

# Utilizing Business Process Models for Requirements Elicitation

Onur Demirörs<sup>1</sup>  
Assoc.Prof.Dr.  
demirors@ii.metu.edu.tr

Çiğdem Gencel<sup>1</sup>  
cgencel@ii.metu.edu.tr

Ayça Tarhan<sup>2</sup>  
ayca.tarhan@bg.com.tr

<sup>1</sup> Middle East Technical University, Informatics Institute,

<sup>2</sup> The Bilgi Group Software Research, Education, and Consultancy Ltd., Ankara, Turkey

## Abstract

Acquisition of software intensive systems demands significant work on requirements prior to establishing the contract. The acquirer needs to understand the domain, needs, and constraints of the project clearly in order to make realistic size and effort estimates, and to have a solid foundation for defining contract requirements. In this study, an approach for requirements elicitation based on business processes is investigated. The approach proposes determination of requirements of a software intensive system to be acquired, according to the business objectives and base lining business processes. This study presents the implementation of the approach in a large innovative military application within the boundary of a project for Request for Proposal (RFP) preparation.

## 1. Introduction

Requirements elicitation is the process to gather, process, and track evolving customer needs and requirements. Although conventional acquisition cycles perceive requirements elicitation as the process to understand customer needs, the attributes of the system to be acquired and the characteristics of the acquisition organization frequently bring unique challenges for requirements elicitation.

During the development of large and innovative systems, requirements elicitation entails more than obtaining and processing customer needs. In most cases, such systems have different stakeholders with conflicting needs, and have major risks related to cost, quality, and time schedule. The acquirer needs to understand the concept, the domain as a whole, the technology to be utilized and technical and management constraints of the project clearly. Then the current business processes should be made explicit and potential new technologies should be prototyped. Such an understanding creates a solid foundation for defining the contract requirements as well as to make realistic estimates of size and effort.

We assumed that establishment and transformation of the need from concept to system requirements could be

supported by means of notations and tools developed primarily for business processes reengineering. To validate this assumption, we defined a requirements elicitation approach together with its supporting notation and tool. We then examined its usability as a basis for defining the contract requirements for a large innovative military application within the boundary of a project for RFP preparation. The project, targeting the requirements elicitation for a model Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) sub-system for the Turkish Land Forces Command, was started in December 2001 and completed in eight months. The project staff consisted of 16 persons. The total effort spent during the project was 18 man-months. The project outcomes formed the major parts of the Request for Proposal currently issued by the Turkish Armed Forces. The size of the software to be contracted for the model system was estimated as 11,000 function points by the project team.

In this paper, we focus on the implementation of the approach, and describe the details of and the lessons learned from this experience. The last section draws the conclusions of the study.

## 2. Process Implementation

The approach developed as part of this study builds on the assumption that business process definition should be the key activity for requirements elicitation. Business process modeling has been implemented by a large number of organizations as part of business process reengineering [1], [2], or similar approaches during the last decades. Business process based approaches are helpful in identifying business requirements as the knowledge is captured at a more abstract, business need level than many other specification approaches [3].

The life cycle of the requirements elicitation process basically included management, technical and quality assurance key processes. The project management and quality assurance key processes applied throughout the life cycle. The implementation of the management, technical and quality assurance key processes are

described in the following sections. Original inputs and outputs of the processes are not given due to security constraints. Instead, the details of the activities were described with the work experienced.

## 2.1. Management Implementation

At the start of the project, a project management plan was prepared in which organizations of the project, activities of the project, and the responsibilities of the project staff for each activity were described. The project activities included business process modeling and model validation, process based requirements elicitation for hardware and software components, requirements based estimation, management, and quality assurance. The ad hoc workgroups, responsible for business process analysis, and hardware and telecommunication analysis, were developed. During the project, weekly meetings with the project team and monthly meetings with the project coordination committee were held. Periodic meetings helped to track the project's progress, and enabled visibility of the project to the stakeholders. Progress reports were prepared for monitoring purposes. These reports were also used to decide on the new activities or new resources needed. The results were reflected to the updated project management plans.

## 2.2. Technical Implementation

The activity sequence for the technical key process within the life cycle was as follows:

1. Concept exploration and orientation
2. Analysis and modeling of current business processes
3. Modeling of target business processes
4. Requirements generation for the target system

**Concept exploration and orientation:** This activity was performed to get knowledge about the domain and to review previous documents. A concept document for the project had been prepared prior to requirements elicitation contract. The METU Project Office reviewed the concept document in order to have a general understanding of the domain. The plan had mostly addressed current hardware and tele-communication infrastructure at an introductory level, so it was just used as a means to start the domain analysis.

The TLFC Project Office attended several orientation meetings together with the METU Project Office for the staff to know each other, provided short presentations about to the domain, and answered the questions of the METU Project Office. All the materials related to the domain were gathered. Written resources such as books, instructions, forms, and reports were asked by the METU Project Office, and provided by the TLFC Project Office where available.

