CHURILOV, 2004), *goal-oriented process modeling* proposals are often the result of an integration or extension of existing goal modeling and process modeling works. *Goal-oriented* approaches in requirements engineering are considerably more advanced in the area of goal modeling and goal-process integration (NEIGER e CHURILOV, 2004), although further research is necessary to promote a better methodological support for performing goal-driven processes across the different RE activities (KAVAKLI e LOUCOPOULOS, 2003). Along this work, several proposals have been presented with this purpose of grasping the problem of the alignment, including those which use ontologies. For instance, in (HALLEUX *et al.*, 2008), the authors use the Resource-Event-Agent (REA) ontology(MCCARTHY, 1982) with the purpose of expressing the business models in a formal manner; the Super Project (SUPER CONSORTIUM, 2009) is intended to achieve a Semantic Business Process Management (SBPM) initiative by taking as advantage Semantic Web technologies; Soffer and colleagues (SOFFER e WAND, 2005) proposes a theoretical framework developed on the basis of Bunge's ontology to associate softgoals and processes. These are just few examples of how ontologies can be used with the purpose of providing semantic annotations for business processes.

In a general manner, we have noticed that most of current proposals tend to adopt a *process-centered* view, i.e., business processes are accounted as the sole element within organizations necessary for achieving goals. Another direct conclusion of an analysis of the current literature is that the alignment which has been approached in the literature lacks a rigorous

semantics. Although the proposals founded on ontologies provide formal semantics for business process models, we felt that these approaches are driven by the needs that emerge in computational applications and try to give a theory that deals satisfactorily with these problems (e.g. in the Super Project, the ontologies are developed to support machine-readable ontologies). On the contrary, we have tried to address the problem from a social and "clean" theoretical account which is more appropriate given the real scenario we were facing. Concerning this issue of dealing with a real world organization, we believe that this kind of experience has enriched the case study by providing extra complexity which generally not found is theoretical examples. Moreover, the realistic effort in business process modeling has confronted us with situations which we have not found documented in the literature (as in the case of broad scope/restricted scope goals in our goal taxonomy).

This thesis discusses the alignment of goal analysis methods (using the Tropos methodology) and business process modeling methods (using the ARIS framework) breaking with these two trends in the current literature. Our proposal addresses a multitude of factors for clarifying how business goals are affected within the organizational setting. In this sense, the case study departs from the conventional idea that plan execution is the only aspect that should be taken into account when facing the alignment problem. A second methodological aspect refers to the ontological approach used for establishing the connections between goals and the elements which are related with their satisfaction. This issue has been discussed extensively in the conclusions to Chapter 6.

Our approach has been divided in three steps: the *elicitation phase*, the *harmonization phase* and the *alignment phase*. The goal *elicitation phase* in the context of BPM has presented some challenges, among of which we can cite the difficulty in conciliating the strategic and operational concerns of the organization. We have tackled this issue with some strategies for obtaining the organizational knowledge as described in (KAVAKLI, 2002): elicitation of knowledge founded on the prescriptions given by organizational experts, i. e., physicians, residents, nurses and receptionists, among others (prescriptive approach), observation of actors in developing their daily practices as well as the organizational state (descriptive approach) and the exploration of the documentation led us to reasoning about the goals and needs of the organization, producing additional knowledge from the existing one (analytical approach). By adopting these strategies, we were able to acquire the organizational knowledge and to capture the different concerns into the same models.

Our proposal for eliciting goals with the usage of the NFR catalogues has demonstrated useful for addressing the elicitation of a more strategic standpoint. NFR catalogues in the context of RE addresses the elicitation of NFRs which in turn limit the possible operationalizations of the system in terms of operations, functions and data (CHUNG *et al.*, 2000). Interestingly, the catalogues in the context of BPM also specified quality attributes for business processes which should be embodied in multiple aspects of the organization (cross-cutting concerns). Further, the catalogues have served to reveal more abstract (organizational) goals which are not easily identified by other abstraction techniques.

