A Secured e-Tendering Model Based on Rational Unified Process (RUP) Approach: Inception and Elaboration Phases

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***Abstract*— Due to the rapid rise in the e-Tendering transaction over the internet and the increasing use of e-Tendering solution by large organizations, there is a need to construct a secured e-Tendering model to ensure some security mechanisms such as confidentiality, integrity, and accessibility of the document are embedded in the e-tendering model. This to ensure the e-tendering transaction is secured and the most important is to gain trust from the e-Tendering stakeholder. Therefore, there is a need to develop a secured e-Tendering model as a guideline to e-tendering developers in developing the system. The Rational Unified Process (RUP) is the most appropriate system development methodology that can guide researchers in generating secured artifact. Therefore, this study aims to construct a secured e-tendering artifacts based on RUP. The Unified Modeling Language (UML) is used to generate the secured e-tendering artifacts. This paper discusses the generation of use case, misuse case and class diagrams based on security mechanism that need to be embedded in the e-Tendering model. This study also found that, the RUP is one of the best system development methodology that can be used as one of the research methodology in the Software Engineering domain, especially related to secured design of any observed application. This methodology has been tested in various studies, such as in Simulation-based Decision Support, Security Requirement Engineering, Business Modeling and Secure System Requirement, and so forth. . This study may contribute to the software industries in developing a secured system application in the future, and also to the secured system modeling domain.**

***Keywords*—** *e-Tendering; Rational Unified Process; Inception; elaboration, secured artefact; Use Case Diagram; Misuse Case Diagram; Class Diagram Incremen*

1. Introduction

E-Tendering is an electronic processing of the tender document via internet and allow tenderer to publish, communicate, access, receive and submit all tender related information and documentation via internet (Australian Standard Code of Tendering, 1994)[1]. As competition on the internet grows, tenderer seeks to obtain as much information as possible from tender competitors by using various methods that threaten data security and help them gain an unfair advantage [4].Therefore, concerns over the security of the e-tendering transaction need to be addressed in order to allow principle organizations to continually improvise their tendering performance and maintain competitive advantage [2-5].

Therefore is a crucial to construct a secured e-tendering model to become a guideline for the e-tendering developers. This to ensure a secured e-tendering system is developed and implemented, thus to avoid some security threats such as Integrity violation, confidential violation, Impersonate and so forth, during the tender document transaction in the electronic environment [2-6].

2. Literature Review

In order to construct a secured e-Tendering model, an appropriate system development methodology that can guide researchers in delivering a secured artifact for the secured e-tendering model must be identified. Based on previous studies, Rational Unified Process (RUP) is one of a good system development methodology that can assist researchers in delivering a secured artefact of the secured e-tendering model [7-9].

The Rational Unified Process (RUP) is one such life cycle approach that enables to produce quality software. As Figure 1.0 illustrates, RUP consists of the following four phases: Inception:

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Establish the basic scope of the project, on the other hand, Elaboration: Define the architecture of the system in order to provide a stable basis for the design and implementation effort in the Construction phase.

RUP provides a disciplined approach on how to assign tasks and responsibilities within the software development process. It consists of nine process workflows (business modeling, requirements, analysis and design, implementation, test, deployment, configuration management, project management, and environment). Correlated within each process workflow is a set of artifacts and activities, for example business model, use case model, and so forth. RUP provides a generic process framework, which can be customized to fit many different projects, different types of organizations, different levels of competence and different project sizes [10]. Therefore, it can be concluded that the RUP has a strength and ability to assist researchers in generating artifacts systematically and produce required documents in the inception and elaboration phase. This is because the characteristics of RUP itself that can guide researchers in creating a centralized architecture, iterative and additional process.

The scope of this study is only focusing on Inception and Elaboration phases as step to develop the model and perform only three of nine workflows (business modeling, requirements, analysis and design). The UML notation and the software program, StarUML, are used to support this work.

The RUP is the most regularly used by software developers in software development processes especially in the industry. Currently the RUP is recognized as one of the methodology that enhances and streamlining the process of identifying requirement as compared to conventional approaches [10]. Conventional software development process models comprise of four core process steps: analysis, design, implementation and test. These processes guarantee the correct analysis of requirements and their valid implementation, but not necessarily support quality attributes like usability or security [11]. RUP delivers artifacts that can easily understand by software development and client [12]. It has a structured framework that consists of phases and workflows that easy to understand and facilitates [13].

