

Systematization of Requirements Definition for Software Development Processes with a Business Modeling Architecture

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Abstract. There are several modeling methods, techniques and tools available in order to facilitate the understanding and the analysis of the complexity of the modern organizations. Such methods, techniques and tools are used to make the complex organizational practice more understandable. Some of them support information systems development methodologies. Nevertheless, what is observed is lack of integration of the analysis between two domains: the business domain and the system domain. The alignment between the software requirements and the actual need for the business informatization can be improved by means of business modeling techniques. In this work, it was proposed activities for the business modeling to be inserted in the UP (Unified Process) based methodologies or in any other methodology basing on the same principles, with the purpose of systematizing the identification of software requirements aligned with the business objectives. The activities defined in the method comply with the iterative and incremental model, as well as with interfaces well established with the UP pre-established activities, showing some advantages.

Keywords: *Enterprise modeling, Unified process, Information system*

I. INTRODUCTION

The modern business organizations need to be constantly evolving in order to maintain their competitiveness. It is necessary to implement frequent changes and innovations in the business processes and, consequently, in the information systems which support them. The integration among the business objectives, the business processes and the information systems is an important factor for the organizational dynamics and also a challenge to the managers. There are several modeling methods, techniques and tools available in order to facilitate the understanding and the analysis of the complexity of the modern organizations [1]. Such methods, techniques and tools are used to make the complex organizational practice more understandable. There are also several methodologies employed in the information system development. Nevertheless, what is observed is lack of integration of the analysis between the two domains: the business domain and the system domain [2, 3]. Among

all the software system development methodologies, the Unified Process (UP) has been currently highlighted. However, even in the UP, the requirement survey is still an empiric process, not taken systematically into consideration the importance of the focus on the business objectives.

In this context, it is evidenced in the software development processes the need for a closer approximation between the software system requirements and the actual business needs. In the object-oriented paradigm, the requirement analysis has been carried out based on a UML modeling element called Use Case. Although there is some heuristics proposed in order to identify the use cases, such as the ones presented in Schneider and Winters [4], Jacobson et al. [5] and Lilly [6], there are no established methods to make this activity more systematic. The alignment between the software requirements and the actual need for the business informatization can be optimized by means of business modeling techniques.

Thus, this paper presents some definitions regarding the Requirements Engineering, the Unified Process (UP) and some concepts related to the business processes modeling with the UML and issues related to the identification of business use cases. Therefore, the activities proposed to be inserted in UP-based methodologies are described, and the final considerations are presented.

2. REQUIREMENTS ENGINEERING AND UP

The software engineering follows a set of steps. Each of the phases may comprise methods, tools and procedures. Their structuring is mentioned as a software engineering model [7]. Pressman [7] considers that, regardless of the software development model, the software development process has three generic phases: definition, development and maintenance. Four software engineering models have been widely discussed: The classic life cycle (or cascade), the prototyping, the spiral model and the Fourth generation techniques [7]. A new model has been currently used, that is, the iterative and incremental model [5, 8]. The requirement analysis is a phase which is always present in the software definition phase, regardless of the software engineering model adopted. It links the need for process informatization to the software project meeting such needs. A series of analysis methods and requirement specifications was developed. However, there are few propositions aiming at requirement identification systematization in order to make this activity less subjective.

The Unified Process (UP) is a process established to the software development which resulted from three decades of development and practical use. Jacobson *et al.* [5] presents the UP origins from the Objectory process (the first version in 1987), passing through the contributions of the Rational Objectory Process (in 1997), up to the Rational Unified Process – RUP [9]. The UP purpose, as any other development process, is to determine a set of necessary activities to make requirements into software systems. It uses the UML as a language to the modeling of software artifacts produced during the development process. The UML was adopted by the Object Management Group (OMG) in 1997 as a standard language to the modeling of object-oriented systems. It is a language for the specification, visualization, construction and

documentation of software system artifacts, as well as for the business modeling and other systems, except for software systems. This language represents a collection of the best engineering practices which proved to be successful in the modeling of large and complex systems [10].

