1-1-2010

# Business modeling with the support of multiple notations in requirements engineering

Mohammad Moshiur Bhuiyan
*University of Wollongong*, mmrb95@uow.edu.au

Aneesh Krishna
*University Of Technology, Perth*, aneesh@uow.edu.au

# BUSINESS MODELING WITH THE SUPPORT OF MULTIPLE NOTATIONS IN REQUIREMENTS ENGINEERING

Moshiur Bhuiyan, OptInfra Systems, Australia. and Decision Systems Laboratory, School of Computer Science & Software Engineering, University of Wollongong, NSW 2522, Australia, moshiurb@optinfra.com

Aneesh Krishna, Department of Computing, Faculty of Science & Engineering, Curtin University of Technology, WA 6102, Perth, Australia, a.krishna@curtin.edu.au

## Abstract

*Requirements specification should not be concerned only with the software specification, but should also be able to integrate with the organizational models describing the environment in which the system will function. Agent–oriented conceptual modeling notations such as i* represents an interesting approach for modeling early phase requirements which includes organizational contexts, stakeholder intentions and rationale. Business Process Modeling notations such as BPMN are used to effectively conceptualize and communicate important process characteristics to relevant stakeholders. On the other hand, Unified Modeling Language (UML) is suitable for later phases of requirement capture which usually focus on completeness, consistency, and automated verification of functional requirements for the new system. In this paper, we illustrate the use of a methodology that facilitate and support the combined use of notation for modeling requirement engineering process in a synergistic fashion in a complex project for a large government Department. The notations we used were i*, BPMN and UML Use Case.*

***Keywords:*** *Agent-Oriented Conceptual Modeling, BPMN, PRINCE2, Constrained Development Methodology*

# 1 INTRODUCTION

A Business Process can be described as a set of dynamically coordinated activities, controlled by a number of socially dependant participants, aimed towards the achievement of a specific operational objective (Koliadis G et al. 2006; Smith H et al. 2003). Business Process Management is a re-emerging discipline, aimed towards supporting the effective and automated (Smith H et al. 2003) management of business processes within an organization via specialized tools and methods. Business Process Management promotes that a clear understanding through the explicit modeling of the processes underlying an organization is required to support effective organizational management / improvement practices (Hall C et al. 2005). In this paper we present a case study on a large scale project in a government body in Australia. This case illustrates how the business modeling phase of the project was implemented with the support of multiple business modeling notations.

The following section starts with background information about the project. We then describe the business modeling strategy that was followed along with a brief discussion on the notations used. We then provide an illustration of the methodology, techniques and templates. Finally we have a discussion section about the project and some concluding remarks.

# 2 PROJECT BACKGROUND

This case study is based on a large public Department in Australia. This Department is one of the largest state government bodies which provide Education and Training services. The organization structure is a complex array of directorates and business units with varying needs. It required an enterprise software solution, which can accommodate its strict security requirements while supporting standardised and decentralised processes for time tracking, project management, resource management, financial management and reporting. The Department chose to configure the CA Clarity system since it provides the solutions to the organisation's requirements under the terms of strict tender.

Since the Department was very large in terms of the number of employees, types of services provided complexity to manage day to day activities and service delivery; it started with piloting Clarity within one of its learning and business reform program. The idea was, on the successful completion of the pilot project the Department will implement the software solutions across a wider collection of business units.

The piloting program itself was a large scale program that will bring about a staged and coordinated replacement of the current personnel, finance and student administration systems in schools, Technical Institutions across Department (on a four to five year time period). CA Clarity™ Project and Portfolio Manager (PPM) will be used to manage the suite of projects necessary to achieve this objective. The Clarity system will also support the Department's requirement to decentralize system administration, resource and project set up and maintenance, time tracking, project accounting, project cost allocations, posting and reporting processes. The project was a result of the Department's need for a long-term project governance solution that will also be used to manage a variety of critical variables such as resource management, project portfolios, and demand for services in a number of major programs.

