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Volatile Requirement Prioritization: A Fuzzy Based Approach

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***Abstract*: Requirement prioritization is acknowledged as the most important activities of requirement engineering. The intention behind requirement prioritization is to inspect the leading requirements that can be implemented which finally result in customer satisfaction. Generally, requirement prioritization is done just as a post elicitation step. Every change in the requirements must be prioritized also to provide better chances for a successful project development. This research work focuses on developing a requirement prioritization technique with the perspective of its changeability using fuzzy approach. As requirement continues to be changed all through the life cycle of a project development, therefore prioritization must be performed concerning the volatility attributes.**

Index Terms: Requirement Engineering, Requirement Prioritization, Volatile Requirement,

I. INTRODUCTION

Requirement Volatility vigorously improve the usability of software and to increase its business value, but sometimes this requirement volatility becomes a major cause of the failure for many projects because of scant understanding of the causes for change and inadequate or improper handling of this volatile requirements. Conversely requirement volatility cannot be avoided every time as the customer may reject the product without full of his need, it must be taken care very efficiently [1]. Any system is defined to be successful only if it satisfies its users and customers with respect to their requirements. Every stakeholder of the software has its own concern to be facilitated and requirement prioritization techniques are used to prioritize the requirements. Many requirement prioritization techniques have been proposed in this area of paramount importance but there is not the evidence of a single technique that would help in prioritizing the requirements in the presence of Requirement Volatility.

II. REQUIREMENT PRIORITIZATION TECHNIQUES

In general requirement prioritization techniques consider the requirements with the view of cost and benefits. The information is used in numerous ways to rank the requirements in the view of its importance. At present various techniques are available for requirement prioritization [2].

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Few techniques are quantitative and use logical approach to congregate data and calculate a priority. Following subsections portray few eminent techniques for requirement prioritization:

2.1 Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP) is a statistical technique for decision making problems in the presence of complex multicriteria [3]. It is being used in requirement prioritization based on different characteristics of requirements that is risk, time and importance. The approach compares the requirements in pairs to find out the level up to which a requirement is imperative than another one. The process performs $n \times (n-1) / 2$ comparisons for n number of requirements.

2.2. Cost-Value Approach

This approach was produced by Joachim Karlsson [4] to prioritize the requirements on the basis of their relationships of value to cost. This method employs AHP scheme to compute the value-cost ratio and represents it in a graph as input to release decision. It is believed that this method is based on AHP and its two-dimensional values make it easy to plot them on cost-value graph.

2.3. B-Tree Prioritize

This technique is capable of integrating the dynamic nature of requirements since it continues coming and are never freeze [5]. It uses binary tree algorithm that has a function for mapping of requirements based on the priority value against the set of all requirements already prioritized. It is having run time capability meaning that prioritization can be start even all the requirements are not finalized and late coming requirements can be added or deleted later. It keeps the fixed number of comparison to prioritize a requirement if the overall number of requirements is known at an early stage.

2.4. Commulative Voting, The $100 test

It is a subjective scheme [6] where, every stakeholder purchases requirements by spending money out of $100. At next step a total value is computed and these written values are listed on a chart. The requirement with the maximum score is deemed as the most important one. This technique is very simple in nature and can easily be employed by the stakeholders but it becomes complex with the larger numbers of requirements.

2.5. Numerical Assessments (Grouping)

This method is based on ordinal scale in order that requirements are grouped jointly in assorted groups that can be related by the stakeholders.

Generally three groups that are critical, standard and optional used to achieve the objective. The stakeholder allocates a number on the scale of 1 to 5 to each requirement in every group based on his own perception. The average value of ranking to the requirements given by the stakeholders is used to calculate the final priorities. Although the technique is widely applicable, one major issue is to clearly define the groups.

2.6. Ranking

This technique is based on ordinal scale but and ranking is done devoid of ties in rank [7]. In the scheme, the most and least imperative requirements are ranked as 1 and n respectively. Different sorting techniques are used to acquire the ranks of the requirements. On the other hand the technique combines multiple aspects of the requirement by intriguing the mean of the priority of each requirement. It may result in ties in the priorities of the requirement that is contradiction to the basics of this technique.

2.7. Top Ten Requirements

In this scheme, the stakeholders are expected to choose their top-ten requirements from a specified requirements set. In the process, the stakeholders are not bounded to assign any internal order among the chosen requirements. The explanation behind it is to avoid unnecessary conflict among the priorities. The technique is very easy technique and very useful in the case of multiple stakeholders having equivalent importance. Conversely, it is exceptionally coarse with respect to the granularity [8].