3. BUSINESS PROCESS MODELING BY UML

According to Johansson et al. [11], a business process is a set of connected activities which receives input and transform it into output. In theory, the transformation of the business process must add value and create a useful and effective result to the receiver, above or below the chain. There are several techniques, methodologies and notations to the business modeling [12]. In order to make a company adaptable to the changes, it needs to have a simple and unified description of its entities. Although this is the purpose of many modeling efforts, they provide an extensive, inflexible and fragile description [13]. Recently, UML, which is already consecrated to the software systems modeling, has been proposed to the business modeling by means of its extension mechanisms. According to OMG [10], the UML has extension mechanisms allowing its adjustment to new things and specific domains. The extensions defined by the UML users take place by means of stereotypes, tagged values and constraints that extend and adapt the UML to a specific domain. In the next subsection, a proposal of extensions for the business modeling by using UML will be presented.

The Eriksson and Penker's proposals [14] form a UML-based Architecture for the business modeling in which a business architect can add convenient stereotypes, tagged values and constraints for their business domain. Their work is based primarily on UML extensions in order to represent: processes, resources, rules and objectives. Their proposal is based on the hypothesis that a business can be modeled by means of objects and the relations among them. A modeling architecture provides view for the modeling with a focus on significant aspects. Each view can be modeled by one or more types of diagrams. The proposed Architecture offers the following view [14]:

- Business Vision: It models concepts and objectives to be followed according to the business strategies;
- Business Process: It models the business processes and their relations to the resources, to be followed in order to achieve the objectives;
- Business Structure: It models the (physical, informational, human) resource structure;
- Business Behavior: It models the behavior and interaction among resources and among processes.

Within this Business Process view, it is highlighted the Business Process Diagram and the Assembly Line Diagram. The Business Process Diagram describes the business processes by means of its relations to Objects (Objectives, Inputs, Outputs, Suppliers and Controls). At the top of the Assembly Line Diagram, there is a Business Process Diagram. Below, there are various horizontal packages, which are called assembly line packages, each one representing a group of objects. The objects of a

package may be from specific or different classes. An assembly line package is a UML package item stereotyped to `<< assembly line >>` and designed as a long horizontal rectangle. It supports the identification of use cases related to the business process. The purpose of this diagram is to demonstrate how the process in the upper part of the diagram uses and generates objects in the assembly line. The reference of an object in an assembly line is indicated by an object flow (represented by a dashed line in the UML) between the process and the object within the packet, in the assembly line. The assembly line diagram can be used as a technique to the use case survey of the system or systems which will support the business processes. The identification of use cases by means of this technique makes the business objectives and the requirements of the system (represented as use cases) be aligned with the global objectives of the business, since they are analyzed based on the business processes, which were defined in terms of the business objectives.

4. ACTIVITY PROPOSAL FOR THE SYSTEMATIZATION

This paper recommends the insertion of a workflow in the UP for the business modeling, based on the modeling technique proposed by Eriksson and Penker [14]. Updates on some UP pre-established activities are also proposed. Such activities are proposed so that they can be applied to any UP-based methodology. The construction technique of business architecture proposed by Eriksson and Penker is, considering all the researched UML business modeling proposals, the only one which has a systematic approach in the transition of the business architecture into a software architecture. However, Eriksson and Penker do not explore the systematization of this transition within a context of system development process or methodology. In the UP, workflow activities to the requirement analysis can be used in all phases of the software development, especially in the Conception and Elaboration phases. In the Conception phase, the requirements identification of the system is emphasized, however, the detailed specification must be performed in the Elaboration phase. A requirement identification method which derive the use cases of a UP software architecture must define activities and their flows, as well as the expected artifact state generated by such activities, in each phase of the process (Conception, Elaboration, Construction and Transition), considering such structure as iterative and incremental. The application of the Eriksson and Penker technique to the UP is performed by means of the definition of a workflow to the business modeling and updates in the activities established for other workflows, so that they can be integrated. Some activities are added and others are only updated, by inserting sub-activities. It is also defined the approach that each activity proposed must have in the Conception and Elaboration phases. As previously shown, these are the phases in which the requirement analysis activities must be more present.

4.1 Business Modeling Workflow

The workflow defined to the business modeling is presented in Figure 1. Following, the descriptions for each activity and the approach for each phase of the development process are presented. Figure 2 shows a part of the development process related to the Concept phase.

