UPROM Tool: A Unified Business Process Modeling Tool for Generating Software Life Cycle Artifacts

Banu Aysolmaz[1] and Onur Demirörs[2]

[1, 2]Informatics Institute, Middle East Technical University, Ankara, Turkey
[1]banu@aysolmaz.com, [2]demirors@metu.edu.tr

Abstract. UPROM tool is a business process modeling tool designed to conduct business process and requirements analysis in a unified way to constitute a basis for process automation. Enabling the application of UPROM methodology, the tool provides editors for six different diagram types based on a common meta-model. It ensures conformance to the rules and offers features so that modelers can develop a cohesive set of models. These models are utilized to automatically generate artifacts of requirements document, software size estimation, process definition document and business glossary.

Keywords: Business process modeling, requirements analysis, software size estimation, business glossary, process documentation, artifact generation

1 Introduction

UPROM tool is a business process modeling (BPM) tool supporting six diagram types: Value Chain (VC), Function Tree (FT), extended Event Driven Process Chain (EPC), Organization Chart (OC), Conceptual Entity Relationship (ER) and Function Allocation (FA). Diagrams represent different business process perspectives which are functional (VC and FT), behavioral (EPC), organizational (OC) and data (ER and FA).

Business process definitions serve both pure organizational purposes like process improvement and other practices like project management, requirements specification and knowledge management [1]. Usually in the organizations, artifacts that utilize business process knowledge are developed independently. Eventually, the effort spent to define business processes and develop related artifacts is duplicated, organizational knowledge becomes untraceable to processes and artifacts are maintained separately resulting in conflicts. Especially when business processes are to be automated by a process aware information system (PAIS) [2], process knowledge is intensively needed. To overcome the problems, we developed a unified BPM methodology, UPROM, to conduct business process and requirements analysis in an integrated way. When UPROM is applied, following artifacts can be generated by using the models: user requirements document and COSMIC functional size estimation [3] for the PAIS, and process documentation including process definition document and business glossary.

UPROM tool is a graphical BPM tool that supports UPROM methodology and automatically generates the mentioned artifacts. Model driven approach is followed based

on Eclipse Modeling Framework (EMF) and Eclipse Graphical Modeling Framework (GMF). Eclipse plugins are developed for editors. All editors are based on a common meta-model. Some plugins including EPC and VC editors were reused from bflow* Toolbox [4], thus inheriting its special features such as continuous verification.

UPROM tool is used by process modelers for descriptive analysis of processes in business domain. End users utilize it to review and validate the models. The tool provides specific functionality for modelers to integrate business process and requirements analysis. There are tools that can generate process documentation, but we did not encounter a BPM tool generating textual requirements and functional size estimation. UPROM tool was utilized in various projects, including two e-government projects for Company and Trademark Central Registration Systems, Public Investment Analysis of Ministry of Development, and other applications for case study purposes.

In this paper, we present the features particular to UPROM tool to support the methodology and generate the artifacts. In section 2, UPROM methodology is briefly presented. Section 3 describes the tool features and provides a brief comparison with other tools. Section 3 summarizes the paper and presents the future work.

2   UPROM Methodology

UPROM methodology aims to integrate the practices of descriptive business process definition, requirements analysis, software size estimation and process documentation; and generate artifacts that are outputs of these practices. By unifying analysis activities for these practices, a set of models can be developed that embeds all information to generate those artifacts. The methodology includes the notation, meta-model, process, guidelines and artifact generation procedures. The artifacts that can be generated by UPROM methodology are: user requirements document, software functional size estimation, process definition document and business glossary. As all of these artifacts are based on a single source of model set, completeness and consistency of them are improved, they become traceable to business processes and maintainability is enhanced. More information on UPROM methodology and outputs of case studies can be found in [5] and [6]. UPROM methodology is applied in two iterative phases:

Developing Core BPM Diagrams: Functional, behavioral, and organizational perspectives of business processes are analyzed. As a result, VC, FT, EPC and OC diagrams are developed in a hierarchical manner.

Developing Analysis Diagrams Associated to BPM Diagrams: If a function on an EPC diagram is to be automated by PAIS, an FA diagram is created as a sub-diagram. FA diagram is used to analyze the responsibilities to conduct the function, related entities, operations on entities, related applications and constraints. In parallel, conceptual definitions of entities and their relations are modeled in ER diagram.