# 3 BUSINESS MODELING STRATEGY

The project management team decided to conduct detailed business modeling in order to configure the Clarity Systems based on PRINCE2 project management methodology. The project team also needed to make sure the individual directorate and business units' requirements were also addressed. There were few challenges; the Department was very large with complex organisational structure making it almost impossible to implement the software solutions by eliciting and analysing requirements from every directorates and business unit. On the other hand CA Clarity itself is an extensive project and program management tool covering variety of organisational requirements with its own configuration

complexity. The Department chose PRINCE2 as the project management methodology, so Clarity must be configured according to the PRINCE2. Considering the complexity of tailoring PRINCE2 according to business needs, the Department decided to solve the "to-be world" without looking into the "as-is world" which is not very usual. The idea was to perform business modeling exercise in three different notations (*i** Organisational Modeling, BPMN and UML Use Case) that will produce the ideal scenario for the "to-be world". Then "as-is world" will be adjusted towards the "to-be world". A transition management plan was also produced suggesting the ways of how the Department can make it happen. However, for this paper's purpose we will only talk about the business modeling side of this project.

Business modeling strategy was developed that examined the requirements for developing and maintaining one or more business models within the project, recommended the most appropriate approach and defined the techniques, standards, roles and responsibilities for developing and maintaining the required models during the course of the project. The business modeling strategy informed the Project Plan, the Stage Plans, the Project Quality Plan and required Business Models. Proposed products of business modeling were: High Level Organisational Model (in *i** organizational modeling notation), Business Process Model (in BPMN) and Implementation Model (UML Use Case).

Given the organisational size and complexity of the Department it is quite normal to have a varied and large range of business requirements models. The larger the number or scope of the business units are, the greater the complexity is. It was decided that a combination of notations will be used in order to facilitate the maintenance of the models in lieu of changes in the context of their usage over the course of their lifecycle.

For initial requirement engineering *i** organisational modeling technique was used. These models represented the scope, organisational actors/roles and their dependencies and intentional rationale. As Prince2 is a process-oriented method for project management, it was decided to have the business process models with an illustration of "as-is" and "to-be" world so that everyone has more control over the processes of the projects. Business process models can be easily mapped into BPMN from the *i** organisational models without any inconsistency. There are methodologies that support the mapping. We used a constrained development methodology to develop the process models. Details of this methodology can be found in (Koliadis G et al. 2006) (G Koliadis et al. 2006).

In the third step building of use cases / test cases were done by analysing the models and refining the requirements. Use case modeling technique was preferred at this stage as it is widely known and do not require specialist training.

# 4 BACKGROUND OF NOTATIONS

## 4.1 Agent Oriented Conceptual Modeling

It has been argued that notations such as *i** help answer questions such as what goals exist, how key actors depend on each other and what alternatives must be considered. Furthermore, *i** has been acknowledged as illustrating the key social/strategic interrelationships between actors (Katzenstein G et al. 2000) (Yu E, 1995) required for effective business process redesign. This is achieved via support for reasoning about organizational activities and their assignment to various organizational agents (Yu E, 1995) in respect to: the ability, workability, viability, and believability of their routines; and, level of commitment (Yu E, 1995).

The central concept in *i** is that of intentional actor. These can be seen in the Meeting Scheduling model as nodes representing the intentional/social relationships between three (3) actors required to schedule a meeting: a Meeting Initiator (MI); Meeting Scheduler (MS); and Meeting Participant (MP). (Figure-1)

The *i** framework consists of two modeling components: Strategic Dependency (SD) Models and Strategic Rationale (SR) Models (Yu E, 1995). The SD model consists of a set of nodes and links. Each node represents an actor, and each link between the two actors indicates that one actor depends

on the other for something (i.e. goals, task, resource, and soft-goal) in order that the former may attain some goal. The depending actor is known as *depender*, while the actor depended upon is known as the *dependee*. The object around which the dependency relationship centers is called the *dependum*. The SR mode further represents internal motivations and capabilities (i.e. processes or routines) accessible to specific actors that ensure dependencies can be met.

