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***Methods and Tools for Human-centric Business
Process Management – Comparative Study***



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Abstract

Business Process Management (BPM), as a methodology, has been the state of art, for many years, in organizing an enterprise's workflow through implementing business processes. This approach was adopted as it seems ideal for handling the routine work every organization has to deal with in a daily basis. However, as organizations, nowadays, throughout the globe, tend to employ more and more knowledge workers, this approach seems to become inappropriate to manage workflows in knowledge-intensive working environments. To this end, alternative approaches have been developed to handle work within knowledge-based and human-centered domains. Three of these approaches, Adaptive Case Management, Subject-Oriented Business Process Management and the Notify & Register approach, are examined within the scope of this master thesis. To gain a spherical knowledge for each one of these theories, the literature upon which these methodologies are based was reviewed, as well as a meta-model for each one of them was created. These conceptual meta-models were evaluated upon the same human-centered environment, healthcare. A healthcare case study was used, more specifically, the Patient Treatment case study, as an agile and continuously changing working environment, which is both human-centered and knowledge-intensive. Finally, a comparative study between these three human-centric approaches has taken place, so as to make a comparison of their key features and a matching of meta-models elements when possible. That way, it is examined how it is possible for business analysts to alternate this based-upon-human part of Business Process Management, and make it more efficient and more effective by making it more agile, more adaptive and more "change-proof".

Keywords: Business Process Management, Adaptive Case Management, Subject Oriented Business Process Management, Notify & Register, Meta-model, Healthcare.

Abstract in Greek

Η Διαχείριση Επιχειρησιακών Διαδικασιών (BPM), ως μεθοδολογία, υπήρξε για πολλά χρόνια το πρότυπο για την οργάνωση των εργασιών μέσα σε μία επιχείρηση, υλοποιώντας επιχειρηματικές διαδικασίες. Αυτή η προσέγγιση υιοθετήθηκε καθώς μοιάζει ιδανική για την διαχείριση των εργασιών ρουτίνας που κάθε οργανισμός πρέπει να φέρει εις πέρας σε καθημερινή βάση. Παρόλα αυτά, καθώς η οργανισμοί, την σημερινή εποχή, σε ολόκληρο τον κόσμο, τείνουν να απασχολούν όλο και περισσότερους υπαλλήλους με υψηλό γνωστικό υπόβαθρο, η παραπάνω προσέγγιση μοιάζει να γίνεται ακατάλληλη για την διαχείριση εργασιών σε υψηλού γνωστικού περιεχομένου εργασιακά περιβάλλοντα. Για το λόγο αυτό, γίνεται προσπάθεια από τον ακαδημαϊκό κόσμο εύρεσης εναλλακτικών προσεγγίσεων για την διαχείριση εργασιών σε ανθρωποκεντρικά εργασιακά περιβάλλοντα έντονου γνωστικού περιεχομένου. Τρεις από αυτές τις προσεγγίσεις, η Adaptive Case Management, η Subject-Oriented Business Process Management και η Notify & Register μεθοδολογία, εξετάζονται στα πλαίσια αυτής της διπλωματική μελέτης. Προκειμένου να αποκτηθεί μια σφαιρική άποψη και γνώση για καθεμία από αυτές τις θεωρίες, η βιβλιογραφία και η σχετική έρευνα πάνω στην οποία στηρίζονται αυτές οι μεθοδολογίες αυτές παρουσιάζονται, καθώς δημιουργείται και από ένα μεταμοντέλο για κάθε μια από τις προσεγγίσεις αυτές. Τα μεταμοντέλα αυτά αξιολογούνται μέσω μιας κοινής μελέτης περίπτωσης στο ίδιο ανθρωποκεντρικό περιβάλλον, τον τομέα της Υγείας. Ο τομέας αυτός επιλέχθηκε, και πιο συγκεκριμένα η μελέτη περίπτωσης για την περίθαλψη ενός ασθενούς, καθώς αποτελεί ένα ευέλικτο και συνεχώς μεταβαλλόμενο εργασιακό περιβάλλον, το οποίο είναι και ανθρωποκεντρικό αλλά και υψηλού γνωστικού περιεχομένου. Τέλος, λαμβάνει χώρα μια συγκριτική μελέτη ανάμεσα σε αυτές τις τρεις ανθρωποκεντρικές προσεγγίσεις, με σκοπό να γίνει μια σύγκρισή των σημαντικότερων χαρακτηριστικών τους, αλλά και μια αντιστοίχιση των στοιχείων των μεταμοντέλων που δημιουργήθηκαν όπου αυτό καθίσταται δυνατόν. Με αυτό τον τρόπο, εξετάζεται το πόσο πιθανό είναι για τους επιχειρησιακούς αναλυτές να διαφοροποιήσουν αυτό βασισμένο στον άνθρωπο κομμάτι της Business Process Management, ώστε να γίνει πιο αποδοτικό και αποτελεσματικό, κάνοντας το πιο ευέλικτο, πιο προσαρμόσιμο και ανθεκτικότερο στις αλλαγές.

Λέξεις-κλειδιά: BPM, Adaptive Case Management, Subject-Oriented Business Process Management, Notify & Register, μεταμοντέλο, Τομέας Υγείας.

Table of Contents

Acknowledgements	- 2 -
Abstract	- 3 -
Abstract in Greek	- 4 -
1. Introduction	- 8 -
1.1. Business Process Management	- 8 -
1.2. Problem Statement	- 9 -
1.3. Thesis Structure	- 10 -
2. Thesis Approach	- 11 -
2.1. Introduction	- 11 -
2.2. Case Study	- 11 -
2.2.1. Healthcare - Patient Treatment	- 11 -
2.2.2. Patient Treatment - Process Description	- 11 -
2.2.3. Patient Treatment – Users and Tasks	- 13 -
3. Adaptive Case Management	- 15 -
3.1. Introduction	- 15 -
3.2. Related Work	- 16 -
3.2.1. Adaptive Case Management definition	- 16 -
3.2.2. Knowledge Work characteristics	- 17 -
3.2.3. Adaptive Case Management characteristics	- 18 -
3.2.4. Comparison to Business Process Management	- 19 -
3.3. Description of Basic Entities	- 21 -
3.3.1. Case Management Modeling and Notation (CMMN)	- 21 -
3.3.2. A data-model for Case Management	- 22 -
3.4. Proposed Meta-model	- 25 -

3.4.1.	Meta-model Description	- 25 -
3.4.2.	Compliance with CMMN standard	- 27 -
3.5.	Experimental Tool.....	- 29 -
3.5.1.	Implementation through Oracle BPM Suite	- 29 -
3.5.2.	Case Study Evaluation	- 33 -
4.	Subject-Oriented Business Process Management	- 41 -
4.1.	Introduction	- 41 -
4.2.	Related work	- 42 -
4.2.1.	Subject-Orientation	- 42 -
4.2.2.	Main Idea: S-BPM as an integrated organizational structure	- 43 -
4.2.3.	Natural Language as a boost for Subject-Oriented Modeling	- 44 -
4.2.4.	Steps of S-BPM Process Modeling.....	- 45 -
4.3.	Description of Basic Entities.....	- 46 -
4.3.1.	Processes and Process Groups	- 46 -
4.3.2.	Subjects	- 47 -
4.3.3.	Messages	- 48 -
4.3.4.	States and State types.....	- 49 -
4.3.5.	Transitions.....	- 50 -
4.4.	Proposed Meta-Model	- 51 -
4.4.1.	Meta-Model Description	- 51 -
4.5.	Experimental Tool.....	- 53 -
4.5.1.	Processes	- 54 -
4.5.2.	Subjects	- 55 -
4.5.3.	Assigning Roles to Subjects.....	- 56 -
4.5.4.	Messages	- 57 -

4.5.5.	Subject's internal behavior	- 58 -
4.5.6.	States and Transitions	- 59 -
4.6.	Case Study Evaluation	- 61 -
5.	The Notify & Register Approach.....	- 67 -
5.1.	Introduction	- 67 -
5.2.	The approach	- 67 -
5.2.1.	The event.....	- 67 -
5.2.2.	The approach's objective	- 68 -
5.3.	The Notify & Register approach Meta-Model	- 69 -
5.4.	Compliance with Patient Treatment	- 71 -
6.	Approaches' Comparative Study	- 72 -
6.1.	Modeler's Perspective Comparison	- 72 -
6.2.	Approaches' meta-model elements matching	- 81 -
7.	Conclusions and Future Work	- 83 -
7.1.	Conclusions	- 83 -
7.2.	Future Work	- 85 -
	References	- 86 -

1. Introduction

1.1. Business Process Management

Nowadays, there is not even one successful company which does not organize and execute its business work through processes. The number of processes a company or an organization implements, depends basically on its size. Large companies tend to have a massive number of running processes on everyday basis. Other, smaller industries limit their processes amount to a lower level. On the other hand, these processes can vary from remarkably simple processes, with only one or two involved participants to highly complex business processes with a dozen or hundreds of participants. (Fleischmann, et al., 2013)

The main goal of a business process is to define how an organization reacts to business events inside a continuously changing business environment. Thus, daily handling of such business processes seems to be of great importance for organizations in order to keep them both effective and efficient while they would retain the ability to react accordingly to changes. (Fleischmann, et al., 2013)

This can be ensured through the usage of Business Process Management (BPM). It could be described as a universal concept of organizing and executing business work in any type of organization, a concept that uses a variety of methodologies and tools so as to identify, handle and improve a company's processes. (Fleischmann, et al., 2013) However, the most well-known definition of this type of management is described as “a discipline involving any combination of modeling, automation, execution, control, measurement, and optimization of business activity flows in support of enterprise goals, spanning systems, employees, customers, and partners within and beyond the enterprise boundaries.” (von Rosing, et al., 2015) From this definition some conclusions could be drawn.

The first one is that by the term “discipline” as it is mentioned in the BPM definition, a structure is described, a set of actions which the organizations are taking so as to control their business workflows. This set of actions includes the analysis and modeling in the design phase of a process, the validation and optimization of the process by the time it will be implemented, embedding the process into the organizational scheme and any existing IT infrastructure into the created process

and finally, running and monitoring the process. (Fleischmann, et al., 2013) Any enterprise can adapt its business processes to this concept so as to gain a well-structured workflow.

The second conclusion that can be drawn from the above mentioned definition is that Business Process Management is system-centered or enterprise-centered. Namely, the sequence of actions described in a business process management model aims in accomplishing the business goals and supporting the enterprise systems and does not aim in supporting decision making and adaptivity¹ in change. On the contrary it aims in controlling workers within an organization, leaving them no responsibilities and ad-hoc actions to take.

1.2. Problem Statement

This philosophy does not fit with today's service industry, where people who undertake activities in knowledge-intensive service processes are highly qualified. Those people, who probably are specialists in their areas of expertise, usually would prefer being left to define their work by themselves rather than being controlled by a firm business workflow model. (Fleischmann, et al., 2013) For that reason, a facilitating and supporting concept would be preferable than a restricting one.

What was mentioned above consists the great drawback of Business Process Management, namely the fact that, while it is considered as a so commonly used discipline for the organizations around the world in order to construct their business strategies and activities, BPM seems unable to support organizations in adapting their business activities, strategies and workflows in changing environments and stakeholder needs.

These environments are domains of work where the ability for the enterprise or the organization to handle change is of great importance. Those could be healthcare, legal, social work and few other. The common characteristic between these domains is that the work procedure simply cannot be implemented through usage of machine programs uniquely, as it needs human worker involvement because the work that has to be done in these domains is highly variable (Motahari-Nezhad, et al., 2013)

¹ Adaptivity is the ability to adjust behavior to changes in context. (Sem, et al., 2013)

1.3. Thesis Structure

After introducing the scope of this master thesis in brief, as well as stating the problem that at this time exists and for which an attempt to find an appropriate solution is made, a view of the thesis structure and the context of the following chapters is described below.

Chapter 2 describes in detail the proposed approach of this thesis. The domain, upon which a comparative study between Adaptive Case Management, Subject Business Process Management and Notify & Register approaches takes place, is presented as well as a characteristic case study with which an evaluation of the above mentioned approaches is made too.

Chapter 3 discusses the theory of Case Management as a principle of handling human-centric processes in agile environments. A brief presentation for this theory, and a view to the related work that is done already from other academics on this context is projected as well as a meta-model is created in order to have a conceptual, simple and understandable description of this approach. In addition, the created meta-model is implemented through a recognized tool for Case Management so as to check its validity.

Chapter 4 discusses the theory of Subject Business Process Management. A quick view of the theory main concepts as well as a revision of the characteristics for this approach, takes place in this chapter. As in Chapter 3, a meta-model for this principle is presented and validated through a tool that supports appropriately S-BPM.

Chapter 5 presents the key features of the Notify & Register approach. A description of the philosophy upon which this methodology is based takes place as well as the presentation of its core features is made in order to conceptualize this event-driven approach into a meta-model. This meta-model is not created as part of this thesis scope, as it already exists and is rather conceptual and descriptive.

Chapter 6 contains the most important part of this master thesis. That is where the comparative study between the three, above-mentioned, methodologies takes place. A matching between the approaches, based on their meta-models elements, as well as a comparison of their main characteristics are included in this chapter. That chapter provides a complete understanding of the human-centered business process management alternatives.

Chapter 7 includes the conclusions upon this thesis context and some proposals for future work.

2. Thesis Approach

2.1. Introduction

In order to achieve a better management of work in the above mentioned domains, more agile approaches need to be examined. As it is described in the thesis title, the goal of this master thesis is to examine how a more human-centric aspect of Business Process Management can be implemented through different and alternative modeling approaches which present the business processes from the view of a human, namely a worker, who has the knowledge to execute them properly. These three approaches are Adaptive Case Management (ACM), Subject Business Process Management (S-BPM) and Notify & Register (NR), upon which a comparative study will take place as well as upon the tools that support those methods by adopting a typical process management example in a case study settled in a human-centric environment.

2.2. Case Study

2.2.1. Healthcare - Patient Treatment

A significant and representing example of such a case study is Patient Treatment. Patient Treatment is a challenging issue, since it largely depends on human decision often taken in an ad-hoc manner, a fact that makes it highly dynamic. It fits into the domain of Healthcare, which, as it was mentioned above, is a domain where the work procedure needs human worker involvement as the work that has to be done is highly variable. As far as Healthcare is concerned, it represents the largest business segment in the world. According to Organization for Economic Co-Operation and Development on its annual report in 2009, Healthcare was accounting for around 10% of GDP of developed world, whereas in the non-developed world is still one of the most critical areas for future growth. (Swenson, 2010)

2.2.2. Patient Treatment - Process Description

As a comparative study needs to take place between these approaches for human-centric Business Process Management, the field of Patient Treatment Process has to be examined closely. The aim is to familiarize ourselves with the variety of Tasks performed by the end users during Patient Treatment.

*To begin with, the patient is admitted to a hospital's Medicine Clinic if he/she needs to be hospitalized, a decision that is taken at the Emergency Department. The **Emergency Department personnel** provide the physicians of the clinic with information regarding the clinical status of the patient, such as medical history and any examinations that have been done or scheduled.*

*Based on this initial information, **the physicians** of the Medicine Clinic start the treatment of the patient. They specify a diagnosis for the patient and prescribe the medication accordingly. Such information is registered into the patient's file. During treatment, a clinical examination takes place every morning by the physicians, aiming at monitoring the patient's clinical course. To this end, laboratory and/or imaging examinations may be scheduled. The results, which are also registered into the patient's file, are evaluated by the physicians and if necessary the diagnosis and medication are revised. There may be cases that the physicians will need to consult a specialist in order to conclude about the patient's health problem or about the way the patient should be treated.*

***The nursing personnel** aids in the treatment process through operations regarding, for example, the preparation and administration of the specified medication, blood drawing and measurements of vital signs (e.g. temperature, blood pressure, etc.). Medication administration and measurements are performed at the times specified by the physician. The measured values are written in the patient's chart. Moreover, the nursing personnel keeps notes of anything remarkable regarding the patient, for example, a sign they observed, as well as of any action they performed by their own initiative, for example any ad hoc medication they may have administered to the patient (e.g. the administration of an analgesic pill in case the patient suffers from a headache).*

*During treatment, several unexpected situations may arise, which may lead to ad hoc clinical, laboratory or imaging examinations, as well as to reconsideration of the medication administered or even of the diagnosis specified so far. The patient may need to be transferred to **the Intensive Care Unit** or to undergo an urgent surgery.*

The need for a patient to remain hospitalized is daily examined after the morning clinical examination based on the data gathered up to that point. If it is decided that the patient does not need further hospitalization, the treatment process ends and the patient is discharged. (Alexopoulou, et al., 2009)

As it can be easily identified, users are the highlighted ones, who respectively are responsible for the execution of specific tasks within the Patient Treatment Process. An interaction between users is identified, as well as a fluidness in tasks' sequence of execution, characteristics that consist a variable human-based process environment.

2.2.3. Patient Treatment – Users and Tasks

As a better identification of the correspondence between users and tasks needs to be made a classification of tasks per user is presented in the table below:

Table 1. A first reading of the Patient Treatment Process case study's main elements.

Users	Tasks
Emergency Department Personnel	Provide health status information
Physicians	Start treatment
	Specify diagnosis
	Prescribe medication
	Clinical examination
	Schedule examination
	Evaluate examination results
	Revise diagnosis / medication
	Consult a specialist
Nursing Personnel	Administrate medication
	Blood Drawing
	Vital signs measurements
	Record measurements
ICU Personnel	Urgent surgery

As a comment for this first representation of case study's main elements (users and tasks), it can be highlighted that the main users such as *Physicians* and *Nursing Personnel* have more responsibilities than the secondary users who work in other departments but are ready to get involved in the patient treatment process when needed.

Secondly, another fact that is needed to be mentioned is that although there might be a slight sequence and dependence between some tasks, there are some ad-hoc actions that are conditionally taken, or emergency tasks that are not in the process main workflow.

3. Adaptive Case Management

3.1. Introduction

A case is not a common sequence of business processes. It requires knowledge work, namely thinking, skills, expertise and experience as far as the details of the situation is concerned in order to make all the essential process design appropriately. The human resource in those domains is described as knowledge workers, people with high degrees of expertise, education or experience. (Mundbrod, et al., 2012)

Moreover, in knowledge work systems like healthcare, legal and social work that were mentioned above (see Chapter 1.2), the knowledge workers that are involved in the case process are expected to interfere in multiple contexts and adopt in different roles. That means that they have to interact between each other, to collaborate, with the aim to produce better results in their changing and adaptive activities.

To that end, the meaning of collaborative knowledge work, described as a type of knowledge work which is jointly performed by a team of knowledge workers with the aim to fulfil a common organizational goal, (Mundbrod, et al., 2012) leads to a practice used to organize and structure case handling actions in organizations with changing workflows, the Case Management or as it is most commonly known in conference papers and proceedings Adaptive Case Management (ACM).

Case management as a practice is not something new; references to the term “case management” go back to the 1980s or earlier and the Case Management Society of America was founded back in 1990. This type of management refers not only to the coordination of work in one organization that is not routine and unpredictable, and requires human judgment in order to be executed, but it also refers to gathering all of the relevant information into one place, which is called case folder, and acting upon this source of information to fulfill any organizational requests. (Motahari-Nezhad, et al., 2013)

A deeper look in Adaptive Case Management is following, reviewing the basic characteristics for this approach. In addition, a brief description is given of the standard for Case Management which was published by Object Management Group ([OMG](#)) named as Case Management Modeling and Notation ([CMMN](#)) as well as how it is interpreted in a tool created by academics for ACM.

3.2. Related Work

3.2.1. Adaptive Case Management definition

As described above, ACM refers to a practice that when certain requirements are met, optimizes knowledge work in domains such as healthcare, legal and social work. An appropriate definition for an Adaptive Case Management system would be:

*A system that is able to support **decision** making and **data capture** while providing the **freedom** for knowledge workers to apply their own understanding and subject matter expertise to respond to **unique or changing** circumstances within the business environment.* (Swenson, 2010)

There are some highlighted terms that describe quite precisely the philosophy behind this approach.

First of all, the center of attention in Adaptive Case Management is data exchange. Data that represent either the input streams in the Case Management process, or the outputs of the Case Management tasks. By capturing data, what is really captured is knowledge about the case that is executed and experience that will be valuable to future similar knowledge work. Valuable data about the case that is executed, are often outside the main case process, usually in inboxes of knowledge workers that are involved, isolated and useless to case. (Motahari-Nezhad, et al., 2013)

In addition, supporting decision making means that the system except from not restricting the case workers as far as their “next move” is concerned, it also assists them to choose which one is the best option for the executed case. In some extent, the system leaves its users (knowledge workers) free to prioritize the sequence of their activities in their own way, even to change it on runtime as there is great need to be agile and adaptive in these human-centric environments.

Before the main elements of Adaptive Case Management are presented, a look into the base of this approach needs to be taken. In order to have a deep understanding of the ACM and its features, it is essential to understand which are the characteristics of knowledge work, how these characteristics are implemented in Case handling, and how are finally translated in Adaptive Case Management features.

3.2.2. Knowledge Work characteristics

A brief definition of knowledge work was given in the introduction of this chapter. It was described as the combination of thinking, skills, expertise and experience about a situation in which knowledge workers are involved. This type of work is different from a traditional business process, as while it proceeds, the sequence of actions may change depending on the situation and plan is not predefined but is evolving throughout the knowledge work's execution. The exact opposite of knowledge work is routine work that can be planned in detail up to certain level. The routine work procedures are similarly executed between each other; thus these procedures can be easily automated. Something that is inevitable in case of knowledge work. (Swenson, 2010) What, in reality, differentiates knowledge work is highlighted below:

Firstly, as was mentioned above, knowledge work is not repeated in the same way, multiple times in a row. There are always some similarities between knowledge work procedures but the differences are so many and the cost in time of automation so big that it can be considered as a realistic technique in knowledge-intensive environments.

Secondly, knowledge work is quite difficult to be predicted in advance. This unpredictability of knowledge work refers to the fact that it is inevitable for a process designer to know in advance the sequence of specific human acts within the situation. Knowledge work context may differ from case to case, and may change before the work is finished. But the fact that makes knowledge work so unpredictable is the following one.

What really makes knowledge work unpredictable is the fact that it unfolds during execution. Any step that is taken towards the work's completion creates some knowledge. The next step uses the knowledge created previously and unfolds equally creating greater knowledge and so on. That iterative unfolding nature of knowledge work differentiates it the most from routine work. (Swenson, 2010)

The last characteristic of knowledge work is its flexibility in changing conditions. Unlike strictly defined and rigid business processes that in case of change seem extremely fragile, knowledge work can adapt in changing environments. Such a changing and variable environment is Healthcare as it was mentioned in Introduction. (See Chapter 1.3.2)

3.2.3. Adaptive Case Management characteristics

After highlighting the main characteristics of knowledge work, the elements of Adaptive Case Managements need to be presented. In order to achieve a better understanding of the key features that comprise ACM it would have been better if the term “Adaptive Case Management” was analyzed in two parts. The first one would be “Adaptivity” or as it can also be seen in literature “Agility”, while the second one would be the above mentioned term “Case Management” and how it can be adaptive or agile in context. Then, the identification of both terms characteristics would lead to a spherical understanding of Adaptive Case Management’s most important elements.

