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More on Adding Threat during Software Requirements Elicitation and Prioritization

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***Abstract*—There are two methods that are used to translate the customer requirements into software specification. First one is the Quality Function Deployment (QFD) and the second approach to the identification of software specification comes from the software engineering. Software requirements stipulate what must be accomplished, transformed, produced or provided. It is well documented that requirement engineering saves money. In this paper we have used the Web Surveys approach to elicit the software requirements for a railway projects. In this paper we have also added threat during software requirements elicitation and prioritization.**

***Index Terms*—Software, QFP, Elicitation, and Prioritization of Software Requirements.**

I. Introduction

The most comprehensive study of QFD usage was performed in Japan in 1986 by the quality research section of the Japan Quality Control Association [3, 25]. AHP was developed by Thomas Saaty and applied to software engineering by Joachim Karlsson and Kevin Ryan in 1997 [11, 20]. AHP is a method for decision making in situations where multiple objectives are present. This method uses a pair-wise comparison matrix to calculate the relative value and costs of security requirements. By using AHP, the requirements engineer can also confirm the consistency of the result. AHP can prevent subjective judgment errors and increase the likelihood that the results are reliable.

In the literature there are several elicitation techniques for software requirements like,

1) Soft Systems Methodology
2) Quality Function Deployment
3) Issue-Based Information Systems (IBIS)
4) Joint Application Development (JAD)
5) Accelerated Requirements Method
6) Rapid Application Development
7) Ontology Framework(ONT)
8) Misuse case
9) Web-Surveys

We are going to discuss only few techniques and to get the detailed description about the remaining techniques please refer to [2, 18, 21].

1.1 Misuse Cases: Misuse cases apply the concept of a negative scenario—that is, a situation that the system's owner does *not* want to occur—in a use-case context. For example, business leaders, military planners, and game players are familiar with analyzing their opponents' best moves as identifiable threats. Misuse cases are also known as abuse cases. A deeper discussion of abuse cases as an approach for identifying security requirements can be found in [10, 13]. One significant characteristic of misuse cases is that they seem to lead to quality requirements, such as those for safety and security, whereas other elicitation methods are focused on end-user requirements, so their effectiveness in the identification of security requirements is unknown. Use cases describe system behavior in terms of functional (end-user) requirements. Interplay between misuse cases and use cases could improve the efficiency of eliciting all requirements in a system engineering life cycle. Misuse cases and use cases may be developed from system to subsystem levels—and lower as necessary. Lower level cases may draw attention to underlying problems not considered at higher levels and may compel system engineers to reanalyze the system design. Misuse cases are not a top-down method, but they provide opportunities to investigate and validate the security requirements necessary to accomplish the system's mission. Davis classifies the requirements as (i) Functional requirements (ii) Non-Functional requirements (iii) Performance/ Reliability (iv) Interfaces (v) Design Constraint.

1.2 JAD: A number of requirement elicitation techniques have been developed to extract requirements from a user. So JAD is a method where a software development team and clients all come together in workshop environments. It is not only used to create the ideas for new system but it also raises issues for the software development team [1]. The goal of JAD (Joint Application Development) is to involve *all* stakeholders in the design phase of the product via highly structured and focused meetings. Typical participants in the session include a facilitator, end users of the product, main developers, and observers. In the preliminary phases of JAD, the requirements-engineering team is tasked with fact finding and information gathering. Typically, the outputs of this phase, as applied to security requirements elicitation, are security goals and artifacts. The actual JAD session is then used to validate this information by establishing an agreed-on set of security requirements for the product. If JAD has some

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advantages so it has also some disadvantages. The important disadvantage of JAD is that if there are too many JAD sessions while the project is progressing then user may develop a feeling that the developer are shifting their work and responsibility onto the users.

1.3 RAD: Rapid Application Development (RAD) is a technique that is used to create the screens while the developers and client discuss various fields and buttons that are needed. Like use case models, RAD adds visual clarity to scenarios and dialogue structure [21].

1.4 Ontology Framework: Researchers in the requirements engineering community have been studying and developing a number of ontology based approaches in order to elicit system requirements unambiguously and correctly. In the multiple ontology frameworks there are four types of ontology and these are (i) top level ontology, (ii) domain ontology, (iii) task ontology, (iv) application ontology [14].