The goal *harmonization phase* intended to address the issue of equalizing the goal domain to be subsequently aligned with business processes. Moreover, this phase supported the mapping between the goal domain and the business process domain though a relationship of supporting.

Finally, in the *alignment phase*, we directed our attention to organizational ontologies for clarifying the social concepts which allows goals to be achieved. Initially, a survey in the literature of ontologies revealed the basic social components which form organizations and how these elements are related with the goal achievement. A difficulty found in the stage was the incipiency of the literature in enterprise ontologies as the support for grounding our analysis. As argued in (ISTC-CNR), organizations are very difficult to define, at least from an ontological point of view. Besides, some relationships between goals and some elements (e.g. beliefs) are divergent among several proposals as well as some terminologies are also not well-established (e.g. the term "interaction" can denote two distinct ontological concepts). A clear advantage of using ontologies refers to the methodological guidelines dictated by them for using Tropos and ARIS language. Since ARIS and Tropos are intended to capture the organizational setting from a social standpoint and enterprise ontologies clarify the basic elements from the social domain, then the usage of these languages can be supported by elements extracted from ontologies.

A second step in our methodology refers to the application of this theoretical framework in a real-world organization. In this interpretation from an ontological standpoint, we have attempted to explain why the agents manipulate the organizational environment (i.e., to bring about their goals) and how the elements of the enterprise architecture are employed for

achieving these goals. Furthermore, these explanations are given for how and why things happened in some particular real world situation.

As argued by (GREGOR, 2006), this kind of approach of searching for causality in the production of events is denominated as causal teleological analysis. This work also classifies information systems theories according to five interrelated types, namely, (i) theory for analyzing; (ii) theory for explaining, (iii) theory for predicting; (iv) theory for explaining and predicting and (v) theory for design and action. According to this categorization, we positioned our methodology as corresponding to the type (ii) since we intended to explain how and why the goals are fulfilled in an AS-IS environment, looking for causality in the employment of the elements of the enterprise architecture for achieving goals. With respect to the usage of a case study to acquire patterns for goal satisfaction, we believe that the experience of deriving guidelines in the format of patterns from the case study has added conclusions about the theory of the alignment of goals and enterprise models to the theoretical literature (GREGOR, 2006) (WIERINGA *et al.*, 2004). Furthermore, these conclusions are to some extent general (generability of results), i.e., they can be applied to multiple situations if the same field study conditions are reproduced/collected in future applications.

Concerning the results found, there are two levels of satisfaction: in the "meta-level", goals are defined by the administrators and assigned to agents who perform plans to achieve them, whereas in the lower level, goals are achieved by agents. Furthermore, goals in both levels can be satisfied with different intensities which generally are stated by softgoals.

With respect to the tools used for our case study (Tropos methodology and ARIS framework) we noted that the languages constrained our ability of capturing some important concepts or relationships in both domains due to the limited expressivity. Examples of these limitations are: in the ARIS framework, the (ontological) concepts of interaction, delegation, complex action event and atomic action event are all mapped to same concept of Function; in the Tropos modeling language, the concepts of interaction and delegation have been captured as being dependencies, the delimitation of agent's personal goals and organizational goals (and their relationships) have not been made due to expressiveness limitations as well as the the emergent/common goals of many agents, language constructs are also required to capture the goal taxonomy as well as the agent's mental distinctions (beliefs, desires and intentions) and

finally, the semantics of means-end relationship and decomposition in Tropos must be clarified so that practical applications of the language can lead to common understanding.

Although these languages have prevented us to characterize some important aspects of organizations, we have verified that the adoption of the language Tropos has contributed substantially for capturing the intentional and strategic aspects of our case study. With respect to the adoption of ARIS framework, the advantages mentioned in chapter 3, such as the ease to conjugate several views in dynamic EPC models, have also been very helpful in capturing the behavioral aspects of the organization.

Last but not least, it is also important to emphasize that as argued in (LANKHORST *et al.*, 2005), the dynamics of the organization were such that perfect the alignment is never completely attained. There were many changes in business processes (creation), organizational policies, introduction of new goals and so forth along the case study, so that the final version of the models that we have obtained was a trade-off between the importance of the changes and the associated cost of introducing them. About this issue, Henderson (HENDERSON e VENKATRAMAN, 1993) also affirms that the idea of alignment directs the choices made by the organization, evoking responses to these decisions. The perfect alignment is not a finished event, instead is a continuous adaptative process.