3.2.3.1. *Adaptability and Agility*

Firstly, as it was defined in the introduction of this thesis adaptivity refers to the ability to adjust behavior to changes in context. (Sem, et al., 2013) The ability to change, for an organization, is essential when is established in a human-centric business environment. Being adaptive equals to the organization undergoing internal changes, caused by outside conditions that become permanent and make the organization more fitting to those new conditions. (Swenson, 2010) On the other hand, being agile refers to the ability to move quickly from one state to another and without preparation or support. What is needed to be identified is how difficult is it for an organization to achieve agility within its workflow.

Because of the pressing challenges organizations face today, agility has become vastly important for them. Not only for this, but also because agility enables organizations reacting to those challenges positively and covering higher and higher expectations getting a competitive advantage over its rivals. In globalization, where competitors can appear out of nowhere, enterprises are bound to be open to global opportunities. That is what characterizes an agile organization. The ability to **sense** the opportunity or threat, **prioritize** the potential responses, and **act** both efficiently and effectively. (Swenson, 2010)

This how agility is achieved. At first by sensing the threats, namely being aware of its operating environment and the interactions within it, as well as its competitor’s capabilities and their ability to respond, on their turn, to changing realities. Secondly, by analyzing the organization’s purposes, bringing them to its people’s attention, making the aware of the demanding conditions and the corporational strategy that creates responses to these difficulties and setting the goals which are

pursued by the organization's staff. Finally, acting efficiently and effectively means that the prioritized actions and the organizational strategy are executed exceptionally well in order to adapt in business needs change. (Swenson, 2010)

3.2.3.2. Agility in Case Management

Being agile, enables corporations that are characterized within their context with knowledge work, to gain a competitive advantage and makes these organizations more efficient. What is more, it enables organizations to adapt their strategy while the business processes are executed. Accordingly, being adaptive or agile reinforces organizations that implement case processes.

In case of Case Management, knowledge workers need to be free to be adaptive. So, they would be able to sense, prioritize and act. Namely, they would be able to understand the circumstances under the case is to be implemented, ensure that case management activities fit with the organizational goals and finally execute these activities so as to have the best possible results.

3.2.4. Comparison to Business Process Management

After defining Business Process Management in the introduction of this thesis, as well as the terminology of Adaptive Case Management and its basic characteristics a comparison between ACM and BPM is needed to be made. With that, we get a view of what really differentiates these two approaches in the level of their scope and their features.

Firstly, Business Process Management is concerned with the lifecycle of the process definition. It differs from Adaptive Case Management in that its focus is the process which is to be executed and it is used as an organizing paradigm. In addition, process models are prepared in advance. On the other hand, differs from Business Process Management in that the case information is the center of attention and the thing around which the other artifacts are organized. (Swenson, 2010)

According to Amin Jalali and Ilia Bider, Adaptive Case Management and Business Process Management aim to achieve different goals through separating the work that has to be done in different ways. (Jalali, et al., 2014). Business Process Management is highlighted as an important area which aims in supporting operational activities in business processes within the enterprise boundaries so as to achieve business goals, while Adaptive Case Management is described as a paradigm created to support adaptivity of processes in more fluid and changing environments. It

is also endorsed that in opposition to BPM systems which handle the business processes as a strict workflow, ACM allows a high level of flexibility in systems since knowledge workers need more freedom in order to complete their work. (Jalali, et al., 2014)

The question that arises from the comparison above, is whether these two approaches can co-exist in a common environment, namely to be used in order to achieve common organizational goals. Keith D. Swenson, in one of his positions he makes a statement in order to argue with that and come to a conclusion. (Swenson, 2012) He says: “Any work support system that depends upon processes that designed with BPM cannot be considered as ACM systems”. In order to support this statement, he provides some further explanation about some types of BPM-oriented systems such as Human Process Management (HRM) systems and Production Case Management (PCM) systems, a type of Case Management system used in production related organizational environments. He highlights the fact that these two types of systems need programming skills to model a workflow in contrary to ACM systems whose activities are designed by case – knowledge workers who are the end-users for these systems. (Swenson, 2012)

3.3. Description of Basic Entities

From what was presented before, a setting is created that BPM cannot co-exist with ACM in a supporting system because different levels of expertise are needed. Although an attempt to understand further the key features of Case Management is required. Object Management Group also known for creating the standard for Unified Modeling Language (UML) published a standard for Case Management almost a year ago named as Case Management Modeling and Notation (CMMN). (OMG, 2014)

3.3.1. Case Management Modeling and Notation (CMMN)

In this standard the key features of Case Management are described vastly with extended and special terminology, as well as the appropriate notation that represents its features graphically. What needs to be taken into account is the fact that in a Case model processes, as are known through BPM are also included. The philosophy through which structured workflow is implemented in agile environments does not change.

Firstly, in this general concept description about Case Management the **Case** is described as “*a proceeding that involves a set of actions that need to be taken regarding a subject in a particular situation in order to achieve a desired outcome.*” (OMG, 2014) In the medical treatment case study that is to be examined within this thesis scope, the subject is the patient and the desired outcome is represented as the patient’s hospitalization and medical treatment.

In addition, according to the CMMN standard the notion of **Case Management** evolves from the fact that as experience grows in resolving similar Cases over time, a common set of practices and responses can be consider appropriate to manage Cases in a more repeatable manner. Case management seems to have as a fundamental characteristic the planning at run-time and not in design time phase. During run-time planning the appropriate **Tasks** are selected by the **Case Manager** or the team of **Case Workers**, the above mentioned knowledge workers, people with high level of expertise and experience in the undergone situation. (OMG, 2014)

According to the standard, the determination of which Tasks are applicable or which Tasks are to be executed next is not predefined and require decisions to be made. However, these decisions may be triggered by some **Case Events**, which vary from completing certain Tasks to achieving

some **Case Milestones**, under certain circumstances though, some Tasks may be predefined procedural **Processes**, but the overall Case cannot be considered as a predefined sequence of Tasks. (OMG, 2014)

Moreover, in order to make important decisions about the Case's execution, Case workers need to have access to data about the situation or the subject that the actions to be taken are concerned. This collection of Case data is often described as **Case File**, within which documents and either structured or unstructured data about the Case are captured for later reference by the Case Workers in order to make decisions. Except from references to data, decision making is enhanced and slightly redirected by Case Management rules that apply in specific phases of Case's execution, and that are triggered by Case events. Rules and data form the **Knowledge** that the Case produces, and that enables case workers to potentially change the planning in run-time. (OMG, 2014)

As a conclusion for this Case Management Modeling and Notation first description, what has to be mentioned is that no extensive presentation of the elements of CMMN is described in this section of the thesis. That is because the special terminology and the extensive description is difficult to be described in brief. What needs to be outlined is that the CMMN is targeted to business analysts that by using this standard are bound to capture and formalize the above mentioned Tasks, Events and Milestones into a Case Model.

3.3.2. A data-model for Case Management

Although, there is not an extensive description of the elements that are included in the Case Management Modeling and Notation standard at this part of the thesis, a highlighting of the most important characteristics would be helpful in order to have a better understanding over the Adaptive Case Management and the CMMN standard itself.

There is not such a thing as a complete model that projects all the notions included in the OMG's standard. However, a useful tool was created by Hamid R. Motahari-Nezhad and some other researchers which is called "Casebook". This cloud based system was created as an engagement platform for Case Management. (Motahari-Nezhad, et al., 2013) The data-model of Casebook is presented below, in order to have a general idea about its structure and the philosophy upon which it is based:

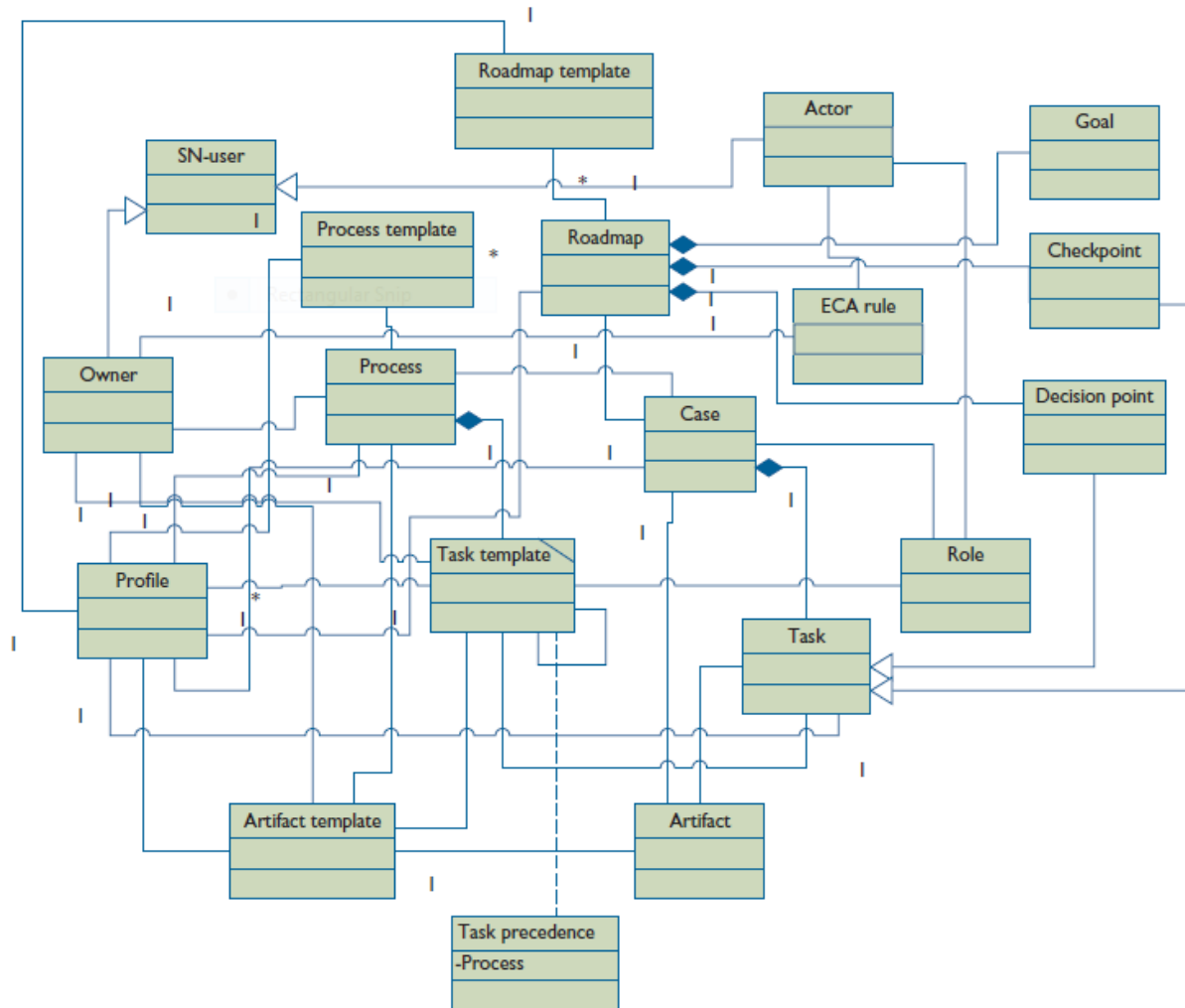


Figure 1. Casebook data model. Case element is in the center of the diagram and connected with most of the diagram's elements. (Motahari-Nezhad, et al., 2013)

Though the above displayed data model simplifies the vastly described features and the long sequence of modeling instructions provided with the Case Management standard, it still includes features that describe aspects of collaborative knowledge work² such as social collaboration, social network users and profiles that are not included in CMMN and are not part of this thesis' scope. However, some very important of characteristics of the meta-model for Adaptive Case Management we created, arise from the above diagram.

² Collaborative knowledge work (CKW) is described as knowledge work jointly performed by two or more knowledge workers in order to achieve a common business goal. (Mundbrod, et al., 2012)

Firstly, the Case element is the center of attention and one of the key features of our conceptual modeling attempt as it is connected to most of the whole diagram's primary and secondary elements. It is located in the center of the meta-model and represents the case folder which, as outlined in the introduction of this master thesis, is the center of reference for the knowledge workers and Case managers. The Case element is the first thing a knowledge worker or a case worker creates when attempting to start a new case. It is where all the relevant information about the case will be stored for later reference and describes the key characteristics of the new case.

Secondly, the data model created by Hamid R. Motahari-Nezhad et al. introduces two important features into Case Management. The first one is the notion of Roadmap and the second one is the term Artifact. Roadmap represents all the actions taken from case workers so as to accomplish the Case's milestones and goals. These actions are being recorded and are comprising an informal Case plan. On the other hand, an Artifact represents a valuable piece of information created through the Case designing, implementation or execution process. As Artifacts could be considered all the information that can create knowledge about the particular case or its template in general, and are characterized as reusable from case workers in other cases or can be data upon which knowledge mining techniques can be performed.

Moreover, the concept of Template is introduced as a repository of knowledge for the Case that is being executed, or is still in its design-time phase³. The aim is to save time for the knowledge workers when trying to build up a new case, when creating a new task or when identifying a new case artifact. (Motahari-Nezhad, et al., 2013) When a Case is created, then implemented and during its execution all the knowledge that is produced during the procedure is stored in the case folder. From the case description, the case workers that will be involved to the tasks that the case is comprised of, all these can be useful guidelines for future workers.

Thus, in our meta-model, the element of Template had to be inserted for each of the Case, Task, Artifact and Roadmap elements in order to represent the ability to store knowledge about these elements for future use or reference. Combining the characteristics singled out from Casebook's data model and the CMMN we managed to create a meta-model for Adaptive Case Management.

³ During the design-time phase, business analysts engage in modeling, which includes defining Tasks that are always part of pre-defined segments in the Case model, and "discretionary" Tasks to be applied in addition. (OMG, 2014)

3.4. Proposed Meta-model

In an attempt to project and visualize the key features of Case Management as they are described in the Case Management Modeling and Notation ([CMMN](#)) standard published by Object Management Group ([OMG](#)) as a combination with the characteristics which were singled out from Casebook's data model, we managed to create a conceptual but rather simple meta-model for Adaptive Case Management which is projected below:

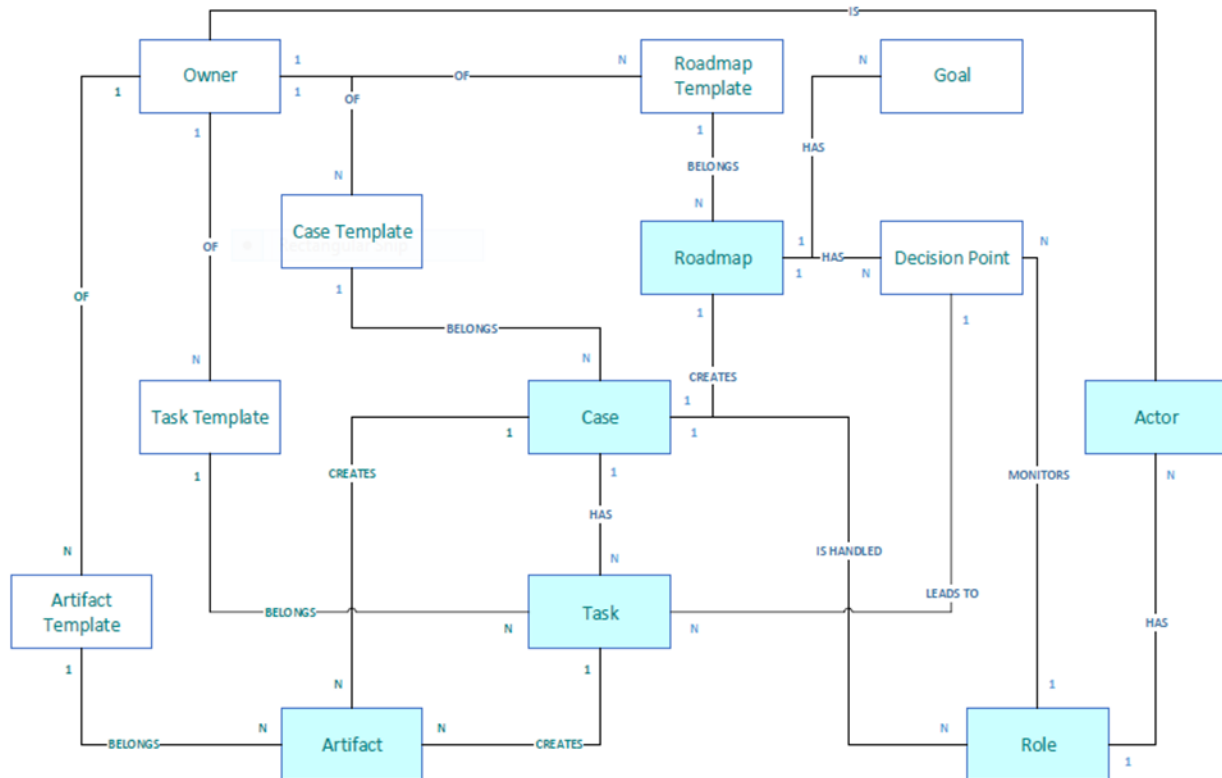


Figure 2. A meta-model for Adaptive Case Management based on Casebook's data model (Motahari-Nezhad, et al., 2013) and Case Management Modeling and Notation (OMG, 2014)

3.4.1. Meta-model Description

Inspired from the Casebook data model's conceptuality, the above shown meta-model indicates the connection between the most important elements of Case Management as they are described in the Case Management Modeling and Notation. The highlighted as cyan elements are the key features that are described below in detail, while the templates in addition to some other secondary elements are left normal.

To begin with, as it was mentioned before, the Case element is in the center of the diagram and represents the Case file of Case folder where all the relevant information for the ongoing Case is stored. If any of the stored data either create knowledge for the Case or can be considered as information useful for later reference then these data constitute an Artifact. Artifacts and the knowledge provided with them can be different since they can refer to different stages of the Case execution. Different Artifacts can be divided in different Artifact Templates and so can the different types of Cases.

Furthermore, a Case is comprised of Tasks of any type. A Task is a set of activities taken in order to accomplish a business goal, or reach a milestone for the Case's life cycle. It can be connected directly to the Case or can be part of a sub-case. In Adaptive Case Management and other human-centric process management environments, Tasks are, in majority, not predefined and are more "discretionary" and available to the Case worker, to be applied in addition, to his/her discretion. (OMG, 2014) The predefined Tasks, if any, that include routine activities, which may be essential in some Case implementations, are not excluded from the meta-model's philosophy, neither are the processes as we already know them in usual Business Process Management systems. Processes are considered as "black boxes", containing a set of predefined Tasks, which are used when needed in the Case's life cycle and are not creating any knowledge or Artifacts for the Case.

During the Case's designing, implementation and execution, Tasks are created with no predefined sequence between them. However, when they are accomplished their sequence is mapped in a Case plan as it is described in the CMMN standard (OMG, 2014), or in a Roadmap as it is used in the Casebook's data model (Motahari-Nezhad, et al., 2013) A Roadmap, except from either predefined or fixed process Tasks contains and some important milestones, defined in the design-time phase of a Case. These milestones can be divided in important Goals for the Case and in some checkpoints that when these are accomplished, a decision for the Case needs to be taken. We considered these checkpoints as Decision Points. All Task, Goal and Decision Point elements consist a Roadmap, and this way, a plan for the ongoing Case is created. This plan, after the case's execution can be classified into a Roadmap Template for future use from Case workers in similar Cases.

As we left three elements undescribed, at this point the notion of human as the center of attention is to be introduced into the model's description. It is the main characteristic of this type of process management systems and is the main ingredient that provides these systems with the sense of adaptivity.

Firstly, any Case includes, except from Tasks, Roles that will take part in the Case's life cycle, different types of specials who will accomplish different Tasks and will achieve different Goals for the Case. Secondly, this human-centric architecture for process management systems though has one more level of adaptive modeling. Every Role is divided in different Actors, specific people with the specialization of a Role but with different mental characteristics, such as judgement and determination that will differentiate him/her from the Case co-workers and will be considered the most appropriate person to handle a Task, or even a sub-Case. Additionally, the term of the Owner is introduced in order to describe the person who creates and owns a Template, who creates knowledge for the system and for future reference to knowledge workers working on similar Cases.

3.4.2. Compliance with CMMN standard

3.4.2.1. *Case*

The **Case** element in CMMN standard is the core feature of this approach. It contains the Case folder named as **CaseFile**, which contains all the relevant data about the case. Any of the data that are stored within the CaseFile element are considered as **CaseFileItems**, namely the inputs and outputs of the Tasks, as well as any piece of information, either structured or unstructured data that the Case execution produces. The CaseFileItem is a type of **Artifact** element as well.

3.4.2.2. *Task*

The **Task** element is divided into **ProcessTask**, **HumanTask**, and **CaseTask** sub-elements. ProcessTask represents those Tasks that may be predefined or automated processes that are essential for the case execution as it was highlighted in the CMMN description (see Chapter 3.3.1.). On the other hand, HumanTask represents those Tasks that are created from Case workers during the design phase of the Case. Finally, CaseTask describe the notion of the Sub-Case, namely a different set of activities, about a different subject.

3.4.2.3. *Artifact*

As it was described above, the **Artifact** element can be either described as a **CaseFileItem** that exists within the **CaseFile**, or in detail as a **Parameter** that accompanies the **Task** element types and represent their inputs and outputs. Namely, there are three types of parameters, the **CaseParameters**, the **ProcessParameters**, and the **TaskParameters**. These inputs and outputs of the **Tasks** are also the connections between them as a **Task**'s output may be the essential input of a following **Task**.

3.4.2.4. *Role*

The **Role** element is another core feature of Adaptive Case Management that is considered similarly as important in the Case Management Modeling and Notation standard. More precisely, a **Case Role** can authorize the case workers to perform **HumanTasks** as these were described in paragraph 3.4.2.2. However, the assignment of **Roles** to different participants, which would implement the notion of **Actor** is not included in the CMMN's scope.

3.4.2.5. *Roadmap*

The **Roadmap** element is implemented through the term of **PlanItemDefinition**. A **PlanItemDefinition** contains all the different ingredients that may consist a **Roadmap** in a **Case**. Namely, it is comprised of **Tasks** that were defined above, **Checkpoints** which are represented as **Stages** within the standard, different organizational **Goals** that are indicated as **Milestones**, or **Decision Points** that are described as **Sentries**.

3.5. Experimental Tool

After explaining the above displayed meta-model's validity with Object Management Group's Case Management Modeling and Notation standard, it is about time to examine and prove the meta-model's usability and implementation with a tool that supports Adaptive Case Management of human-centered business processes. For this purpose we have chosen to use [BPM Suite](#) from Oracle Inc.



The Oracle BPM Suite is not a standalone suite for Business Process Management. On the contrary is an embedded tool in the famous Oracle Development Tool “JDeveloper”. The reason why this suite was chosen among others was just because it comes from a big corporation with enterprise systems installed in many international organizations, and great support. Also, this suite was chosen because of the fact that in its latest version update the Oracle BPM Suite had included an implementation for Adaptive Case Management, as well as a complete tutorial in order to familiarize its users with the context of use.

3.5.1. Implementation through Oracle BPM Suite

Before a walkthrough in implementing the above meta-model is made, in the context of the Case Study that is described in Chapter 2.2. , a highlighting of the core meta-model's elements, as they are found into the Oracle tool, is shown in the table below:

Table 2. Meta-model elements accordance to the Oracle tool.

