Chapter 3 The Integrated Requirements Management Framework (IREQM)

During the software requirements development process, customer and development team meet together for many times to obtain customer and product requirements from customer need, but they usually hold different views because of the different background and expertise. Therefore, the customer needs are usually ambiguous for development team and need to be elicited and documented by a useful requirements development technology.

In contemporary software development methodologies like RUP, the customer or product requirements are developed and validated iteratively. While the approved and documented requirements are evolving and changed, a continuous requirements change management is necessary. The requirements generated by the Requirement Development (RD) process are usually reviewed jointly and documented as a Software Requirements Specification (SRS), as well as some other documents such as vision, stakeholder requests. A Requirement Management (REQM) process is also needed to manage those formal documentations, the agreements obtained from requirements providers such as customer, and the commitments from requirements implementers. The process also needs to maintain the traceability among the documents, agreements, and commitments (CMU/SEI, 2002).

3.1 The Framework Description

This study proposes an integrated process tailored from requirements activities in RUP to better meet the joint objectives of RD and REQM process areas in CMMI. An activity diagram, as shown in Figure 6, represents the framework of integrated requirements management, called IREQM, composed of RMP (Requirements Management Planning), RD (Requirements Development) and RCM (Requirements Change Management). In order to make the accessibility for the stakeholders, a CMMI support system is built along with the proposed IREQM framework to tackle the requirements problems during the software development process.

The proposed IREQM framework is shown in Figure 6. IREQM focuses on the requirements activities. Other system development activities, such as Background Analysis, OOAD, Implementation, and Testing, are included in the figure to exhibit their relationships to the IREQM activities. Table 10 exhibits the 5W1H analysis for the IREQM process, illustrating the why, when, what, how, who, and where of the IREQM process details.

