Requirement Prioritization for Multistakeholders

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Abstract -- In today's world almost every electronic device uses various kind of software. As the use of various kind of software increases so the requirements. In software development increase in software requirements directly affects the cost and time of software development, whereas the cost and time are important aspect for any industries. Hence here arises the need, which balances between both of them. It is a difficult task to involve the multiple stakeholders that have same kinds of requirements but different criteria. Eliciting the required information from customers is difficult to achieve, especially when multiple customers with diverse expectations are involved in such kind of situation. When multiple stakeholders are involved, requirements will conflict. Conflicts occur because the requirements are usually unspecified and individually refined, without considering on others impact. Requirements prioritization should be based 1) Type, 2) Estimated benefit to stakeholders, 3) Estimated size of software that embeds the requirement, 4) Estimated cost to build what embeds the requirement, 5) Priority 6) Requirement dependencies .But problem is that to fulfill all the functional and non-functional requirements of all the stakeholders are not possible. Hence there is need to prioritize the various requirements of stakeholders in term of cost, and time.

Keywords—Software engineering, Software Requirement ,Requirement Prioritization, Multi Stackholder.

I.   INTRODUCTION

Software development has already become one of the largest industries in the world. Software helps in running and supporting manufacturing industry, education, entertainment, health and financial services, economic analysis, research, management activities, and many other domains. Requirements engineering is the process of discovering the purpose of software systems [1]. It is a set of activities concerned with identifying and communicating the purpose of a software-intensive system , requirements engineering acts as the bridge between the real-worlds" need of users, customers, and other constituency affected by a software system, and the capabilities and opportunities afforded by software-intensive technologies. It is also concerned with the relationship of these factors to precise specifications of software behaviour, and their evolution over time and across software families [2]. Requirements Prioritization is one of the most important activities that are done in requirements engineering. Many projects face the fact that not all the requirements can be implementing because of limited time and resource constrains. The priority of requirement is a characteristic that can be used for different purposes, depending on the program and company needs [3]. Requirements prioritization is also recognized as a very challenging activity. Involving stakeholders in requirement prioritization is a complex communication and negotiation process because the customer might not want to prioritize their requirements, because they are afraid of having just the most important ones done and developer do not want admit that they are not able to implement all the requirements [3]. Requirement can be prioritized taking different factors into account. some of the factors include penalty, cost time and risk[4].

II.   LITERATURE REVIEW

There are many definitions of what Software Engineering is. The definition given in [5][IEEE, 1990] states the following: "Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation and maintenance of software; that is, the application of engineering to software."

A definition of software engineering is given by D.M. Berry [6] which describes its different facets: "Software engineering is that form of engineering that applies a systematic, disciplined, quantifiable approach, the principles of computer science, design, engineering, management, mathematics, psychology, sociology and other disciplines as necessary and sometimes just plain invention, to creating, developing, operating and maintaining cost-effective, reliably correct, high-quality solutions to software problems." Requirements engineering is the process of discovering the purpose of software systems [1]. Requirements engineering is categorized as one of the domains in software engineering which is concerned with goals, functions, and constraints of software systems [7]. Requirements engineering is one of the most important stages in software development and design, as it addresses the design of the right software for the customer 7 [8]. Requirements engineering is a set of activities concerned with identifying and communicating the purpose of a software-intensive system, and the contexts in which it will be used. Hence, requirements engineering acts as the bridge between the real-world needs of users, customers, and other constituency's affected by a software system, and the capabilities and opportunities afforded by software-intensive technologies.

One of these activities is requirement prioritization. This is used to make a best decision in choosing one requirement among a group of candidates. The requirements engineering process varies due to the different contexts of technical maturity, disciplinary involvement, organizational culture, application domain, and market situation. Several process models already exist, as an example, in the conceptual linear model each activity may be undertaken several times [9]. One of these activities is requirement prioritization. This is used to make a best decision in choosing one requirement among a group of candidates. The requirements engineering process varies due to the different contexts of technical maturity, disciplinary involvement, organizational culture, application domain, and market situation. Several process models already exist, as an example, in the conceptual linear model each activity may be undertaken several times [9].