Meta-Model Component	Implementation through Oracle BPM Suite
Case	<p>Primary component of meta-model.</p> <p>The Case element can be implemented as a Case Management application in a BPM project in the Business Process Management tier of the Oracle Inc. tool.</p> <p>During its creation and initialization the case's description can be defined as well as its priority (in the business project hierarchy) and duration (fixed or dynamic).</p>
Task	<p>The Case Management application among other is consisted of Activities which is the representation of the Task elements in the BPM Suite.</p> <p>Activities can be defined with a unique name so as to be recognized by the tool and a display name in order to be recognizable by the user.</p> <p>An Activity can be defined as Required, Repeatable or Conditionally Available as it may be mandatory for the Case implementation, it may be required to be executed more than once or at last it may be available under specific terms (decisions).</p>
Task Template	<p>By the time a new Activity (Task) is created in the Oracle suite alongside with activity's name and display name an Activity class is required to be defined.</p> <p>This class categorizes the various Activities in the Case Management application in different domains, function that represents the notion of Template that was outlined above in the meta-model's description.</p> <p>It enables us to have each time a categorized set of Activities, fact that enables us to create knowledge and draw conclusions as far as the interaction between Activities and between sets of Activities is concerned.</p>
Artifact	<p>Another important element of the meta-model, the Artifact, is implemented while a new Activity is created.</p> <p>When creating a new Task in the Case Management application it is required to define inputs and outputs for the new Task/Activity.</p> <p>That is because Activity has the philosophy of a process, namely a method that has some inputs and after or during its execution produces some outputs.</p> <p>These outputs, which can be data, results, achieved goals or messages, are the Artifacts that each one of the Activities is creating for the Case, and that can help knowledge workers achieve the organization's set milestones and goals, and create knowledge for future work.</p>

Artifact Template	<p>Except from Task Template element, the Artifact Template element can be implemented as well.</p> <p>As it was mentioned above, Artifacts can be represented as the inputs and outputs that are inserted in and are created by an Activity accordingly. The existence of different types of inputs and outputs for the Activities though equals to the existence of different types of Artifacts for the Case.</p>
Role	<p>BPM Suite enables the definition of Roles as well. When in the Case Management tab, except from general description information, user can insert the Case's Shareholders.</p> <p>In this section by the term Shareholders are described all the different Roles that act upon the Case, and apply changes to its state, create or modify Activities, notify different Actors and so on.</p> <p>When defining a new Role or Shareholder, a unique name is required, and a display name as well.</p>
Actor	<p>Not only Roles can be implemented but Actors as well. By the time a new Role is created, it can be instantiated in different Actors.</p> <p>As it was highlighted in detail in the meta-model's description an Actor is in fact an instance of a Role. A human with a specific role that is a different Actor from another human with the same Role.</p> <p>Thus, in the Oracle tool different instances of a Role can be created that represent the implementation of the Actor element.</p>
Decision Points	<p>One of the secondary elements of the ACM meta-model presented above but with great influence in the Case's development is the Decision Point element.</p> <p>Decision Points generally are considered as points in the evolvement of a procedure that redirect the center of attention on what will be the next step that must be taken in order to achieve the goals ahead.</p> <p>In the BPM tool by Oracle Inc. are considered as events, that change the direction of the Case procedure, triggered by humans (Actors) or by the Case design itself (Rules). These events can be the end of an Activity, the creation of an important Artifact, or even the completion of a Milestone.</p>
Goals	<p>A Case procedure is initiated and executed in order to achieve specific organizational goals.</p> <p>Either considered as minor checkpoints or as major organizational milestones that end the Case Management procedure, it was essential for the Case's goals to be able to be represented in the BPM Suite.</p> <p>Goals are defined in the General properties tab during the initiation of the Case, described as Milestones and Outcomes.</p>

Roadmap	<p>The Roadmap element is created alongside the Case execution, and step by step. Thus it cannot be initiated in advance.</p> <p>A Roadmap is a sequence of actions both for the Case conceptually and the Oracle tool. The key characteristic that enables the implementation of this element in the tool is the existence of business rules.</p> <p>Business rules alongside with the events (Decision Points) trigger the changes in the sequence of actions. There is also interaction between these two functions, because an event can trigger a business rule and vice versa.</p> <p>With the usage of business rules in the BPM Suite the Roadmap is generated, while there is the ability to have a view of the sequence of the non-predefined actions that are taken during the Case's execution.</p>
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3.5.2. Case Study Evaluation

At this point of the thesis, an evaluation of the meta-model created for Adaptive Case Management through the Patient Treatment case study presented in Chapter 2.2 is taking place. A step-by-step implementation of the processes, which are involved into the case study description, by using the Oracle BPM suite is to be shown in screenshots and how these tasks and processes are in accordance to the connection and interaction of the meta-model's elements.

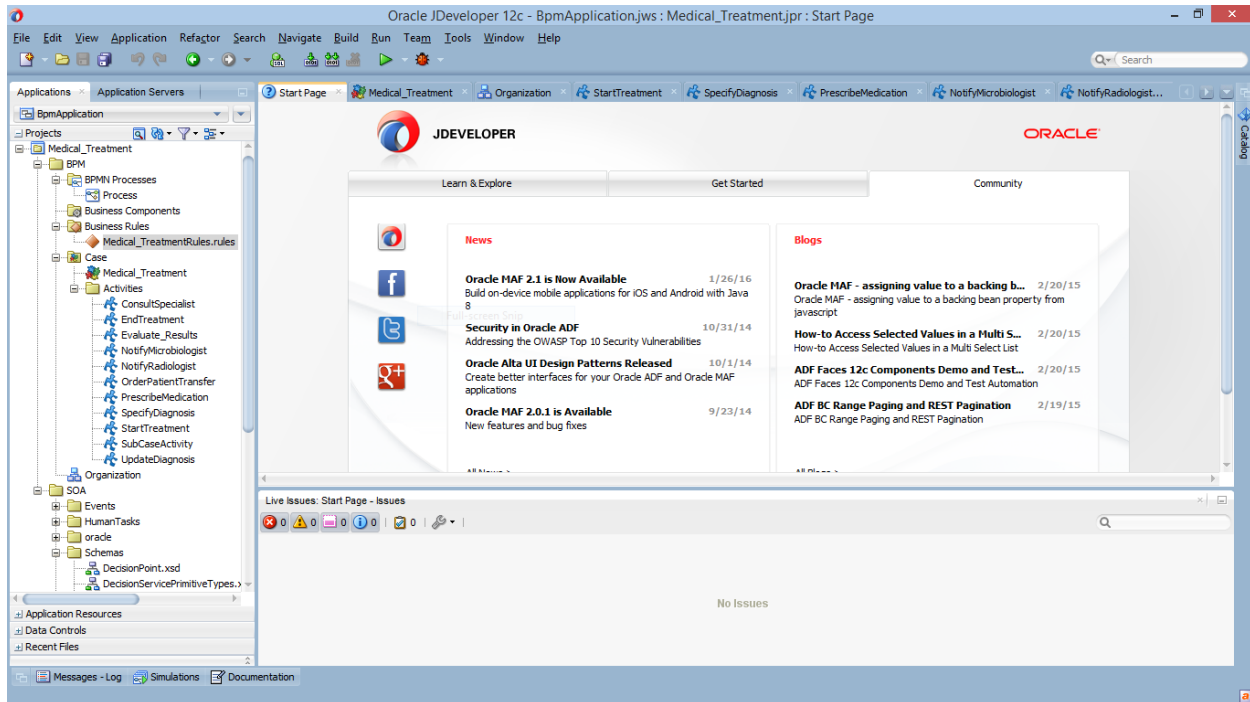


Figure 3. JDeveloper-BPM Suite Start Page

To begin with, after starting the Oracle BPM Suite through the JDeveloper Platform, the Start Page of the program appears as can be seen in the screenshot above. A few words about the program. Because this suite is addressed to general process management users, the implementation of a case management project is achieved through creating a general BPM application that contains a case management process. Namely, a user cannot create a standalone ACM application through this tool, but instead it is doable to implement all the core features of Adaptive Case Management under a Business Process Management project that could contain only a case management process execution. By navigating through New->Applications->BPM Application, a new BPM project is created, for which a specific name is chosen and on the next screen the composites that this project will include. At this point, case management composite has to be selected as is projected below:

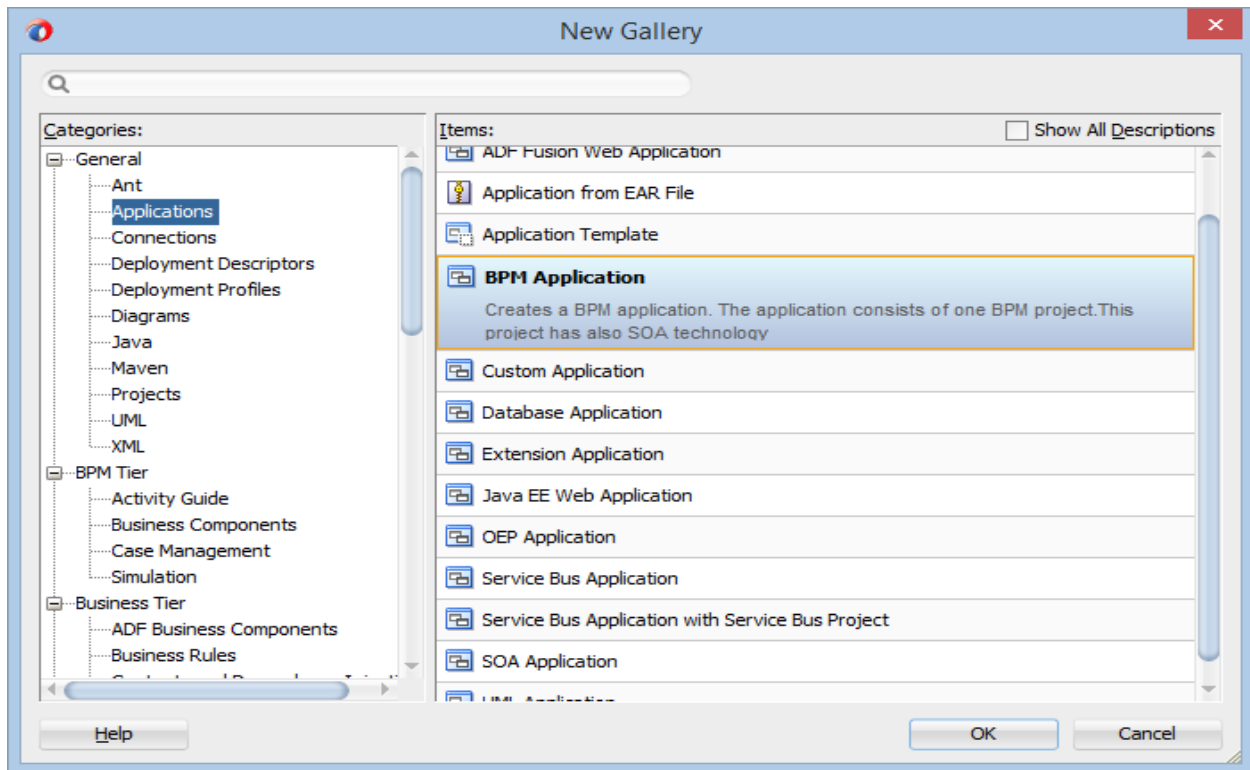


Figure 4. Selecting New->Applications->BPM Application and pressing OK leads us to next page

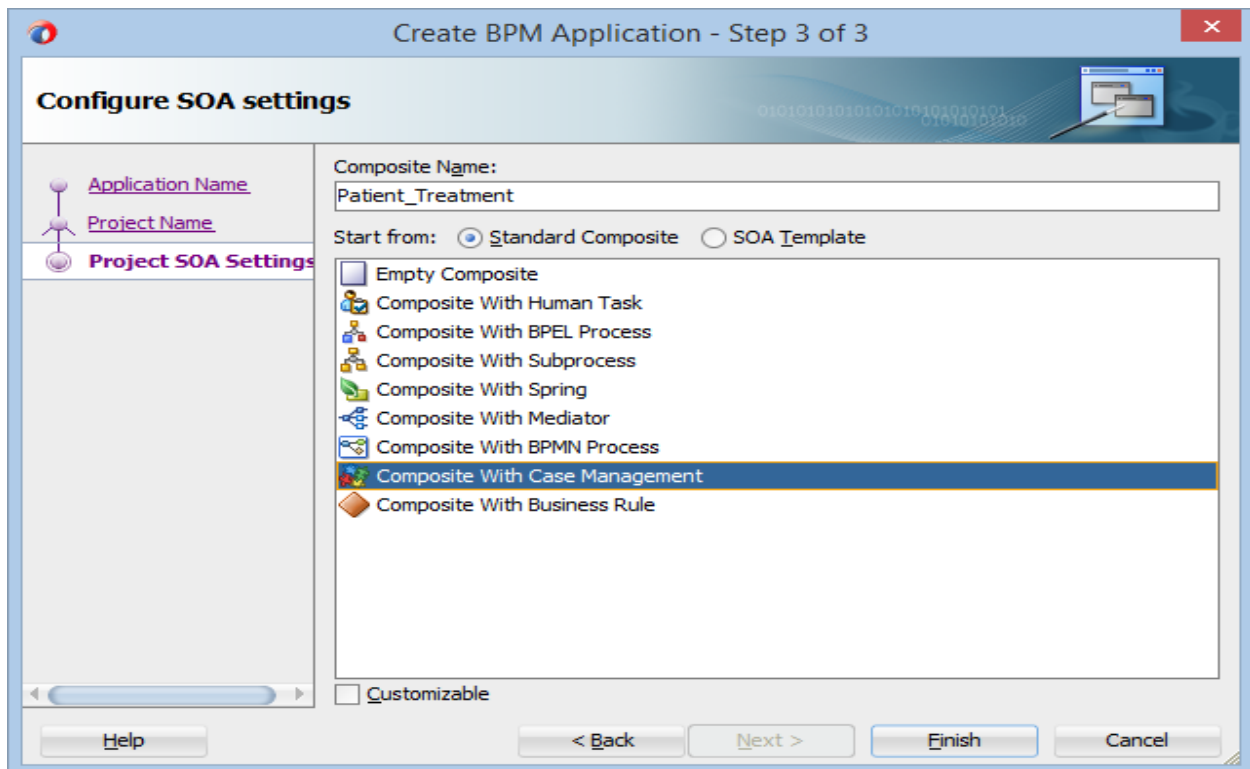


Figure 5 after inserting a proper application and project name, Case Management composite must be chosen.

3.5.2.1. Implementing the Case element

What is more, after creating the BPM application under which our Case Management project is created, it will be presented how the core features of Adaptive Case Management are implemented through Oracle Inc.'s BPM Suite. To begin with, let us describe the Case element implementation.

By the time the Case Management project is created, named as **Medical_Treatment**, the initial screen of the Case is projected as is presented below:

Case Management - Medical_Treatment
Specify the case information below and use the tabs on the left.

General
Data & Documents
User Events
Stakeholders & Permissions
Translation

Title: Plain Text medical_treatment_case

Summary: Plain Text A case when a patient is treated into a hospital clinic.

Priority: 1 (highest)

Category: Plain Text

Due Time

Duration: By Value 0 Years 0 Months 0 Days 0:0:0

☐ Use Business Calendar

Organizational Unit: By Value

Milestones

Name	Can be Revoked	Duration Type	Duration
Admission	<input type="checkbox"/>	By Value	0 Years 0 Months 0 Days 0:0:0
Diagnosis	<input type="checkbox"/>	By Value	0 Years 0 Months 0 Days 0:0:0

Outcomes

Name
Completed Admission
Finished Hospitalization

Designer History

Figure 6. Case element initial page.

On the *General* tab of this page, the title, the priority and the expected duration of this Case are inserted. In addition, the checkpoints (milestones) as well as the case goals (outcomes) can be defined at this stage. According to the Case study, some important milestones of the Patient Treatment process are the patient's admission from the Emergency Unit to the Hospital Clinic, and the physician's diagnosis of the patient's health problem. As far as the Case's goals is concerned, the completed admission and the successful complete hospitalization of the patient are two important goal for this particular Case, which can be seen as defined above. Moreover, on the *Data & Documents* tab of the Case element page, the case folder can be defined and initialized.

3.5.2.2. Implementing the Role and Actor elements

After defining the initial Case characteristics, it is about time to present the Role and Actor elements implementation. At the same central page for the created Case element, under the *Stakeholders & Permissions* tab, the different roles involved in the case can be defined:

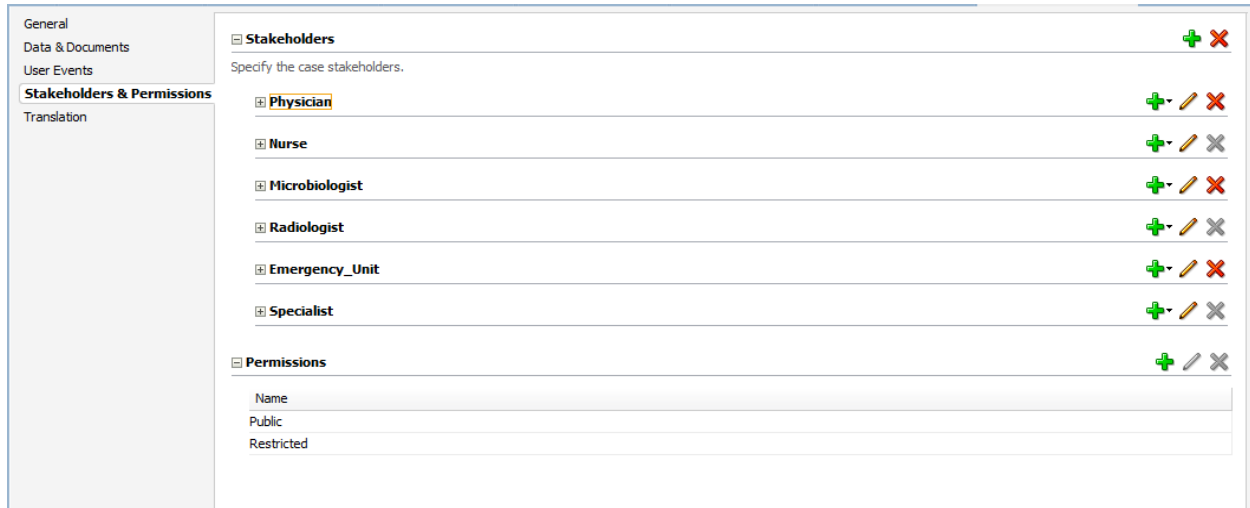
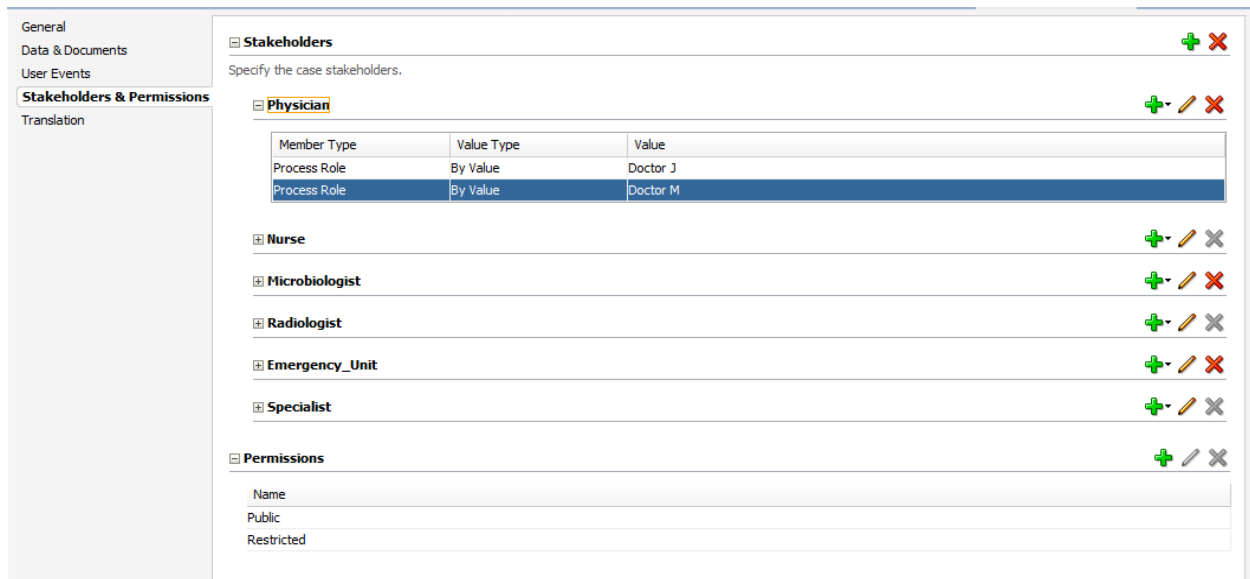


Figure 7. The Role element implementation.

As it is projected above, the different roles of our Case Study are defined. By expanding each one of this role (using the “+” at the left) the actors of the case that may have the same role can be initiated as well:



Member Type	Value Type	Value
Process Role	By Value	Doctor J
Process Role	By Value	Doctor M

Figure 8. Expanding each one of the Roles, the different Actors of this Role are presented.

3.5.2.3. *Implementing the Task and Artifact elements*

One of the most important characteristics of Adaptive Case Management is the Task element. Whether it is considered as a human activity that is non-predefined or as a scheduled process, handled as a black box by the Case Management philosophy, the Task element is the one that represents the Case's implementation and execution into any situation. As far as the examined Case Study of Patient Treatment is concerned, there are two ways of implementing the Task element into the Oracle BPM Suite.

The first one is to create a Case Activity. In order to do so, under the Projects tab on the left, and navigating to New->Custom Case Activity. By providing a variable name and a display name, you initialize the Task as a Case Activity. What is more, by providing also a Class for each Case Activity that is created, a categorization of the Tasks into Templates takes place in addition. After initializing the Case Activity element the following screen appears:

The screenshot shows the 'Case Activity - UrgentSurgery' configuration window. The 'General' tab is active. The 'Manually Activated' radio button is selected. The 'Conditionally available' checkbox is checked. The 'Case Activity Input' section has a table with columns: Name, Source, Save user input in case, and Case Data Name. The 'Case Activity Output' section has a table with columns: Name, Store Data, and Case Data Name. Both sections have expand/collapse icons.

Figure 9. The initial Case Activity screen, where inputs and outputs of each activity are defined.

On that screen, as it is projected above, the type of each activity is defined. There are three options between required, repeatable, and conditionally available. On the second part of the screen the required inputs and outputs for every Activity are defined. These inputs represent the created

Artifacts of previous executed Human Tasks that are essential for this activity's execution, as well as the Artifacts that this Activity's execution produces.

The second way of implementing a Case Task, is to implement it as a process, which is to be handled as a black box that what would be important for the Case's execution, is the Artifacts that this process is going to produce. In order to implement such a Case Management process, a BPMN process has to be implemented and then to be promoted as a Case Activity accordingly. To create such a process can be done by navigating in New->BPMN process, on the next screens provide a name for this process, as well as its inputs and outputs and finally, what would be its representation, and which Role would implement this process as it can be seen below:

Name	Description	Implementation Type	Role
Case Activity		<input checked="" type="checkbox"/> Activity	Doctor

Figure 10. The Case Process Task creating page. Assignment to a specific Role is available at this stage.

These Case process tasks can be promoted into Case activities so as to be integrated into the Case.