Generated artifacts are utilized as inputs to subsequent phases of software development. User requirements with process models and documentation are inputs to detailed requirements analysis, testing and acceptance phases. Functional size estimation is critical for software development planning in early phases. Process definition document and business glossary are used by different stakeholders types in operation phase.

3 UPROM Tool

UPROM tool provides an integrated environment for the notation and common meta-model for six diagram types. Diagrams of the same scope are maintained under a repository as a "modeling project". Features particular to UPROM tool enable users to apply UPROM methodology process and guidelines. Such features are described in the following sections. A snapshot of the modeling environment can be seen in Fig. 5.

3.1 Diagram Editors for BPM and Requirements Analysis

UPROM tool editors run in conformance with the meta-model. VC diagram comprises value chain, risk, objective and product constructs. FT diagram has only the function. EPC include event, function, process interface, logical operators, business rule, application, organizational elements, information carriers, key performance indicator (KPI), technical term and improvement [7]. OC covers organizational elements. FA diagram has organizational elements, function, entity, application and constraint. ER diagram covers entity, cluster, attribute, generalization, aggregation and relationship.
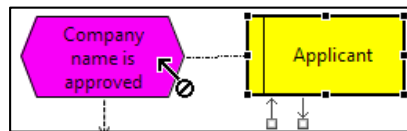

Fig. 1. Disabled connections based on the metamodel

Relations between constructs are restricted by the meta-model. The tool prevents formation of a connection not allowed and informs the user with a sign as shown in Fig. 1. Predefined connection names are assigned between some constructs. Two examples are shown in Fig. 2. First one is the connection assigned between an organizational element and function to show the responsibility of the role, and the second is between function and entity to specify operations conducted on the entity by the function.
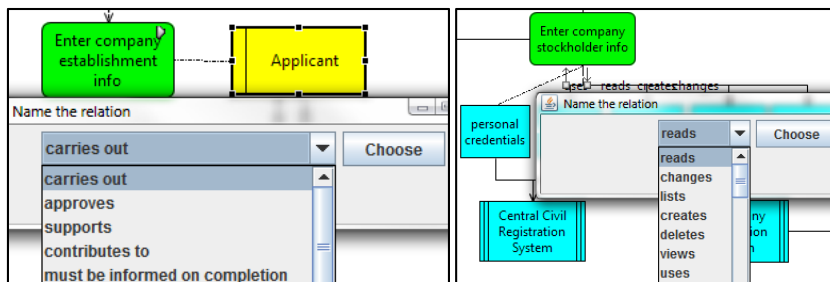

Fig. 2. Assigning connection names by selection from the combo box

3.2 Unique Object Assignment

Objects in the same modeling project are assigned to be unique if they are named the same. Instances of the object can exist at any diagram regardless of the type. Objects

of logically similar types are also assigned to be unique; e.g. information carrier and entity; function, process interface and value chain objects with the same name are unique.

When a new object is added, if there is already an object with the same name and type (or one of the alternative types) in the project, the user is asked if the new object is the same with existing object(s) as shown on left of Fig. 3. If the user approves that they are the same, attribute values of the objects are assigned to be the same. When attributes of any instance of the unique object are updated, all other instances also have the updated values. Users can search for the occurrences of unique objects, see the list of instances and open the diagrams as shown in the right part of Fig. 3.
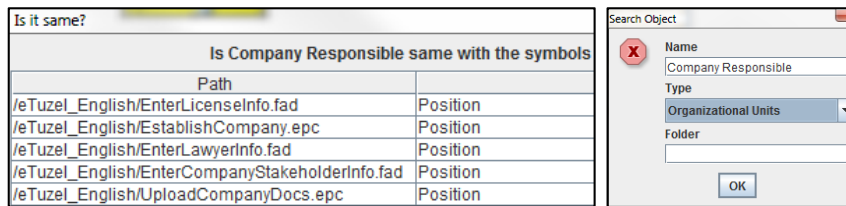
Is it same?		Search Object

Is Company Responsible same with the symbols		Name: Company Responsible
Path		Type: Organizational Units
/eTuzel_English/EnterLicenseInfo.fad	Position	Folder:
/eTuzel_English/EstablishCompany.epc	Position	
/eTuzel_English/EnterLawyerInfo.fad	Position	OK
/eTuzel_English/EnterCompanyStakeholderInfo.fad	Position	
/eTuzel_English/UploadCompanyDocs.epc	Position	