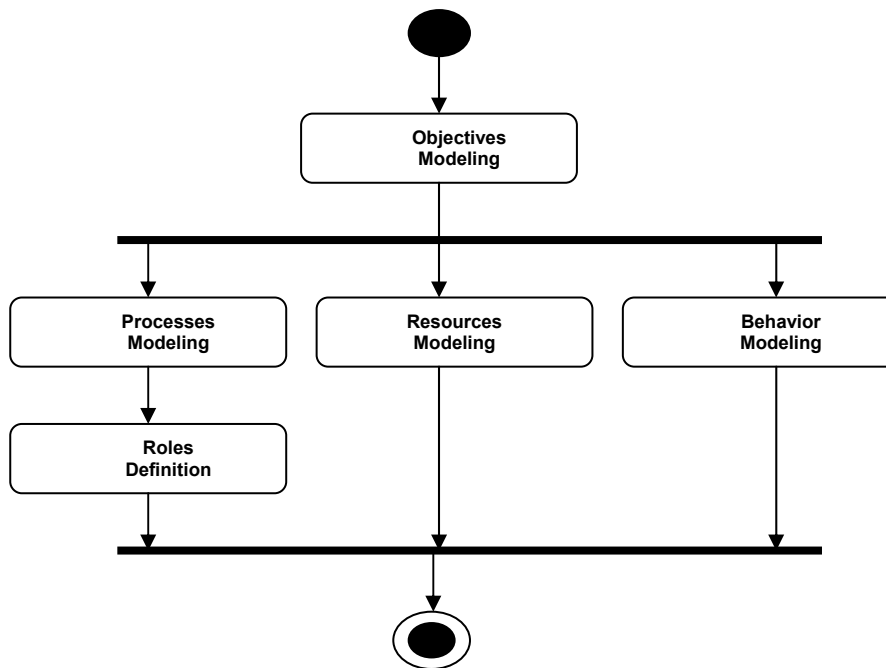


Figure 1. Workflow for Businesses Modeling

4.1.1 Modeling the Business Objectives

The objectives modeling activity must identify the main objectives and sub-objectives of the business in a hierarchical structure that allow the visualization of the dependence aspect among such objectives. This model will be the base for defining the business processes. The business objective modeling must be performed based on interviews with the businesspeople. Resulting product: Objectives Model Diagram. Approaches for each phase:

Conception phase – the Objectives Model must comprehend the objectives relevant to the project, from the strategic ones to those related to the business process objectives themselves.

Elaboration phase – the Objectives Model in terms of possible clarifications must be updated.

4.1.2 Modeling the Business Processes

The business processes must be defined by searching for the achievement of the businesses objectives identified in the Objectives Model. However, there is no need to exist a 1-to-1 relation between the business processes and objectives, because many auxiliary processes will not be necessarily related to an objective of the Objectives Model. It is imperative that interviews with the involved ones also be performed in order to provide subsidies to define the business processes. Resulting product: Business Process Diagram.

The approaches for each phase are:

Conception phase – the main business processes must be identified, as well as their relations to the resources (inputs, outputs, suppliers, controls and objectives), and the sequence for their accomplishment. However, it is not necessary to describe in details the event flow taken place internally in the process.

Elaboration phase – To detail the event flow of the processes which will be approached at the iteration.

4.1.3 Modeling the Involved Resources

The resources, information and organizational units must be modeled by means of the Business Structure View diagrams. The modeling of these elements must be performed paralelly with the Business Process Modeling activities, in order to have a better understanding of the terms related to the business, and, consequently, a greater consistence in its modeling. Resulting product: Resource Model Diagram, Information Model Diagram and Organization Model Diagram. Approach for each phase:

Conception phase – all the significant resources identified in the Business Process Model defined in the Conception phase must be modeled, so that the dependence between such resources and the properties can be analyzed.

Elaboration phase – to model all the significant resources identified during the detailing process of the event flow in each business process.

4.1.4 Modeling Resource Behavior

A Resource State (Statechart) Diagram can be created in order to facilitate the determination of the business processes when it is characterized by refining of a same object along the value chain. For example, taking into consideration a sales business, the order can be regarded as an object whose state is being altered (refined) along all the value chain, from the start of the order to the confirmation of the order delivered to the client. In a case like this, the identification of the possible states for the object (such as requested order, order to be verified in the inventory, order in production, order in expedition and order delivered), can facilitate the identification of business processes needed to the accomplishment of the changes in the state of the product. Resulting product: Statechart Diagrams and Interaction Diagrams. Approach for each phase:

