

Evaluation of Usability Using Soft Computing Technique

Aishwarya Singh and Sanjay Kumar Dubey

Abstract— In the recent years, many factors have been recognised as an important contributor in evaluating software quality. Evaluating software is significant for managing, controlling and improving a software development life cycle. Quality of software cannot be measured easily, it depends on various factors. Usability is one of the chief quality factor and important aspect of software quality. This paper proposes a usability evaluation model using fuzzy multiple criteria weighted average approach. A case study is used to evaluate the usability of proposed model.

Index Terms— Usability, Quality model, Fuzzy, Software system, Soft Computing.

1 INTRODUCTION

Usability is a quality attribute that assesses how easy user interfaces are to use. The word 'usability' also refers to methods for improving ease-of-use during the design process [1]. It is the ability to provide good quality service. Since usability is fuzzy in nature, many models have been proposed over the years like McCall's quality Model, Bohem's quality model, FURPS quality models, ISO 9126 model etc. Each of these models explained and defined usability but still they lacked in one way or another. ISO 9126-1 has represented the latest research into characterizing software for the purposes of software quality control, software quality assurance and software process improvement [2].

Over the period of time, the demand for measurement of quality of software system has increased in order to meet the users demand and expectations. Measurement can be done at any stage of a software development. It is highly useful as it is half times the cost to as much it will cost if the software fails. It provides a necessary feedback to check a software quality and find errors in it (if exists). Measurement of usability is quality measure of the product software and plays a vital role in giving user an ease to use the software as well as the user's satisfaction and reliability. This paper have made an attempt to add more attributes to the software quality factors, with the help of the quality factors already being stated in 9126-1 model [4]. Paper proposes an integrated model that describes multiple criteria on which usability depends. Fuzzy multi criteria approach is used to prove feasibility of the software quality factors. This is the approach taken with software qualities factors such as functionality, efficiency and portability, and it

enables quality to be designed into software product [3].

2 LITERATURE SURVEY ON USABILITY MODEL

Over the years, many methods and surveys have been performed in order to measure the usability of software system. It is part of usability inquiry in which surveys is a sub part. Survey is a method which focuses on problems and conclusions, which is acquired from the collected information. It has been a useful way to determine the usability in large group of users. Usability depends on certain factors which in turn depend on sub factors and which are further dependent on several characteristics. There is a hierarchy of structure which is designed and shown in figure 1.

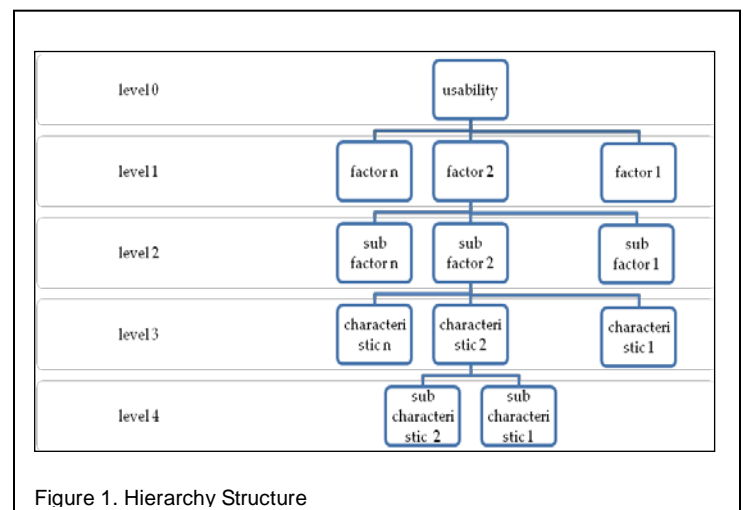


Figure 1. Hierarchy Structure

3 EVALUATION STEPS OF USABILITY

Step 1. In the hierarchy structure, assign the fuzzy ratings (r_i) to all the leaf nodes.

Step 2. In the hierarchy structure again, assign the fuzzy weights (w_i) to all the nodes (sub characteristics, characteristics).

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	Legal Safety of Resources Environmental	Less of effort by users	Of language Of cultural conventions.	Time to learn Testable
Pictorial Static Dynamic	Confidentiality	Readable Font size Font type	Memorability Formal Conceptual	Accomplishment of - tasks Quality Quantity Precision
AESTHETICS	CONTROLLABILITY REVERSIBILITY TECHNICAL CONFIGURATION FREEDOM IN TASKS		COMFORT USE OF PRODUCT DESIGN	MANAGEMENT - OF LARGE NUMBER OF USERS - OF LARGE STORAGE OF DATA

3

p value is calculat-
quantify the usabil-
d by the weighted
teristic_1) + r (char-
(characteristic_n)*