7.2 FUTURE DIRECTIONS

The following lines of research have been envisioned as promising directions for further investigation:

(i) The lack of current goal discovery approaches in the BPM literature as well as feedback from the experience reported here with the usage of NFR catalogues for eliciting goals suggests that there are promising research opportunities in methods for goals discovery in the context of BPM;

(ii) In (KAVAKLI e LOUCOPOULOS, 2003), the authors argue that further research is necessary to understand the role of goal analysis across different RE activities as well as a better methodological support for performing goal-driven processes. Since much of the tools applied for performing goal-oriented processes in BPM are borrowed

from RE, methods in BPM are also to be expanded to accommodate the notion of goal as a central business driver. Concerning this issue, the Super project (SUPER CONSORTIUM, 2009) addresses the development of semantic artifacts for business process management, although further research is still necessary in this direction.

(iii) Once we have presented a method for aligning goal models and enterprise models in an AS-IS situation (theory for explaining the alignment), the next step comprises in proposing methodological guidelines which stipulates how the TO-BE goals are fulfilled in a future situation (theory for predicting how the goals will be fulfilled in a future situation). During the business process reengineering, the change goals are used as the drivers for proposing solutions for the current problems. These solutions are laid on suggestions of business specialists who hold the required knowledge to propose the reengineering steps based on domain-specific solutions. The theories for predicting and for designing are strongly related with the generality of the results found in our case study as well as with the causality of the suggested patterns. With respect to the generality, as argued by (GREGOR, 2006), case studies add conclusions to the theoretical literature and then, our results can be considered general to a certain degree. With respect to the causality, we were able to find some causal relations which also can be applied in future situations. Although the non-causality found in the case study can damage the applicability of these relations in future situations, this an issue which still must be taken into account since real world organizations present this intrinsic characteristic of unpredictability due to a large number of conditons which can impact the final outcome.

(iv) The mapping established in this thesis is not aimed at comparing the ARIS and Tropos modeling languages in terms of a reference model; instead it had the purpose of interpreting our organization from an ontological standpoint. A systematic mapping between these modeling languages to organizational ontologies can clarify the ontological meaning of the concepts which form these languages. This disambiguation has as associated advantages:

    a. Providing better methodological support for guiding the usage of the modeling languages in future case studies;

b. Enabling a subsequent extension of these modeling languages to support some concepts in ARIS and Tropos which cannot currently be captured;

(v) If business process models are to be used as a starting point for the definition of process-oriented information systems (CARDOSO *et al.*, 2008), then the alignment between goals and business process directly affects the alignment of information systems and organizational goals and strategies. In other words, goal models play an essential role in increasing the quality of business process models by incorporating the notion of intentionality in these models. The alignment between business process models and goal models promotes the development of process-oriented information systems which are fully aligned with organizational goals. Therefore, the generation of system designs from business process models of the case study (with the usage of MDA techniques) can potentially produce process-oriented information systems which are better aligned with the Rheumatology Department's goals. These systems can support the organizational activities so that the organizational goals are better satisfied.

(vi) The alignment between enterprise models in our case study has been conducted without regarding the existence of computational systems which support the business processes under consideration. The introduction of computational systems in the Rheumatology department will most likely reflect in the organizational goals and in the enterprise models; therefore, introduction of computational systems will justify a new alignment effort.

CHAPTER 8.   REFERENCES

International Journal of Business Process Integration and Management (IJBPIM), 2009.

ALEXANDER, I. Modelling the Interplay of Conflicting Goals with Use and Misuse Cases, 2002.

ALMEIDA, J. P.; GUIZZARDI, G.; SANTOS JR, P. Applying and Extending a Semantic Foundation for Role-Related Concepts in Enterprise Modelling. **International Journal of Enterprise Information Systems (IJEIS)**, n. IGI-Global, 2010.