As a conclusion, for the Task element implementation, could be drawn the fact that, a Case Task could be either an assigned Human Task that is created as a process Task but is implemented by a Case's Actor, or as a custom Case Activity that represents better, the unexpected actions into the Case's run-time implementation. As far as our Case study is concerned the majority of the created Patient Treatment Case activities are created it can be seen below:

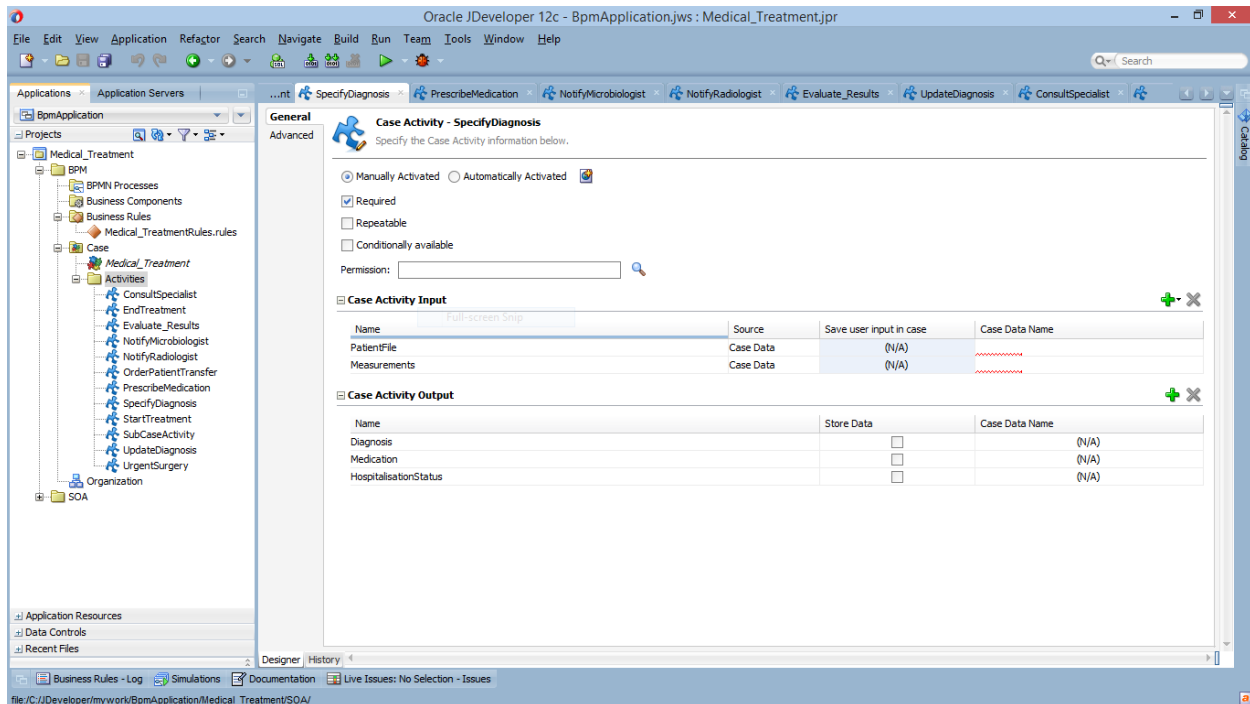


Figure 11. The set of created Case Activities is on the left as well as the definition for each one of the Activities with inputs and outputs.

3.5.2.4. Implementing the Roadmap element

What was left undescribed, is the Roadmap element of the Adaptive Case Management meta-model. It is the connective element of the whole theory of ACM, as well as the projection of the whole Case's execution. As far as the examined Case Study is concerned there is no need of implementing any specific user requirements through a roadmap element. On the other hand, for the implementation of the connection between Activities and Roles is essential to define the appropriate rules.

For the implementation of the Roadmap element, what is needed is the configuration of Business Rules for the Case project that is executed. These business rules, define the interaction between the Adaptive Case Management elements that were presented above as well as the assignment of

the different human tasks to the appropriate actors. The Business Rule are created in the Oracle Inc. tool as it is projected below:

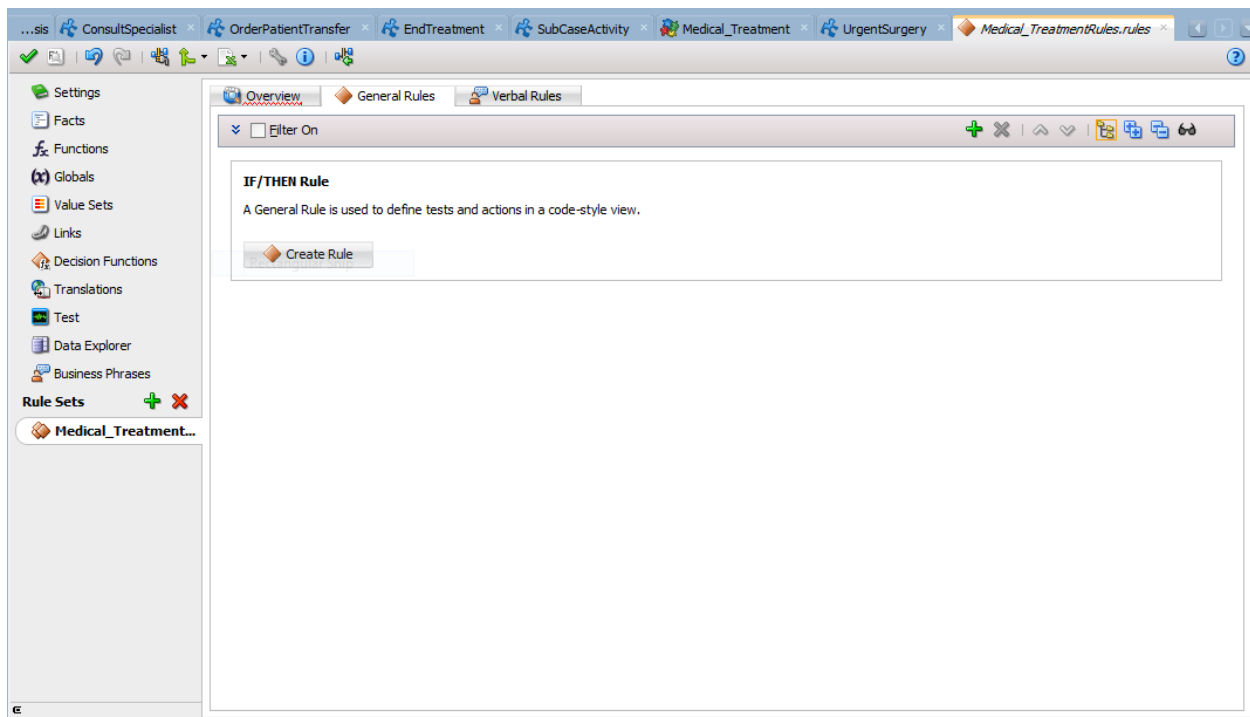


Figure 12. The initial screen of Business Rules set creation

In order to create the sequence of actions that represents the whole execution of the Case into a Roadmap element a new business rule needs to be created. The rule not only combines the Human Tasks with the Case Management roles defined in previous step, but it also represents the various decisions that need to be taken in some points of the whole execution. Thus, the Decision Point element of the meta-model is implemented through the usage of events and event triggers. Whenever a new artifact is created, or a Task is completed, namely an event takes place, a new rule is triggered that leads to the execution of a specific Task. That is how the Roadmap is implemented, through the interchange of events-triggers-rules that interact and create the sequence of actions taken into a Case execution.

4. Subject-Oriented Business Process Management

4.1. Introduction

For the past decades, as it was described in the introduction of this thesis, the approach of Business Process Management was developed, as a principle for designing, organizing and executing various business processes within an organization. However, that approach seems to be not applicable in organizations or enterprises that bestir themselves in domains such as healthcare, legal and social work, namely knowledge intensive and human-centered environments where coordination between knowledge workers is of utmost importance.

That is because, it was highlighted before, in knowledge intensive environments and human-centric domains, there is the need of the work to be divided to different people. At many times, this work has to be divided to different people from different organizations who have to work together. Namely, they have to collaborate appropriately, while in such situations there cannot be any central control to organize the sequence of actions to be taken. So the parties that are involved in business processes ought to communicate. (Fleischmann, et al., 2013)

For that reason, nowadays, several approaches have been developed in order to find an alternative way of handling processes and workflows in knowledge intensive domains. At this chapter, another approach is examined, named as Subject-Oriented Business Process Management. This type of Business Process Management, S-BPM as it is also known in literature, differentiates itself both from ACM, as it handles business processes more rigidly, and BPM, as the center of attention in this theory are the various subjects that are involved in a workflow management process, rather than regular Business Process Management where the point of examination is the process itself.

In addition, this subject-oriented approach of Business Process Management, also supports the traditional flow-oriented way of designing and implementing business processes if necessary. That can be done as the central control, that takes place in the ordinary BPM theory, is just another case of communication, but rather special, as it is most strict and rigid as far as its ability to adapt in change. So, S-BPM is able to cover both, communication-oriented and flow-based business processes.

4.2. Related work

4.2.1. Subject-Orientation

Thus, a question arises, as far as what is special about subjects and why someone should think in a subject-oriented way. The answer seems to be pretty simple, as already in literature on business processes, processes are considered as sequences of activities. With a closer look taken, it is never mentioned who performs these activities, namely the process stakeholders that in S-BPM approach are called **Subjects** and exist in all business processes.

The notion of the so-called subject-orientation is based on two fundamental features in the S-BPM methodology that assign prominent roles to subjects. The first one, considers subjects as first-class entities in the process models. In order to model a process in a subject-oriented way needs to start the modeling procedure by specifying the subjects involved and their communication. After this network is established, the individual tasks of each subject have to be defined using sequences of activities. (Kannengiesser, et al., 2013)

On the other hand, the second feature considers subjects as the re-designers of the process models. That is because, this subject-oriented methodology views human participants to the process both as subjects within the process and as re-designers of the process itself. This enables the process participants to actively collaborate with others within the process redesign procedure, as it does not require any expert skills but it is also essential in order not to produce an inconsistent overall process model. (Kannengiesser, et al., 2013)

So, the examination of subjects that interact in the business processes' lifecycle seems to contain knowledge that was either unexplored previously or needs revision, because subjects are taken for granted and are considered as implicit or secondary information about a process (Fleischmann, et al., 2011) What needs to be examined additionally, is which might be the results of transferring the attention from the process to the subject, and how the entire perspective on the process changes.

Before examining the impact of moving the focus from the process itself to the process management subjects, it is about time to gain a better understanding upon the Subject-Oriented Business Process Management, its philosophy and finally how it, in reality, differentiates itself from the ordinary Business Process Management approach.

4.2.2. Main Idea: S-BPM as an integrated organizational structure

Subject-oriented Business Process Management is implementing this need of communication between business workers as it signals a change from the flow-oriented execution of the various business activities, to a communication-based view of Subjects interacting and as active teams in a business process. By bringing the subject of a business process to the center of attention, it considers business processes and their organizational environment from a new perspective, and as a consequence meets the organizational requirements in a much better way. (Fleischmann, et al., 2011)

What is more, the S-BPM approach provides a rather coherent procedural framework of reference to manage the various business processes of an organization or of an enterprise as it mainly focuses upon the cooperation of the actors (mainly stakeholders) who are involved in the strategic and operational issues and are sharing their expertise and knowledge upon a networked structure into the organization. Hence, Subject-oriented Business Process Management, could be considered as an integrated approach for the organizational design in general, as well as for the organizational development. (Fleischmann, et al., 2011)

The integration of S-BPM lies to the fact that, this subject-oriented management process is not only results-oriented, as the common BPM appears to be, but it rather substantially reshapes modeling as a comprehensive construction process within an organization's philosophy. That is because, in the long run, the managers of the higher organizational tier, are expected to trust their staff to reflect interactively their business processes and reconstruct dynamically these processes. (Fleischmann, et al., 2011)

Additionally, it allows the decentralized, self-organized view of the work that has to be done, in accordance to the modern organizational theory. This can be implemented because the subjects, that were mentioned above, are directly involved in the design of their process by outlining their individual view of their task by specifying their doable activities. These activities are divided into three categories: receiving information, sending information and performing functions. (Fleischmann, et al., 2013) Each one of these categories is described in detail at a later chapter of this thesis.

4.2.3. Natural Language as a boost for Subject-Oriented Modeling

What was outlined above, was the fact that Subject-Oriented Business Process Management does not require expert skills in modeling. So, another question arises about what is the prerequisite of achieving the ability to model in a subject-oriented way. Trying to answer this query, what is important about S-BPM is that it facilitates communication, and uses it as the central method above which the whole subject-oriented theory is structured. Hence, in order to have a good communication the only skill that is needed is a good command of natural language.

In further detail, a business process is considered as a highly complex bundle of communication within an organizational environment. We, as humans, have learned to communicate through the usage of our language. As the focus of the S-BPM modeling theory is on subjects, namely humans, it allows expressing the knowledge in terms of natural language, through sentence semantics. The idea is that as it is done in natural language, a sentence consists of a subject, a predicate and an object. (Fleischmann, et al., 2011)

The subject-oriented approach that represents S-BPM can be directly influenced by the natural language representations, as language is a complex communication system that uses symbols which can be combined in many ways that produce information. (Fleischmann, et al., 2011) Another important output of language usage in communication is to exchange **Messages**. What is important about messages in Subject-Oriented Business Process Management is presented later at this chapter.

The good usage of natural language meaning goes beyond the knowledge and the application of the grammar of the language to convey any information. In order to interpret information appropriately, knowledge of the overall context is needed. The information that arise from a sentence or a sequence of words can only be determined when the receiver of this sentence is known and the situation under which these messages are exchanged between the sender and the receiver. (Fleischmann, et al., 2011) When this knowledge is applied to the development of the organizations through S-BPM, this organizational development is enhanced from the following characteristics:

1. **Semanticity.** Models that are based on the representation of the natural language express organizational development opportunities.

2. **Productivity.** Refers to the achievable situation of the future.
3. **Substitutability.** It describes the ability of holding on ideas that may prove productive in the future. (Fleischmann, et al., 2011)

In conclusion, the ability to translating business process interaction through natural language, enables the organizational stakeholders to actively participate in the organizational development as well as to these business processes' execution. (Fleischmann, et al., 2011)

4.2.4. Steps of S-BPM Process Modeling

With the introduction of the subject-oriented approach to Business Process Management, a new scope is inserted to BPM. Namely, the business processes focus on structuring communication interactions between the subjects (individuals or parties) involved in a work procedure. Business operations are supported through this theory but to do so, subject-oriented models need to be created as well as embedded into an organizational environment. (Fleischmann, et al., 2013) In order to create and implement such S-BPM process models, and hierarchy of actions needs to be followed.

Firstly, the S-BPM stakeholders have to be identified. As the creation of a business process is an individual process itself, implemented by a stakeholder, the subjects of these process creations have to be singled out. In order to achieve a spherical understanding of the various stakeholders, a categorization is needed. Thus, subject-oriented Business Process Management stakeholders are divided into **Governors**, namely people who care for, taking responsibility for or driving business processes), **Actors**, people who manage work tasks, and **Specialists**, people with a high expertise upon a domain of knowledge. (Fleischmann, et al., 2011)

Secondly, after the stakeholders are identified, the steps that are required so as to achieve S-BPM are presented below:

- Subject-oriented process analysis.
- Subject-oriented process modeling.
- Subject-oriented validation of processes and process models.
- Subject-oriented process optimization.
- Subject-oriented processes implementation.

- IT-implementation of S-BPM processes
- Subject-oriented process monitoring

As a conclusion, what arises from the steps above is the fact that there is no big difference between regular BPM and S-BPM as far as the sequence of modeling actions is concerned. However, in case of Subject-Oriented Business Process Management, all the modeling actions should be taken with the focus upon subjects under consideration. It is the center of attention, and what differentiated the theory of S-BPM.

4.3. Description of Basic Entities

In an attempt to provide the general idea of the modeling philosophy behind the Subject-Oriented Business Process Management approach, at first, a business process is undertaken within an organization's work procedure. This **process** may be unique or may be part of a set of business processes that are executed at the same time by an enterprise. This **process group** may consist of several business processes undertaken by different departments with different actors (**subjects**) to be involved and communicate with each other through **messages**.

The modeling in a subject-oriented way is done while keeping in mind that each subject has an **internal behavior** with a specific sequence of actions that can implement and act upon, which are categorized into some internal behavior **states**. These states generate the communication between the subjects within a process because except from performing actions, lead to message generation, messages that are exchanged between the actors of the work procedure. This message exchange, lead to **transitions** from state to state, and from subject to subject, through sending and receiving of specific **business objects**.

4.3.1. Processes and Process Groups

Within an organization's workflow procedures, what is examined in a subject-oriented way is the modeling of business processes. The process is an executable sequence of actions that produce outputs, important for the organizational development, either generating profit, or producing knowledge and that also has a specific duration, within which it has to be finished. The processes are at the top of the pyramid that describe the S-BPM approach and contain subjects, the messages that these subjects exchange, and the business objects that are exchanged through these messages.

As it was mentioned above, in a work procedure of an organization there may be more than one running business processes. Processes are organized in process groups, which are created in order to integrate these interrelated processes, the different subjects and the business objects they exchange within the framework of the processes execution. When a process group is created, the processes that group includes, are connected though some **external subjects**, namely subjects with the same characteristics (same internal behavior), that are taking actions in different processes' execution. A further explanation about subjects and their behavior is given in the paragraphs below. (Metasonic, 2014)

4.3.2. Subjects

4.3.2.1. *Subject Types*

In a previous description, the **Subject** represents the actor (individual or team) that is involved in a business process execution. It also represents the role in a process, as far as the specialization upon a specific domain of expertise is concerned. The general idea behind subjects within an S-BPM process modeling approach, is that subjects act in parallel. A subject completes its task individually and strictly sequentially, as tasks are executed within a regular BPM environment.

There are some types of subjects that differentiate themselves from each other in the terms of communication, as well as their organization. To be more specific, subjects are divided into **internal** and **external** subjects. (Metasonic, 2014)

The internal subjects are those who get involved in the same business process execution. On the other hand, external subjects are the connections between different processes within an organization's workflow, namely the connections that the ongoing examined process has with other external processes. The main difference between internal and external subjects lies to the fact that unlike the internal subject that has an internal behavior that can be examined, the external subject's internal behavior is not examined within the ongoing process scope.

Additionally, the process subjects can be organized in **multiple subjects**, namely a representation of teams that act in an organization. What is important about working with multiple subjects is the fact that the behavior and communication of these teams can be modeled and implemented. These process teams share the same internal behavior as far as their communication is concerned, although compared to single subjects, they create multiple instances when the process is executed.

4.3.2.2. *Subject Internal Behavior*

The most important feature of a subject in S-BPM is its internal behavior. When a process model execution starts, a corresponding process instance starts as well. In addition, when this process instance starts, a subject instance starts, the so-called start subject. Any other subject is not instantiated immediately, but only when it receives a message. By the time a subject is instantiated, the internal process of each subject starts as well, namely the sequence of actions this subject takes in order to rigidly execute its tasks.

This internal behavior of the subject, has a bottom-up approach as far as its modeling is concerned, and the individual tasks are depicted strictly in sequence. In order to model the examined subject's internal behavior, the states that consist this behavior have to be created, and the way that the subject will pass through these states, namely their transitions. When this top-down diagram and the interchange between states and transitions comes to an end, the tasks of the specific subject has been finished as well as its involvement to the process generally. (Metasonic, 2014)

4.3.3. Messages

What was outlined previously, was the fact that subjects communicate with each other through messages. Every message is sent from a sender (source) and has a recipient (target). When a message is created, its type is defined in order to make every message's characteristics distinctive. In order to create a message, at least two subjects within a business process is essential to exist and then the messages these two or more subjects are to be defined. In addition, with the message's creation, a message type needs to be assigned.

There are two main message types, the **local** messages and the **global** messages. A local message is a message type that is only available for the current executed process within a process group. On the other hand, a global message is available to all processes within a process group. As a good practice, a global message type should be used if it is important to ensure that all participating subjects in all processes are able to view the messages ingoing and outgoing.

One restriction that exists about message type assignment, is that when a message is exchanged between two or more external subjects then the message type is mandatorily global. What is more, multiple message types can be assigned to a message transfer, as several responses to previous sent messages can be included into a sent message. (Metasonic, 2014)

4.3.4. States and State types

In a further description of the subject's internal behavior, the different states that consist its sequence of actions are to be explained at this stage of the thesis. As the subjects behave as it was mentioned above in a purely sequential manner, they seem to perform only a task at a time. This behavior can be explained through a sequence of states. Every state gets an input and generates an output in the end. These inputs may be data from folders inserted during the states initialization, or KPIs for measuring the overall subject's performance. In general there are three types of states, the **send state**, the **receive state** and the **function state**. In addition, **start** and **end** states are included to the function state category. (Metasonic, 2014)

4.3.4.1. *Send State*

As far as the modeling of a subject's internal behavior is concerned, the Send State represents the sending of a message from this subject to another subject. Any send state is followed by a send transition, as the message is not sent in the send state duration, but as it passes through the transition. So, it seems essential after a send state to exist either a send transition or another state receives the message's response.

4.3.4.2. *Receive State*

On the other hand, the Receive State stands for the receiving action of a message. Therefore, it implements a wait for/ listen function as it is known in programming. When a subject receives a message, then it is proceeded to all the actors assigned to this **subject's role**, unless it is sent to a specific actor. Then the subject is activated at the same time or is instantiated as it was described before. As in the Send State, the receipt of the message does not take place in state itself, but rather in the outgoing receive transition. So, a receive state must be followed by a receive transition or another state. When the recipient of a message, receives an incoming enquiry about a task's execution, and open it, then automatically becomes the owner of the task and its editor as well.

4.3.4.3. *Function State*

As it was highlighted before, except from the regular function state, within this category the start and end states are also included. Every modeled subject must have only a start and only one end state. As far as the main function state type is concerned, during this state the subject performs a task without any communicating with another subject in terms of sending and receiving messages.

4.3.5. Transitions

The above described subject's internal behavior states are connected to each other by transitions. Every transition has a label indicating what was the output of the preceding state, for instance, whether a completed task's results (function state) need to be sent to another subject (via send state). As in states, there are some transition types that are depending on following state. Thus, there are **Send Transitions**, **Receive Transitions** and **Function Transitions**. (Metasonic, 2014)

To begin with, any message is sent as it passes through a send transition. What is restricting about send transitions is the fact that, only one can be included in send state. When a send transition is created, what has to be defined is the receiving subject of the sent message, the message type and the send type (whether new instances are to be instantiated or not).

Furthermore, in case of a receiving state, the subject examined, is waiting for a message. By the time this message arrives, the recipient can select the receive transition and accept the message. When a receive transition is created, the sending subject, the message type and the receive type (when the sending subject is a multiple subject) need to be defined. As far as the receiving transitions are concerned, there can be transitions based on the message type. For instance, whether a loan enquiry from the bank was approved or denied. To further extent, there can be receive states with multiple receive transitions, namely, a subject waits for several responses before moving to the next function state. (Metasonic, 2014)

What is more, a function state creates an output for the task that is executed by the specific subject. This output is transferred to the next state through a function transition. When a function transition is created, what the function state produces must be defined.

Except from dividing the transitions according to the preceding state, another categorization could be made. Transitions could be divided into **incoming** and **outgoing** transitions. Usually, the incoming transitions, either multiple or a single one, are directed to a receive state. On the other hand, the outgoing transitions, may be a result of a function states and rarely to have a receive state as a source.