Fig. 3. Assigning unique objects with a list of instances and searching for the instances

3.3   Process and Object Attributes

A set of attributes representing metadata of a process can be assigned to each diagram as shown on left in Fig. 4. All objects have the attributes of name, id, description, incoming and outgoing connections. In addition to these, some object types have special attributes. One is technical term attribute for organizational elements, information carriers, application, entity, cluster, KPI and attribute. The other is document link attribute for information carriers, entity, cluster, business rule and constraint. Sub-diagrams can be assigned to function, process interface and value chain objects. An example list of attributes assigned to a document object is shown at right of Fig. 4.

Author	METU		**Land register**	
Description	Companies are established by Registr...		**Property**	**Value**
Model Name	Establish Company		Description	This land register should then be the propr
Purpose	Define high level operations to establ...		Id	34
Scope	All companies including free zone		In	
Status	Completed		Link	/eTuzel_English\ExampleLandRegister.docx
Version	2.0		Name	Land register
			Out	
			TechnicalTerm	The registry of the land to be assigned to tl

Fig. 4. Process metadata and object attributes

3.4   Structure of the Modeling Project

Folder structure of the modeling project must be established in conformance to its sub-diagram decomposition. The tool controls the folder structure and does not generate artifacts if it is not validated. An example modeling project structure is shown on the left part of Fig. 5 (FA diagrams are hidden for simplicity). Only one diagram of type VC, FT or EPC exists in top level, which is the process map (e.g. eCompany.ftd). For

each sub-diagram assigned in the process map, a folder is created and the sub-diagram file is placed inside it. Folder and file names match. The same rules apply for lower level diagrams. FA is assigned as sub-diagram for the functions in EPCs, and placed under the folder of the related EPC. ERD and OC diagrams can be placed anywhere.
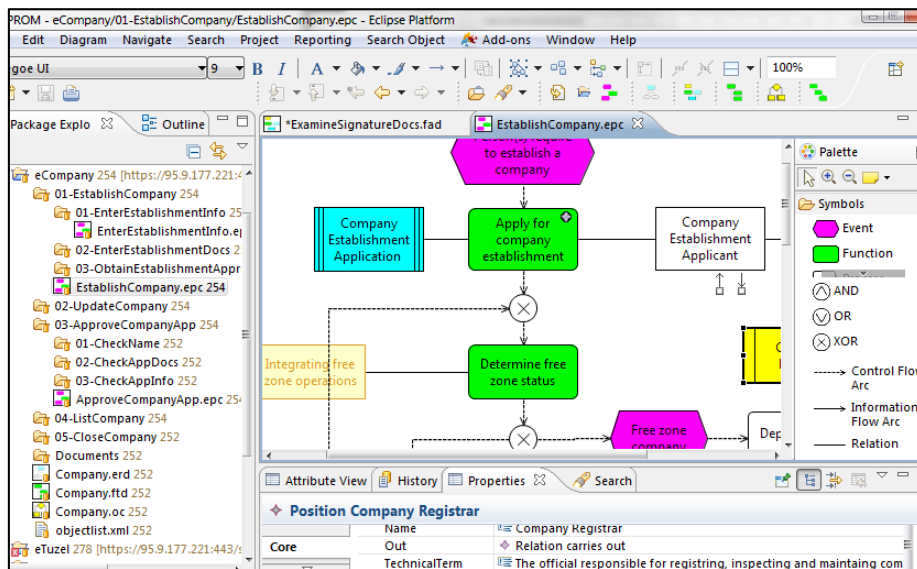

Fig. 5. Typical UPROM modeling environment and example project structure

3.5 Generation of Artifacts

Utilizing the information embedded in the modeling project which is formed by using the features and conforming to the rules explained in the above sections, UPROM tool can be used to generate the following artifacts. The tool parses XML diagram files and generates the artifacts in PDF format using iText library.

Business process models report: VC, FT and EPC diagrams in the modeling project organized by the hierarchy are reported. Name and address of the process are placed as the heading for each diagram. OC diagram(s) are placed at the end of the report.

Analysis models report: FA diagrams are given in this report. For each diagram, model name, address, and the EPC process it is related to are placed as the heading.