ANDERSSON, B. et al. On the Alignment of Goal Models and Business Models, 2007.

ANDERSSON, B. et al. Using Strategic Goal Analysis for Enhancing Value-based Business Models, 2007.

ANDERSSON, B. et al. Enterprise Sustainability through the Alignment of Goal Models and Business Models, 2008.

ANTÓN, A. I. Goal Identification and Refinement in the Specification of Software-Based Information Systems, Atlanta GA, 1997.

ANTON, A.; POTTS, C. The Use of Goals to Surface Requirements for Evolving Systems, Kyoto, Japan, 1998.

ASNAR, Y. et al. From Trust to Dependability through Risk Analysis, Vienna, 2007.

BASILI, V. R.; CALDIERA, G.; ROMBACH, H. D. The Goal Question Metric Approach, v. 2, p. 528-532, 1994.

BIRGIT, K.; LIST, B. Extending the EPC and the BPMN with Business Process Goals and Performance Measures, 2007.

BITTENCOURT, R.; ARAUJO, R. Identificando Expectativas de Qualidade de SIs com o apoio de Modelos de Negócio, Vila Velha, ES, Brazil, 2008.

BOARDMAN, A.; SHAPIRO, D. A Framework for Comprehensive Strategic Analysis. **Journal of Strategic Management Education**, 1, 2004.

BOELLA, G.; VAN DER TORRE, L. A Foundational Ontology of Organizations and Roles. [S.l.]: Springer, v. 4327, 2006. ISBN 3-540-68959-1.

BOTTAZI, E.; FERRARIO, R. Preliminaries to a DOLCE Ontology of Organizations. **J. Business Process Integration and Management**, Vol.1, 2006. pp.64–74.

BOTTAZZI, E. et al. From Collective Intentionality to Intentional Collectives. **Journal of Cognitive Systems Research**, 7(2-3), 2006.

BOTTAZZI, E.; FERRARIO, R. A Path to an Ontology of Organizations, Enschede, the Netherlands, 2005.

BOTTAZZI, E.; FERRARIO, R. Preliminaries to a DOLCE Ontology of Organizations, v. 1, Nos. 1/2/3, p. 64–74, 2006.

BOTTAZZI, E.; FERRARIO, R.; MASOLO, C. **Mostro, deliverable 3 - Ontology of Organizations and Security**. Autonomous Province of Trento. [S.l.]. 2007.

BOTTAZZI, E.; FERRARIO, R.; MASOLO, C. **Mostro, deliverable 3 - Ontology of Organizations and Security**. Autonomous Province of Trento. [S.l.]. 2007.

BRESCIANI, P. et al. Tropos: An Agent-Oriented Software Development Methodology. **Journal of Autonomous Agents and Multi-Agent Systems**, 2004. 203–236.

BRESCIANI, P.; SANNICOLÒ, F. Requirement analysis in TROPOS: a self referencing example, Berlin, Germany, 2003.

BUBENKO, J.; PERSSON, A.; STIRNA, J. **D3 Appendix B: EKD User Guide**. Stockholm, Sweden. 2001.

CARDOSO, E.; ALMEIDA, J. P. A.; GUIZZARDI, G. Uma Experiência com engenharia de requisitos baseada em modelos de processos, Recife, 2008.

CASTELFRANCHI, C.; FALCONE, R. Towards a Theory of Delegation for Agent-based Systems. **Robotics and Autonomous Systems**, 24, n. 24, 1998. 141-157.

CASTRO, J.; KOLP, M.; MYLOPOULOS, J. Towards requirements-driven information systems engineering: the Tropos project. **Information Systems**, Amsterdam, The Netherlands, 27, n. 6, 2002. 365-389.

CHANDRASEKARAN, B.; JOSEPHSON, J. R.; BENJAMINS, V. R. What are ontologies, and why do we need them?, 1999.

CHUNG, L. et al. **Non-Functional Requirements in Software Engineering**. [S.l.]. 2000.

CYSNEIROS, L. Evaluating the Effectiveness of using Catalogues to Elicit Non-Functional Requirements, p. 107-115, 2007.