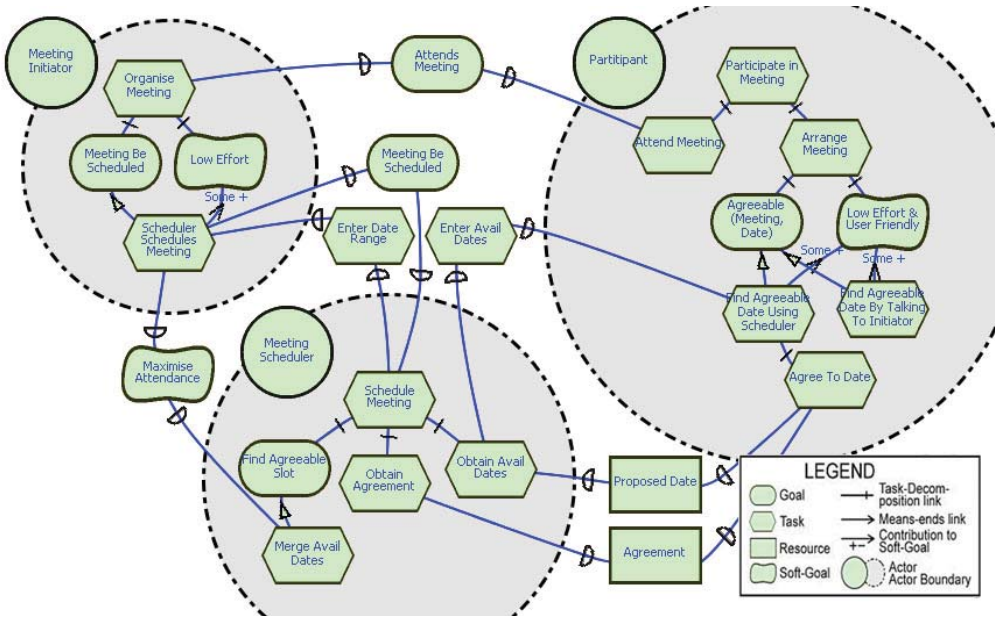


*Figure 1: An i* Strategic Rationale (SR) Meeting Scheduling Model*

The intentional properties of an agent such as goals, beliefs, abilities and commitments are used in *i** for modeling organizations (Yu E, 1995). Actors are [inter]related through dependencies that may involve goals to be achieved (e.g. *Evacuation* & *RescueMission*), tasks to be performed (e.g. *GatheringLocalInformation*), resources to be furnished (e.g. *FieldInformation*), or soft-goals to be satisfied (e.g. *RespondFast*).

### 4.2 Business Process Modeling with BPMN

Many existing BPM notations primarily focus on technical process aspects including the flow of activity execution/information and/or resource usage/consumption (Yu E, 1995). This perspective is aimed at describing the sequence of activities, events and decisions that are made during process execution, however social and intentional components lack representation. The technical focus of these notations is especially suited for applications in the description, execution and simulation of business processes but is lacking in support for process redesign and improvement (Yu E, 1995).

One such notation is the Business Process Modeling Notation (BPMN), developed by the Business Process Management Initiative (BPMI.org). Processes are represented in BPMN using flow nodes: events (circles), activities (rounded boxes), and decisions (diamonds); connecting objects: control flow links (un-broken directed lines), and message flow links (broken directed lines); and swim-lanes: pools (high-level rectangular container), and lanes partitioning pools. These concepts are further discussed within (White S, 2004).

Since its initial publication (White S, 2004), BPMN has been accepted by the greater Business Process Management community (Becker et al. 2005; Smith H et al. 2003), due to its expressiveness and ability to map directly to executable process languages including XPDL (Hall C et al. 2005) and BPEL (Ouyang C et al. 2006; White S, 2004). The wide uptake of the notation by most Business Process Modeling tool vendors is also a sign of its longevity (Hall C et al. 2005). Some practitioners have hailed BPMN as supplying a rich representation that allows Business Process Management Systems (BPMS) the ability to control the required interactions with humans and 3rd party applications (Miers D, 2004). Furthermore, an analysis of BPMN also stated its high maturity in

representing concepts required for modeling business process, apart from some limitations in terms of representing state, and the possible ambiguity of the swim-lane concept (Becker et al. 2005).

### 4.3 PRINCE2

PRINCE2 is a project management method covering the organisation and management of projects. It is designed to be tailored for use on any type of project. Al-though PRINCE was originally developed for the needs of IT projects, the latest version, PRINCE2 which was re-leased in October 1996 and has since been updated, is a generic, best practice approach to meet the needs of the whole organisation. (OGC, Internet)

It is widely used in both the public and private sector and is the de-facto standard for project management in the UK. PRINCE2 is increasingly being used in several countries outside the UK, including USA, Australia. New Zealand, The Netherlands, France, Italy, Hong Kong, South Africa, Croatia, Poland. PRINCE2 is in the only public domain project management method and is there-fore freely available and does not require a license to use. It is unique in being an off-the-shelf, practical method, which is well supported by development and training resources.