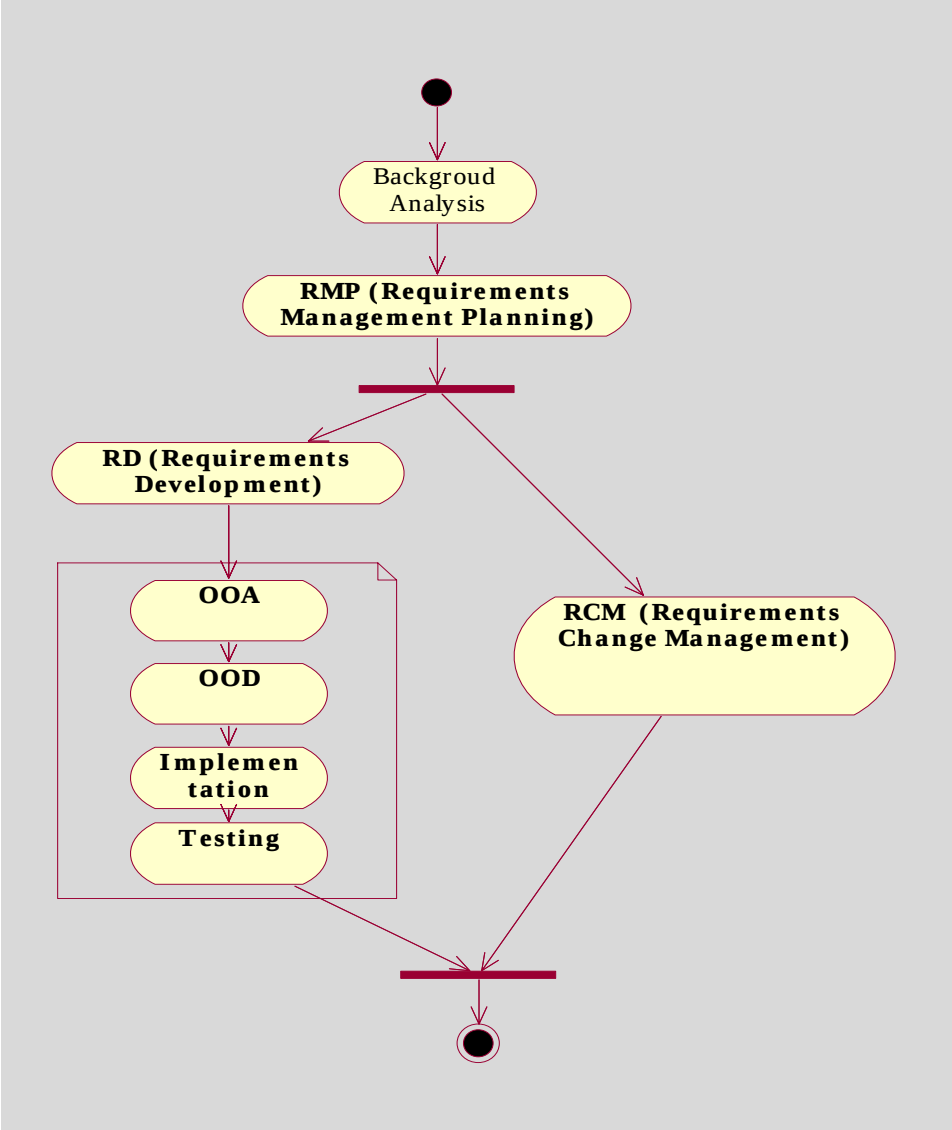

Figure 6 IREQM Framework

Table 10 5W1H Analysis for the IREQM Framework

Why	To meet the RD and REQM goals in CMMI to help enhancing the quality of requirements management.			
When	**What** (artifacts)	**Who**	**How** (activities)	**Where**
After a project is initiated	Text Description, Business Rules, Business Goals	Customer, Other Stakeholder, PM, **System Analyst**	Background Analysis	Joint meeting (workshop, session)
	Requirements Management Plan	**PM**, System Analyst	RMP	Development Group
After RMP	Questionnaires, Interviews, Vision, Stakeholder Requests, Workflow Activity Diagram, 5W1H Analysis Matrix, Use Case Model, Use Case Description, Supplementary Specification, Integrated Glossary, SRS, Requirement Dependencies	Customer, Other Stakeholder, PM, System Analyst, Developer, Software Architect, Requirements Specifier, Technical Reviewer	RD	(See the 5W1H analysis for RD)
When a change is requested	Requirement Change Request Form, Requirement Change Request Impact Assessments, Document for approvals and commitments to Requirements Change , Requirements Change Summary Table , Review Record , Requirements Traceability Table, Requirements Change History, Statistic Chart/Report	End User, Customer, Other Stakeholder, System Analyst, Developer	RCM	(See the 5W1H analysis for RCM)

3.1.1 Background Analysis and Requirements Management Planning (RMP)

An effective requirements management relies on the complete background understanding and requirements management planning. The Background Analysis navigates the project from the business perspective at the beginning of software development. The understandings of these business-related issues can help develop and analyze the requirements fulfilling the business goals.

During the RMP activity, some important items should be planned and taken into consideration first, including incorporating the requirements management planning into the project plan, establishing objective criteria for the acceptance of requirements, establishing related tables, and defining requirements change process. All of above are described in Requirements Management Plan, as well as other concerned items about requirements management such as requirements types/attributes, traceability items and their criteria. The Requirements Management Plan predefines these items to be collected and mechanisms to control requirements change for subsequent RD and RCM activities. In the implementation of IREQM framework, some templates or

samples for the concerned items can be provided to be chosen during the RMP activity.

3.1.2 Requirements Development (RD)

The Requirements workflow in RUP is a complete framework with the well-defined documentation, artifacts, activities, roles or relationships among them. Following the previous studies (Sung, 2001; Chu, 2002; Fang, 2003; Object Dynamics, 2003), a set of improved Requirements Development activities is described in Figure 7, and the elaborative workflow details is expressed in Table 11. This table exhibits the 5W1H analysis for the RD process, illustrating the why, when, what, how, who, and where of the RD workflow details.