**Analysis and modeling of current business processes:** This activity was performed to understand the current business processes with their business flows, inputs, outputs, and responsible bodies. It provided the foundation for definition of the target business processes.

People to be interviewed including top executives, domain experts, executives, project managers, and end users, were determined by the METU Project Office together with the TLFC Project Office, and a schedule was made to hold these interviews. The stakeholder representatives, who would join the workgroup for determining and modelling the key business processes, were determined. The outcome of this task was an interviews plan, which was also reflected to the management plan.

The key business processes were determined after a study of the workgroup. This study took some time due to confusion of business processes with system functions by domain experts, and constituted the foundation for more detailed business process analysis. After guided by the METU Project Office, the business process analysis benefited a lot in terms of contribution from domain experts and stakeholder representatives. After this study, the domain was better understood by the METU Project Office, and further modeling studies were based on the key business processes identified.

Next, the workgroup analyzed the key business processes in detail. The key business processes were further decomposed into sub-processes up to several levels when required, until the lowest level sub-processes did not involve any nesting and had simple flow of execution. Uncertainties and disagreements about the execution of the business processes were discussed by domain experts and stakeholder representatives, and resolved by referring to domain books and instructions where available.

Organizational charts, function trees, and Extended Event Driven-Process Chain (EEDPC) diagrams were used as basic process modeling notations, while modeling the business processes. Each lowest level sub-process was modeled in terms of its processes, process flow, inputs, outputs, and the responsible bodies. Totally, 210 distinct diagrams were created to model existing business processes of different levels of organization units by using the EEDPC notation. Ease of understanding of this notation resulted in extensive contribution and feedback from the customer. Feedbacks including change requests taken at anytime were reflected to the models by the staff of the METU Project Office.

**Modeling of target business processes:** This activity was performed in order to describe the information system (IS) oriented target business processes, prior to elicitation of requirements.

Current business process models were revisited from the beginning for possible enhancements, or even redesign, considering the business goals and needs. The

weaknesses, bottlenecks, and deficiencies of the current business processes were determined.

The need for IS support was determined for each business process. Models of target business processes did not include identification of IS infrastructure within the business process models since these were reflected in the work breakdown structure prepared simultaneously. At the end of this study, gaining satisfactory domain knowledge, the analysts could associate the system architecture with the business process models and foresee the requirements of the target system.

**Requirements generation for the target system:** This activity was performed to depict the target system's software, hardware, and telecommunication requirements. The following sub-activities were performed to execute this activity:

*Requirements generation for software components:* The functional, non-functional, and security requirements of the target system were elicited using the current business models by the METU Project Office. Executed in parallel, this sub-activity was performed in interaction with eliciting hardware and telecommunication requirements.

Functional requirements of the target system were elicited by analyzing the business processes including the process flow, inputs, outputs, and actors defined in the business process models. A small organizational unit of the domain (approximately 1/10 of the model system in terms of size) was selected as pilot, and its functional requirements were defined as a trial by the workgroup. The functional requirements of the pilot unit were verified and validated before the elicitation process was extended to other units of the domain. The result was successful, and the experience of the pilot study was used in planning the rest of the functional requirements elicitation efforts. After defining a standard way of working, three teams of the workgroup were formed and worked in parallel for the rest of the elicitation, which benefited in time saving. Functional requirements defined during this sub-activity were used for estimating the size of the software to be acquired in terms of function points [4].

Non-functional requirements of the target system were determined by analyzing implicit requirements of the current business process models as well as weaknesses, bottlenecks, and deficiencies of the system. The ISO/IEC 9126 [5] was used as a guideline while determining non-functional requirements. The values for function understandability, inherent availability, mean time between breakdowns, mean time to repair, and failure resolution rate were defined for the target system.

Security requirements of the target system were defined by analyzing access restrictions of the actors to processes, and process inputs and outputs. Since this was a military project, security was so important that a military student of the METU worked specifically for generating security requirements. Subjects and objects of the model system

were identified and subject-object-authorization matrices were constructed. The size of the resulting security requirements appendix was about 50 pages.

Commercial off the shelf (COTS) product requirements of the target system were largely determined based on the requirements of sponsoring organization. After the system component allocation, previously determined activities including make/buy decision and cost analysis [6] were not performed.

*Requirements generation for hardware and telecommunication components:* The specifications of the hardware and the telecommunications infrastructure were performed according to the architecture of the organization where the system was targeted. Materials related to the architecture of the organization were examined, and an organizational chart was prepared. Then, existing hardware and telecommunication infrastructure of the organizational units were defined. Executed in parallel, this sub-activity was performed in interaction with the requirements generation for software components.