Requirement capture helps to understand the problem of contexts, needs, and expectations of users. It is the communication between engineers and the customer that is performed during the first step of requirements engineering. Capture and elicitation is one of the most important stages in requirements engineering, because of its impact on other stages [10]. The concept of requirement is fundamental in requirements engineering. A "requirement" is defined as [IEEE,1990]: "(1) A condition or capability needed by a user to solve a problem or achieve an objective; or (2) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents."

Requirement capture helps to understand the problem of contexts, needs, and expectations of users. It is the communication between engineers and the customer that is performed during the first step of requirements engineering. Capture and elicitation is one of the most important stages in requirements engineering, because of its impact on other stages [10].If the wrong requirements are implemented and users resist using the product, it does not matter how solid the product is or how thoroughly it has been tested [11]. Most software projects have more candidate requirements than can be realized within the time and cost constraints. Prioritization helps to identify the most valuable requirements from this set by distinguishing the critical few from the trivial many. It is easy to prioritize requirements by considering one aspect, but when the number of aspects increases, making a decision becomes extremely hard. Another point that should be considered about requirement prioritization's aspects, are the interdependencies between aspects in which changing one will cause changes in others as well [12].

III. PROPOSED WORK

A new algorithm based on the linguistic approach is proposed for requirement prioritization for multi stakeholders" software application. The most important feature of the proposed algorithm is that it uses fuzzy approach to combine the multiple stakeholders requirements together.

The proposed algorithm is explained here stepwise
.
Step 1:- Take the list of stakeholders and give the weightage to each stakeholder. i.e. make pairwise comparison matrix and calculate their priority vector(normalized eigen vector) respectively.
Step 2:- Ask each stakeholder to prioritize the requirements using the pairwise comparison matrix in linguistic scale.
STEP 3:-In this step, the priority value of the each stakeholder calculated in step-1 are multiplied with the comparison table of stakeholder's requirements respectively.

STEP 4:-Convert the each stakeholder's matrix into the linguistic variables expressed as positive triangular fuzzy number (TFN).
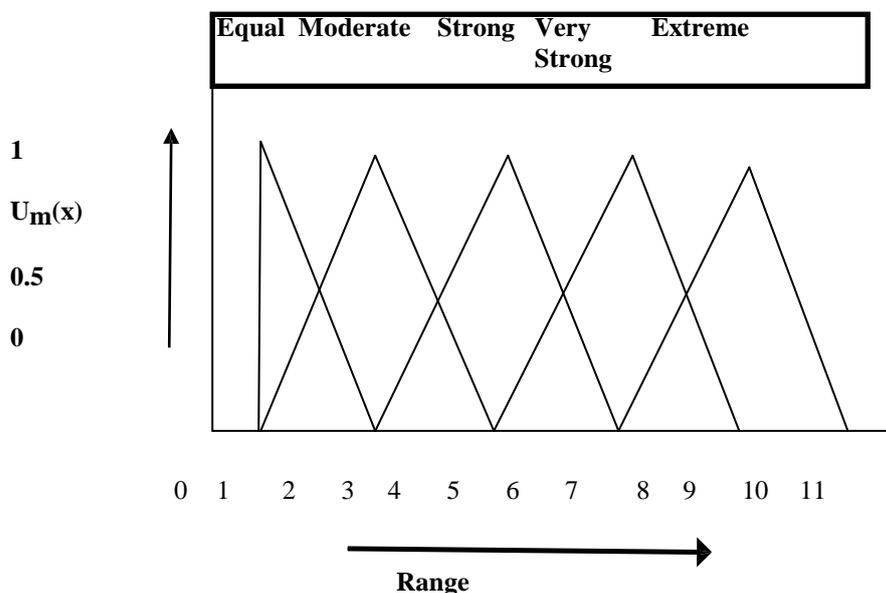

Figure.1 Linguistic Variables With Range

STEP 5:- Now calculate the aggregate fuzzy weights W for each requirement

STEP 6:- Apply de-fuzzification on the above matrix using method.

STEP 7:- Find the $^{\alpha}$S set for different values of α belongs to [0,1]. Find the total orderings $^{\alpha}$O that are compatible with the pairs in the crisp relation $^{\alpha}$S.

IV.   RESULTS

1. Take the list of stakeholders and give the weightage to each stakeholder. i.e. make pairwise comparison   matrix and calculate their priority vector(normalized eigen vector) respectively.