2.8. Planning Game

Using this technique, prioritization is performed in consultation with the customers. The customers are expected to split their requirements into a set of stories [9]. The requirements are written on some cards in a small number of sentences.

2.9. Theory W

It is also known as Win-Win model [10]. The ideology of the technique are risk assessment, progress based on predefined plan and risk handling. The basic idea behind the scheme is to perform negotiation to resolve any conflicts of beliefs among different stakeholders. Initially, all the stakeholders are required to rank their requirements cautiously representing requirements they are eager to negotiate.

3. PROPOSED WORK: VOLATILE REQUIREMENT PRIORITIZATION BASED ON FUZZY APPROACH

It can be observed from the above discussion that each technique has its own advantages and limitations. However no technique is available which can deal with the volatile requirements. On the basis of these observations, it is being proposed in this research work to develop a technique that can prioritize the requirements on the basis of its volatility.

3.1 Volatile Requirement Prioritization Factors

To develop a methodology for volatile requirement prioritization, initially the attributes have to be identified. There are various attributes on which these volatile requirements can be prioritize. These attributes are defined on the basis of various features, that is determined to be present or not. Once all features are recognized, the requirement is assessed against each feature. Selection of accurate factors for prioritization is the key for effective prioritization. In this research work various factors are considered and after critical analysis of various factors on the basis of their role, project support and impact of prioritization process, following attributes are identified which can give better results in volatile requirement prioritization process: 1. Detectability, 2. Dependability and 3. Changeability. These three factors have a considerable role in prioritization of volatile requirements. The identified factors have a great impact on volatile requirement prioritization as contrast to other factors.

Table 1.1: Prioritization Factors

Input Attributes	Definition	Value		
Detectability	Defines the level at which the volatile requirements can be detected.	Low Level	Medium Level	High Level
Dependability	Defines the level of interdependence among various volatile requirements	Low Degree	Medium Degree	High Degree
Changeability	Defines the level at which the requirement can be changed.	Low Level	Medium Level	High Level

3.2 Fuzzy Inference System

Fuzzy Logic is a strong problem solving method to deal with elusiveness and information granularity [11, 12]. A fuzzy model is usually used in the cases where the conventional approaches of analysis is not suitable or in the presence inaccurate, uncertain or vague data. Fuzzy Logic begins with the notion of fuzzy set theory. It is an extension to the classical set theory with sharp boundaries [13]. The fuzzy inference system has five steps as follows: **1**. Fuzzifying Inputs, **2.** Applying Fuzzy Operators, **3**. Applying Implication Methods, **4**. Aggregating Outputs and 5. Defuzzifying Results. Fuzzification is the process to determine the degree up to which inputs belong to appropriate fuzzy sets by mean of membership functions. The fuzzy operator is applied to find one value if the antecedent of a given rule has extra part. The implication function is responsible for modification of output fuzzy set to the degree defined by the antecedent. Aggregation represents a single fuzzy set as an output of each rule. Defuzzification process takes the output of aggregated fuzzy set as the input and the final output is computed as a single crisp value.

3.3. Volatile Requirement Prioritization using Fuzzy System

A fuzzy based model for Volatile requirement prioritization has been proposed in this work. In fuzzy based approach, linguistic inputs are used as input to fuzzy based system. The three factors mentioned above usually support all type of projects. The three factors selected for prioritization works as linguistic inputs.

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The proposed model for volatile requirement prioritization has an input phase consisting of three linguistic variables. The output phase consists of one linguistic variable called Volatile Requirement Priority Ranking (VRPR). The input and output variables are mapped into fuzzy sets using appropriate membership functions. The output of fuzzy inference system is Volatile Requirement Priority Ranking (VRPR). The higher value of VRPR shows the relative importance of the volatile requirement.

3.5 Description of the proposed Algorithm

Step 1: Using Fuzzy Inference System to Prioritize Volatile Requirement: The scheme begins its execution with the concept of a fuzzy set. A fuzzy set is a set without a crisp and clearly defined boundary. A membership function (MF) is a curve that describes how each point in the input space is mapped to a membership value between 0 and 1. The Mamdani method is used in this research work as it is comprehensively recognized to capture expert knowledge.