System architecture definition and integration of the requirements generated for software, hardware, and telecommunication components: The purpose of this sub-activity was to define the system architecture showing all hardware components and telecommunication infrastructure in the organization, and to integrate the requirements of the software, hardware, and telecommunication components.

A work breakdown structure, including the detailed specifications of the hardware to the fifth level, was prepared. Schematic representation of the system architecture, showing all the hardware components and telecommunication infrastructure with their location information in the organization, was prepared. Then, each software item was assigned to hardware item(s) on which it will function. The telecommunication infrastructure on which the hardware will reside was also defined.

Taking into account the system architecture as well as hardware, telecommunication, and software requirements elicited in detail, the target system requirements were generated. The number of functional system requirements was about 400 in pages, and about 1380 in number of basic requirements, each composed of 3 sub-requirements on the average (e.g., 1a, 1b, 1c).

### 2.3. Quality Assurance Implementation

The METU Project Office performed internal reviews for all project outputs. Specifically, current business process models, target business models, and system requirements were reviewed after their definitions and updates.

Verification of target business process models against current business process models, and system requirements

against target business process models were executed. Following their internal reviews, models and requirements were verified by the METU Project Office against previously generated documents, in order to make sure that nothing was missed out and that traceability existed between present and past entities. The project team ensured that system requirements were traceable to target business process models, and target business process models were traceable to current business process models.

Validation of current business process models, target business process models, and system requirements were performed after they are internally reviewed and verified. The TLFC Project Office, domain experts, and stakeholder representatives validated the business process models as well as the system requirements, in order to make sure that all models and the requirements reflected the realities of the domain. The system requirements and the models were modified based on corrections and/or changes in business requirements.

## 2.4. Lessons Learned

Following are the lessons learned and experience gained from the implementation of the proposed approach:

Modeling existing business processes took significant time and effort - almost half of the total project effort - but it helped the stakeholders to identify the bottlenecks and the improvement points needed in the business processes. It also enabled us to create an early consensus with the representatives of other C4ISR projects.

Identifying domain experts and reaching them on time were one of the most challenging tasks. Furthermore domain experts needed guidance in thinking in terms of business processes, and in identifying and decomposing the key business processes using the notations we used.

Modeling and analyzing current business processes provided considerable guidance for creating target business processes. Process-oriented analysis also enabled extensive understanding of the domain. This baseline helped the workgroup to model target business processes without associating information technology (IT) components to them prior to eliciting system requirements.

Determination of IS supported functions, new information flows, and changes in existing workflows were the results of the target business process modeling. Indeed, current and target business process modeling were performed together to some extent, because bottlenecks, deficiencies, and problems were already captured in current business process modeling.

During the requirements generation, selecting a pilot unit was very useful instead of generating requirements for all of the business processes. Experience gained from the pilot study helped a lot in planning and executing the rest of the studies.

Identifying system interfaces with other sub-systems of the TLFC was very difficult since other system components and related processes were not well defined at that moment. Although the explicit model enabled us to identify the required input from other units, the interface requirements of other systems from the one we identified were unknown.

## 3. Conclusion

Our requirements elicitation experience demonstrated that establishment and transformation of the need from concept to system requirements can be supported by means of notations and tools developed for business processes reengineering. When determining requirements, process oriented approach helped the organization to see the big picture and enabled them to focus on the required improvements to be able to utilize the acquired system.

We observed that business process modeling is an effective way to explicitly define business requirements while creating visibility and consensus among different stakeholders of major IT projects. However, business process modeling requires significant effort. To overcome difficulties of business process modeling, user oriented tools and techniques are better to be used. Such tools and techniques also help the studies of the workgroups in which user and developer are trying to find out the requirements of the target system. Both customer and developers can formulate the system's requirements easily on a standard format that can be easily understood by all the stakeholders, and the specification document obtained can be verified, validated and modified. We also observe that our approach enables not only to generate the requirements of large and innovative projects, but also enable to determine the project size and cost by means of requirements based estimation.

## 4. References

- [1] Hammer M., Champy J.A. "Reengineering the Corporation: A Manifesto for Business Revolution", 2001.
- [2] Davenport, T., "Process Innovation: Reengineering Work through Information Technology", Ernst & Young, 1993.
- [3] O. Demirors, E. Demirors, M.M. Tanik, D. Cooke, A. Gates, B. Krämer, "Languages for the Specification of Software", *Elsevier Science, J. Systems Software*, Vol.32, pp. 269-308, 1996.
- [4] UK Function Point Users Group (FPUG), Mark II FPA Counting Practices Manual, Version 1.1, 1994.
- [5] ISO/IEC, "ISO/IEC 9126: Information Technology - Software Product Evaluation - Quality Characteristics and Guidelines for Their Use", 1991.
- [6] E. Aslan, "A COTS-Software Requirements Elicitation Method from Business Process Models", Thesis, Middle East Technical University, MS, Information Systems Department, August 2002.