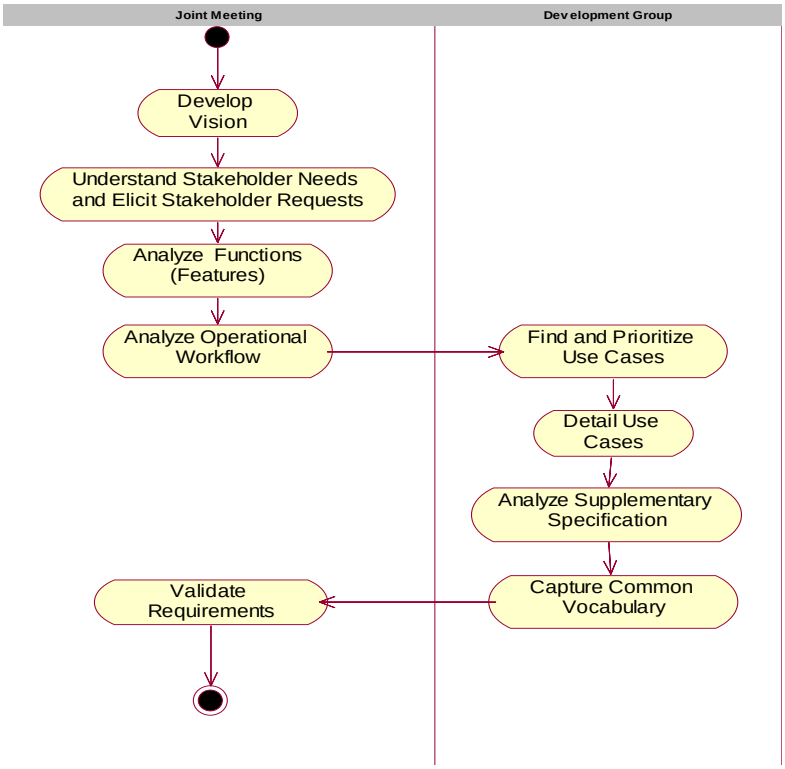

Figure 7 Insititutionalized RD Process

On the first phase Develop Vision activity develops vision, system goal and analyzes strategic goal by SWOT matrix. Vision document is specified in terms of the high-level stakeholder key needs and features and provides the contractual basis for the more detailed technical requirements such as use cases. On the Understand Stakeholder Needs and Elicit Stakeholder Requests, relevant stakeholders are engaged for eliciting needs, expectations, constraints and external interfaces. Analyze Functions activity lists the system's functional requirements. The purpose of Analyze Operational Workflow is to link up these functions from the business operational process perspective. The major consultation with stakeholders in the joint meeting has

been continued till this phase.

During the later stage of the RD process, the primary works are imposed on the requirements development group. Find and Prioritize Use Cases structures use cases model including use cases, use case package, and use cases description. Analyze Supplementary Specification activity analyzes supplementary requirements that can not be described in individual use cases. The traceability dependencies and common vocabulary are also established when the requirements are specified. Capture Common Vocabulary activity integrates the previous glossary items to provide document for reference to the subsequent software development works. The final activity Validate Requirements ensures that the resulting requirements meet the stakeholder needs and expectations.

Table 11 5W1H Analysis for the RD Process

Why	To elicit, organize, and document the requirements of the system in software development			
When	**What**(artifacts)	**Who**	**How**(activities)	**Where**
After RMP	*Vision* (SWOT Matrix, Problem Statement, Stakeholder Description)	Customer, Other Stakeholder, **PM**, **System Analyst**	Develop Vision	Joint meeting
	Questionnaire, Interviews, Stakeholder Need (described in *Vision)*, Stakeholder Requests, Dependencies (Traceability)	Customer, Other Stakeholder, End User, PM, **System Analyst**	Understand Stakeholder Needs and Elicit Stakeholder Requests	Joint meeting
	Feature List, Feature Description (described in *Vision*), Dependencies (Traceability)	End User, Customer, Other Stakeholder, **System Analyst,** Developer	Analyze Functions (Features)	Joint meeting
	Workflow Activity Diagram, 5W1H Analysis Matrix	End User, Customer, Other Stakeholder, **System Analyst**	Analyze Operational Workflow	Joint meeting
	Use Case Model (Use Cases, Use Cases Package, Use Case Diagram), Prioritized Use Cases, Glossary, Dependencies (Traceability)	**System Analyst**, Software Architect	Find and Prioritize Use Cases	Development Group
	Use Case Description, Glossary	**Requirements Specifier**, System Analyst	Detail Use Cases	Development Group
	Supplementary Specification (for those not defined in Use Case), Glossary, Dependencies (Traceability)	**System Analyst,** Requirements Specifier	Analyze Supplementary Specification	Development Group
	Integrated Glossary	**System Analyst**	Capture Common Vocabulary	Development Group
	(Validated) SRS	Customer, Other Stakeholder, **PM**, **System Analyst**, Requirements Specifier, Technical Reviewer	Validate Requirements	Joint meeting

Except for vision, the other artifacts produced through the process can be

packaged in SRS, a major deliverable during the software development process. The SRS is a formal documentation to be agreed upon and approved by requirements providers and receivers. Once the SRS is validated, any change in requirements must rest on the SRS as the basis of requirements management.