In addition, there may be transitions of special types. These could be transitions that use timeouts, abort transitions, or even transition that are using loops. (Metasonic, 2014)

4.4. Proposed Meta-Model

In an attempt to project all the above described basic entities and features of Subject-Oriented Business Process Management, as they are described in the manual provided by [Metasonic](#) for the tool that supports S-BPM, the Metasonic Suite, and the theory that was reviewed in Chapter 4.2 as it is implemented in books about this subject-oriented approach of Business Process Management, a meta-model about S-BPM was created. Some new notions that were left undescribed in the previous chapter are inserted in the meta-model like the **Role** element and the **Business Object** element, that are described in the general meta-model description below:

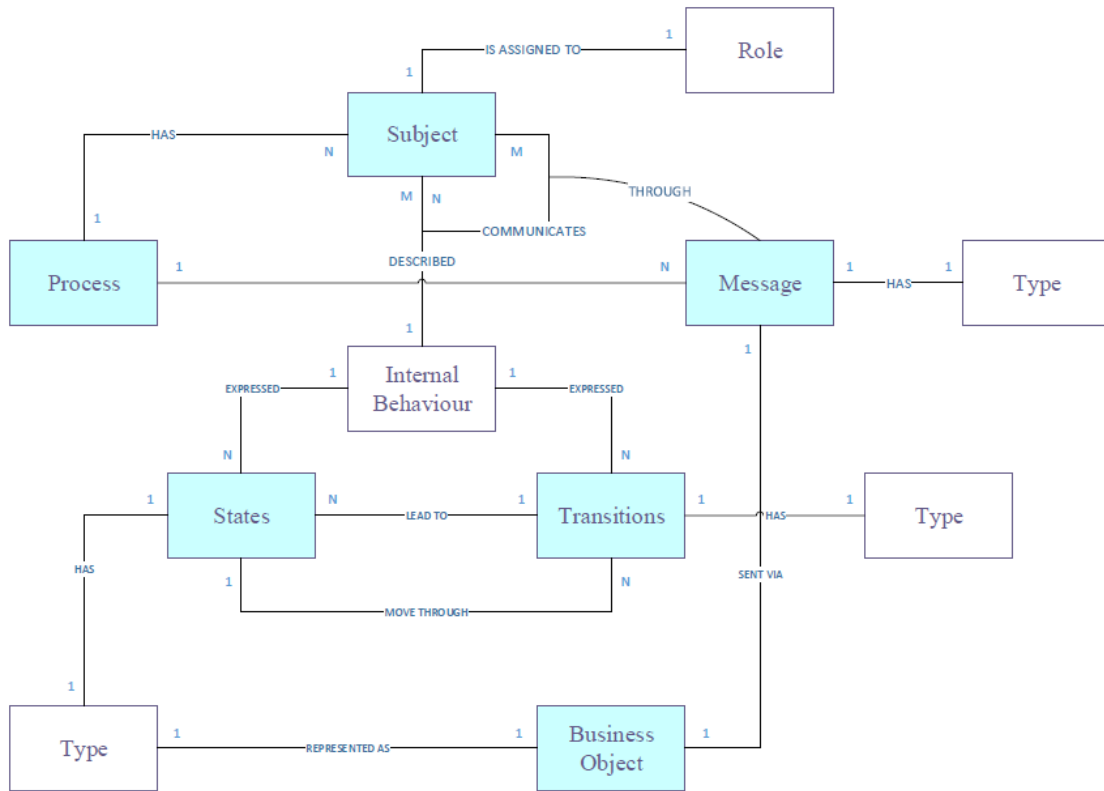


Figure 13. The meta-model for Subject-Oriented Business Process Management. The Subject is on the top and its internal behavior is explained in a top-down approach.

4.4.1. Meta-Model Description

In order to gain a spherical knowledge about the S-BPM and the change it produces to the organizational development by bringing the subject and not the process to the center of attention, an attempt to find the proper connections between the basic elements of this theory should be made

carefully. As far as the **process** is concerned, it contains subjects and messages. A single process may be executed with many subjects to be involved and during this execution many messages are exchanged between those subjects.

From the part of the subjects, the subjects are assigned to specific **Roles**. Namely, these roles describe the different domains of expertise that the actors, which the subjects represent, are specialized to, as well as the differentiation in the level of involvement into the process according to each actor's skills and experience. What is more, the **Subject** element communicates with other subject within the process or with external subject through **messages**. They also have an internal behavior that as it was outlined before is expressed through **states** and **transitions**.

States and transitions interact with each other as far as the sequence into a subject's internal behavior. Every State is moving to another State through Transitions, while Transitions lead surely to a next state. Both State and Transition elements have types that need to be defined in order to have a distinction between the interchanging states and transitions. According to theory of Subject-Oriented Business Process Management, one transition can lead to a single state but a state can use multiple transitions in order to move to a next state.

What is exchanged at the interchange between states and transitions are the messages that the process subjects send and receive. Every message has a type, while it can include, tasks to be done, instructions, or simple results about implemented business activities. It is the way that the subjects communicate and is one of the most vital feature of the S-BPM approach. Every subject can send many messages, between the stages of its internal behavior, or to send the same message to different recipients. What else messages may contain is Business Objects, which the subjects send and receive between each other.

The various Business Object may be several different business items that the subjects may exchange. These could be forms, enquiries, pages, artifacts or information and results about previously executed and implemented business processes. The reason that the Business Object element is not connected directly to the State element of the meta-model for S-BPM and in contrast is connected through the State Type element, is because there may be a differentiation to the Business Objects according to the state type. For instance, different states may require different types of Business Objects to be sent.

4.5. Experimental Tool

At this point the tool, which is used in order to validate the above projected meta-model, is presented. The tool is Metasonic Suite, from Metasonic GmbH Inc., which is a tool created to model and execute Subject-Oriented Business Process Management projects. With its latest version released, the Metasonic tool seems to fully implement the whole philosophy of the S-BPM approach, as it arises from both the literature and the academic references about this theory. A description of how the meta-model is implemented through this tool is following, however, emphasis is given to the basic elements, like process, subjects, messages as well as a brief description of the secondary features.



Figure 14. The Metasonic Suite load screen

To begin with, the description of the meta-model implementation through the Metasonic Suite starts with the process element. This entity encloses all the other elements presented upon this modeling attempt, as it contains both subjects and messages, in addition to their internal elements. In order to have a better understanding for the philosophy of the S-BPM theory, the modeling result that is shown in Figure 13, seems like a pyramid. At the top of this pyramid there is the process element that contains all the others.

4.5.1. Processes

As a result the **process** element is the first to be shown. In order to initiate the modeling of a subject-oriented approach of a business procedure a process must be created. At the Metasonic Suite, a process is created through navigating to New->Process. Then the following screen appears, where the process name is given, and the **process group** that this process belongs to. If no other process group is created before, is mandatory to create one, as no process can stand alone in the program.

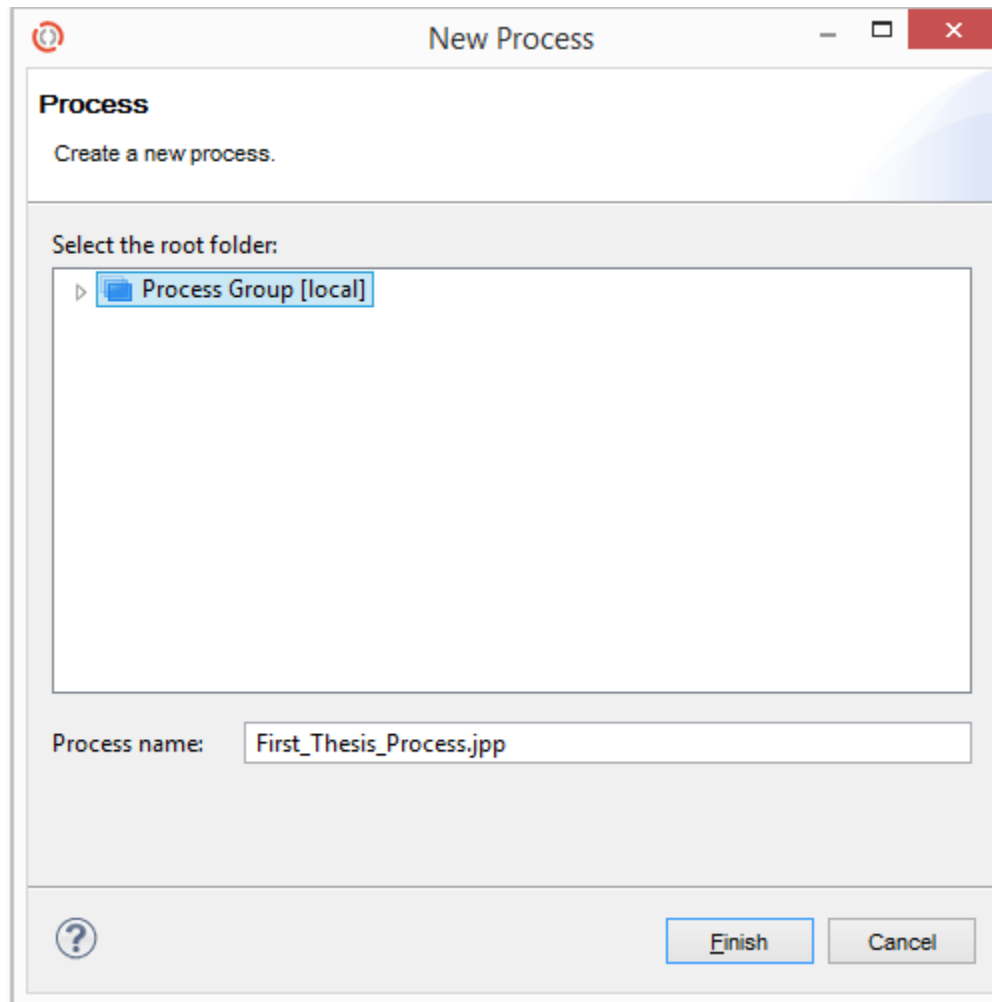


Figure 15. Process creation screen

After finishing the process entity creation, then the initial process screen appears which includes the canvas upon which the involved subjects are created, as well as the process's properties such as the parameters that can be inserted into the process and the duration that the process may have.

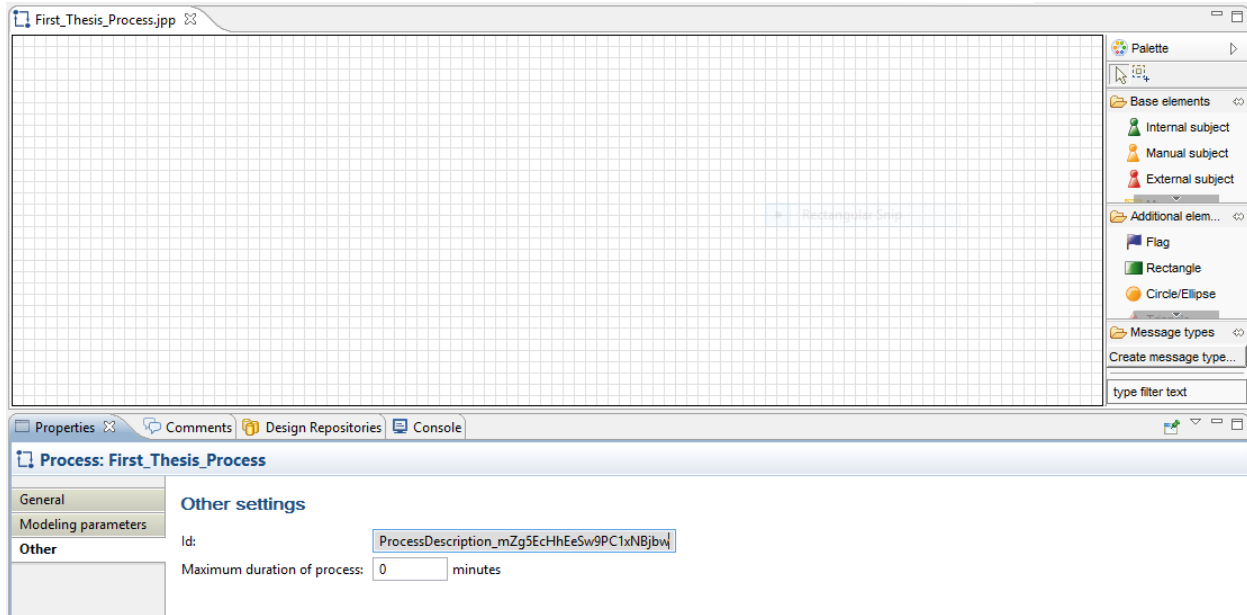


Figure 16. The process screen where subjects and messages can be inserted as well as process properties.

4.5.2. Subjects

Having the process created, the next step is to implement the **subject** element that is projected in the meta-model above. A subject is either involved into the process's execution as an internal subject or interacts with the ongoing process as an external subject. As only one process was created before, the subjects that are projected below are considered both as internal. In order to create a subject for the process that is being modeled, you drag and drop an internal subject from the palette at the right hand side of the screen (Figure 16) into the process canvas. Instantly, the subject creation screen appears as it is shown below:

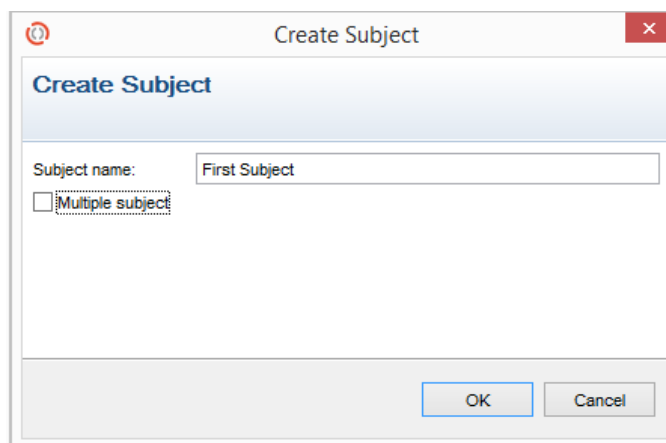


Figure 17. The subject creation screen

During the new subject's creation, the option to create it as a multiple subject is given as it can be seen in Figure 17. This option would implement the ability to create a team, namely a set of actors with the same domain of expertise. As the new subject is created, it appears in the process canvas, as well as the subject properties section of the screen.

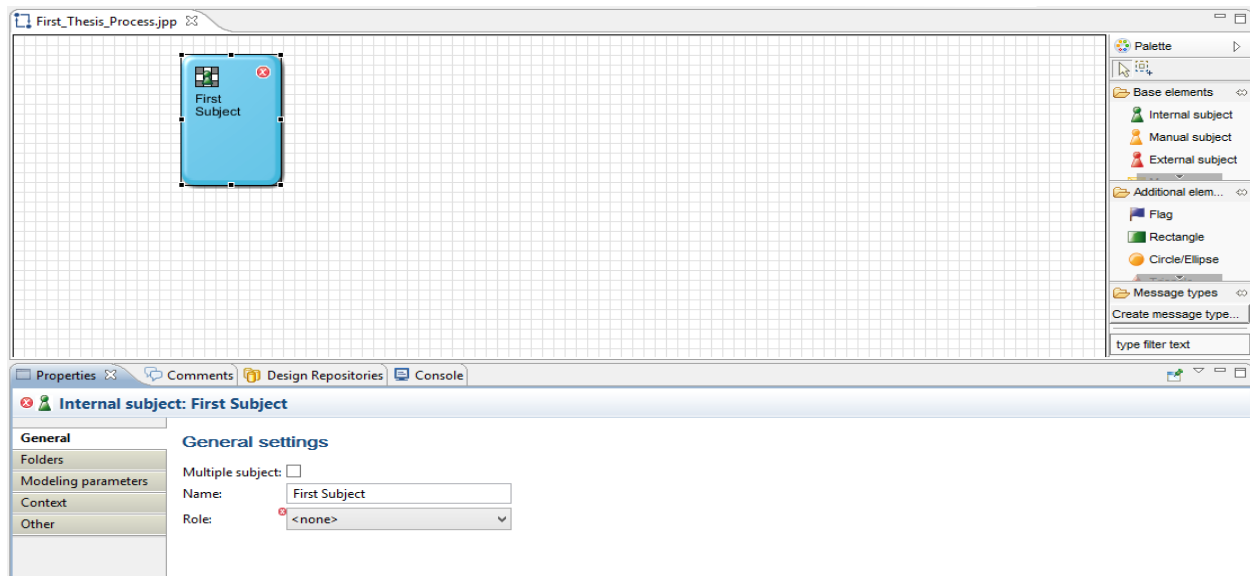


Figure 18. The subject appears to the process canvas.

4.5.3. Assigning Roles to Subjects

As it is shown below, the subject appears with a red “x” upon it. That is because a **role** must be assigned to the newly created subject. A role is created using the green “+” in the role screen that is projected below. When a new role is created, it can be assigned through the subject properties.

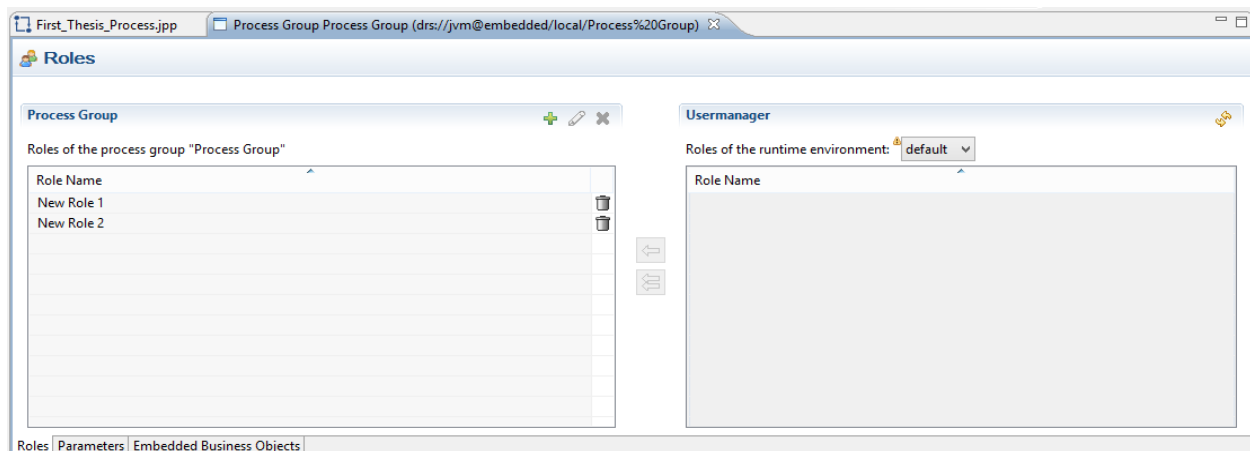


Figure 19. Role creation screen

4.5.4. Messages

At the process canvas screen, except from subjects, messages can be created as well. This is can be done directly by dragging a new message from a subject to another already created, or a subject that will be created at this time. More specifically, the message element is the connecting element between two or more subjects within a process. By the time a new message is created between two or more subjects, then the following screen appears.

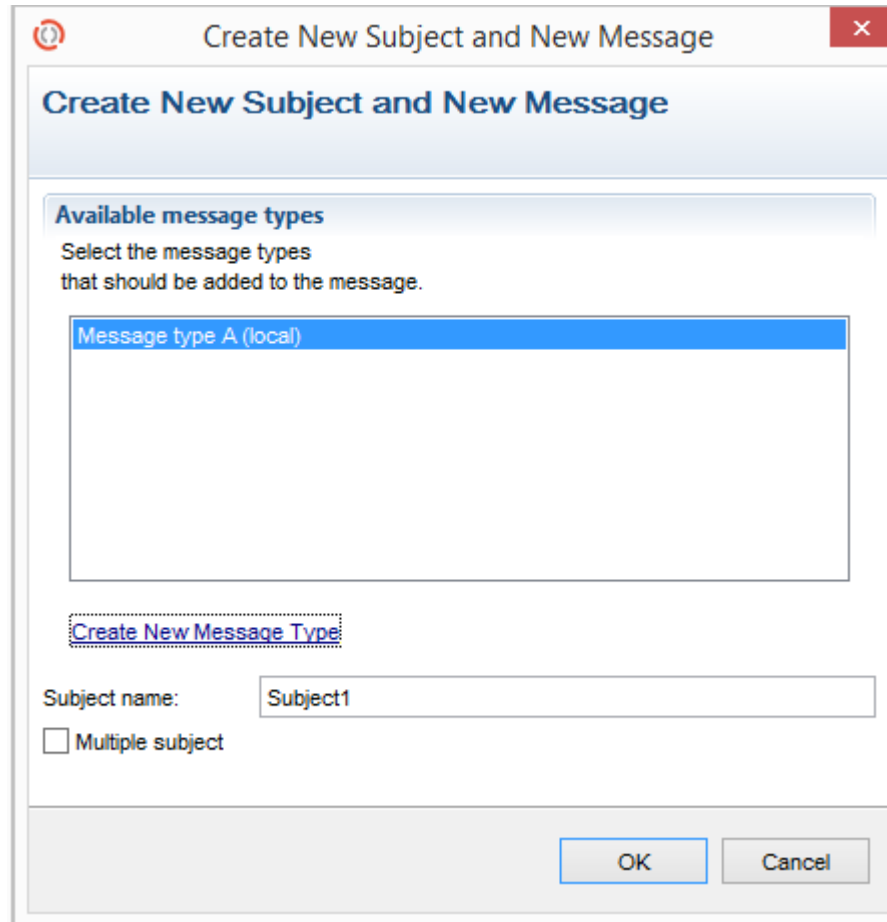
The image shows a software dialog box titled "Create New Subject and New Message". It has a standard Windows-style title bar with a red close button. The main content area is divided into sections. The first section, "Available message types", contains the instruction "Select the message types that should be added to the message." and a list box with "Message type A (local)" selected. Below this is a dashed border containing the text "Create New Message Type". The next section has a "Subject name:" label followed by a text box containing "Subject1". Below the text box is a checkbox labeled "Multiple subject" which is currently unchecked. At the bottom right, there are "OK" and "Cancel" buttons.

Figure 20. The message creation screen. The second connected subject is created here as well.