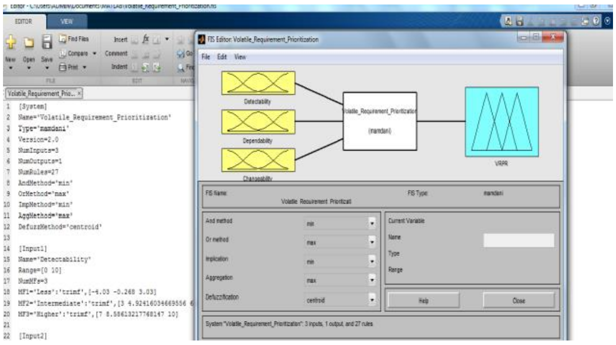

Figure 1.1: FIS editor for Volatile Requirement Prioritization

Step 2: Defining FIS variables and fuzzification of the input variables using membership function editor

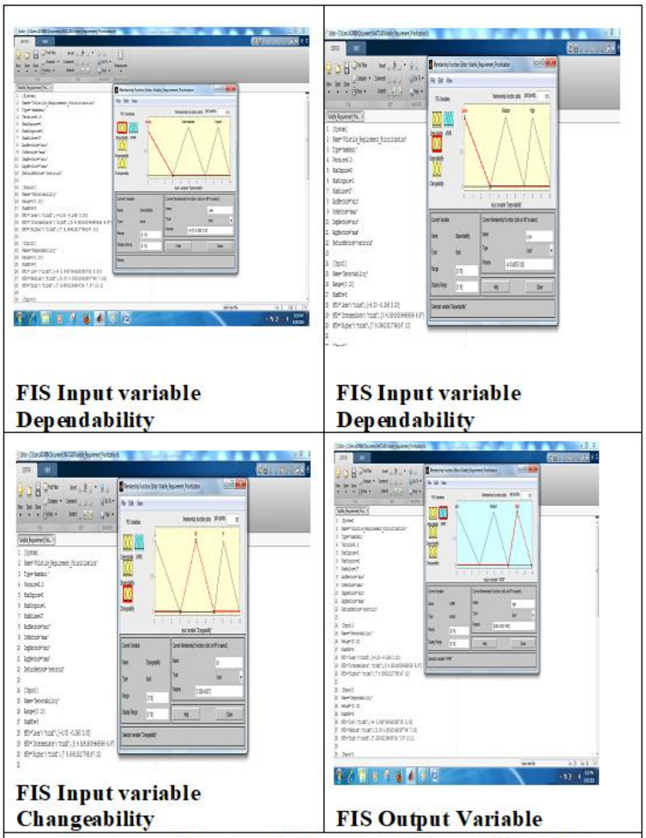

Figure 1.2: Different FIS Input and Output Variables

Step 3: Specifying rules for Fuzzy inference system using Rule Editor for Volatile Requirement Prioritization

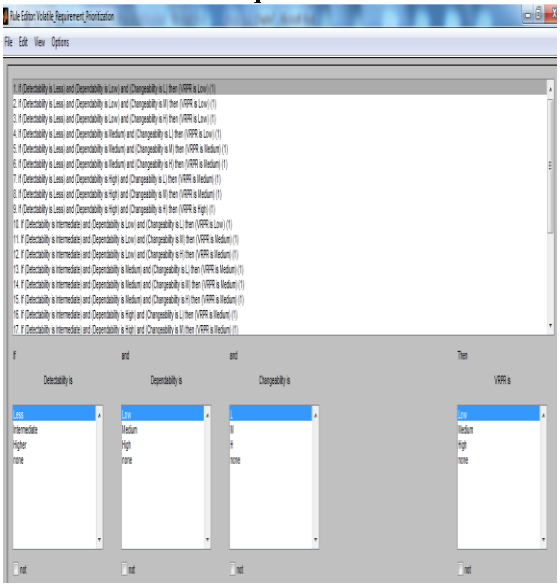

Figure 1.3: Rule Editor for Volatile Requirement Prioritization Problem

Step 4: Rule Evaluation Aggregation of the rule output and Defuzzification of the output value.