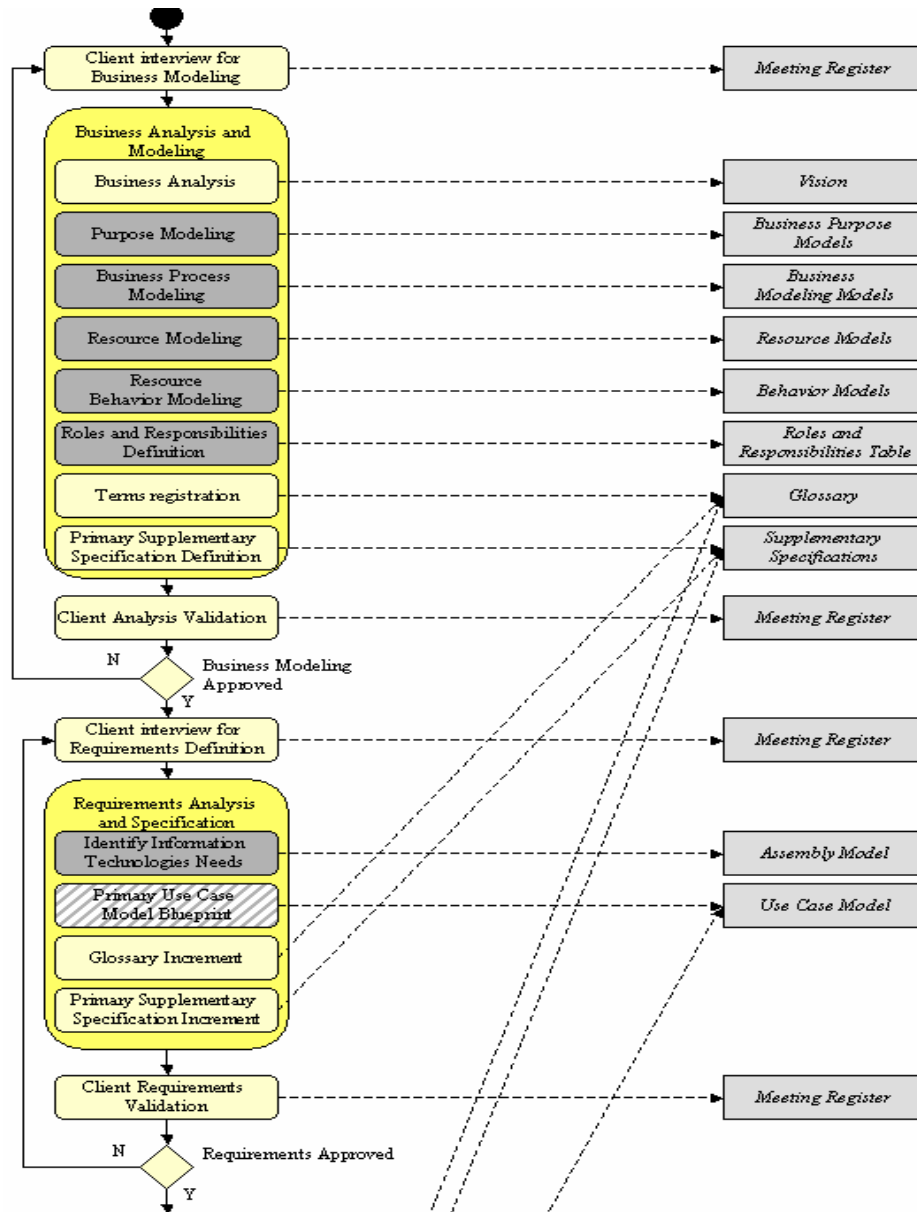


Figure 2. Part of the Development Process Related to the Concept Phase

Conception phase – to model the behavior of the resources when they undergo several changes during the business processes, and this changes dynamic must be better understood.

Elaboration phase – to detail the Statechart Diagrams, in case they have been created in the Conception phase, based on the detailing process of the event flow of the processes.

4.1.5 Defining Roles and Responsibilities

Each business process must have a person in charge, since it will not be connected to only one organizational unit, but passing through many of them. Each process defines an event flow which can involve one or more actors. It is necessary to define which actors act in each one of the processes. It can be done by means of an analysis of the event flow and their association with the actors involved in the process. Resulting product: Table of Roles and Responsibilities. Approach for each phase:

Conception phase - to define solely the people in charge for each business process, whether they are organizational units or functions.

Elaboration phase – to define the roles (actors) associated with the events which take place in the event flow of each business process.