1.5 Web Surveys: Survey represents one of the most common types of quantitative, social sciences research. Web-survey tool for software requirements elicitation solves shortfalls of paper- surveys. One of the most common shortfalls is not answered question, there lack of desired information. Web-survey tool solves it by not allowing the user to proceed to the next question until he answers the previous one. Possibility of the invalidated answers is also prevented by the tool interface [26].

Elicitation is all about determining the needs of stakeholders and learning, uncovering extracting and /or discovering needs of the users and other potential stakeholders [14]. Requirement elicitation is recognized as one of the most critical knowledge intensive activities of the development of software. The analysis of secure software system based on the system requirements elicited in the form of use case and misuse case. Use cases have proven helpful for elicitation of communication about, and documentation of the function requirements. The integral development of use and misuse cases [8, 10] provides a systematic way for the elicitation of both the functional and non functional requirements [13]. Using an elicitation method can help in producing a consistent and complete set of security requirements. However, brainstorming and elicitation methods used for ordinary functional (end-user) requirements usually are not oriented toward security requirements and do not result in a consistent and complete set of security requirements. The resulting system is likely to have fewer security exposures when security requirements are elicited in a systematic way. The paper is organized as follows: Section 2 contains the background and related work. In section 3 we have used the framework proposed by [27], in section-4, experimental work is carried out and finally we conclude the paper in section-5.

II. Background and Related Work

D. Firesmith [6], have worked for prioritization dimensions, prioritization approach, prioritization techniques and processes. This paper does not explain how the software requirements will be prioritize mathematically? It has only a list of prioritization techniques.

In [5] C. Kuloor and A. Eberlrin have explained the requirements engineering for software product lines. It has limited number of elicitation techniques. This paper does not include ontology framework, misuse cases, rapid application development etc.

In [12] J.Karlsson, C Wohlin, and B.Regnell have evaluated six different methods for prioritization software requirements. In [1] the authors have provided the different elicitation technique and criteria for its selection. In [15] the authors have proposed a framework to elicit and prioritize the software requirements using AHP and QFD [16, 17, and 22] but this framework does not rank the requirements by the relative level of threat.

In [23] the authors have presented an approach for requirements prioritization using B tree. In this paper the authors have mentioned that AHP is most promising method, although it may be problematic to scale up and they have also discussed that AHP are not useful for project that have large number of requirements. They have included AHP, Hierarchical AHP, spanning tree matrix, bubble sort, binary search tree, priority groups, and B tree in the same category. But with out having any data we can not prioritize anything. So AHP is a technique which is used to find out the importance weight of the requirements, after applying the AHP on the given set of requirements, we can use spanning tree matrix, bubble sort, binary search tree, priority groups, and B tree. It means we have to divide the given approaches into 2 groups. In the first group we have considered only AHP and Hierarchical AHP, and in the second category we will have to consider the spanning tree matrix, bubble sort, binary search tree, priority groups, and B tree.

In [27] authors have proposed a framework that will elicit the software requirements and also prioritize it. The proposed framework will also rank the requirements by the relative level of threat associated with each requirement. In this paper we have expended the work of [27].

III. Elicitation Technique

In this section we have used the Elicitation and prioritization framework proposed by [27] that will rank the requirements by the relative level of threat associated with each requirement.

1) Elicit the software requirements with the help of the following
   1.1 Collect information about user expectations.
   1.2) Train the Clients, Users and Managers.
   1.3 Write the description of the user need for the proposed system.
   1.4 Now you can apply Misuse cases or JAD or RAD, or Ontology framework.
2) In this framework we are using AHP technique for prioritization.
   For using AHP
   {
   Create the overall performance matrix
   }
   Then calculate the Eigen vector (Importance Weight)
3) Find out the risk associated with each requirement.

4) Compare the values of the importance weight of software requirements with step 3 and then rank or prioritize the requirements. (Adopted from [27])

IV. Experimental Work

The software requirements elicitation comprises an early and critical but highly error-prone phase in software development. The purpose of surveys in requirements elicitation is to gather significant amount of data about the software product at the very beginning of the development process. A survey inquires about business objectives of the product and expected product usage shows scope limitations, purposes success criteria. There are several disadvantages in conducting paper surveys like skipping questions, giving more answers then required and answering questions that are not asked. Some other disadvantages of paper surveys, like difficult handwritings, also have influence on validity of final result. Web-tool has browsers without any additional plug-ins installed not asked. Some other disadvantages of paper surveys, like difficult handwritings, also have influence on validity of final result. Web-tool has browsers without any additional plug-ins installed.

