Global Journal of Computer Science and Technology
Software & Data Engineering
Volume 13 Issue 6 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Ipod System's Usability: An Application of the Fuzzy Logic

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GJCST-C Classification : H.2.m

IPOD SYSTEMS USABILITY AN APPLICATION OF THE FUZZY LOGIC

Strictly as per the compliance and regulations of:

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I. Introduction

Due to technological advances, the world is getting more and more dynamic and competitive. Making use of automated and more complex systems becomes indispensable in this scenario. Thus, more qualified professionals and more user-friendly systems are required.

This paper assessed the usability of the MP3 and MP4 IPod software. The metrics for the analyses are as follows: ease of use, efficiency, and effectiveness to accomplish their tasks and the satisfaction the system provides its user. The methodology can be used for assessing any other systems and equipment with the same results. With such results, an excellent basis is achieved that allows for possible changes and improvements in the desired system.

Initially, a review of the literature on the usability of the fuzzy logic is presented; after that, the methodology used in the research. Closing the article is a presentation of the results and conclusions.

II. Systems Usability

The usability of a system is a relevant factor to motivate the user (client) into maximization of fidelity. Nevertheless, if the system does not make the user an ally, the user will certainly search for another system (PRESSMAN, 1992). The system must provide its user with ease of interaction, in an effective, efficient and satisfying manner.

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Many techniques exist to assess the usability of systems such as those based on questionnaires assigned to the users; on formal models; knowledge-based ones; checklists; interaction essays; or monitoring systems (CYBIS, 2003). The Fuzzy logic has come to innovate these techniques.

III. The Fuzzy Logic

The first notions of the Fuzzy logic were developed by Jan Lukasiewicz (1878 – 1956) in 1920. Instead of using strict rules as well as line of logical thinking based on premises and conclusions, Lukasiewicz ascribes levels of pertinence {0, ½, 1} to classify vague and inaccurate concepts. Eventually, he expanded this set for all the values contained in the interval [0, 1]. However, the first publication on the Fuzzy logic dates back to 1965 by Lotfi Asker Zadeh, a professor of the University of California, Berkeley (CEZAR, MACHADO and OLIVEIRA JR., 2006).

The Fuzzy logic is based upon the theory of the Fuzzy Sets. This term is a generalization for the Traditional Sets theory to solve the paradoxes derived from the "true or false" classification of the Classical Logic. The Fuzzy Sets and the Fuzzy Logic provide the basis for generating powerful techniques towards problem-solving with broad applicability, especially in the fields of Control Engineering and decision-making.

The strength of the Fuzzy Logic stems from its ability to infer conclusions and generate answers based upon vague, ambiguous and qualitatively incomplete and inaccurate information. In this regard, the Fuzzy systems have the ability to 'think' like humans do. Its behavior is represented in very simple and natural way, leading to the construction of comprehensible and easy to maintain systems.

The Fuzzy Logic is based on the Fuzzy Sets theory. This is some generalization to the theory of Traditional Sets to solve the paradoxes arising from the "true or false" classification according to the Classical Logic. Traditionally, a logical proposition has two extremes, either "completely true" or "completely false". However, according to the Fuzzy Logic, a premise ranges in the level of truth from 0 to 1, thus causing it to be either partially true or partially false. By incorporating the "level of truth" concept, the Fuzzy Sets theory provides some expansion to the Traditional sets theory,

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whereby the groups are labeled qualitatively (by using such linguistic terms as: high, warm, active, small, near etc.) and the elements of these sets are so characterized by varying the level of pertinence (a value that indicates the level at which an element belongs to a set). For instance, temperatures between 30º (thirty degrees) and 40º (forty degrees) belong to the "high temperatures" set, although the 40º temperature has a greater level of pertinence in this set (OLIVEIRA JR. et al, 2007).

The level of association is not probability, but a measure of compatibility of the object with the concept represented by the Fuzzy Set. For example, number 0.7 is the compatibility of temperature 35º with the definition of the high temperatures Fuzzy Set. This figure (0.7) is not a probability of 35º being a high temperature, since this temperature is already defined as 35º (CEZAR, MACHADO and OLIVEIRA JR., 2006).

The conventional systems theory is based upon algebraic equations, either differential or difference ("crisp" mathematical models). For some types of systems, mathematical models can be obtained such as the electromechanical systems, since the laws of physics backing the process are well understood and defined. However, on a daily basis, we come across countless practical problems, and this makes it difficult to achieve a stable level of information required for the physics modeling to be accomplished. A great part of such systems can only be obtained through the knowledge of experts who directly take part in the process under analysis. Many times, such knowledge may be vague of inaccurate to be expressed by mathematical models.