3.1.3 Requirements Change Management (RCM)

Figure 8 shows the institutionalized RCM process in the proposed IREQM framework. The process is further illustrated by another 5W1H matrix, as presented in Table 12, to define the why, when, what, how, who, and where of the RCM workflow details.

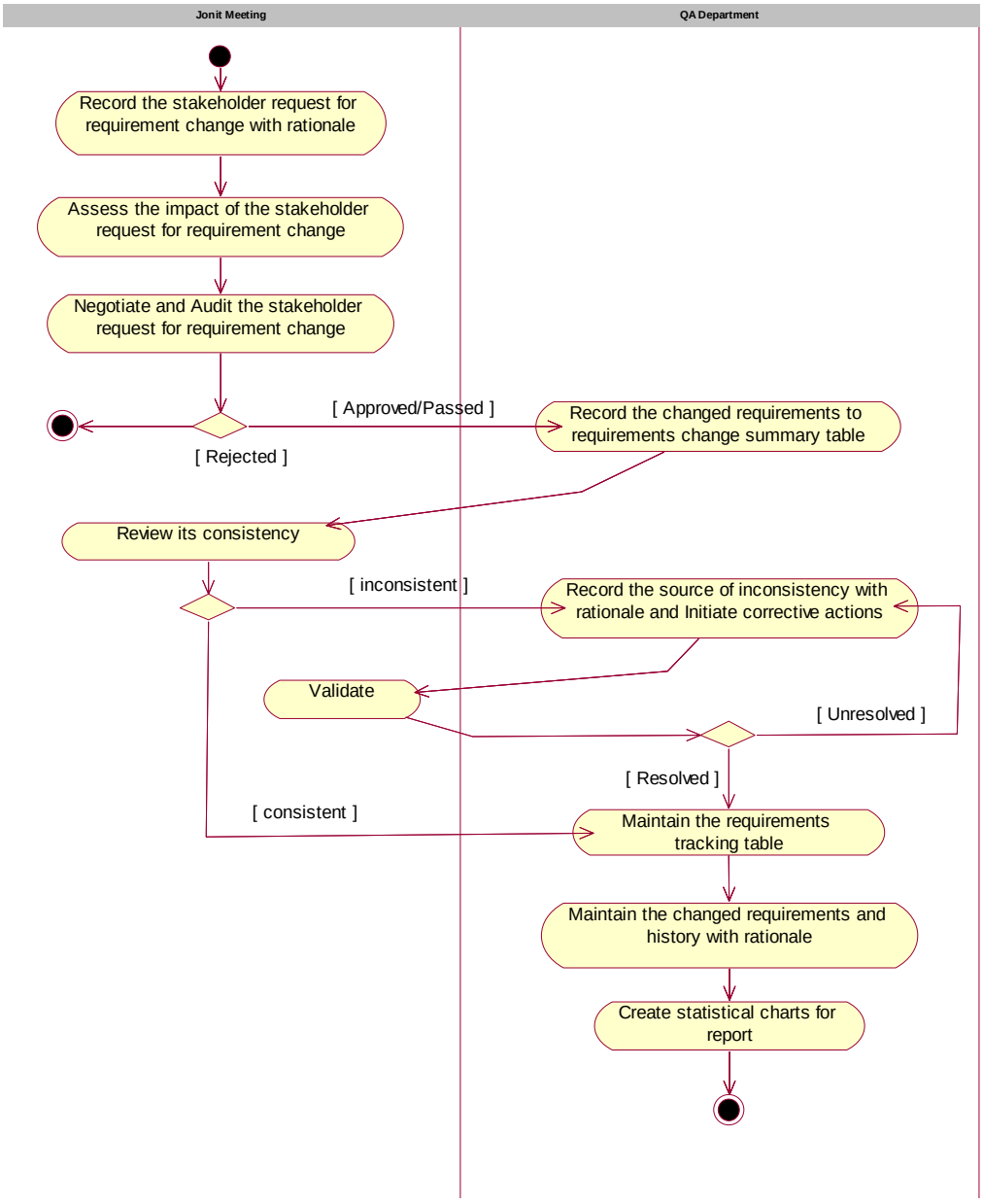

Figure 8 Insitutionalized RCM Process

The most commonly causes of project failure include lack of user input, incomplete requirements, and changing requirements (Rational Software Corporation,, 2003). By applying the RD activity in the IREQM process, the development team could elicit, organize, and document the requirements of the system in software development. Afterward, a successful requirements management is to avoid the disturbance of requirements change on resource consumption, and to maintain the consistencies among those requirements and the project's plans and work products.

Table 12 5W1H Analysis for the Institutionalized RCM

Why	To manage all changes to the requirements, and maintain the consistencies among the requirements, the project plans, and work products.			
When	**What**(artifacts)	**Who**	**How**(activities)	**Where**
When a change is requested	Requirement Change Request Form	End User, Customer, PM, REQM Personnel, Developer	Record the stakeholder request for requirement change with rationale	Joint Meeting
	Requirement Change Request Impact Assessments	**PM**, **REQM Personnel**, Developer, System Analyst, **Technical Reviewer,** REQM Personnel	Assess the impact of the stakeholder request for requirement change	Joint Meeting
	Audit Results (including Approvals and Commitments)	**PM, REQM Personnel** , Customer, End User, System Analyst, Developer	Negotiate and Audit the stakeholder request for requirement change	Joint Meeting
When request is passed and approved	Requirements Change Summary Table	**REQM Personnel**	Record the changed requirements to requirements change summary table	QA Department
	Review Record (Inconsistence rationale, Corrective Actions), Requirements Traceability Table	PM, REQM Personnel, System Analyst, **Technical Reviewer**	Review its consistency	Joint Meeting (Review Team)
When inconsistencies exist	Review Record (Resolution)	**REQM Personnel**	Record the source of inconsistency with rationale and Initiate corrective actions	QA Department
When changed requirements are validated	Requirements Traceability Table	**REQM Personnel**	Maintain the requirements tracking table	QA Department