TABLE 1.
PROPOSED USABILITY MODEL

Attractiveness	Operability	Understand- ability	Learnability	Usability Compliance
Colourful Brightness Hue	Tangible Sensitivity Technology used	General Purpose User friendly Interactive Practical to use	Feasible Adaptability	User Satisfaction Worthiness Resource Utilization
Clarity Pixel density	Safety Physical Legal Safety of Resources Environmental	Directness Completeness Less of effort by users	Simplicity Universality Of language Of cultural conventions.	Save time Execution time Time to learn Testable
Pictorial Static Dynamic	Confidentiality	Readable Font size Font type	Memorability Formal Conceptual	Accomplishment of - tasks Quality Quantity Precision
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4 CASE STUDY

To evaluate the working of the usability model proposed above, a sample case study of MS POWER POINT 2007 has been chosen. The evaluation steps has been shown in the next paragraph.

A group of 5 users was made to fill a questionnaire in which the fuzzification criteria for the all the characteristics and sub factors were given. In the process of fuzzification, real time

values were assigned to the fuzzy sets. They are assigned as Very High (VH), High (H), Medium (M), Low(L) and Very Low (VL). These abbreviations are used throughout this section. The fuzzification criteria of language and fuzzification criteria of cultural conventions is reperesented in Table 2 and Table 3 respectively.

As discussed earlier, each leaf node is associated with corresponding rating and weight. The rating is the fuzzy value given by the user for a particular sub characteristic/characteristic/sub factor according to their usage of MS

PowerPoint 2007. The weight is the fuzzy value given by the user for a particular sub characteristic/ characteristic / sub factor/factor according to its importance for calculating the usability.

For example, for the sub factor Simplicity, there is one characteristic universality .Universaliy is further dependent upon 2 sub characteristics, language and cultural conventions. The Triangular fuzzynumbers were assigned to fuzzy ratings and weights obtained by the users.

Similarly, Fuzzy ratings of (leaf nodes) Attractiveness, Operability, Understandability, Learnability and Usability Compliance were obtained and also the Fuzzy weights (sub characteristics, characteristics, sub factors, factors) were obtained.

The fuzzy weighted average of language and cultural conventions sub characteristics give the fuzzy rating for the cultural universality characteristic.

$$r(\text{cultural conventions}) = (0.0,0.25,0.5)*(0.5,0.7,0.9) + (0.0,0.25,0.5)*(0.5,0.7,0.9)$$

$$r(\text{cultural conventions}) = (0.0,0.36,0.9).$$

w(cultural conventions) is obtained from the users which is (0.3,0.55,0.75).

The values of weights and ratings for Attractiveness leaf nodes as obtained from 5 users are given in the Table 6 and Table 7 respectively.

Similarly, we get the ratings and weights of other sub factors under Attractiveness shown in Table 8.

Now, to calculate the rating of the Attractiveness factor, the fuzzy weighted average of these sub factors are taken. It is calculated and the value is obtained and then the ratings of all the five factors are calculated and the weights are obtained from the users (Table 9).

Table 2
Fuzzification Criteria of Language

NO. OF LANGUAGES SUPPORTED	FUZZY VALUE
1	VL
2	L
3	M
4	H
5	VH

TABLE 3
FUZZIFICATION CRITERIA OF CULTRAL CONVENTIONS

Variation Of Usage With Changing Cultures	Fuzzy Value
Extreme	VL
A lot	L
Moderate	M
Slight	H
No	VH

TABLE 4
TRIANGULAR FUZZY SETS FOR FUZZY RATINGS

Fuzzy value	Fuzzy ratings
VL	(0.0,0.1,0.3)
L	(0.1,0.3,0.5)
M	(0.3,0.5,0.7)
H	(0.5,0.7,0.9)
VH	(0.7,0.9,1.0)

TABLE 5
TRIANGULAR FUZZY SETS FOR FUZZY WEIGHTS

Fuzzy value	Fuzzy weights
VL	(0.0,0.0,0.1)
L	(0.0,0.25,0.5)
M	(0.25,0.5,0.75)
H	(0.50,0.75,1.0)
VH	(0.75,1.0,1.0)

$$r(\text{usability}) = r(\text{attractiveness}) * w(\text{attractiveness}) + r(\text{operability}) * w(\text{operability}) + r(\text{aunderstandability}) * w(\text{understandability}) + r(\text{learnability}) * w(\text{learnability}) + r(\text{usability compliance}) * w(\text{usability compliance}).$$

$$r(\text{usability}) = (0.356,0.75,0.81)*(0.278,0.65,1.0) + (0.24,0.75,0.82)*(0.40,0.50,1.0) + (0.18,0.75,0.1)*(0.50,0.68,0.92) + (0.20,0.52,0.89)*(0.75,0.1,0.1) + 0.125,0.32,0.869*(0.34,0.50,1.0)$$