CYSNEIROS, L. M. Personal page of Luiz Marcio Cysneiros, 2009. Disponível em: <http://math.yorku.ca/~cysneiro/nfrs/nfrs.htm>. Acesso em: 19 fev. 2009.

DANEVA, M. et al. Exploiting a Goal Decomposition Technique to Prioritize Non-functional Requirements. [S.l.]: [s.n.], 2007.

DANIEL, D. D. **Management information crisis**. [S.l.]: Harvard Business Review, v. 39, 1961. 111-121 p.

DARDENNE, A.; LAMSWEERDE, A. V.; FICKAS, S. Goal-directed Requirements Acquisition. [S.l.]: [s.n.], v. 20, 1993. p. 3-50.

DAVENPORT, T. **Process Innovation:** Reengineering work through Information Technology. [S.l.]: Harvard Business School, 1992.

DAVIS, R. **Business Process Modelling with ARIS - A Practical Guide**. [S.l.]: Springer, 2001.

DIGNUM, V. A Model for Organizational Interaction: Based on Agents, Founded in Logic, Utrecht University, The Netherlands., 2004.

DIJKMAN, R. Consistency in Multi-Viewpoint Architectural Design., 2006.

ESTRADA, H.; MARTÍNEZ, A.; PASTOR, O. Goal-based business modeling oriented towards late requirements generation. [S.l.]: [s.n.], v. 2813, 2003.

FERRARIO, R.; OLTRAMARI, A. Towards a Computational Ontology of Mind. [S.l.]: IOS Press, pp. 287-297., 2004.

FOX, M. S. et al. An organization ontology for enterprise modelling, Menlo Park, CA, 1998.

FRANKEL, D. **Model Driven Architecture:** Applying MDA to Enterprise Computing. [S.l.]: OMG Press, 2003.

GIORGINI, P. et al. Formal Reasoning Techniques for Goal Models, 2004.

GIORGINI, P. et al. The Tropos Metamodel and its Use. **Informatical journal**, 2005.

GONZÁLEZ, J.; DÍAZ, J. S. Business process-driven requirements engineering: a goal-based approach, 2007.

GREGOR, S. The Nature of Theory in Information Systems. **MIS Quarterly**, 30, n. 3, 2006. 611-642.

GRUINGER, M.; ATEFI, K.; FOX, M. Ontologies to Support Process Integration in Enterprise Enginnering, p. 381–394, 2000.

GUIZZARDI, G. Ontological Foundations for Structural Conceptual Models, University of Twente, The Netherlands., 2005.

GUIZZARDI, G. On Ontology, ontologies, Conceptualizations, Modeling Languages, and (Meta)Models, Amsterdã, 2007.

GUIZZARDI, G.; FALBO, R.; RENATA, G. Grounding Software Domain Ontologies in the Unified Foundational Ontology (UFO): The case of the ODE Software Process Ontology, Recife, 2008.

GUIZZARDI, R. et al. Towards an Integrated Methodology to Develop KM Solutions with the Support of Agents, Waltham (MA), EUA, 2005.

GUIZZARDI, R. et al. Ontological Foundations for Agent-Oriented Organizational Modeling, Recife/PE, 2008.

GUIZZARDI, R. S. S. Agent-oriented Constructivist Knowledge Management, The Twente University, the Netherlands, 2006.

GUIZZARDI, R. S. S. et al. Towards an Ontological Account of Agent Oriented Goals, 5, 2007.

GUIZZARDI, R.; PERINI, A. Analyzing Requirements of Knowledge Management Systems with the Support of Agent Organizations. **In Journal of the Brazilian Computer Society (JCBS). Special Issue on Agents Organizations**, 11, n. 1, 2005.

HALLEUX, P.; MATHIEU, L.; ANDERSSON, B. A Method to Support the Alignment of Business Models and Goal Models, 2008.

HAMMER, M. **Reengineering Work:** Don't Automate, Obliterate. [S.l.]: Harvard Business Review, 1990.