IV. Methodology

This paper is based upon an applied research, since it aims at using a real case to support its analysis. The applied research is driven by the need to solve concrete problems with a practical purpose (VERGARA, 2000).

The system selected was the Ipod. The name IPod refers to a series of digital audio players designed and sold by Apple Inc. The players of the iPod family provide a simple, click wheel-based, interface for the use. The largest of the iPod models stores media in an attached hard drive, whereas the smaller models, like the iPod shuffle and the iPod Nano, use a flash memory. Like the majority of digital portable players, the iPod may act as a data storage device when connected to a computer.

Usability is one of the items considered in the standards established by the ISO (International Standardization Organization) related to quality. The ABNT (Brazilian Standards Association) is the official entity accountable for the discussion and publication of technical standards in Brazil. It is the ISO representative in Brazil.

However, the ISO standards do not include a set of criteria or metrics for assessing systems usability. For that reason, the metrics used in this study are those presented by Santos (2007), who established a set of metrics for assessing system usability on the basis of a review of the literature on Brazilian scientific bases between 1995 and 2006. These system usability metrics are based on the ISO 9126 and on the assessment criteria according to some authors such as Shackel, Nielsen, Bastien & Scapin, Jordan, Shneiderman and Quesenbery.

According to Santos (2007), the metrics considered for usability assessment as well as those used in this research are as follows:

- Ease of learning
- Ease of remembering
- Error control
- Efficiency
- Effectiveness
- Satisfaction

'Ease of learning', or intelligibility, according to the ISO 9126 (2003), is the capability of the software to enable the user to learn how to handle it.

Such metrics is being assessed according to the following constructs:

a) User's ease to accomplish a task for the first time;
b) The user's first impression upon using the system;
c) Number of attempts in order to learn how to accomplish a task;
d) Time required for learning how to accomplish a task successfully;
e) Interaction with the system's interface;
f) Accomplishment of tasks in the system regarding message clarity, error recovery etc.;
g) Ease of learning a task;
h) Number of different possibilities the system provides in order to accomplish the same task, for example: standard path versus shortcut keys, shorter paths, macros, specific buttons etc.;
i) Gain and productivity regarding the quickest way the user can accomplish a task in comparison with the standard way the system provides by default;
j) The flexibility the system provides to perform the tasks in different ways, for example: personalization of shortcuts, values, menus, macros etc.;

'Ease of remembering', according to Nielsen, assesses system functionalities so they are easy to remember even after the user does not use them for some time, without the need of new coaching.

Such metrics is being assessed according to the following constructs:

a) The capability of the system to guide through its execution with hints, help, notices etc.;
b) Briefness to successfully accomplish a task in the system for the first time;

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c) Remembering how to perform a task after a certain period of time without using the system.

'Error Control', or operability, according to the ISO 9126, is the capability the software has to enable the user to operate and control it.

Such metrics is being assessed according to the following constructs:

a) Ease of remembering the utilization of the system;
b) The agility to remember how to use the system after a period of time without using it;
c) The amount of errors caused by the system;
d) Time elapsed before the system resumes normal operation when an error occurs;
e) The feeling regarding the amount of errors caused by the system;
f) Re-work due to the amount of errors caused by the system, resulting in some loss of information;
g) The time spent to resume the execution of the task from the point where it was interrupted when an error occurs.

'Efficiency', also called operability, according to the ISO 9126, is the capability the software has to enable the user to operate and control it.

Such metrics is being assessed according to the following constructs:

a) Satisfaction regarding recovery from the error by the system, undo, redo, back, save before closing etc.;
b) System performance;
c) The velocity for accomplishing the tasks;
d) System productivity.

'Effectiveness', according to Quesenbery, assesses how the tasks were exactly accomplished and how often they produce errors.

Such metrics is being assessed according to the following constructs:

a) Keeping the system under control;
b) The amount of steps required to accomplish a task;
c) The time taken to accomplish any task in the system.

'Satisfaction', or attractiveness, according to the ISO 9126, is the capability the software has to attract the user, to be pleasant.

Such metrics is being assessed according to the following constructs:

a) The amount of steps required to accomplish a task in the system;
b) The clarity of the error messages presented by the system;
c) The user's feeling for using the system as a whole.

After collecting data and consolidating users' opinions, a Fuzzy methodology was applied in order to achieve a fuzzy triangular figure resulting from the frequency of users' opinions for the sets making up the constructs of the metrics being assessed.