Requirements document: Each FA diagram is utilized to generate three types of natural language requirements sentences [6]. In the document, requirements sentences are organized under EPC diagrams. Headings for each EPC diagram is numbered according to diagram's hierarchical position in the modeling project.

COSMIC functional size estimation report: FA diagrams which serve the purpose of requirements analysis are also utilized to make an early functional size estimation of the software to be automated. The estimation is based on COSMIC standard [3]. Various rules are applied to interpret the operations on entities (modeled as connection name

between function and entity as shown in Fig. 2). For each EPC diagram, data movements and total size in function points (FP) of every FA diagram under that EPC is reported. The total FP size of each application is calculated and provided in the summary section of the report.

1.1. Process name: EstablishCompany.epc **Process address: eCompany/01-EstablishProcess** 1.1.1. REQ1. Company Establishment Applicant shall carry out the operation of applying for company establishment. 1.1.2. REQ2. During this operation, application status and company records shall be created on Company Establishment Application System. 1.1.3. REQ3. During applying for company establishment, company status shall be assigned as "data entrance". 1.1.4. REQ4. Company Establishment Applicant shall carry out the operation of selecting company type. 1.1.5. REQ5. During this operation, company type record shall be created and updated on Company Establishment Application System. 1.1.6. REQ6. During selecting company type, company type shall be selected from a list of types determined in the legislation. 1.1.7. REQ7. Company Establishment Applicant shall carry out the operation of determining free zone status.	1.1. Pocess name: EstablishCom Process Address: eCompany/01- 1.1.1. MSR1. ApplyforCompanyEstab Company Establishment Application: Entry Function Point: 1 Read Function Point: 0 Write Function Point: 2 Exit Function Point: 1 Total: 4 CFP 1.1.2. MSR2. SelectCompanyType Company Establishment Application: Entry Function Point: 2 Read Function Point: 1 Write Function Point: 2 Exit Function Point: 1 Total: 6 CFP

Fig. 6. Excerpts from Requirements Document (left) and Size Estimation Report (right)

- **Process definition document:** VC, FT and EPC models, with the attributes embedded in the models, are utilized to generate process definition document conforming to a template. The parts of the document for an EPC model is as follows:
  - Information: Purpose, scope, status, version, author, description of the process
  - Responsibilities: Name, type and participation of the role
  - Inputs: Name, type, source (if input is provided by another role), document link
  - Outputs: Name, type, target (if outputs are handed to another role), document link
  - Entrance criteria: Name, other processes that exit with this event, their address
  - Exit criteria: Name, other processes that start with this event, their address
  - Activities: Detailed information including: responsibilities, inputs and outputs, application, sub-diagrams/external processes, detailed information
  - Business rules: Name, related activity
  - External processes and sub-processes utilized by the process
  - KPIs: related activity, information sources used, measurement period, target
- **Business glossary**: All definitions in the project are obtained from the models by using technical term attributes of organizational element, information carrier, application, entity and cluster objects. By means of unique object property, an object has single definition regardless of the number of instances. The report is composed of three parts: Organizational, application and general definitions. ER diagram is utilized to organize general definitions. An aggregate entity is placed at the top, left indented. The components of the aggregate entity are grouped under that and indented right. Relationships and generalizations are also shown in a similar manner.

2. Establish Company

/01-EstablishCompany/EstablishCompany.epc/

1 Process Information

Purpose: Define the high level process to establish a company
Scope: All companies to be registered as general and free zone company
Status: Approved by customer
Version: 1.0

2 Responsibilities

Responsible	Type	Responsibility Type				
		R	A	S	C	I
Company Establishment Applicant	External Person	X				
Company Registrar	Position	X				

3 Inputs

Name	Type	Source	Link
declaration of registry	Document	Company Establishment Applicant	Documents\Ek4-6.ms1.pdf
clearance record	Document	Company Establishment Applicant	

4 Outputs

Name	Type	Target	Link
Approval of documents	Log		

5 Entrance Criteria

Event	Processes that exit with this event	Address
Person(s) require to establish a company		

6 Exit Criteria

Event	Processes that start with this event	Address
Applicant is informed for the inappropriate documentation		
Company establishment completed	Obtain Establishment Approvals	

7 Activities

7.1 Apply for Company Establishment

Responsibles: Company Establishment Applicant - carries out

Application System: Company Establishment Application System
Any citizen registering as a user of e-Company system with her ID info can apply for the company establishment. To establish a private company two or more people shall apply.