As it can be seen above, any created message must be given a message type. The already created message types are projected at the form, and only one type can be selected. At this point, the second corresponding subject is created as well, in order to achieve a message connection. Again, the option to define the second created subject as multiple is given at this screen. After the message and the second subject creation, the process canvas screen is turned into the one below:

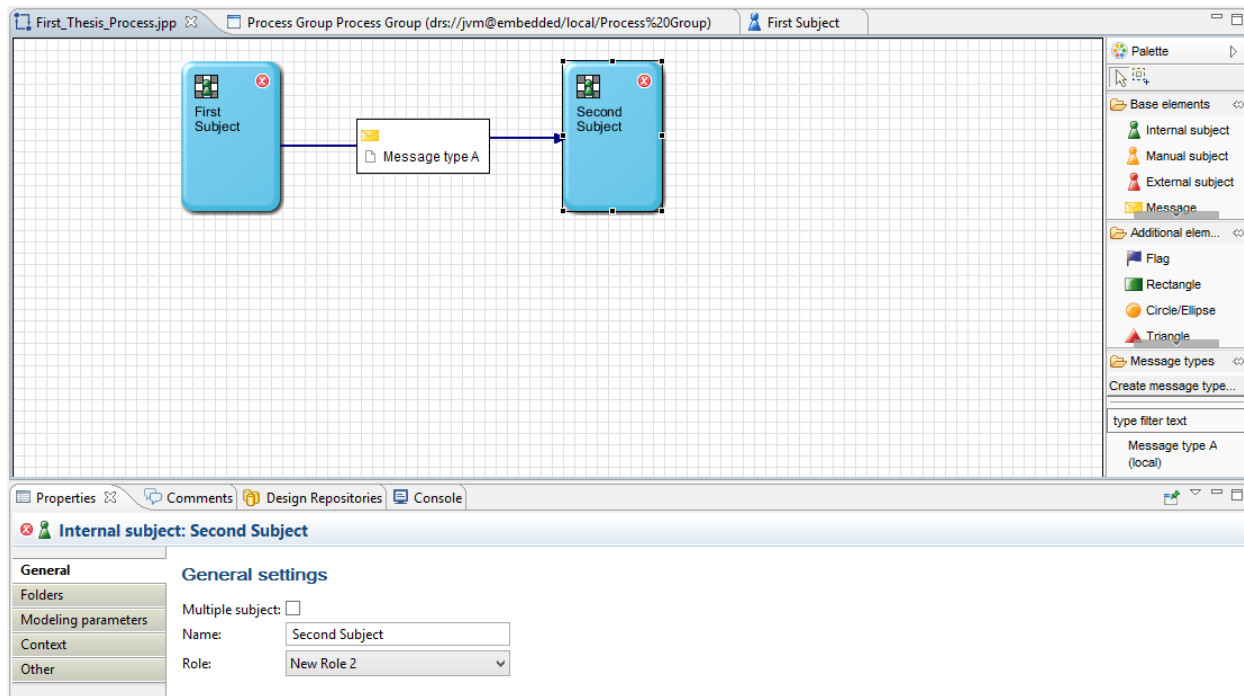


Figure 21. The updated process canvas screen. A role is assigned to the second subject as well.

4.5.5. Subject's internal behavior

As it can be seen from Figure 21, both of the created subjects still have a red “x” upon themselves. That is because, after the subjects’ initialization and the creation of the message through which these subjects communicate, it is about time to parameterize the created subjects as far as their **internal behavior** is concerned.

It must be kept in mind that, as it was presented above, the first subject sends the message to the second one. So, in the description of each other’s internal behavior, the first subject is expected to have a send state, while the second subject is expected to have a receive state.

The internal behavior of a subject can be defined or edited by double-clicking the subject itself upon the process canvas. Hence, the subject’s internal behavior screen appears as it is shown below.

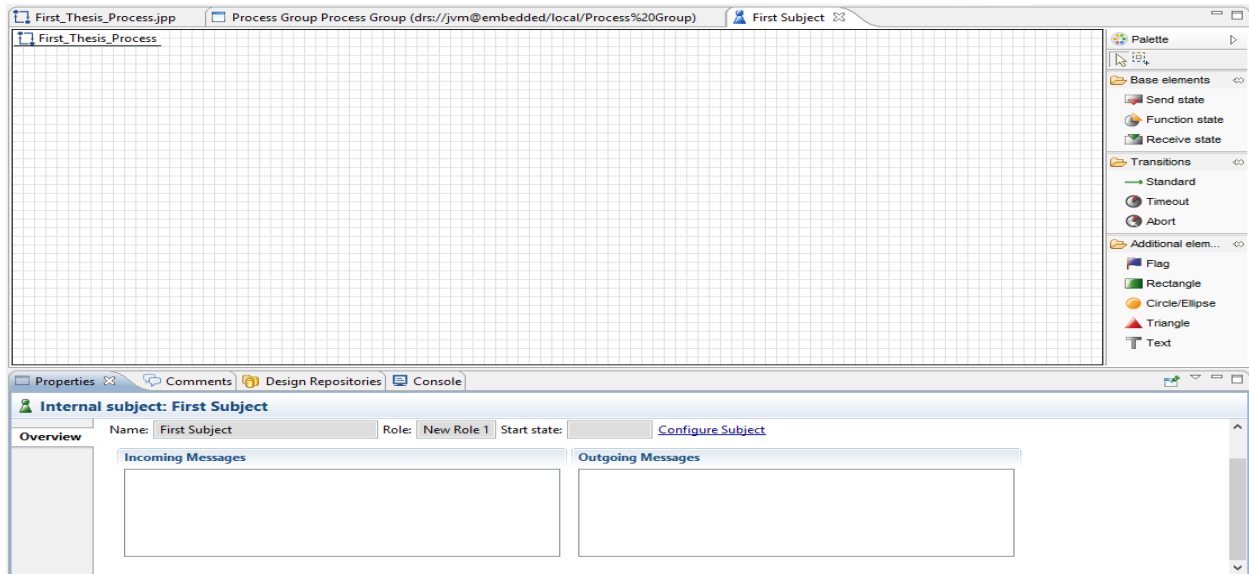


Figure 22. The created subject's internal behavior screen.

4.5.6. States and Transitions

In order to implement the created subject's internal behavior, the **states** through which this behavior is expressed must be defined. This can be done, by dragging a state from the palette at the right hand side of the screen (Figure 22), into the subject's internal behavior canvas. The state creation screen is following.

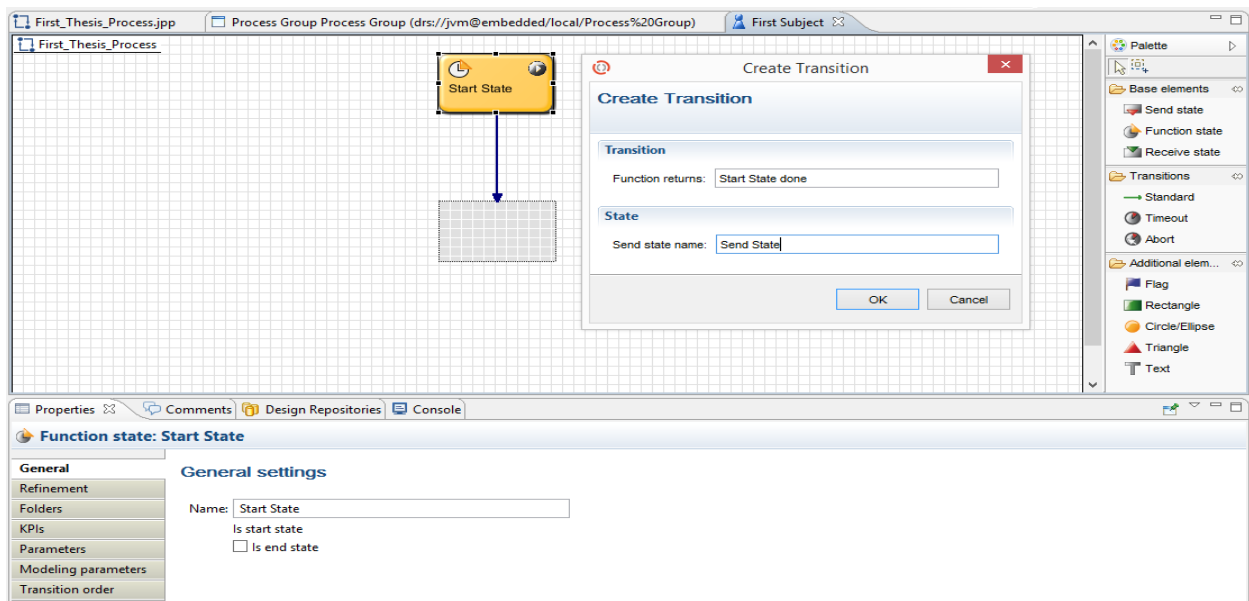


Figure 23. The updated subject's internal behavior canvas page.

As an important notice, every subject must have a start state and an end state, namely function-type states, defined as start and end states accordingly. It can be seen in the figure below that, during the state creation, a new **transition** is created as well that leads to the second created state, the send state, through which the message defined before, is sent. After implementing the whole first subject's internal behavior, the second subject's behavior has to be implemented as well. The fully implemented states and transitions for both of the subjects are projected below.

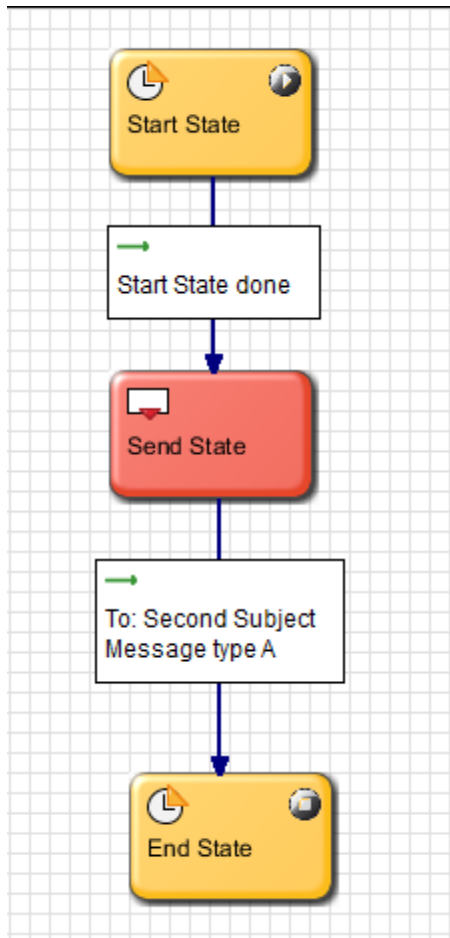


Figure 24. First subject's internal behavior

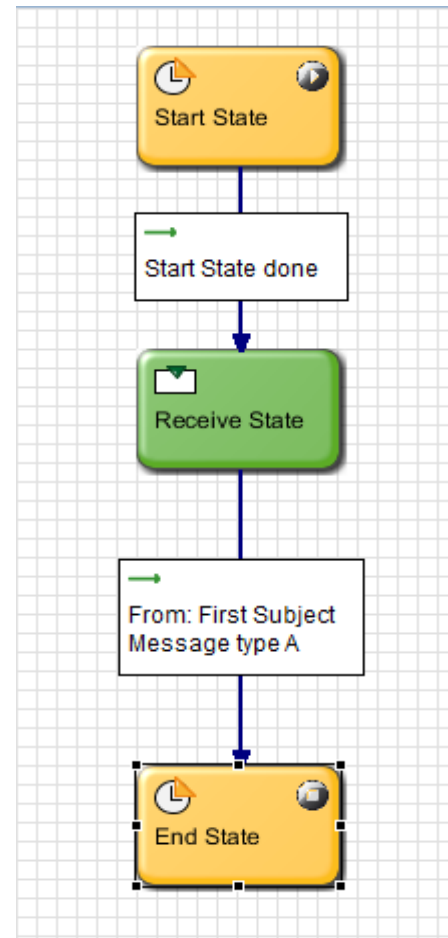


Figure 25. Second subject's internal behavior

What was left undescribed, the Business Object element of the meta-model, is integrated into the message element, as the various business objects, such as forms, reports, or enquiries, that the subjects are exchanging during the overall process execution are exchanged in reality, through sending and receiving messages.

4.6. Case Study Evaluation

At this point, an evaluation of the proposed meta-model is made through the Patient Treatment case study presented in Chapter 2.2. To a certain extent, Healthcare is a domain that requires human communication in order to achieve the best results of the work procedure. So, the Subject-Oriented Business Process Management approach would facilitate such communication. The sequence of actions needed in order to implement a set of Patient Treatment processes is presented, as well as the involved actors in these processes' execution, the messages that these actors exchange so as to communicate, and the business objects that are exchanged through these messages.

To begin with, the Patient Treatment case study includes various processes that are executed with various actors (subjects) involved to the overall workflow. So, firstly a process group has to be created that is bound to include the whole number of process executed in the scope of the ongoing case study.

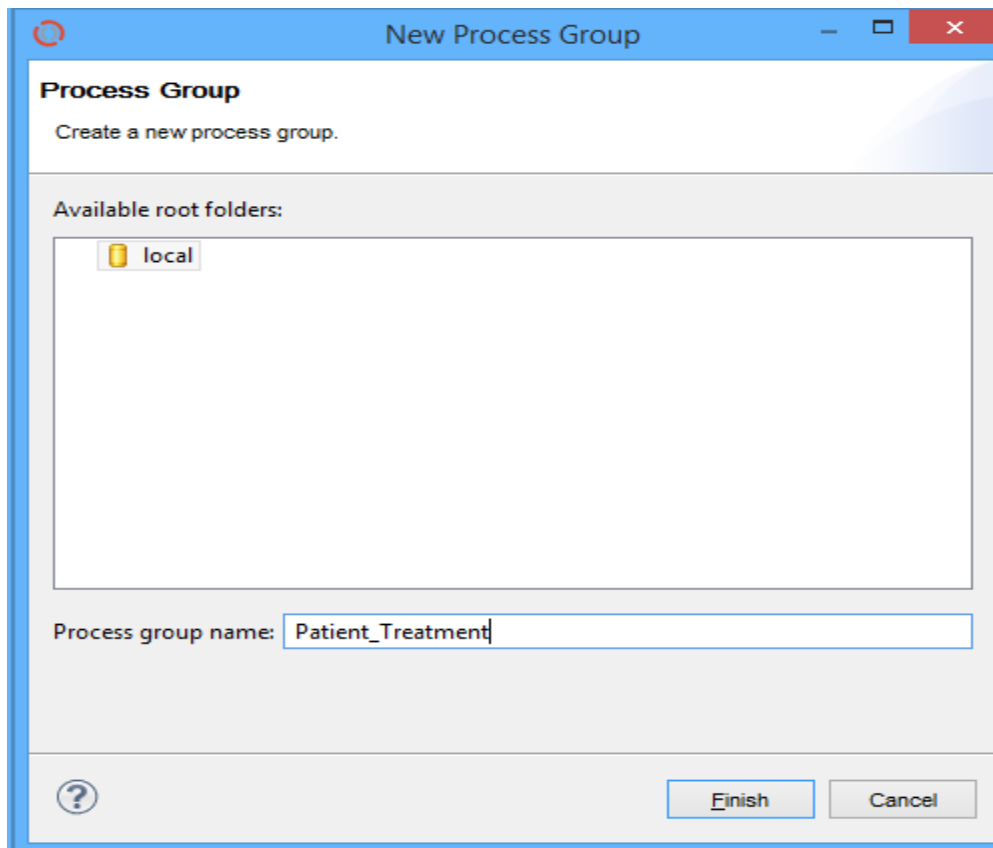


Figure 26. The Patient Treatment case study processes group creation screen

After the process group is created, then the first process has to be created as well. In order to project the whole functionality of the Metasonic Tool in implementing the case study's requirements, a process with complete subject interaction has to be selected. Two processes are created, so as to project in addition the interaction between different processes as far as the internal and external subjects is concerned.

According to the case study's description in Chapter 2.2., at first the patient's admission process takes place. At this process there is interaction between the hospital's emergency unit personnel and the patient that requests hospitalization. Thus, the subjects involved are an emergency unit physician and a patient. Accordingly, the roles that are expected to be assigned to these subjects must be created as well.

Below, the first process canvas screen appears, including the two subjects and the messages that these subjects exchange.

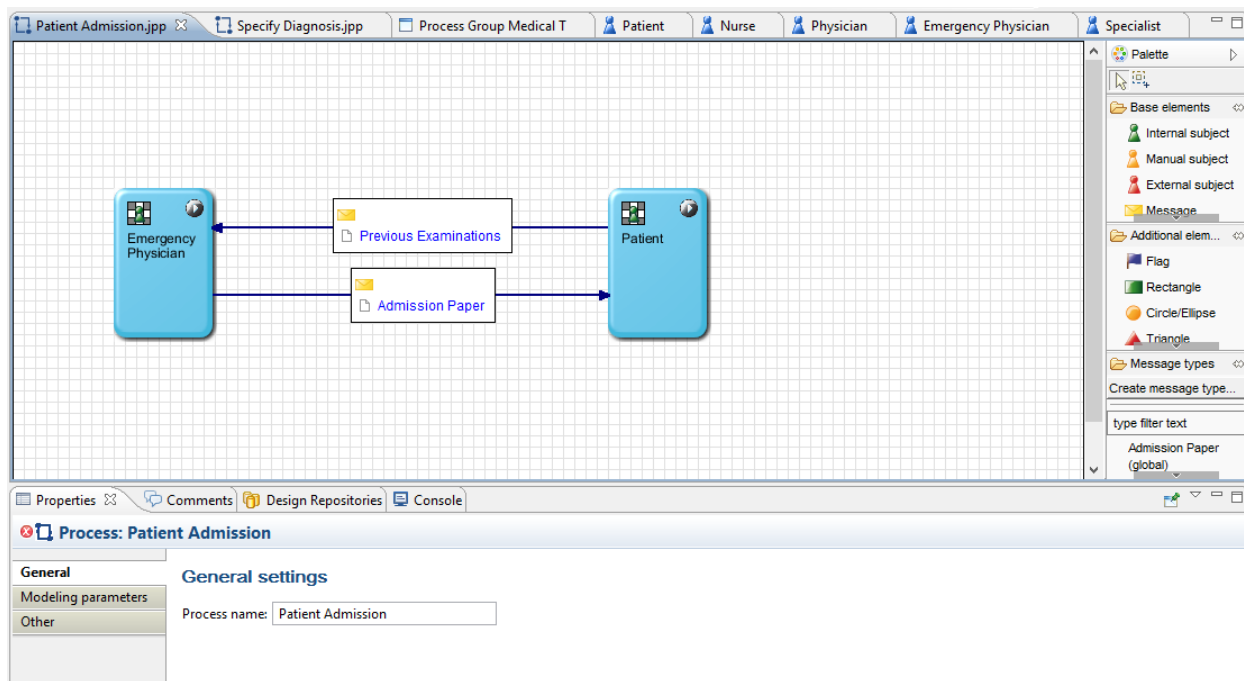


Figure 27. The Patient Admission process canvas screen. The subjects and messages exchanged are visible as well.

As an important notice, it is supposed that when the patient arrives to the emergency unit of the hospital, he submits any previous examinations to the emergency physician so as to check his admission criteria, whether the patient needs hospitalization or not. After the admission criteria

evaluation of the emergency physician, the patient is informed with his admission paper. This functionality is implemented through the two subject's internal behavior which is projected below.

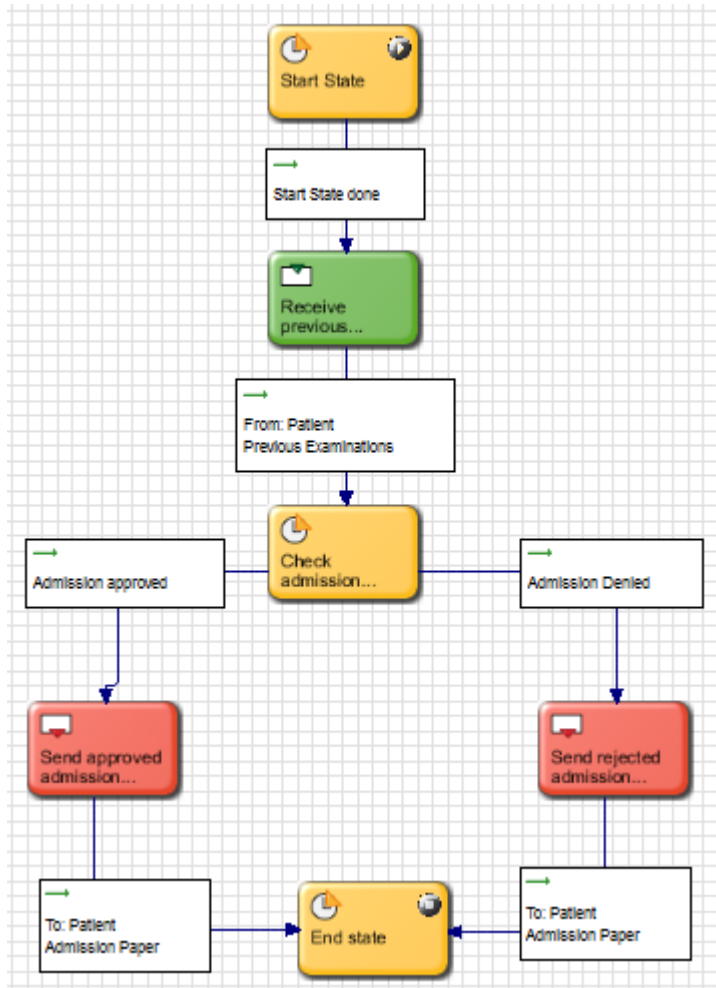


Figure 28. The emergency physician internal behavior.

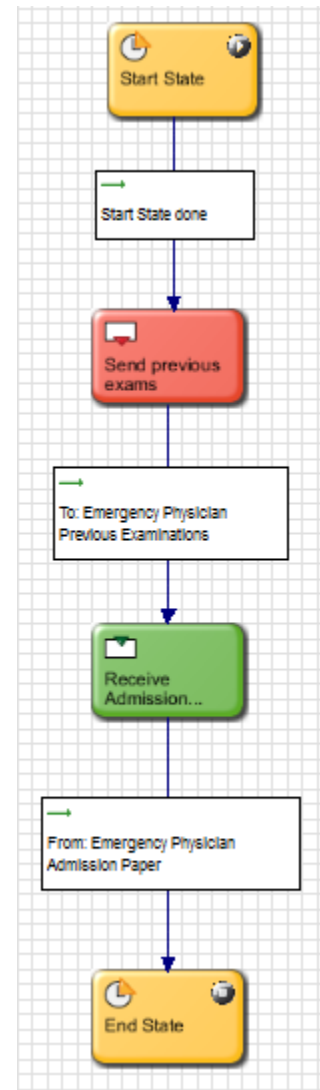


Figure 29. The patient internal behavior

The sequence of actions is easily understandable as for every send state that a subject has, the second one has a receive state. At the emergency physician's internal behavior there is a decision-based transition, as in the function that decides whether the patient needs admission to the hospital's clinic or not, there is a different result which leads to the appropriate send state later. More or less, this is the implementation of the first process which represents the Patient Admission decision process, with an emergency unit physician and a patient as the involved subjects.

The Patient Admission process which was presented above is a very simple process that includes only exchanging messages between two internal subjects and a decision based transition. The next process, the Specify Diagnosis process of the Patient Treatment case study requires a more difficult level as far as the modeling is concerned, as well as a greater number of involved subjects.

That is because, the clinical physicians, after the patient's hospitalization approval, have to specify a diagnosis for the patient's health problem. This has two basic requirements. The first one is the fact that the patient's file alongside with his clinical status and any previous examinations have to be sent from the emergency unit personnel, which is an external subject, to the clinical physician that is responsible for the patient's healthcare. The second one is that in case of a difficult health problem, when specifying a diagnosis is not so simple, an advice from a specialist has to be requested. In that case, involvement of another subject, the Specialist, will be required in order to complete the process of Specifying Diagnosis appropriately. The complete Specify Diagnosis canvas screen is projected below.