## 5 MODELING APPROACH AND METHODOLOGY USED

Business processes evolve throughout their lifecycle of change. Business Process Modeling (BPM) notations such as BPMN are used to effectively conceptualize and communicate important process characteristics to relevant stakeholders. Agent-oriented conceptual modeling notations, such as *i**, effectively capture and communicate organizational context. The methodology we used argues that the management of change throughout the business process model lifecycle can be more effectively supported by combining notations. In particular, we identify two potential sources of process change, one occurring within the organizational context and the other within the operational context. As such the focus in our business modeling was on the co-evolution of operational (BPMN) and organizational (*i**) models. Our intent was to provide a way of expressing changes, which arise in one model, effectively in the other model. We used constrained development methodologies capable of guiding an analyst when reflecting changes from an *i** model to a BPMN model and vice-versa. (Koliadis G et al. 2006; G Koliadis et al. 2006).

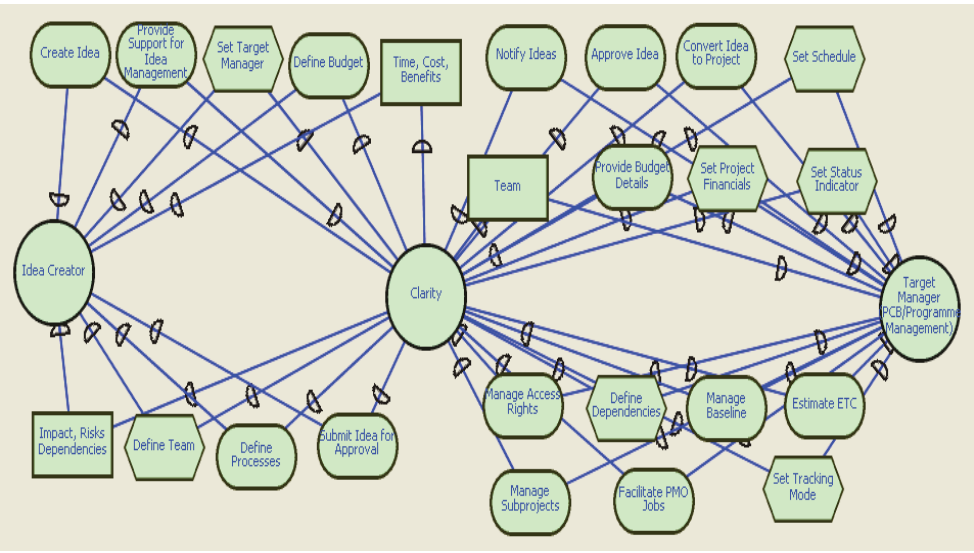


*Figure 2: SD Model of Demand Management in Clarity*

We also applied constrained development methodologies to guide the derivation or maintenance of one type of model given the availability of the other. The development was supported with the introduction of two concepts: fulfillment conditions (i.e. as in (Fuxman A et al. 2004)) and effect annotations. Effect annotations may possibly be formalized using the formal layers of some currently

well-developed Goal-Oriented Requirements Engineering (GORE) methodologies (Fuxman A et al. 2004) (Lamsweerde, 2001), however, we only state their applicability in this work.

Fulfillment conditions were annotated to tasks and goals assigned to actors in an SR diagram, and dependencies (i.e. not including soft-goals as these are used during assessment of alternatives and describe non-functional properties to be addressed) in an *i** model. A fulfillment condition (Fuxman A et al. 2004) is a statement specifying the required conditions realized upon completion of a given task, goal or dependency. Fulfillment conditions recognize the required effects on a business process model. For example, a fulfillment condition for a task dependency to *EnterADateRange*, may be the *DateRangeCommunicated* effect (subsequently required by the task assigned to a *dependee* actor).