2 Application Systems

Name	Definition
Company Establishment Application	The system on which application for a new company establishment is conducted, updated and status updates viewed.

3 General Definitions

Name	Definition
Company	Any company established and registered as 1949 Company Law.
company communication info	Address of main and branch office, web address, phone, GSM, e-mail
company fundamental info	all fundamental info regarding the company
business domains	domains selected from NACE codes.
application no	
company name	
free zone status	

Fig. 7. Excerpts from Process Definition Document (up) and Business Glossary (down)

Excerpts from the generated artifacts are shown in Fig. 6 and Fig. 7. Complete versions of the outputs for multiple case studies can be seen in [5]. UPROM tool is developed specifically to apply UPROM methodology. Before developing the tool, we tailored diagrams in ARIS Business Architect [7] to meet meta-model needs and developed scripts to generate the artifacts. However, this did not provide a native solution to apply UPROM methodology. As an alternative to Eclipse, we could also use a modeling language creation tool such as MetaEdit+ [8] to design and use the diagrams based on the meta-model and generate the artifacts, however we preferred an Eclipse based system as we were able to reuse plugins from bflow Toolbox. There are tools that provide abundant notation alternatives such as ARIS. In the contrary, diagram types of UPROM tool are limited and focused on structured analysis of descriptive process models and requirements in an integrated way as guided by the methodology. There are other BPM tools with process documentation functionality such as Signavio, Bizagi and Visual Paradigm. However to our knowledge, there are no tools that can generate textual requirements and functional software size for the process automation together with the process documentation and providing guidance by a methodology.

4   Conclusion and Future Work

In this paper, we presented unified BPM tool. UPROM tool is based on EPC for control flow modeling, and supports five other diagram types. It provides an integrated modeling environment for requirements analysis in relation with business process models. If one applies UPROM process and guidelines by using tool features, she can use the tool to automatically generate some essential artifacts for software development practices.

UPROM is used in two e-Government projects of Company and Trademark Central Registration Systems and Public Investment Processes of Ministry of Development. Generated artifacts were used as project deliverables and acceptance is completed by the users [5]. The results collected by observations and interviews revealed that completeness, consistency and maintainability of the generated artifacts were improved.

For future versions, we plan to develop a functionality to enable users design the format and content of the artifacts and add new process documents presenting process information from different perspectives like RACI charts. At the moment, requirements sentences are generated in Turkish and generation of English sentences are planned for future versions. BPM tools supporting EPC notation are rather restricted in number. EPC is commonly accepted as a good notation for analyzing processes with end users. We believe that similar functionality can be achieved for also BPMN and plan to implement the methodology in a similar way also based on BPMN.

References

1. Becker, J., Rosemann, M., Uthmann, C. Von: Guidelines of Business Process Modeling. Business Process Management (2000). pp. 30–49. Springer (2000).
2. Dumas, M., Aalst, W. V d., Hofstede, A. ter: Process-aware information systems : bridging people and software through process technology. John Wiley & Sons, New Jersey (2005).
3. Abran, A., Desharnais, J.-M., Oligny, S., St-Pierre, D., Symons, C.: The COSMIC Functional Size Measurement Method Version 3.0.1 Measurement Manual. (2009).
4. Böhme, C., Hartmann, J., Kern, H., Kühne, S.: bflow* Toolbox-an Open-Source Modeling Tool. Business Process Management Demonstration Track 2010. pp. 1–6 (2010).
5. Aysolmaz, B.: Unified Business Process Modeling Methodology (UPROM) Application: Case Study Results METU/II-TR-2014-32. , Ankara, Turkey (2014). http://expertjudgment.com/publications/METU_II_TR_2014_32.pdf
6. Aysolmaz, B., Demirörs, O.: Modeling Business Processes to Generate Artifacts for Software Development : A Methodology. Modeling in Software Engineering (MISE), 2014 ICSE Workshop on. , Hydarabad, India (2014). DOI: 10.1145/2593770.2593775
7. Davis, R., Brabander, E.: ARIS Design Platform Getting Started with BPM. Springer London (2007).
8. Tolvanen, J., Pohjonen, R., Kelly, S.: Advanced Tooling for Domain-Specific Modeling : MetaEdit +. Object-Oriented programming systems, languages, and applications (OOPSLA) (2007).