In this paper we have elicited the software requirements for a railway projects. These requirements are (R1) the platform should increase the predictability of trains arrivals; (R2) the platform should provide info on the evolution of transportation conditions; (R3) The platform should ensures safety of transports; (R4) Steps to find out the Minimum transportation cost; (R5) The platform should reduce load times; (R6) non-stop accessibility; (R7) Information presented in an easy to understand format; (R8) The platform should reduce transportation costs. Consider the following overall performance matrix (OPM) that is derived from customer needs statement for Railway Project.

TABLE-1 (OPM)

C		R1	R2	R3	R4	R5	R6	R7	R8
R1	PA	1	1/5	1/3	1/7	3	3	1/5	1/3
R2	AC	5	1	1/5	1/9	3	3	1/3	1/5
R3	EA	3	5	1	1/7	3	3	3	5
R4	FA	7	9	7	1	9	1/5	1/3	5
R5	GI	1/3	1/3	1/3	1/9	1	5	3	1/5
R6	RI	1/3	1/3	1/3	5	1/5	1	3	5
R7	PW	5	3	1/3	3	1/3	1/3	1	5
R8	NI	3	5	1/5	1/5	5	1/5	1/5	1

After applying the AHP we have got the importance (I) weights and it is summarized in table- 6.

TABLE-2

Category	I. Weight
1	0.0569
2	0.0674
3	0.221
4	0.2667
5	0.0627
6	0.100
7	0.141
8	0.083

According to figure 1, three most valuable requirements are SR-3, SR-4 and SR-7. The three least valuable requirements are SR-1, SR-2, and SR-5. Figure -1 and Figure-2 shows the value distribution and Cost distribution of the requirements respectively.

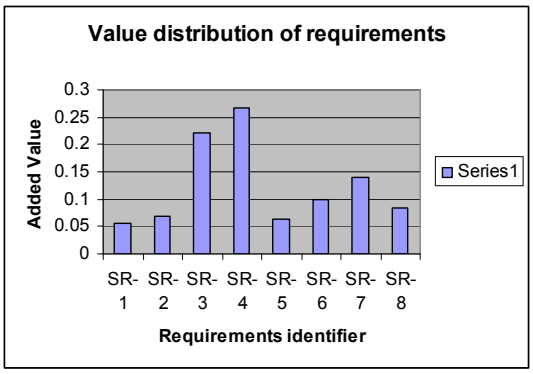

Figure 1. Value distribution of requirements

Figure-2 shows that requirements SR-2, SR-5, and SR-8 are three most expensive and the three least expensive requirements are SR-1, SR-3, SR-6

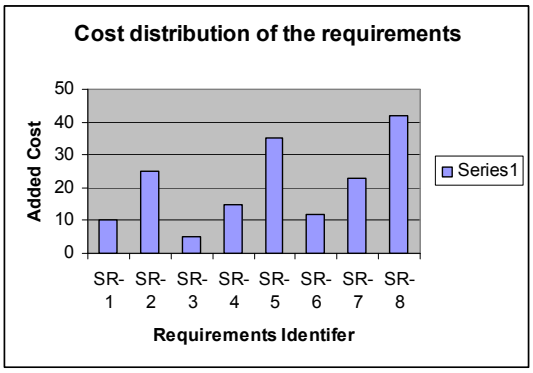

Figure 2. Cost distribution of requirements

From Figure-1 and Figure-2 we conclude, in terms of Cost- Value ratio distribution that SR-1, SR-3, SR-4, SR-6 are identified as high priority and SR-2, SR-5, and SR-8 are identified as low priority**.** In our study we have computed the value of the RE for each requirement.

V. Conclusion

In this paper we have used the framework proposed by [27] to elicit and prioritize the software requirements. In this paper we have shown that AHP is used only to evaluate the

importance weight of the requirements not to prioritize the requirements, after this we apply the existing prioritizing techniques. This paper is the extension of the work that has been accepted for the publication in [28].

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