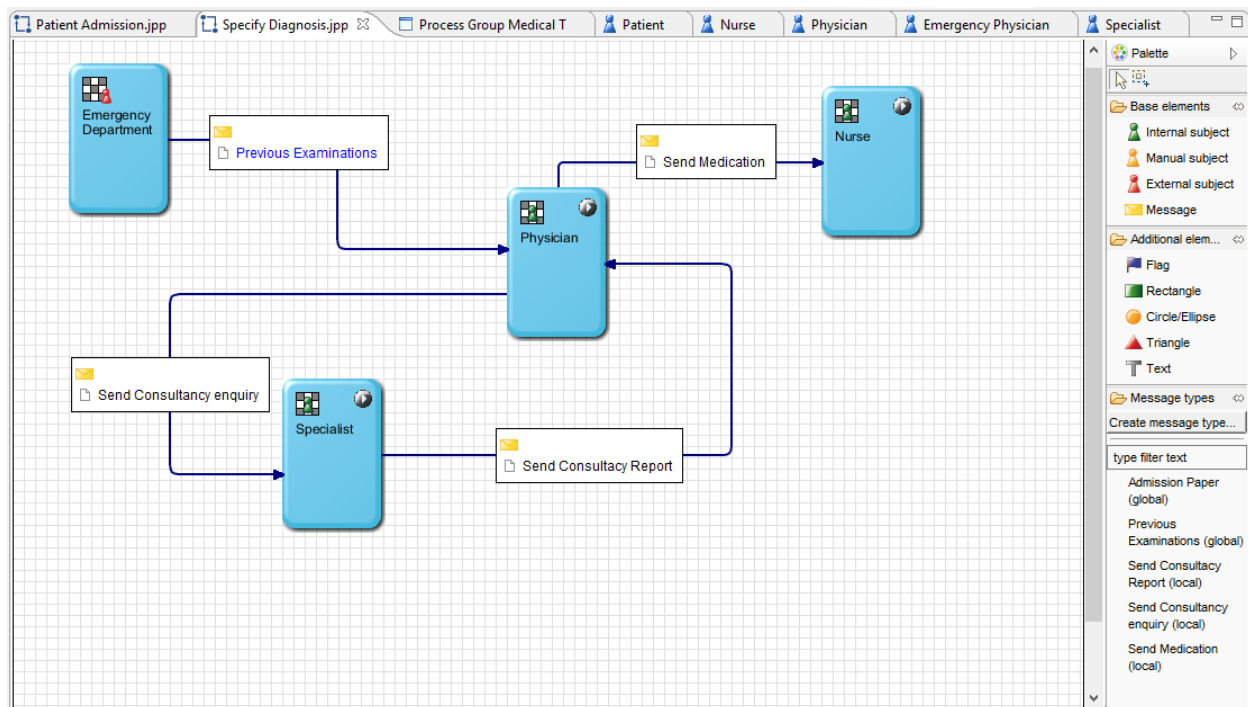


Figure 30. The complete Specify Diagnosis process canvas screen.

In an attempt to explain the whole processes functionality, at first the clinical physician receives the patient file and the previous examinations from the Emergency Department personnel.

Emergency Department personnel as a subject to this process is considered as an external subject. So, no internal behavior is implemented for this subject.

As far as the physician subject is concerned, after the patient's file receipt, the diagnosis specification is attempted. If it is successful, then the medication of the patient is prescribed and daily examination instructions are given to the nursing personnel. If the diagnosis specification is unsuccessful, and an advice from a specialist is needed, then an enquiry for consultancy is sent to the appropriate specialist and a response is awaited. When received the diagnosis is specified, and the instructions are now sent to the nursing personnel. The whole clinical physician's internal behavior canvas screen is presented below.

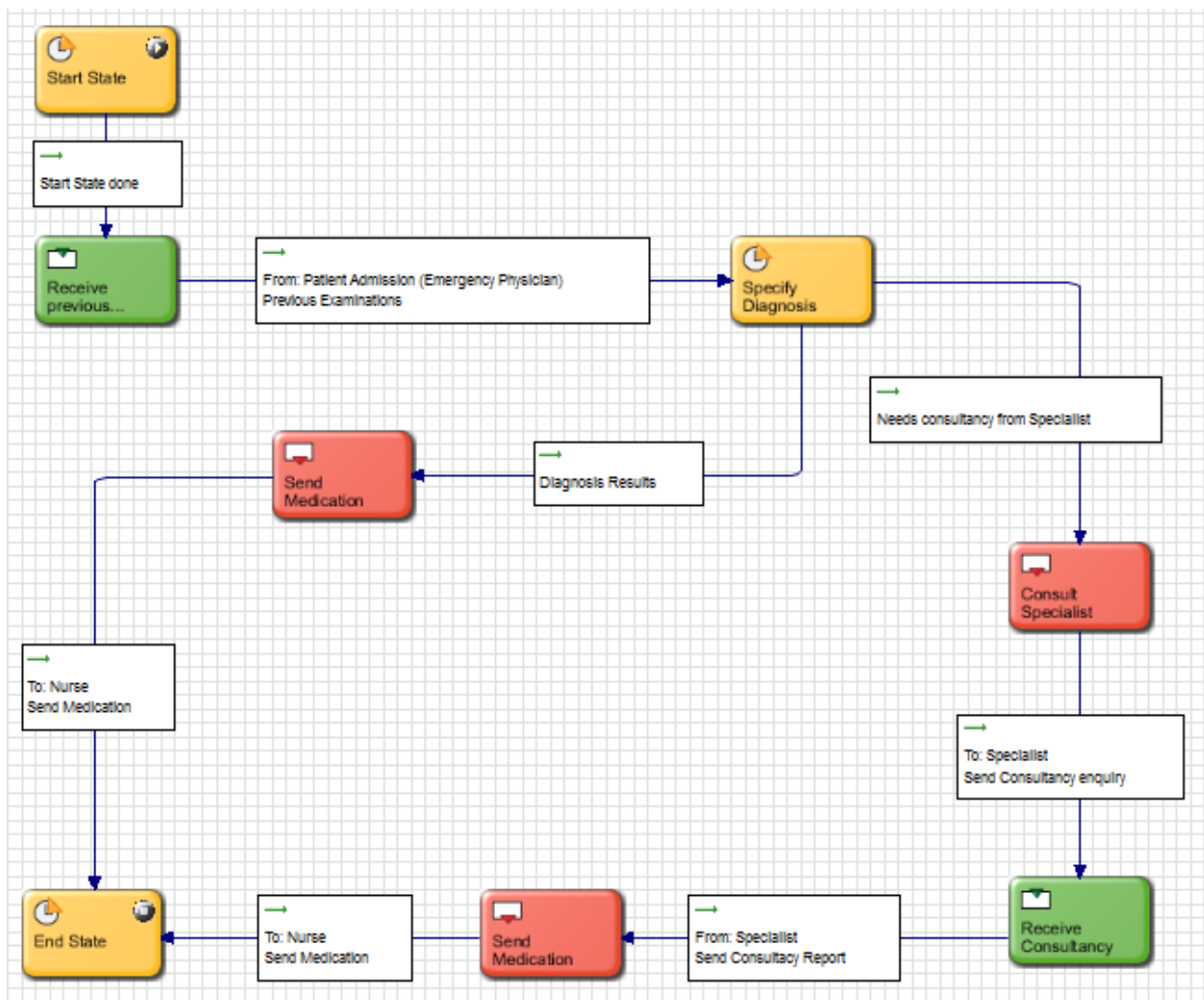


Figure 31. The complete Clinical Physician's internal behavior canvas screen.

For the Specify Diagnosis process, what was left undescribed is the behavior of Nursing Personnel and Specialist subjects. Both of these subjects interact with the Physician Subject with simple send and receive message states, in order to facilitate the Physician sequence of actions. For these two subjects their internal behaviors are projected below.

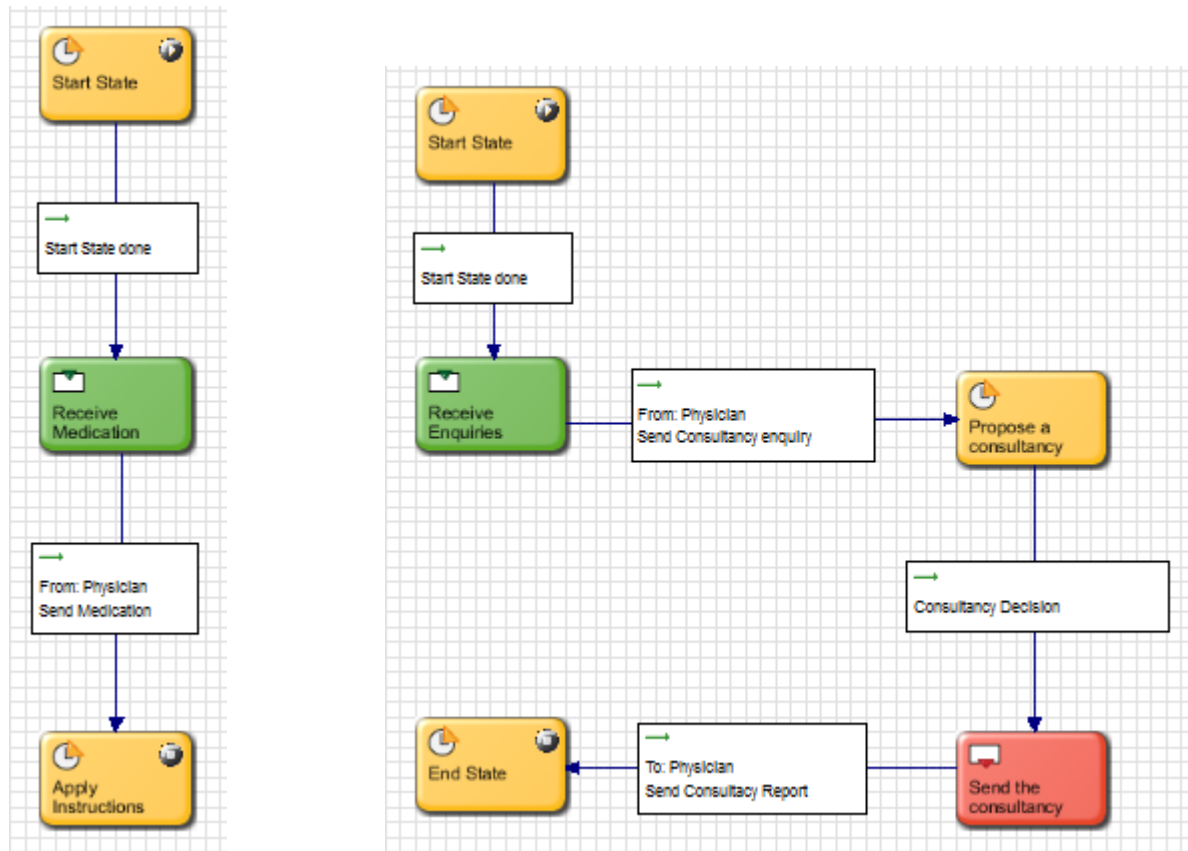


Figure 32. The Nurse internal behavior Figure 33. The Specialist internal behavior.

As far as the Nurse subject is concerned, it only receives the daily examinations instructions and the prescribed medication when available from the Physician subject. Then it applies the instructions. To a further modeling, an interaction between this subject and the Physician subject could take place, as reports about patient's health condition update could be sent for examination. From the Specialist subject point of view, the tasks that this subject performs are very strict and include only providing consultancy to physicians for difficult cases as far as the patient diagnosis is concerned.

That concludes the meta-model's validation through the Patient Treatment case study and the Metasonic Suite. Processes presented before are representing of the functionality of Subject-BPM.

5. The Notify & Register Approach

5.1. Introduction

As described in previous chapters, one of the most challenging business environments, are those that require agility as well as dynamic behavior in terms of intense human decision making. It was highlighted additionally that attempting to automate such processes through common Business Process Management techniques would constrain the agility of the business processes executed within those human-centric environments, fact that represent a vital feature of this type of processes.

Having presented the Adaptive Case Management approach as well as the Subject-Oriented Business Process Management approach for such human-centered business environments, the last approach that is to be examined within this master thesis scope is the Notify & Register approach. This approach consists an Event-Driven Business Process Modeling approach that seems to be applicable to both modeling and execution of human-centered business processes. (Alexopoulou, et al., 2009)

5.2. The approach

5.2.1. The event

The Notify & Register approach emphasizes upon these two main characteristics of human-centered environments, namely, the dynamic behavior of business processes and the intense human decision making. For that reason, the event-driven paradigm for the development of a business process modeling approach was adopted, for the design of dynamic and human-intensive processes. (Alexopoulou, et al., 2009)

It mainly focuses upon the event, as an entity of modeling actions need to be taken in order to complete a business process and achieve specific organizational goals. What is innovating about this theory is the fact that, although the event-driven paradigm which was adopted, appears to be well-established and completely appropriate for the business processes execution, there was not such a thing like the potential of applying events as a core concept of modeling business processes before, and no such an attempt was made previously as well. (Alexopoulou, et al., 2009)

The event, as an entity, represents something that happens and is meaningful for an organization, and for that reason it can express abstractly the conditions under which a business activity should be initiated. These conditions, vary from data configuration, human decisions or even anything that would lead to a situation that needs handling. This event could be even from an unknown source (Alexopoulou, et al., 2009), and to a certain extent, it must be defined only when it is meaningful for the organization and its occurrence should be handled appropriately. What needs to be highlighted is the purpose of the Notify & Register approach (N&R).

5.2.2. The approach's objective

The objective of this modeling approach is to project the occurring events of the real world and specify whether and when notification and registration actions are needed to be performed. As the event appears to be the central concept of the N&R approach, various business events that occur permanently are used to represent these traces of the real world human-performed activities that are important to the business process model. (Alexopoulou, et al., 2009)

While the domain of activity continues to be an agile and rather dynamic human-centered business environment like healthcare or legal work, the business activities do not take place in a predefined sequence. Instead, these activities are performed whenever and wherever required, according to human decision making. Thus, N&R does not focus on these activities but rather on the events that cause their execution by humans, and relevantly upon the registration of the information about these occurring events, as well as upon the notification of appropriate actors to be involved into the overall business process.

In that way, it leaves the decision about how these activities will be performed to the human actors, as these tasks cannot be automated by a process model, fact that makes sense, especially in human-centric processes execution and implementation. This latter case, outlines that the dynamic behavior feature that was mentioned before, is implemented through an N&R model.

5.3. The Notify & Register approach Meta-Model

For the Notify & Register approach, a meta-model was also created, therefore there was no need from our point to attempt creating another meta-model for that theory. In addition, the meta-model projected below, seems to fully implement the purpose and the philosophy of the approach which was described on an earlier stage, including all the basic entities which are furtherly prescribed in the meta-model's description below the following figure.

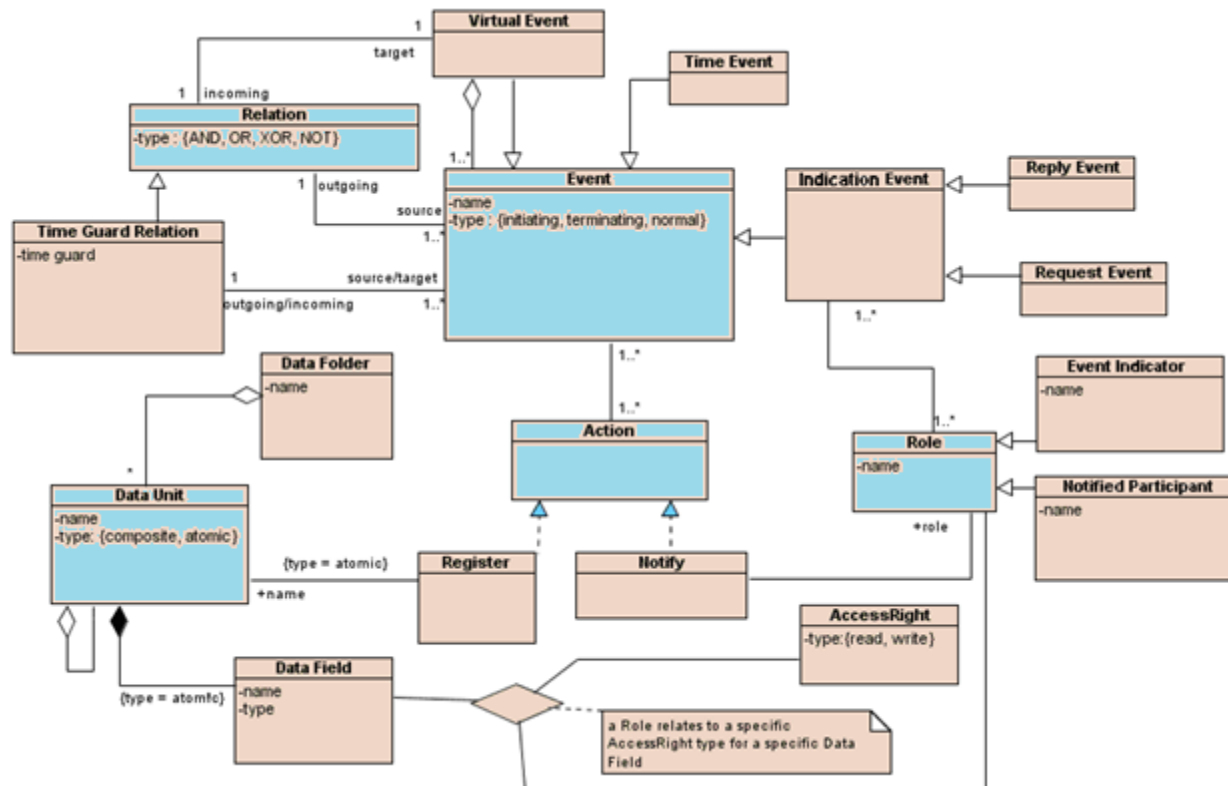


Figure 34. The Notify & Register approach meta-model (Alexopoulou, et al., 2009)

As a setting, for this meta-model, can be stated the fact that the activities that possibly would be enacted by a Business Process Management System (BPMS) in a human-centered business environment, are data registration and participant notification. For that purpose, the coordination would probably involve **efficient data access and update**, according to specific **access policies**, as well as instant notifications of the participants who would be responsible for accomplishing a task and logging every action.

As far as the meta-model's description is concerned, the above projected meta-model includes entities and their relations. To begin with, **registration** is an activity that involves **data insertion** in a **data folder** whenever the respective event occurs. A data folder is comprised of **data units**, thus a data folder can be expressed as a unit hierarchy, while the lower level of this hierarchy, data fields specify the actual data inserted in a folder. (Alexopoulou, et al., 2009) Data for these data fields are provided by the **event indicator**, indicating the occurrence of the corresponding event.

In addition, **access policies** are defined as it was mentioned before, specifying the data fields that can be edited. What is important to be highlighted is the fact that, data can be registered only as a result of an event's occurrence. Deletion of already saved data, is outside the N&R approach's scope. As an additional notice, for every N&R model one and only one data folder is defined. Furthermore, as it is indicated in the meta-model's multiplicity a specific event might lead to more than one **registrations** and more than one **notifications**, while a registration to a data folder or unit may be caused by various events. (Alexopoulou, et al., 2009)

What is more, as it can be seen in the meta-model's figure, various **event types** are defined in order to separate the different functionalities that different event occurrences lead to. For that purpose, firstly, **virtual events** are defined so as to aggregate multiple occurred events, which then can be associated with the respective registration and notification actions. Thus, these virtual events are not connected to event indicators, while what needs to be stressed is the fact that within an N&R model is either directly or indirectly connected to registration and notification activities. (Alexopoulou, et al., 2009)

Secondly, special events may be defined, such as **request of reply events**. A request event applies to the need for an actor to do something, while the reply event occurs when a previously requested task has been completed. Thirdly, **time events** may occur, namely, events that may implement the design of regular activities that may need to be performed routinely, in specific moments around the clock. (Alexopoulou, et al., 2009) As it can be obviously outlined, is the fact that these events are automatically generated and are not related to any **roles**. In order to define the time interval between two events occurrences a **time guard** has to be inserted, functionality that can be also used when time restrictions are needed between successive occurrences of the same event. Finally, there are **initiating events** and **terminating events** that start and end business processes.

5.4. Compliance with Patient Treatment

In order to examine both the approach in general, and the meta-model, the whole theory was applied upon a medical treatment case study (Alexopoulou, et al., 2009). This case study is the same case study that is used throughout this master thesis (its description can be seen in Chapter 2.2.). The philosophy behind of the Patient Treatment case study usage, lies in the fact that the sequence of actions is comprised of occurring events, triggered activities, notifications and registrations. That is how agility is granted to the whole case study implementation, and how the development of the whole patient treatment process takes place. (Alexopoulou, et al., 2009) In an attempt to understand more deeply this interrelationship to the N&R meta-model elements a table was created where the sequence of actions is projected.

Table 3. Patient Treatment Case Study main activities through N&R approach analysis table. (Alexopoulou, et al., 2009)

Occurring Events	Triggered Activities	Notified Participants	Registered Data
Patient Admission	Start Treatment	Clinical Physicians	Patient Health Status
Treatment Started	Specify Diagnosis	Specialist (conditional)	Medical History Updates
Diagnosis Specified	Prescribe Medication	-	Medication Recipes
Medication Prescribed	Administrate Medication	Nursing Personnel	-
Diagnosis Specified	Order Daily Examinations	Nursing Personnel	Examinations
Daily Examinations Ordered	Blood Drawing	-	Vital Signs Measurements
Vital Signs Measured	Evaluate Examination Results	-	-
Examination Results Evaluated	Revise Diagnosis / Medication	Nursing Personnel	Medical History Update
Unexpected Problem	Order Urgent Surgery	ICU Personnel (conditional)	Medical History Update

As the meta-model for N&R pre-existed and no tool was available to evaluate the approach, what was preferable was to interpret the case study's main activities as these are presented in Table 1, into the above presented table, in order to project this previously mentioned interrelationship between them. It is easily understood that this is how the sequence of actions is developing when the N&R approach is used into a human-centered environment like healthcare.

6. Approaches' Comparative Study

Having presented three human-centered approaches for Business Process Management, namely, the Adaptive Case Management, the Subject-Oriented Business Process Management and the Notify & Register approach, it is about time to make a comparative study upon and between these theories in order to present a holistic view of the alternation of BPM in knowledge-intensive environments.

6.1. Modeler's Perspective Comparison

At first, to do so, a comparison takes place between these theories as far as, both the implementation tool and the whole method itself, is concerned. This comparison is made through a series of queries, which when answered provide us with a spherical view of the differences between mainly between Adaptive Case Management and the subject-oriented approach of Business Process Management and on a second level, in comparison with the Notify & Register approach. (Nieto-Ariza, et al., 2006) (Aldin, et al., 2009)

The queries are addressed to the modeler of each one of the approaches, namely the creator of the meta-models for these theories. A person that having reviewed the literature between these methodologies and having linked the main notions of each one of the theories into a meta-model, has a complete understanding of the connections between the characteristics and the key features of each one, as well as the interaction and the interrelationship between these elements.

Additionally, some of the queries are about the theory itself, and others about the experimental tool that was used in a case study in order to evaluate the created meta-model. There is no differentiation between the queries, while some of them refer to both of the subjects mentioned above. Below a table with the queries, as well as the responses is presented. The left column contains the queries whose answers differentiate themselves from approach to approach. The answers about each one of the approaches is projected in separate column.

Table 4. The Modeler's Perspective Comparison table.