HAMMER, M.; CHAMPY, J. **Reengineering the Corporation:** A Manifesto for Business Revolution. London, England: Nicholas Brealey Publishing, 1993.

HARRINGTON, H. J. **Business Process Improvement:** The Breakthrough Strategy for Total Quality, Productivity and Competetiveness. New York: MacGraw-Hill, 1991.

HENDERSON, J.; VENKATRAMAN, N. Strategic Alignment: leveraging information technology for transforming operations. **IBM Systems Journal** , 1993.

IEEE. IEEE Recommended practice for architectural description of software-intensive systems. **IEEE Std 1471-2000**, New York, 2000.

ISTC-CNR. **Mostro, deliverable 2 - Designing Organizations: Towards a Model**. Autonomous Province of Trento. [S.l.]. 2005-2007.

ISTC-CNR. **Mostro, deliverable 5 - Methodologies for Organization and Security**. Trento. 2006.

ISTC-CNR. **Mostro, deliverable 3 - Ontology of Organizations and Security - An Ontology of the Teleological Dimension in Organizations**. [S.l.].

ISTC-CNR. Ontology of Organizations and Security - An Ontology of the Teleological Dimension in Organizations.

JONKERS, H. et al. Concepts for Modelling Enterprise Architectures. **International Journal of Cooperative Information Systems**, 2004.

JONKERS, H. et al. Enterprise architecture: Management tool and blueprint for the organization, Netherlands, 8, 2006.

JURETA, I.; FAULKNER, S.; SCHOBBENS, P.-Y. A More Expressive Softgoal Conceptualization for Quality Requirements Analysis, Arizona, 2006.

KAVAKLI, E. Goal-Oriented Requirements Engineering: A Unifying Framework. **Requirements Engineering Journal**, 6, 2002. 237-251.

KAVAKLI, E. Modeling Organizational Goals: Analysis of Current Methods, Nicosia, Cyprus, 2004.

KAVAKLI, E.; LOUCOPOULOS, P. Goal-driven business process analysis application in electricity deregulation. **Information Systems**, 1999.

KAVAKLI, E.; LOUCOPOULOS, P. Goal Driven Requirements Engineering: Evaluation of Current Methods, 2003.

KEENEY, R. L. Creativity in Decision Making with Value-Focused Thinking. **Sloan Management**, 4, 1994.

KOBRYN, C.; SIBBALD, C. Modeling DoDAF Compliant Architectures: The Telelogic Approach for complying with DoD Architectural Framework., 2004.

KOLIADIS, G. et al. A Combined Approach for Supporting the Business Process Model Lifecycle, 2006.

KOLIADIS, G.; GHOSE, A. Relating business process models to goal-oriented requirements models in KAOS, 4303, 2006.

KOTLER, P.; BROWN, A.; ARMSTRONG, G. **Principles of Marketing 7ed**. New Jersey: Prentice-Hall, 2006.

KOUBARAKIS, M.; PLEXOUSAKIS, D. A formal model for business process modelling and design, 2000. 142–156.

KUENG, P.; KAWALEK, P. Goal-based business process models: creation and evaluation. **In Business Process Management Journal 3**, 1997. pp. 17-38.

LAMSWEERDE, A. Goal-Oriented Requirements Engineering: A Guided Tour, 2001.

LAMSWEERDE, A.; DARIMONT, R.; LETIER, E. Managing Conflicts in Goal-Driven Requirements Engineering, 1998.

LANKHORST, M. **ArchiMate Language Primer**. Enschende. 2004.

LANKHORST, M. **Enterprise Architecture at Work - Modelling, Communication, and Analysis**. [S.l.]: Springer-Verlag, 2005.

LANKHORST, M. et al. **Enterprise Architecture at Work - Modelling, Communication, and Analysis**. [S.l.]: Springer-Verlag, 2005.

LAPOUCHNIAN, A. **Goal-Oriented Requirements Engineering: An Overview of the Current Research**. Toronto. 2005.

LIN, Y. Semantic Annotation for Process Models: Facilitating Process Knowledge Management via Semantic Interoperability, Trondheim, Norway, Volume 2008.239, 2008.