The RUP processes include measures of quality assurance, minimum of requirements engineering and software development iterations. All this must involve testing, configuration management, and collaboration with customers during project development. In addition, extra assessment is required to ensure the continuous monitoring of project development quality assurance [14].

Based on the advantages of RUP for industry, therefore this study is adapted the RUP approach in identifying the requirements of secure e-Tendering and delivered the artifacts as required in the RUP process flows. Therefore this study aims to construct a secured e-Tendering model based on RUP approach specifically focusing on Inception and Elaboration phases.

3. Methodology

This study comprises of four phases as describe below:

1.1. Phase 1: Initial Study

The aim of this phase is to explore the existing problems and solutions being address related to implementation of e-Tendering system. This initial phase involves the core activity, namely theoretical study. Apart from that, a preliminary study has been conducted to get an initial idea on e-Tendering system. The threats and secure practices of e-tendering system have been identified to construct matrix with counter measures. The research outcomes of this phase are list of threats, list of secured practices and a matrix of secure practices and threats of e-Tendering process with counter measures. This phase answered the sub objective one of this study.

1.1.1. Identify threats and identify secure practices

Threats and secure practices of e-tendering system have been identified from the literature review. The suitable threats and secure practices are listed to construct a matrix. The matrix of the threats and possible security practices is discussed in the next section.

1.2. Phase 2: Modelling

The main aim of this phase is to construct a secure e-tendering model. Findings from the phase 1 are used to construct the model. The model is based on a generic component of e-tendering and secure requirements. The generic component of e-tendering requirements has been facilitated as a basis for eliciting the functional user requirements. While the security-focused requirements has been facilitated as non-functional requirements which its description are usually specified as supplementary specifications. The secure practices of e-tendering are mapped into Rational Unified Process (RUP) phases. Only the first two phases of RUP which are Inception and Elaboration involved. The details activities for each phase are described in the next section. In each phase, a set of related UML model has been developed to illustrate the process of secure e-tendering system. The final activity in this phase is constructed secure e-tendering model activity in order to produce a secure e-tendering

model using UML. This phase answered the sub objective two and three of this study.

1.3. Phase 3: Validation

The final phase of this study is named as validation phase. This phase answered the sub objective four of this study. The secure e-tendering requirement model constructed in phase 2 has been validated in this phase. The purpose of this activity is to ensure that the requirements for the e-Tendering process and security practices have been clearly identified and validated. The experts review approach is used to validate the requirement model. There are two experts from each perspective have reviewed the model in separated session. Feedback from the validation is used as input for enhancement and improvement of the proposed model and also can be used to enhance the secure e-Tendering architecture in the future.

4. RUP and E-tendering modelling

This study adapting two phases of the RUP: 1) Inception, and 2) Elaboration phases. The brief descriptions of the activities are presented in Table 1.0.

2.1. First phase RUP: Inception

In this phase of RUP below tasks most placed in the priority of project teams:

- Identify scope of the project
- Identify current business status
- Identify actors of the organization and their requirement and expectations
- Identify goals and requirements of the project
- Model the organization's strategic planning using UML in Domain Class Diagram
- Establishing a team to identifying current way of performing processes and model them using UML in Use case and Activity Diagram.

This study started with a review of tender process, security mechanism, possible threats and security solution. Then the requirements of e-tendering is documented and modeled in the form of domain class and use case diagrams, followed by the matrix of threats and security solution. Table 1 show the list of requirements for the tender process which composed of nine functional requirements in the Inception Phase.

Table 1. Inception Phase

Business Modeling	**Requirement**	**Analysis and Design**
Establish a business case and project scope Establish Project Plan **Outcome:** Use case diagram Domain Class Diagram	Capture threats of the e-Tendering Capture generic security Requirements Capture secure e-Tendering requirement **Outcome:** a) List of Requirements (Table 4.2): • Functional Requirements: 1. Verify Pre-Qualification Requirements 2. Registration New Tendered 3. Public invitation 4. Submit Tender 5. Open tender 6. Close tender 7. Evaluation Tender 8. Award tender 9. Archive Tender ▪ Non-Functional Requirements: Security requirements: 1. Confidentiality 2. Integrity 3. Availability b) Matrix of threats and possible security solutions (refer Table 5).	None

Main focus in this phase is on requirement discipline and analysis and design discipline. Requirements have been updated and briefly documented in a use case specification. Use case diagram has been reviewed to collaborate with the security mechanism. Next, activity diagram has been modeled to visualize the tendering process. Domain class diagram is refined to produce detailed class diagram.