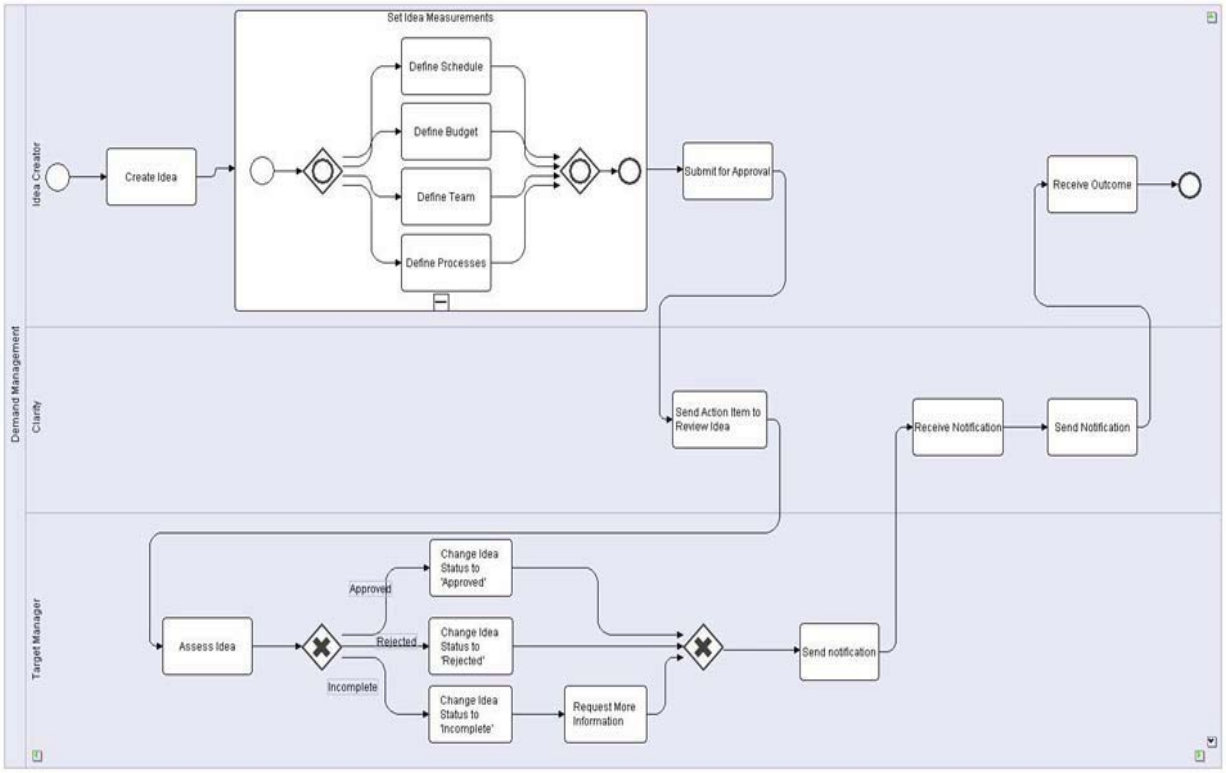


*Figure 3: BPMN Model for Demand Management*

Early-phase RE activities have traditionally been done informally (Yu E, 1995), beginning with stakeholder interviews and discussions on the existing systems and rationales. Initial requirements are often ambiguous, incomplete, inconsistent, and usually expressed informally. We added some structure to this informal consultation process via the use of Requirements Capture Templates (RCTs). In effect, these were forms that the modeller seeks to fill out in the course of a stakeholder consultation session and that were eventually signed off by both the modeller and the stake-holder. Modellers that were working on the capturing of requirements from the theory and tools had to fill in these forms too. The process of filling out these forms provided structure to stakeholder interview sessions. In addition, these forms were designed to seek information specific to the need of the underlying agent-oriented conceptual model (*i**) that the modeller seeks to build.

# 6 DISCUSSION

Business modeling part of this project was very complex to manage. Just in the piloting phase it took the team about a year to complete the modeling exercise. For a Department of this size it is not unlikely at all. Combined business modeling helped the project in the following ways:

- It helped the project to define its scope, identify associated roles, their dependencies, represent the processes embedded in the projects and clarify the developers to design the test cases and implement the configuration of the system.
- Combined models along acted as a common language for communication for varied stake-holders' goals, policy implications, and/or operational constraints by creating a contextual environment.
- It helped to increase the Department's project management capability by representing 'what business process exists', and 'what business process is required to exist'.
- The constrained development methodology used in this exercise helped the modellers in two ways. Firstly, it made the model transformation (*i** to BPMN and also BPMN to *i** when required) smooth and consistent. Secondly, in model management when a change was required. This methodology supported to tracing and managing changes in organisational models and process models. We plan to discuss how it was managed in a separate paper at a later stage.
- The RCTs acted as a holder of requirements which made it easy for the modellers to refer to whenever required and provided a better visibility to the stakeholders.