Table 1: comparison matrix of five stakeholders'

Stakeholders	S/H 1	S/H 2	S/H 3	S/H 4	S/H 5
S/H 1	1	2	5	5	3
S/H 2	1/ 2	1	3	3	2
S/H 3	1/5	1/3	1	1	1/3
S/H 4	1/5	1/3	1	1	1/2
S/H 5	1/3	1/2	3	2	1
Sum of column	2.23	4.16	13	12	6.83

 the initial comparison matrix is changed into the normalized comparison matrix and it is gained by dividing each column by sum of column respectively after that calculating the sum of row and sum of row is divided by 5, the stakeholder priority as a result is obtained.

2. Ask each stakeholder to prioritize the requirements using the pairwise comparison matrix in linguistic scale and multiply their metrics with priority value. By taking the comparison matrix of stakeholders one by one.

After multiplying initial comparison matrix of stakeholder with their respective priority value Prioritized Comparison Matrix is obtained.
To generalize the priority matrix of stakeholder it is multiplied by a factor 10. Generalized Comparison Matrix of Stakeholder is obtained.

3. Convert the each stackholder's priority matrix into linguistic variable expressed as positive traingular fuzzy number (TFN).

Table 2: Generalized Matrix 1 Changed into TFN

1	Cost				Size				Reliability				Delivery Time				Functionality		
	L	M	H		L	M	H		L	M	H		L	M	H		L	M	H
C	4.2	4.3	4.4		0.76	0.86	0.96		12.8	12.9	13		12.8	12.9	13		21.4	21.5	21.6
S	21.4	21.5	21.6		4.2	4.3	4.4		21.4	21.5	21.6		21.4	21.5	21.6		30	30.1	30.2
R	1.33	1.43	1.53		0.76	0.86	0.96		4.2	4.3	4.4		1.33	1.43	1.53		4.2	4.3	4.4
D	1.33	1.43	1.53		0.76	0.86	0.96		12.8	12.9	13		4.2	4.3	4.4		4.2	4.3	4.4
F	0.76	0.86	0.96		0.51	0.61	0.71		4.2	4.3	4.4		1.33	1.43	1.53		12.8	12.9	13

In above table, Stakeholder no. 1"s linguistic priority table is changed into the tri-fuzzy number table(TFN). Where each number is changed into three numbers i.e. low, mid, high.

4. Now the aggregate fuzzy weights W for each requirement are calculated. This can be calculated as follows:

$$W = (w_{jL}, w_{jM}, w_{jH})$$

$$w_{jL} = \min \{w_{jkl}\}$$

$$w_{jm} = (\prod w_{jkm})^{1/n} \text{ (Geometric Mean). } W_{jh}$$
$$= \max \{w_{jkh}\}.$$

5. The TFN table has been combined the formula given above.

Apply de-fuzzification on the above matrix using method:

$$^\alpha A = [l^\alpha, u^\alpha] = [(m-l)\alpha + l, -(u-m)\alpha + u]$$

6. Now the boundary values are changed into the crisp value using the formula given below:

$$\text{crisp value} = \alpha*a + (1-\alpha)b$$

7. Final priority table for all stakeholders

Table 3: final priority table for all stakeholders

Criteria	Cost	Size	Reliability	Delivery time	Functionality
Cost	0	.23	.44	.4	.65
Size	.61	0	.7	.62	.86
Reliability	.37	.34	0	.12	.18
Delivery time	.38	.48	.46	0	.21
Functionality	.62	.6	.19	.53	0

Divide the table by factor 10 from because earlier table is multiplied by factor 10 to generalized the terms and makes the diagonal 0 because there is no need to compare between the same requirements.
The overall ordering of the requirement after calculation are given below:
Size >> Cost >> Reliability >> Delivery time >> Functionality

V.   CONCLUSION AND FUTURE SCOPE
A new algorithm based on linguistic approach is proposed for requirement prioritization for multi stakeholders software application. The most important feature of proposed algorithm is that it uses fuzzy approach to combine multi stakeholders and their prioritization which is based on their expectations. This algorithm is stakeholder oriented. The proposed algorithm is based on stakeholders priority ans their requirements prioritiy. that the proposed algorithm gives the optimum results which are beneficial for Software Company. The result obtained so far demonstrate that the proposed algorithm is promising to combine the various stakeholder together to get a common software application.

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