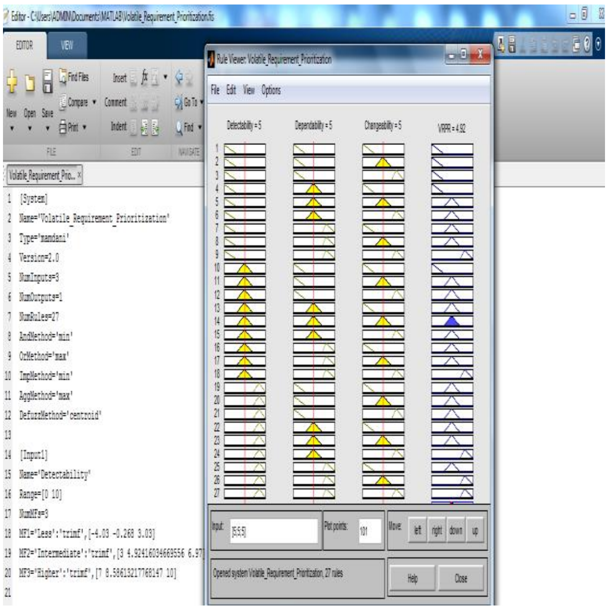

Figure 1.4: Rule Evaluation Aggregation of the rule output

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Step 5: Surface view

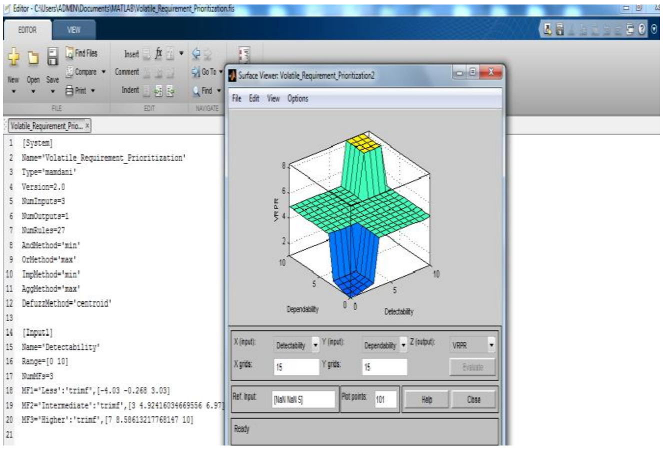

Fig 1.5: Surface view of Volatile Requirement Prioritization problem

IV. EMPIRICAL ANALYSIS

A fuzzy based approach for volatile requirement prioritization at early stage of SDLC is proposed in the previous section. In this section the proposed model for volatile requirement prioritization is applied to a project as a case study. A project **Web based MIS** for **STATE INSTITUTE OF RURAL DEVELOPMENT (SIRD)** is chosen as a case study for the analysis of fuzzy based approach for volatile requirement prioritization. This project had been formulated for setting up of the State Centers for Training and Research in Rural Development as training had come to be regarded as Human Resource Development for accelerating National Development in general. SIRD requires Web Based Application to properly maintain the working of the department. Computers of all the branches of Districts/ Regions of the department will be connected using Broadband Line. The system should be highly secured according to the norms provided by the department. All the Units will access the same database which will be placed on a centralized server at SIRD. The proposed System will be known as Web based MIS for SIRD. Module Wise

Module	**Req_Id**	**Requirement Description**
Finance & Budget Management System	R_1	Maintaining Budget Receiving Details at SIRD
	R_2	Maintaining Budget Allotment Details at SIRD
	R_3	Maintaining Daily Expenses at Institutes
Mess and Hostel Management System	R_4	Addition in Labour Master
	R_5	Maintaining Labour Attendance and Salary
	R_6	Maintaining Cheque / Cash Receiving Detail
	R_7	Maintaining Payment Detail
	R_8	Maintaining Diesel Purchases (for Generator)
	R_9	Maintaining Diesel Uses Detail (for Generator)
Mess and Hostel Management System	R_{10}	Maintaining Daily Expenses
	R_{11}	Addition in Dead Stock Item Master
	R_{12}	Maintaining Dead Stock Items Receiving Details
	R_{13}	Managing Dead Stock Status Details
	R_{14}	Addition in Consumable Item Master
	R_{15}	Maintaining Consumable Items Receiving Details
	R_{16}	Managing Consumable Item Status Details
	R_{17}	Managing Repair Details
	R_{18}	Maintaining Mess Stock Purchase Detail
	R_{19}	Maintaining Mess Stock Issue Detail
	R_{20}	Maintaining Hostel Registration Detail
Inspection Monitoring System	R_{21}	Addition in Inspection Schedule Detail
	R_{22}	Filling Inspection Report for Institute Inspected
Global Master Tables Management	R_{23}	Addition in Region Master
	R_{24}	Addition in District Master
	R_{25}	Addition in Institute Type Master
	R_{26}	Addition in Institute Master
	R_{27}	Addition in Section Master
Letter Tracking System	R_{28}	Addition in Stamp Type Master
	R_{29}	Maintaining Stamp Purchase Detail
	R_{30}	Maintaining Letters' Dispatch and Receiving Detail
Personal Information System	R_{31}	Addition in Scale Master
	R_{32}	Addition in Designation Master
	R_{33}	Addition in Leave Master
	R_{34}	Addition in Designation wise Posts Detail
	R_{35}	Addition in Employee Master
	R_{36}	Maintaining Leave Detail
	R_{37}	Creating a New Enquiry
	R_{38}	Closing any Enquiry
	R_{39}	Maintaining Medical Reimbursement Detail