Property	Adaptive Case Management	Subject-Oriented Business Process Management	Notify & Register
Ease of Modeling	The universal usage of the tool hardens the matching of the meta-model's elements with the provided functionality. What is confusing is the integration of a case management process within a BPM application. The connection between roles and tasks seems the most difficult part.	The complete integration of the S-BPM basic philosophy within the tool facilitates the modeling of a case study like medical treatment. The modeling of the coordination between different actors from different processes is difficult but is doable through familiarization with the tool usage.	-
Role / User Management and Assignment	Very obvious role and actor definition. Roles are implemented with the notion of stakeholders upon a case.	Very clear roles definition. Roles are mandatory to be assigned to subjects in order to represent the distinction of participants in a process execution.	Roles represent people with difference in area and level of expertise. They are notified when an event is triggered.
Resource (Data) Management and Integration	Data management is executed through secondary tools fully integrated with the specific suite. Data folders and data sources can be defined in advance, in design-time phase.	Data are defined as process resources when modeling. Data are exchanged through messages between the subjects. Data mainly are processes inputs and outputs.	Data are organized in three tiers. Firstly in data folders, secondly in data units and finally in data fields. In these data structures the roles' registered actions are stored.
Multi-level Modeling	The approach enables multi-level modeling, as the orientation and the division of basic elements can be done in different layers	The S-BPM theory requires multi-level orientation as different levels of modeling are used (process interrelationship, subject	Within the N&R approach, the modeling is done, again in tiers, with the data-functional-organizational layer

	(data, functional, organizational). The implementation of entities is done in different stages within the tool.	interaction, states sequence). The tool implements this multi-level modeling through a drill-down philosophy.	methodology to be used.
Constraints and Business Policies Representation	Constraints are implemented through Business Rules. Permissions are granted to roles, as to which artifact or task they have access. The sequence of activities is defined through decision points.	Constraints are implemented in messages definition as local or global. The sequence of actions is shown in a subject's internal behavior and is defined through transitions from a behavior state to another.	In N&R approach access policies are implemented as to who has access to data structures. The sequence of actions is defined by the occurring events that trigger the following actions.
Integration with Modeling Tools	The implementation tool not only enables but also requires the integration with other modeling tools (i.e. for data management).	There is not any integration with other modeling tools for the S-BPM suite that was used for the case study implementation.	-
Flexibility in Modeling	Flexibility is the main characteristic of ACM. It is provided in all levels of modeling. Changes are implemented into the different modeling stages in the tool.	Flexibility is not the main characteristic of S-BPM. A flexibility in communication, though, is provided for the process subjects. In the S-BPM tool flexibility is provided through communication of different subjects of different processes.	Little flexibility, that lies upon the event occurrence. This occurrence drives the sequence of actions, and implements the workflow. Roles though have access restrictions that have to be considered carefully.
Flexibility in Process Execution	Changes are applied in run-time phase when a case is implemented. Role involvement can occur although it might not be designed in advance.	When process execution starts there is no change in the sequence of actions. In addition, every subject has a very specific number of tasks that it can implement.	The conditions for the events occurrence is predefined. So, there can be not any change in these conditions.

Strongest Point	The ability of being agile in a changing environment as well as the adaptivity in change are the main advantages of the ACM. Handling of emergencies. (i.e. Medical Treatment)	The drill-down approach of modeling, enables the complete understanding of a process stages. Generally, this theory facilitates an organization to meet with the user requirements when designing a system.	Provides an event-driven approach that differentiates itself from existing approaches. Emphasizes upon the occurrence of the event, and the registration of every action.
Weakest Point	When little emergency handling is required, ACM is preferable only in a few cases. From the tool perspective, there is no continuous modeling ability provided.	In human-centric environments with high emergency cases, S-BPM seems inappropriate. As far as the implementation tool is concerned, further integration with other modeling tools would be preferable.	Being an event-driven methodology, seems to be applicable to very specific cases.

Trying to explain the above table through a description of the queries and their answers, a division in paragraphs was made, with each one paragraph to provide a spherical view for the query asked and its response for each methodology. As an important notice, the responses differentiate from approach to approach, as well as between the tool or the method on the whole.

Ease of Modeling

The first query refers to whether the tool provides a facilitation on modeling the theory in a meta-model, and evaluating this meta-model through a case study implementation. Also, functionalities of the case study that was not doable to be implemented through the tool have to be mentioned here.

As far as the Adaptive Case Management tool is concerned, there is a flaw in the usage of the tool for implementing the case study. Because Oracle JDeveloper is a universal tool that provides with functionality of many methodologies, it harden the matching of each one of the meta-model's elements with the functionality that this BPM Suite provides for ACM. Additionally, is was confusing because in order to create a new case management project, it was mandatory for the user

to create a new BPM application within which the case management process was created. Therefore, the integration of a case management process into a business process management application was a bit contradictory to the whole Adaptive Case Management philosophy. What seemed to be the most difficult part of the case study implementation was the lack of the ability to straightly connect the case roles with the case tasks, something that was implemented only through business rules.

For the S-BPM tool, on the other hand, because its creation was based completely upon the Subject-Oriented Business Process Management theory, the evaluation of the meta-model through the case study, the same that was used for ACM, was much easier as it was fully implemented within the tool's functionality. What was found to be mostly the most difficult part of the meta-model evaluation, was the fact that the modeling of the coordination between the different actors from different processes was a little difficult to be achieved but was rather doable through the familiarization with the tool's usage.

Because the Notify & Register approach is a new human-centered event-driven methodology for Business Process Management, there was no tool in order to implement a case study like the Medical Treatment. Additionally, there was no need to evaluate the N&R meta-model as it was not created within this master thesis scope. For that reason this query was not answered for the N&R methodology.

Role / User Management and Assignment

As far as how the roles / users were handled in the three approaches is responded in the second query. From the modeler's perspective and again referring to the implementation tool for Adaptive Case Management, there was a very clear definition of roles and actors. Within the Oracle tool that was used for the meta-model's evaluation, there was a complete implementation of these elements through the notion of the case stakeholders upon a case.

Similarly, for the S-BPM approach the definition of roles was very obvious as it was a different page within the implementation tool. Additionally, it is mandatory for process roles to be assigned to subjects, so as to give a representation of the difference between the participants involved in a process execution.

Furthermore, for the Notify & Register methodology, the roles are representing people with different area and level of expertise that are notified when an event is triggered. For this approach the differentiation between roles is of utmost importance, as the most important fact is the notification of the right person on the right time (after an event's triggering) and the registration of his actions in detail.

Resource (Data) Management and Integration (with other tools)

For the data management, Adaptive Case Management the various data folders and data sources are defined in advance, in design-time phase and include the case folder items and the artifacts created by tasks or roles. In the Oracle tool for ACM, there is integration with other Oracle tools, through which the data management is executed.

As far as the Subject-Oriented Business Process Management is concerned, the data each process produces are exchanged through messages between the process subjects. In the S-BPM tool data are defined as process resources in modeling time. On the other hand, in the N&R approach, data are organized in tiers. The first tier contains data folders, where various data objects are stored. The second tier contains data units, namely, data objects that are produced from the interchange between notifications and registrations executed through event triggering.

Multi-leveled Modeling

Within this query, the ability of each one of the approaches to be modeled in a multi-leveled way is examined. In case of ACM, the approach enables multi-leveled modeling, as the division of the basic features can be done in different layers. The layers are the data layer, where data storage takes place, the functional layer, where everything that refers to tasks and their interrelationship is placed, and the organizational layer, that contains everything that has to do with the end user, or the roles involved in a process. Within the ACM tool the implementation of the meta-model's entities is done in different stages.

From the view of Subject-BPM, the theory itself requires a multi-leveled orientation as different levels of modeling have to be used. The stages refer to the process interrelationship, the subjects' interaction and the subject's internal behavior different states sequence. In that context, the tool implements this philosophy through a drill-down approach to modeling.

Similarly to the ACM methodology, the N&R approach uses the 3-tier modeling orientation, with the data tier to contain the data structures described above, the organizational layer to contain the roles involved, and the functional layer to contain all the occurring events as well as the actions that these events trigger.

Constraints and Business Policies Representation

For the Adaptive Case Management, business rules are used in order to implement constraints about which permissions are to be granted to which person. Thus, permissions are granted to roles, as to which artifact they have access to. Additionally, the sequence of activities is defined through the use of several decision points, within the case lifecycle.

Furthermore, in S-BPM approach, there are constraints about how the messages are considered. The division is done upon whether a message is local or global. For the sequence of actions, the interchange between them is shown within a subject's internal behavior, where the different states of this behavior are directed by transitions.

In N&R, the sequence of actions is directed by the occurring events that trigger these actions. These actions are taken by roles, who after the action execution, register the results and the created data if any, to the data storages. Again, in the Notify & Register approach, access policies are implemented as far as the permissions to update or modify data structures is concerned.

Integration with other Modeling tools

The ability of an experimental tool to be integrated with other BPMN tools is questioned in this query, for the first two approaches as there is no implementation tool for the N&R approach. For the Adaptive Case Management, the Oracle BPM Suite that was used in the ACM meta-model's evaluation, is deeply integrated with other Oracle tools for data management, document management, and server maintenance and other. In terms of modeling, this ACM tool needs integration with other tools in order to complete the modeling.

On the other hand, there is not any integration with modeling tools for the Metasonic Suite that was used in order to evaluate the meta-model created for the Subject-Oriented Business Process Management approach. Despite that malfunction, the experimental tool appears to cover all the needs for modeling, considering that seems completely representing of the S-BPM methodology.

Flexibility in Modeling

From the Adaptive Case Management approach's definition it arises that flexibility is its main characteristic. Across the modeling tool, flexibility is provided at all levels of modeling. Therefore, any occurring changes are integrated into the different stages of modeling.

On the other hand, flexibility, is not the main feature of the Subject-Oriented Business Process Management approach. Although, there is flexibility in terms of communication, which is provided to the process subjects. What is provided within the S-BPM experimental tool as far as the flexibility is concerned lies to the fact that communication is provided between different subjects from different processes directly.

In the Notify & Register approach, the flexibility of modeling lies to the fact that there is not a predefined sequence of actions, but this sequence is defined through event occurrence. That is how the organizational workflow is designed. However, the access restrictions that exist in modeling have to be kept in mind.

Flexibility in Process Execution

In case of ACM, by its definition, any occurring changes are applied in the run-time phase of the case execution. To a further extent, different roles may be involved, despite the fact that this might not have been scheduled in advance. On the contrary, by the time a subject-oriented process starts, there cannot be any change in the sequence of actions a subject takes, or in his internal behavior. That is because every subject has a very specific number of tasks that it is able to implement when involved to a process. What is an existing option, is the fact that more subjects can be notified in order to be involved in the process execution. As far as the N&R approach is concerned, considering that the conditions, under which specific events occur, are predefined, seems to be a bit strict.

Strongest Point

What seems to be the most important feature of Adaptive Case Management, is the fact that this approach enables an organization to be agile in a continuously changing environment. Therefore, it provides an enterprise with the ability to be adaptive in change so as to be able to handle emergencies when needed. That is why this approach seems to be ideal for a Medical Treatment case study.

Moreover, for Subject-Oriented Business Process Management, what makes this approach unique is the ability that provides a modeler with to have a complete understanding of a process stages, through the drill-down / layered approach that was mentioned in a previous query. On the other hand, this theory more generally, facilitates an organization in terms of meeting with the users' requirements when a system or a project is on its design-time phase.

For the N&R approach, its strongest point lies to the fact that provides a rather new, event-driven approach that is different from any existing human-centric BPM methodologies. What characterizes it as unique is the fact that it emphasizes upon the occurrence of the event, as well as upon the registration of every action's result.

Weakest Point

The biggest drawback of the Adaptive Case Management methodology lies in the case of domains with little emergency to handle, where the ACM approach, although it seems appropriate to use, it is not the most preferable one. As far as the ACM experimental tool is concerned, its biggest drawback lies to the fact that is not a tool dedicated to Adaptive Case Management, fact that leads to not providing a continuous modeling service.

For the Subject-Oriented Business Process Management, as being more strict than ACM, when there is the need of handling processes in changing environments with high levels of emergency occurrence, the S-BPM seems inappropriate. From its experimental tool's perspective, further integration with other modeling tools would be more preferable in order to be able to implement different types of work within the same modeling attempt.

Finally, for the N&R approach, being an event-driven approach makes it applicable to very specific cases, and not in general circumstances where lots of modeling work is needed.

6.2. Approaches' meta-model elements matching

At this stage, in order to complete the comparative study upon the three approaches presented within this thesis scope, apart from the comparison of the capabilities provided by both the methods themselves and their experimental tools, viewed by the modeler's perspective, an element-based matching of the three methodologies would be appropriate to take place. That way the interrelationship of the approaches would be more understandable in terms of corresponding philosophies.

For that reason, a table was created, which is projected below, that contains the basic or secondary elements that are matching with each other. In addition the matching was done upon two different criteria, the first is the notion of each element into each one of the methodologies, and the second one is a view-based matching of the elements, as a categorization within which the various elements are inserted.

Table 5. The Approaches' Elements Matching table.

Notion-Oriented Matching	Adaptive Case Management	Subject-Oriented Business Process Management	Notify & Register	View-Based Matching
Basic Modeling Element	Case	Subject	Event	Functional View
Activity Modeling	Task	State	Action	Functional View
User Modeling	Role	Role	Role	Organizational View
Data Modeling	Artifact	Message / Business Object	Data Unit	Data View
Conditional Modeling	Decision Point	Transition	Relation	Functional View
Action Sequence Projection	Roadmap	Internal Behavior	-	Functional View

What is presented through the above projected table, is the interrelationship between the three meta-models' elements upon two axis. Upon the first axis, the Notion-Oriented Matching, these elements are firstly categorized upon six categories. The first category contain the basic modeling

elements, or the elements that appear to be the response to the question of what is modeled. Within this category, the case element, the subject element and the event element is included. Additionally, the elements included within this category are also contained into the functional view of the approach.

On the second category, the various activity elements of each approach are included that are also characterized into the functional view of these approaches, namely the task element, the state element and the action element. Moreover, in the same category are included the elements of implementing conditions, such as decision point, which is a secondary element, transition, and relation as far as the N&R approach is concerned, and representing the actions' sequence, such as roadmap element, and internal behavior, which is also a secondary meta-model element. The Notify & Register approach does not contain an element of this category.

Finally, the User elements and the Data elements represent two views of the theory's structure, which are the Organizational View in one hand, and the Data View on the other hand. Within these categories are included the role elements of each meta-model for the user modeling category, and the artifact, message or business object element and the data unit element for the data modeling category.

7. Conclusions and Future Work

This master thesis has as a scope to make a comparative study between three human-centric approaches for Business Process Management, the Adaptive Case Management, the Subject-Oriented Business Process Management and the Notify & Register approach. After an extended scientific research and study of the background for these methodologies, respective meta-models were created for each one of these approaches, except from the N&R approach where the meta-model pre-existed and was not modified as it seemed quite representing of the approach's philosophy and scope.

Moreover, after the meta-models' creation, each one of them was evaluated through an experimental tool, that supported at a complete level the whole required functionality of each approach, and a human-centric environment case study, the Patient Treatment. Through these steps, a spherical knowledge for each one of the theories was gained, knowledge that helped us to result in a comparative study between the approaches' main characteristics. During this comparative study, not only a comparison between the methodologies took place, but a matching between their created meta-models primary elements was made as well. What was concluded from the above mentioned comparative study is analyzed below.

7.1. Conclusions

To begin with, there is not such a thing like a holistic human-centric process management approach. What arose from the comparative study between the three approaches, ACM, S-BPM and N&R, lies to fact that these methodologies differentiate themselves from each other in terms of the view their scope stands as far as the human-centric business process management is concerned.

To be more specific, from their characteristics comparison as well as their meta-models primary elements matching, what was realized is the fact that the core features are the same for all these three methodologies. In detail, all three of these methodologies have firstly, as their main characteristics, roles, namely people involved based in their area of expertise in the processes execution. Secondly, there are data that are edited, modified, updated and deleted, in every approach, a fact that means the knowledge that may be created is stored as it may be proved useful

for future use. This knowledge may be the result of different factors. In Adaptive Case Management, for instance, data are a result of executing and implementing different tasks, during an ongoing case implementation. On the other hand, data in Subject-Oriented Business Process Management are handled like resources for the organization. Data in this approach do not play such a big role as the might do in ACM, especially because they are transferred between subjects through messages. That is a type of automatic storage. On the contrary, data are of utmost importance in case of the Notify & Register approach as the registration of every data created during activities execution is one of the main two actions that take place in this methodology.

Additionally, activities are made, that as it was mentioned before lead to knowledge creation, in terms of data. The activities in all of the approaches are driven by events, which are considered and examined differently. In the N&R approach, events are the basic modeling entities, the notion that leads the whole methodology's philosophy. In the S-BPM approach, events are represented as the message exchange occurrence between two or more subjects. On the other hand, ACM implements events through the definition of different business rules. These rules are triggered by events, and lead to the execution of tasks.

As it can be understood from all the facts mentioned above, it that depending how you examine human-centered business process management, it can be considered that your perspective converges upon one of these approaches. For instance, when your approach is data-driven, it can be said that Adaptive Case Management can be used, as it is considered as a data-driven approach. On the other hand, if your approach is role-driven, namely, you examine who can do what, then it can be mentioned that S-BPM is preferable to be used, as it is a role-driven methodology. Similarly, for N&R which is an event-driven methodology.

What is more, as an important notice, the fact that ACM, S-BPM and N&R are put in the same level of abstraction as far as their core features are concerned, must not be distractive and make us consider them similar. What is really the case, is the fact that these methodologies, additionally according to the comparative study made before, are different between them. For instance, ACM is agile and adaptive, leaves the different actors involved in the case to act as they consider best, and focuses upon the knowledge work and whatever is variable, considering routine work

processes as black boxes. On the other hand, S-BPM for instance is rather rigid and strict, and its human-centric feature is the fact that focus is given upon the communication of involved subjects.

7.2. Future Work

What is included within this thesis' scope contains scientific research, and modeling attempt. This master thesis, provides a spherical view of some of the most important human-centric BPM approaches, while the added value of this research work, lies to the fact that the comparative study that took place within this work's scope, arose some important conclusions, that were outlined above. Moreover, the meta-models that were created, were the first for these approaches, and most of all, these models were based upon the theoretical background of these methodologies.

As a future work, from where I stand, could be first of all, an evaluation of the created meta-models through a different case study, which would, of course, include knowledge-intensive and human-based work, but would contain less emergency factors, that boost the usage of Adaptive Case Management. The usage of the legal domain, for instance, seems ideal, in order to evaluate, to a further extent, the meta-models for ACM, S-BPM and N&R.

Secondly, a modeling tool for the Notify & Register approach could be created, as a software to implement event-driven process modeling. That way, a further examination upon this approach could be done, as the already created meta-model, would be evaluated, through this tool, and implementing a case study, as it was already done for the other two approaches.

What is more, a modeling challenge that could be set could be the creation, of a combining model, and in an extent, of a combining meta-model, not for a single approach, but for human-centric process management in general. That could lead, of course, to the creation of a combining implementation tool. This software, could combine the functionalities of these three methodologies, or even more, in a single modeling suite. The last one, would facilitate modelers, to use a single product in order to model human-centric processes, or to model different parts of the same knowledge work, at once.

Generally, the domain of human-centric business process management provides lots of research opportunities as it is something new in enterprise engineering, area of knowledge, an area that organizations have to focus upon, in order to facilitate their workers and make them more efficient.

References

Aldin Laden and Cesare Sergio de A Comparative Analysis of Business Process Modeling Techniques [Conference] // U.K. Academy for Information Systems (UKAIS 2009), 14th Annual. - Oxford, United Kingdom : UKAIS, 2009.

Alexopoulou Nancy [et al.] An Event-Driven Modeling Approach for Dynamic Human-Intensive Business Processes [Conference] // edBPM Workshop of BPM. - Ulm, Germany : Springer Verlag, 2009.

Fleischmann Albert [et al.] Subject-Oriented Business Process Management [Book]. - [s.l.] : Springer Heidelberg New York Dordrecht London, 2011.

Fleischmann Albert, Schmidt Werner and Stary Christian Open S-BPM = Open Innovation [Conference] // S-BPM One. - [s.l.] : Springer-Verlag Berlin Heidelberg 2013, 2013.

Fleischmann Albert, Singer Robert and Raß Stafan S-BPM Illustrated : A Storybook about Business Process Modeling [Book]. - Graz : Springer Science+Business Media, 2013.

Jalali Amin and Bider Ilia Towards Aspect Oriented Adaptive Case Management [Conference] // EDOCW. - [s.l.] : IEEE, 2014.

Kannengiesser Udo and Muller Harald Subject-Orientation for Human-Centred Production: A Research Agenda [Conference] // S-BPM ONE. - Deggendorf, Germany : Springer-Verlag Berlin Heidelberg 2013, 2013.

Metasonic <http://www.metasonic.de/en/documents> [Online] // Metasonic Corporation Web Site. - Metasonic GmbH, 01 23, 2014. - T15.0. - 2 13, 2015.

Motahari-Nezhad Hamid R. and Swenson Keith D. Adaptive Case Management: Overview and Research Challenges [Conference] // Conference on Business Informatics. - Vienna, Austria : [s.n.], 2013. - p. 6.

Motahari-Nezhad Hamid R. [et al.] Casebook: A Cloud-Based System of Engagement for Case Management [Journal] // IEEE Internet Computing. - 2013. - pp. 30-38.

Mundbrod Nicolas, Kolb Jens and Reichert Manfred Towards a System Support of Collaborative Knowledge Work [Conference] // Business Process Management Workshops. - Tallinn : Springer-Verlag Berlin Heidelberg 2013, 2012. - pp. 31 – 42.

Nieto-Ariza Erika M., Rodriguez-Ortiz Guillermo and Ortiz-Hernandez Javier An empirical evaluation for business process tools [Conference] // First International Workshop on Advanced Software Engineering. - Santiago, Chile : Springer US, 2006.

OMG CMMN : Object Management Group [Online] // Object Management Group Web site. - May 5, 2014. - 1.0. - November 7, 2014. - <http://www.omg.org/spec/CMMN/1.0/PDF/>.

Scheithauer Gregor and Hellmann Sven Analysis and Documentation of Knowledge-Intensive Processes [Conference] // Business Process Management Workshops. - Tallinn : Springer-Verlag Berlin Heidelberg 2013, 2012. - pp. 3 – 11.

Sem Helle Frisak [et al.] Patterns Boosting Adaptivity in ACM [Conference] // OTM 2013 Workshops. - Graz, Austria : Springer-Verlag Berlin Heidelberg, 2013. - pp. 102-111.

Swenson Keith D. Mastering the Unpredictable : How Adaptive Case Management Will Revolutionize the Way That Knowledge Workers Get Things Done [Book]. - Tampa, Florida : Meghan-Kiffer Press, 2010.

Swenson Keith D. Position: BPMN Is Incompatible with ACM [Conference] // Business Process Management Workshops. - Tallinn : Springer-Verlag Berlin Heidelberg 2013, 2012. - pp. 55–58.

Tran Thanh Thi Kim [et al.] Setup and Maintenance Factors of ACM Systems [Conference] // OTM 2013 Workshops. - Graz, Austria : Springer-Verlag Berlin Heidelberg 2013, 2013. - pp. 172–177.

von Rosing Mark, Scheer August-Wilhelm and von Scheel Henrik The Complete Business Process Handbook :Body of Knowledge from Process Modeling to BPM [Book] / ed. Elliot Steve. - [s.l.] : Elsevier Inc., 2015. - Vol. 1.

White Michael White Papers and Technical Briefs [Online] // bptrends.com. - July 9, 2009. -
<http://www.bptrends.com/bpt/wp-content/publicationfiles/07-09-WP-CaseMgt-CombiningKnowledgeProcess-White.doc-final.pdf>.