	Requirement Change History	**REQM Personnel**	Maintain the changed requirements and history with rationale	QA Department
	Statistic Chart/Report	**REQM Personnel**	Create statistical charts for report	QA Department

Strategies to RCM include baselining the requirements, establishing a single channel to control change and maintaining a change history (Rational Software Corporation, 2003). The institutionalized RCM process contributes to a record of

decisions, during their assessment process, which ensure that change impacts are understood across the project within a standard/documented change control mechanism. These benefits depend on the baselined requirements and approved artifacts generated from RD process and the recorded requirements change history to control and monitor project schedule or budget. These artifacts provide the contractual basis for tracking requirements, managing requirements change or maintaining agreements and commitment from project participants. Once the requirements providers and the requirements receivers reach an agreement and the commitments to the requirements are obtained from the project participants, it is necessary to manage those formal commitments and identify any inconsistencies among the project plans, work products, and requirements.

The results of requirements change are derived from the stakeholder requests for changing artifacts or process (change request), adding a new functionality (enhancement request), or updating anomaly /flaw of product (defect), and so on. All of them should be collected throughout the project's lifecycle continually.

3.2 CMMI Goals and Practices Achieved by IREQM

The IREQM framework proposed in this study is developed to meet generic goals GG2 and all the generic practices GP2.1~GP2.10 of REQM in CMMI and therefore complements the requirements management practices in RUP. The framework also intend to meet GG3, GP2.1~GP2.10 and GP3.1~GP3.2 of RD in CMMI. The IREQM should also help to achieve all the specific goals SG1 and specific practices SP1.1~SP1.5 of REQM in CMMI level 2, and the SG1~SG3 and most SPs of RD in CMMI level 3.

The proposed IREQM process is planned to help achieving all the GGs, GPs, SGs and SPs of REQM in CMMI maturity level 2, and all the GGs, GPs, SGs and most SPs of RD in CMMI maturity level 3. In the following description of this study, we will discuss the feasibility of our framework via the system implementation and use appraisal checklists to self-check the compliance between the IREQM activities with those specified in GGs, GPs, SGs and SPs of process areas REQM and RD in CMMI.