Table 2. Elaboration Phase

Business modeling	Requirement	Analysis and Design
None	**Iteration 1:** Iteratively update the requirements **Outcome:** Brief specification requirements of e-tendering (refer Appendix specification requirement)	**Iteration 1:** Analyze the problem domain. Associate security requirements into e-Tendering model **Outcome:** Misuse case diagram Activity Diagram Detailed Class Diagram
	Iteration 2: Refined matrix of threats and possible security solutions. **Outcomes:** Details matrix of threats and possible security solution	

Outcomes:
Details matrix of threats and possible security solution.

The main and refined requirements of the e-Tendering system are presented in Table 3.

Table 3. Main Requirements of the e-Tendering System

	Main Requirements	Refined Requirements
1.	Prequalification and registration	Pre-qualification registration Issue username and password
2.	Generate Tender Requirement	Establishment Project Strategy/Specification
3.	Public invitation	Tender advertisement Tenderers view tender advertisement and notice
4.	Open tender	Principal open tender View Tender Document View Tenderer Qualification
5.	Tender submission	Tenderer registration for tender a project Download tender document Adendum distributed by principal Tenderer submit tender document
6.	Close tender	Officially Close tender Tender Guarantee
7.	Tender evaluation	Tender evaluation process
8.	Award of tender	Request for information Award tender or acceptance of tender Signing the formal agreement
9.	Archiving	Retention of the document

Based on the above requirements, the use case diagram is constructed as presented in Figure 2.0.

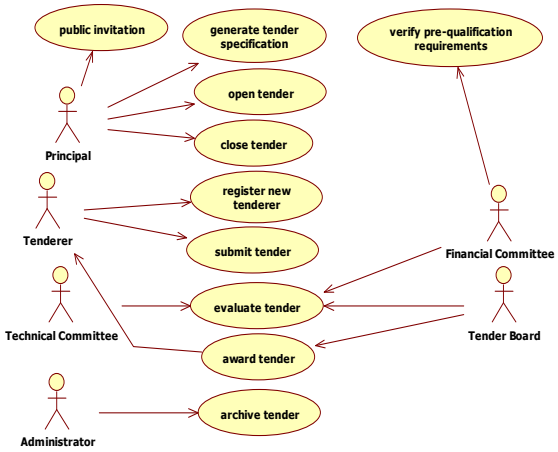

Figure 2 e-Tendering Use case Diagram

The use case diagram composed of 10 use cases: Public Invitation, Generate tender specification, Open tender, Close tender, Register New Tenderer, Submit tender, Evaluate Tender, Archive Tender, and Verify pre-qualification requirements. The use case diagram shows the main modules of the e-Tendering system. After the use case diagram is constructed, the detail for each usecase

specification is described. However it is not presented in this paper.

Next is to construct the e-Tendering class diagram. Figure 2.0 shows the e-Tendering class diagram model that composed of 13 classes: Tender Document together with the Legal Term class. This class has a relationship with tenderer class that composed of tenderer information. Tenderer class also need to has a relationship with Tenderer Proposal class and to the Shortlisted Tenderer class. Shortlisted Tenderer class has a relationship with Evaluation Committee class because the evaluation committee may decide and shortlisted the eligible tenderer for the project. The following class diagram shows all relationships of the classes in the e-Tendering system.

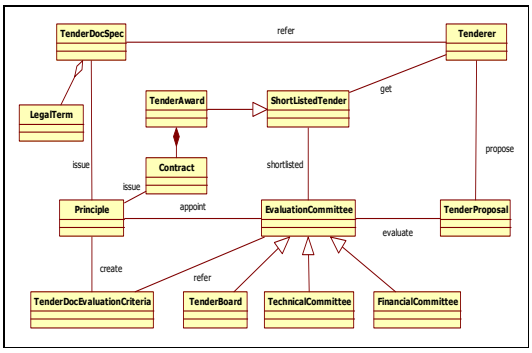

Figure 3. Class Diagram of the E-Tendering System

3.2.1 Security Mechanism of the e-Tendering

The security mechanism of the e-Tendering system is listed in Table 4.0. The security mechanism is important to ensure it is taken into consideration in designing a secured e-Tendering system.