LOUCOPOULOS, P. The S3 (strategy-service-support) framework for business process modeling, Portugal, 2001.

MARKOVIC, I.; KOWALKIEWICZ, M. Linking Business Goals to Process Models in Semantic Business Process Modeling, 2008.

MCCARTHY, W. The REA Accounting Model: A Generalized Framework for Accounting Systems in a Shared Data Environment. **The Accounting Review**, 1982.

MENDES, R. et al. Representing Business Strategy through Goal Modeling, Setubal, 2001.

MINISTÉRIO DA SAÚDE. Portal da Saúde, 2009. Disponível em: <http://portal.saude.gov.br/portal/arquivos/pdf/sus_3edicao_completo.pdf>. Acesso em: 19 set. 2009.

MYLOPOULOS, J. et al. Representing and using non-functional requirements: a process-oriented approach, 1992. 483-497.

NACHMIAS, D.; NACHMIAS, C. **Research methods in the social sciences**. 3rd edition. ed. New York: St. Martins Press, 1992.

NEIGER, D.; CHURILOV, L. Structuring Business Objectives: a Business Process Modeling Perspective, Berlin Heidelberg, 2003.

NEIGER, D.; CHURILOV, L. Goal-Oriented Business Process Engineering Revisited: a Unifying Perspective, 2004.

NEIGER, D.; CHURILOV, L. Goal-Oriented Business Process Modeling with EPCs and Value-Focused Thinking, 2004. 98-115.

NOY, N. Semantic Integration: A survey of ontology-based approaches. **SIGMOD Record**, 33, n. 4, 2004. 65–70.

NURCAN, S. et al. A strategy driven business process modelling approach, 11, 2005. 628-649.

NURCAN, S. et al. Enterprise, Business-Process and Information Systems Modeling, Amsterdam, The Netherlands, 29, 2009.

OBJECT MANAGEMENT GROUP (OMG). MDA Guide, v. V1.0.1, 2003.

OBJECT MANAGEMENT GROUP (OMG). Business Motivation Model (BMM), 2008.

OBJECT MANAGEMENT GROUP (OMG). Unified Profile for the Department of Defense Architecture Framework (DoDAF) and the Ministry of Defence Architecture Framework (MODAF) (UPDM), 2009.

O'SULLIVAN, J.; EDMOND, D.; TER HOFSTEDE, A. What's In a Service? Towards Accurate Description of Non-Functional Service Properties, 2002.

PACHECO, O.; SANTOS, F. Delegation in a role-based organization, LNAI 3065, 2004.

PASTOR, O.; MOLINA, J. **Model-Driven Architecture in Practice**. [S.l.]: Springer, 2007.

PROCEEDINGS of the HCI*02 Workshop on Goal-Oriented Business Process Modeling GBMP'02. [S.l.]: Edited by Ilia Bider and Paul Johannesson, 2002.

QUARTEL, D.; ENGELSMAN, W.; JONKERS, H. Modelling requirements in enterprise architectures, 2009.

RAO, A. S.; GEORGEFF, M. P. Modeling Rational Agents within a BDI-Architecture. **In Proceedings of the Second International Conference on Principles of Knowledge Representation and Reasoning (KR'91)**, Cambridge, 1991. 473–484.

RECKER, J. et al. **Business process modeling: A maturing discipline?** [S.l.]. 2006.

RILSTON, F.; CASTRO, J. Enhancing Data Warehouse Quality with the NFR Framework, Valencia, 2002.

ROCKART, J. F. **Chief executives define their own data needs**. [S.l.]: Harvard Business Review, v. 57, 1979. 81-92 p.

ROLLAND, C.; SOUVEYET, C.; CAMILLE, B. A. **Guiding Goal Modeling Using Scenarios**. [S.l.]: [s.n.]. 1998.

SAMAVI, R.; YU, E.; TOPALOGLOU, T. Strategic Reasoning about Business Models: a Conceptual Modelling approach. **Journal of Information Systems & E-Business Management**, Berlin, 2008.