We do not claim this modeling effort was completed without any problems. First and foremost we had to train the modellers the notations (especially *i** and BPMN) that were used than we had to go through lots of scenarios to make then understand the concept of the methodology. Secondly we found there was no tool to support this methodology. A tool could have saved us a lot of time and could make the work more efficient. However, we did continue to get feedback from all parties on the use of this methodology and modeling exercise. We believe the modeling implementation and management implementation needs to be sustained. The responsibility for this usually lies with modellers, quality group, auditors or even the senior project managers to ensure the methodology lives long past it implementers and original sponsors. We argue the implementation of this business modeling is a long term goal. Once the exercise is complete the aim is to keep them available and ensure the benefits are realised.

# 7 CONCLUSION

In this work we have presented an industrial case study that discussed the business modeling phase of a project. We have illustrated the modeling strategy used, discussed modeling notations used. We have also discussed how we used the constrained development methodology and the requirements capture templates. This paper however, does not cover the full story of the project. In our future work, we plan to elaborate more details on the management of the models produced. We also plan to illustrates the facts of how it was possible for us to implement the transition to the "to be world" from the "as is world".

# 8 REFERENCES


Becker, J. Indulska, M. and Rosemann, M. Green, P (2005). Do Process Modeling Techniques Get Better? A Comparative Ontological Analysis of BPMN, in Campbell, Bruce and Underwood, Jim and Bunker, Deborah, Eds. Proceedings 16th Australasian Conference on Information Systems, Sydney, Australia.

OGC, http://www.ogc.gov.uk/methods_prince_2.asp.

Fischer, L. (2005). Workflow Handbook 2005, Workflow Management Coalition, (WfMC).

Hall, C. Harmon, P. (2005). The 2005 Enterprise Architecture, Process Modeling & Simulation Tools Report, Technical Report, bptends.com.

Lamsweerde, A. Goal-Oriented Requirements Engineering: A Guided Tour. In: The 5th International Symp. In Re-\quirements Engineering (RE'01), Aug. (2001).

Katzenstein G. Lerch F. J. (2000). Beneath the surface of organizational processes: a social representation framework for business process redesign. ACM Transactions on Information Systems (TOIS), 18(4), (pp. 383-422).

Koliadis G., Vranesevic A, Bhuiyan M., Krishna A. and Ghose K. Ghose (2006). A combined approach for supporting the business process model lifecycle. Proceedings of the Asia-PacificConference on Information System

G. Koliadis, A. Vranesevic, Moshiur Bhuiyan, A. Krishna and A. K. Ghose, Combining *i** and BPMN for Business Process Model Lifecycle Management. In the Proceedings of the BPM-2006 Workshop on Grid and Peer-to-Peer based Workflows, Lecture Notes in Computer Science Series, ISBN 978-3-540-38444-1, 416-427, Springer Verlag.

Miers, D. (2004) The Split Personality of BPM, Business Process Trends, bptrends.com

Ouyang, C. W.M.P. van der Aalst, Dumas, M. and ter Hofstede, A.H.M.(2006). Translating BPMN to BPEL, BPM Center Report BPM-06-02, BPMcenter.org.

Smith, H. Fingar, P. (2003). Business Process Management – The Third Wave, Tampa, FL: Meghan-Kiffer Press, 2003.

White, S. (2004). Business Process Modeling Notation (BPMN), Version 1.0, Business Process Management Initiative (BPMI.org).

(Yu E, 1995) Yu, E. (1995) Modeling Strategic Relationships for Process Reengineering. PhD Thesis, Graduate Department of Computer Science, University of Toronto, Toronto, Canada, pp. 124.

Fuxman, A. Liu, L. Mylopoulos, J. Pistore, M. Roveri, M. Traverso, P. Specifying and analyzing early requirements in Tropos. In: Requirements Engineering, Springer London, 9(2) (2004) 132–150