Table 4. Security mechanism of the e-Tendering

Security Mechanism	**Practices**
Secure Sockets Layer (SSL)	▪ Provide integrity and confidentiality in communication. ▪ Use RSA or DSA with a key length of at least 2048 bits as asymmetric algorithm, and AES or triple DES for symmetric encryption (Betts et al, 2006). ▪ Protect the confidentiality of the tender data being downloaded. ▪ Protect information while in transit.
Digital Signature	▪ Used to verify the authenticity and integrity of a message or document. ▪ Used Digital Signature Algorithm (DSA), El Gamal and Elliptic Curve DSA (ECDSA) (Gregory, 2010).
Digital Certificate	▪ Common form of a digital certificate is X.509, an ITU (International Telecommunication Union) standard (Gregory, 2010).
Biometric	▪ Fingerprint reader.
Time Stamping Service (TSS)	▪ Hash function. ▪ Digital signature.

4.2.2 Tendering threat and secure practices

The threats and secure practices are listed to construct a matrix in Table 5.0 Threats and secure practices of e-tendering system are identified from the literature review. After completing the first phase of RUP, the documents and models are reviewed and aligned with the needs, and expectations of the secure e-tendering system.

Table 5. Matrix of Threats and Possible Secure Solution

	Repudiation	Denial of services	Non-verifiable evidence	Impersonation	Confidential violation	Integrity violation	Time integrity violation	Tender Process
Phase 1	Specifying security mechanism such as confidentiality, integrity, and availability, and legal term and condition related to secure e-tendering system							
Phase 2	-	-	Digital Certificate	Digital Signature	SSL	Secure Sockets Layer (SSL) Digital Signature Digital Certificate	-	Pre-Qualification and
	-	-	Digital Certificate	Biometrics	SSL	SSL	-	Public inviation
	Digital Signature Time Stamping Time Based Access		-	Digital Signature Digital Certificate	SSL	SSL	Time Based Access	Tender submission
	Time Stamping Time Based Access		-	Biometrics	Secure Time Server (STS) Biometrics		Time Stamping Time Based Access	Close tender
Phase 3		-	Digital Certificates	-		SSL Biometrics	-	Tender evaluation
	Time Stamping	-	Digital Signature	Biometrics	SSL	SSL	-	Award of tender
	- -	-	-	SSL Biometrics	SSL Biometrics	-	Archiving	

5. Discussion

This study has achieved the main objective to design the e-Tendering system using Rational Unified Process (RUP) approach. However, only two phases involve in constructing the design of a secured e-Tendering system that are Inception and Elaboration phases. Inception focusing on identifying the scope of the project, current business status, actors of the organization and their requirement and expectations, the goals and requirements of the actors functions in from the project, modelling the organization's strategic planning In Inception phase the details requirements of the secure e-Tendering system are identified as presented in Table 5, the requirement of security solution also being identified and are formulated in a form of matrix of threats and possible security solutions. The elaboration phase, focused on analysis and design of the e-Tendering requirements using Star UML. The basic requirements are designed using Use Case diagrams and Class Diagram. Then a secured e-Tendering requirement is designed using misuse case approach which has been discussed in previous paper [6]. This study shows that the RUP is one of the best system development methodologies that can be used as one of the research methodology in Software Engineering domain related to secured design of any observed application. This methodology has been tested in various studies in certain domain, such as in

Simulation-based Decision Support [8], Security Requirement Engineering [9], Business Modeling and Secure System Requirment [11], and so forth

6. Conclusion

As a conclusion, this study has achieved the main objective of the study in constructing a secured e-Tendering model. This study also showed that the RUP successfully assisted researchers in delivering a secured e-Tendering artifact such as use case diagram, misuse case diagram, and a initial class diagram for a secured e-Tendering model. These artifacts can be used as a guideline to the e-Tendering developers in developing a secured e-Tendering system, thus this may gain stakeholders' trust to use the system for tendering process via electronic environment. In addition, this study also found that the RUP is one of a good research methodology that can be adapted in Software Engineering (SE) research domain that required a few artifacts to be generated such as use case modeling, misuse case modeling, activity diagram, and initial class diagram from a list of requirements as identified earlier by the SE researchers.

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