TABLE 6
RATINGS AND WEIGHTS OF THE SUB FACTORS OF ATTRACTIVENESS

Sub factors	Fuzzy ratings	Fuzzy weights
Colorful	(0.58,0.78,0.92)	(0.45,0.70,0.95)
Clarity	(0.7,0.9,1.0)	(0.6,0.85,1.0)
Pictorial	(0.54,0.74,0.92)	(0.5,0.75,0.95)
Aesthetics	(0.54,0.74,0.92)	(0.35,0.60,0.85)

TABLE 7
RATING INPUTS FOR ATTRACTIVENESS

	User 1	User 2	User 3	User 4	User 5	Average Rating
Brightness	H	H	H	H	H	(0.5,0.7,0.9)
Hue	M	H	M	M	M	(0.34,0.54,0.74)
Pixel density	VH	H	VH	H	H	(0.58,0.78,0.94)
Static graphic	M	M	H	M	H	(0.38,0.58,0.78)
Dynamic Graphic	H	VH	H	M	M	(0.46,0.66,0.84)
Aesthetics	H	H	VH	H	H	(0.54,0.74,0.92)

TABLE 8
WEIGHTS INPUTS FOR ATTRACTIVENESS

	User 1	User 2	User 3	User 4	User 5	Average Weights
Brightness	H	M	M	M	H	(0.35,0.6,0.85)
HUE	M	M	M	M	M	(0.25,0.50,0.75)
Pixel Density	VH	H	VH	H	H	(0.60,0.85,1.0)
Static Graphics	L	L	M	M	M	(0.15,0.4,0.65)
Dynamic Graphics	M	M	M	M	M	(0.25,0.50,0.75)
Aesthetics	H	M	H	M	M	(0.35,0.60,0.85)

TABLE 9
RATINGS AND WEIGHTS OF THE FACTORS OF USABILITY

factors	Fuzzy ratings	Fuzzy weights
Attractiveness	(0.356,0.75,0.81)	(0.278,0.65,1.0)
Operability	(0.24,0.75,0.82)	(0.40,0.50,1.0)
Understand -ability	(0.18,0.75,0.1)	(0.50,0.68,0.92)
Learn -ability	(0.20,0.52,0.89)	(0.75,0.1,0.1)
Usability Compliance	(0.125,0.32,0.869)	(0.34,0.50,1.0)

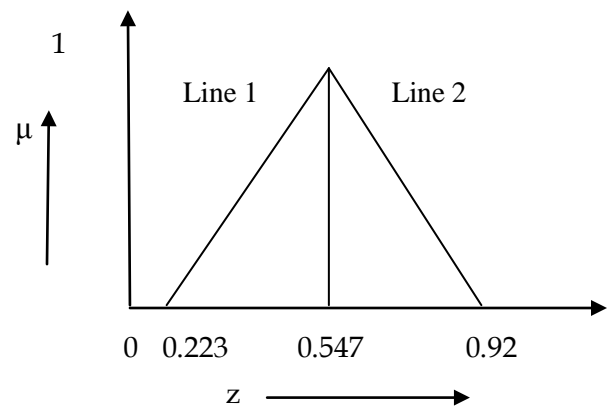


Figure 2. Fuzzy membership function for usability

$$\text{Centroid Formula } z^* = \frac{\int \mu(z).z.dz}{\int \mu(z).dz}$$

Where, z^* is the defuzzified crisp value

z is the value on x -axis and

$\mu(z)$ is the membership function.

Equation of Line 1 : $3.086z - 0.688 = \mu$

Equation of Line 2 : $2.466 - 2.681z = \mu$

$$Z^* = \left(\int_{0.223}^{0.547} (3.086z - 0.688)z \, dz + \int_{0.547}^{0.92} (2.466 - 2.681z)z \, dz \right) / \left(\int_{0.223}^{0.547} (3.086z - 0.688) \, dz + \int_{0.547}^{0.92} (2.466 - 2.681z) \, dz \right)$$

$$Z^* = 0.562 \text{ (Software Usability)}$$

4 CONCLUSION

This paper has represented the software quality parameters using the fuzzy multi criteria approach. In the recent years, many usability models has been proposed .As the factors of usability are fuzzy in nature, a lot of definitions has been given which tend to overlap each other. In this paper, a detailed structure of usability model has been given for evaluating the software quality. This model describes the five factors given in the ISO 9126-1 namely, attractiveness, operability, understandability, learnability and usability compliance and a detailed sub-factors structure on which these factors depend. For the future, in the context of the usability model proposed above, the authors will evaluate the usability of software systems.

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