Requirement Description of the project taken as Case Study is given in table 1.4:

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	R_{40}	Maintaining Deputation Detail
	R_{41}	Maintaining Retirement Detail
	R_{42}	Maintaining Annual Increment Detail
	R_{43}	Maintaining Promotion Detail
	R_{44}	Adding Transfer Detail
Research and Consultancy Management System	R_{45}	Addition in Research Detail
Registration System	R_{46}	Adding Registration Detail
	R_{47}	Addition in Research Detail
Training Scheduling and Monitoring System	R_{48}	Addition in Training Category Master
	R_{49}	Addition in Training Master
	R_{50}	Assigning Training Target
	R_{51}	Scheduling a Training
	R_{52}	Assigning Course Director(s) for Scheduled Training
	R_{53}	Filling Feedback Form for Scheduled Training
	R_{54}	Assigning Trainers for Scheduled Training

Table 1.2: Requirements for Web MIS Project

The project taken as a case study has total of 80 requirements. Here 54 requirements have been taken to validate the functionality of the proposed fuzzy based model for volatile requirement prioritization. Among the requirements discussed in the table 1.5, total 12 requirements have been modified after the initial requirement agreement among the stakeholders through a proper change request form. After successful implementation of all three phases of the proposed framework it has been identified that Requirements {R_3, R_{10}, R_{15}, R_{27}, R_{34}, R_{37}, R_{42}, R_{52}} have been modified from their initial status while the requirement set {R_{13}, R_{14}, R_{38}, R_{44}} has been added at later stage. These 12 requirements are considered to be Volatile Requirements and it may need a prioritization before their incorporation in the new agreed upon set of requirement document.

Table 1.3: Prioritized Volatile Requirements

Req ID	Prioritization Factors	Values	Volatile Req Priority Rating	Priority Region
R_3	DV	6.2	6.1	Medium
	DI	5.5		
	CW	6.9		
R_{10}	DV	2.8	2.9	Low
	DI	3.0		
	CW	1.4		
R_{13}	DV	8.0	7.4	Medium
	DI	2.5		
	CW	9.5		
R_{14}	DV	**9.4**	**9.1**	**High**
	DI	**7.7**		
	CW	**8.3**		
R_{15}	DV	2.3	3.2	Low
	DI	0.7		
	CW	5.3		
R_{27}	DV	8.1	5.3	Medium
	DI	4.9		
	CW	3.4		
R_{34}	DV	3.4	3.1	Low
	DI	0.9		
	CW	4.9		
R_{37}	DV	4.6	6.7	Medium
	DI	8.9		
	CW	7.8		
R_{38}	DV	1.1	5.2	Medium
	DI	6.7		
	CW	7.2		
R_{42}	DV	8.7	7.9	**High**
	DI	4.7		
	CW	8.1		
R_{44}	DV	6.7	4.3	Medium
	DI	5.2		
	CW	1.9		
R_{52}	DV	7.6	8.9	**High**
	DI	8.5		
	CW	9.0		

Where

DV	Detectability Value
DI	Dependability Index
CW	Changeability Weight

The result shown in table 1.5 represents that R_{14}, R_{42} & R_{52} are lying in high priority region.

V. CONCLUSION

Prioritization of Requirement is a vital part of requirement engineering process. Here a Volatile requirement prioritization method is proposed using fuzzy logic based algorithm in MATLAB using fuzzy logic tool box. Since requirements continues to be changing all through the development life cycle, the notion of prioritization of these changing requirements will certainly help the project managers to provide a better technique while handling these changing requirements.

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