SANTOS JR., P.; ALMEIDA, J. P.; PIANISSOLLA, T. Uncovering the Organizational Modelling and Business Process Modelling Languages in the ARIS Method. **International Journal of Business Process Integration and Management (IJBPIM)**, 2009.

SCHEER, A. W. **Aris – Business Process Modeling**. Springer, 2000.

SCHUTT, R. K. **Investigating the social world:** The process and practice of research. Thousand Oaks: Pine Forge Press., 1999.

SEALE, C. et al. **Qualitative Research Practice**. London, UK: Sage Publications Ltd., 2004.

SEARLE, J. The Construction of Social Reality, New York, 1995.

SEARLE, J. **Mind, Language and Society**. [S.l.]: Basic Books, 2000.

SHARP, A.; MCDERMOTT, P. **Workflow Modeling-Tools for Process Improvement and Application Development**. [S.l.]: Artech House, 2001.

SHOHAM, Y. Agent-oriented Programming, 1993.

SINGH, S. N.; WOO, C. A Methodology for Discovering Goals at Different Organizational Levels, 2008.

SOFFER, P.; WAND, Y. On the notion of soft-goals in business process modeling, 2005. 663– 679.

SUPER CONSORTIUM. Super Project, 2009. Disponível em: <http://www.ip-super.org/>. Acesso em: 15 set. 2009.

TEKINERDOGAN, B. Synthesis-Based Software Architecture Design, Twente, the Netherlands, 2000.

TEKINERDOGAN, B.; AKSIT, M. Introducing the Concept of Synthesis in the Software Architecture Design Process. **Journal of Integrated Design and Process Science**, 2006. 45-56.

TELEMATICA INSTITUUT. Archimate Resource Tree. **http:** //www.telin.nl/NetworkedBusiness/Archimate/ART/, 2009. Disponível em: <http://www.telin.nl/NetworkedBusiness/Archimate/ART/>. Acesso em: 14 jul. 2009.

THE OPEN GROUP. What's ArchiMate. **http:** //www.archimate.org/, 2009. Disponível em: <http://www.archimate.org/en/about_archimate/what_is_archimate.html>. Acesso em: 14 jul. 2009.

USA DEPARTMENT OF DEFENSE. DoD Aarchitecture Framework version 1.5 Volume I: Definitions and Guidelines. **The United States Department of Defense**, 2007. Disponível em: <http://www.defenselink.mil/cio-nii/>. Acesso em: 2009.

USCHOLD, M. et al. The Enterprise Ontology, 1998. 31-89.

VAN DER AALST, W. M. P.; TER HOFSTEDE, A. H. M.; WESKE, M. Business process management: A survey, v. 2678, p. 1–12, 2003.

VAN ECK, P. A. T.; BLANKEN, H. M.; WIERINGA, R. J. Project GRAAL: Towards Operational Architecture Alignment. **International Journal of Cooperative Information Systems**, 13, 2004. 235-255.

WIERINGA, R. J.; VAN ECK, P.; BLANKEN, H. Architecture Alignment in a Large Government Organization: A Case Study. **Proceedings of 16th Internationa'l Conference on Advanced Information Systems**, Latvia, 2004.

YAMAMOTO, S. et al. Goal Oriented Requirements Engineering: Trends and Issues. **IEICE - Transactions on Information Systems E89-D**, 2006.

YIN, R. **Case Study research:** Design and Methods. [S.l.]: Sage Publications, Inc; 4rd edition , 2008.

YU, E. Modeling Strategic Relationships for Process Reengineering, 1995.

YU, E. Agent-oriented modeling: Software versus the world. In: SCIENCE, L. N. I. C. **Agent-Oriented Software Engineering II**. Berlin / Heidelberg: Springer , 2002.

YU, E.; STROHMAIER, M.; DENG, X. Exploring Intentional Modeling and Analysis for Enterprise Architecture, 2006.

ZACHMAN, J. A Framework for Information Systems Architecture. **IBM Systems Journal**, 1987. 276-292.

ZACHMAN, J. The Framework for Enterprise Architecture: Background, Description and Utility, 2003.