4.2 Requirement Analysis Workflow

Following, activities added to the Requirement Analysis Workflow are described.

4.2.1 Identifying Informatization Needs

In this activity, it is necessary to associate the business processes to the information systems supporting them, thus identifying the possible needs for news information systems through the identification of lacking of automatized support for information and operations to the processes. It is suggested the use of the Assembly Line Diagram as the base for the accomplishment of this activity. Resulting product: Assembly Line Diagram with the identified assembly line packages. Approach for each phase:

Conception phase – to identify software systems which support the business processes as well as to identify the need for new systems and sub-systems. It is used the Assembly Line Diagram as a supporting tool in the development of this activity. One must start with the packages at a high abstraction level, representing the systems which already exist and the nature of the reference information that the systems produce at each analyzed business process. Next, it is necessary to perform an evaluation with regard to the nature of the information and the operations needed in the process, as well as their accomplishment by the existing systems. So, it is possible identify the types of information and operations which are not being held by the software systems available. Such needs for information and operations must be referenced to another representative package of the system (or systems) to be constructed in order to meet such requirements.

Elaboration phase – it is imperative to update and deepen the analysis started at the Conception phase, based on the description of event flow of the processes. It is

necessary to evaluate each event flow and to identify events which can be aided by information systems, but that still are not. Such aid must be represented as references (relations) of processes to the systems which support them. Considering the scope of a system identified in the conception, one must represent each assembly line as a system class and distribute the responsibilities among the classes by means of references mentioned to each one of them by the processes. Each event to be informatized must result in a reference to the class that will perform it, and in case this class does not exist, it must be created as a new assembly line. This last step must be performed by following the "encapsulation" concept.

4.2.2 Deriving Use Cases of the Business Processes

The use cases must be identified based on the business processes. This activity must result in a list of Use Case in which one must associate each identified use case with the business process. It is suggested the use of the Assembly Line Diagram as the base for the accomplishment of this activity. The identification of the use cases in the Assembly Line Diagram is performed by means of references cluster (between the processes and the systems) of the same nature. Resulting product: Assembly Line Diagram and Use Cases. Approach for each phase:

Conception phase – the activity must aim at identifying the use cases architecturally significant. These use cases represent functionalities at a high abstraction level. These use cases serve as the base for defining the logic view of the software architecture which will perform them.

Elaboration phase – the activity aims at identifying all the system's use cases based on the reference analysis between the detailed processes and the software systems which will support them.

4.3 Workflow for Analysis

The Use Case Realization activity, which is original from UP, was updated by means of the sub-activity Identifying Classes from the Business Architecture.

4.3.1 Identifying Classes from the Business Architecture

This activity consists of the identification of Classes from Business Structure View models and from the Business Process View. Resulting product: Class Diagram. Approach for each phase:

Conception phase - it is attempted to identify the main system Classes based on the analysis of Resource and Information Models.

Elaboration phase - it is imperative to perform a re-evaluation of the identified Classes based on the references of the Assembly Line Diagram developed in this phase. By means of the reference analysis, it is imperative to identify which classes will be in charge of the use cases realizations identified in the Assembly Line Diagram.

5. FINAL CONSIDERATIONS

In the business modeling domain, the business construction technique proposed by Eriksson and Penker is, considering UML business modeling proposals, the only one that has a systematic approach with the transition of the business architecture into a software architecture which is supportive to the first one. However, Eriksson and Penker do not explore the systematization of this transition within a context of system development process or methodology. In this paper, it was proposed activities for the business modeling, based on the technique proposed by Eriksson and Penker, to be inserted in the UP or in any other methodology basing on the same principles.

The activities have the purpose of systematizing the identification of software requirements aligned with the business objectives. The activities defined in the method comply with the iterative and incremental model, as well as with interfaces well established with the UP pre-established activities, showing two advantages: (i) the systematic identification of informatization needs, from the event flow of the processes established in the activity; (ii) the systematic identification of the use cases under an iterative approach, established in the "Deriving Use Cases of the Business Processes" activity. The identification of use cases from the assembly line diagram turned out to be an efficient procedure, thus facilitating the identification of the actual informatization needs in the business processes.

As a proposal for future studies, it is suggested the comparison of this technique with other requirement identification techniques, and the construction of a CASE tool that allows for a larger automation of the activities defined in this paper.

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