The fuzzy triangular numbers are special fuzzy numbers with two very important features, namely: MODA and RANGE. The Moda represents the value of the fuzzy number the pertinence of which is equal to 1 (one). Range is half of the basis of the fuzzy number and represents the confidence interval for the number. Range is inverse to the confidence of the pertinence function: the lower the range, the higher the confidence on the data; the higher the range, the lower the confidence on the data (BRAGA, BARRETO & MACHADO, 1995).

The Likert scale was used to answer each question. This is a scale whereby the respondents are requested not only to agree with or disagree from the assertions, but also to inform their level of concordance or discordance (MATTAR, 1997). A five-point Likert scale was used for measuring usability: (Very Low^Very High).

V. RESULTS

The statistics for the opinions expressed in the questionnaire responded by the twenty-three users is presented below along with the description of the basic statistics followed by the resulting triangular fuzzy numbers for each metrics and the interpretation for them.

a) Statistical Description of the Sample

For the 'ease of learning' metric, Figure 1:

Considering that this system is used for teaching statistics for beginners, it can be observed that it is relatively easy for users to learn.

For the 'ease of remembering' metric, Figure 2:

By observing the table singly, users find no difficulty in remembering.

For the 'error control' metric, Figure 3:

Apparently, users are completely satisfied.

For the 'efficiency' metric, Figure 4:

Apparently, users are relatively satisfied.

For the 'effectiveness' metric, Figure 5:

Apparently, users are relatively satisfied.

For the 'satisfaction' metric, Figure 6:

Apparently, users are relatively satisfied.

b) Fuzzy Numbers

The calculations required for the fuzzy analysis of the results achieved with the metrics were made by using the MatLab mathematical software, which generated the results in graphical mode for each studied metric.

The graph presented for each metric represents two sets. The first set, depicted by a line with square markers, represents the fuzzy number (FN) for the mean of all frequencies found for the metric matters. The second set, depicted by a line with asterisk markers, represents the fuzzy number (FN) in the triangular shape that mostly resembles the first set, which is the final result for the assessed metric.

i. *Ease of Learning*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 1.

It can be observed that the average opinion is 4 (average satisfaction) with range 3, thus indicating an average dispersion in interviewees' opinions.

Result still undefined; sampling to be increased.

ii. *Ease of Remembering*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 2. It can be observed that the average opinion is 6 (good satisfaction) with range 4, thus indicating a high dispersion in interviewees' opinions.

It can be ascertained that the software is adequate regarding ease of remembering.

Even with this result, the sample has to be increased in order to reduce the range of the result.

iii. *Error Control*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 3.

It can be observed that the average opinion is 6 (high satisfaction) with range 3, thus indicating an average dispersion in interviewees' opinions.

It can be ascertained that the software is moderately adequate regarding error control.

Even with this result, the sample has to be increased in order to reduce the range of the result.

iv. *Efficiency*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 4. It can be observed that the average opinion is 4 (average satisfaction) with range 2, thus indicating a low dispersion in interviewees' opinions.

It can be ascertained that the software is moderately adequate regarding efficiency.

Even with this result, the sample has to be increased.

v. *Effectiveness*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 5.

It can be observed that the average opinion is 6 (high satisfaction) with range 3, thus indicating an average dispersion in interviewees' opinions.

It can be ascertained that the software is adequate regarding effectiveness.

Even with this result, the sample has to be increased in order to reduce dispersion.

vi. *Satisfaction*

The triangular fuzzy number achieved for measuring the ease of learning is presented in Graph 6.

It can be observed that the average opinion is 4 (average satisfaction) with range 3, thus indicating an average dispersion in interviewees' opinions.

It can be ascertained that the software is adequate regarding satisfaction.

Even with this result, the sample has to be increased in order to reduce the range of the result.

VI. Conclusions

The results achieved through this study aim at presenting a new criterion for assessing software usability. Depending on the system being analyzed, this result can be interpreted as customer retention, profit increase, production increase, employee satisfaction, amongst other benefits. In this case, the methodology was applied to MP3 and MP4 software on a sample of students; that is, the largest target public to the system. The software must be easy to learn and remember, it cannot cause errors and complete its tasks efficiently and effectively. All these factors imply the user's end satisfaction towards the product.

After analyzing the partial results of this research, the usability of the IPod was obtained as per below:

- Users showed an average ease of learning level on how to use the software;
- Users showed good ease to remember level on how to use the software when they do not use the system for some time;
- Users showed average satisfaction as to error control;
- Users found the software has average efficiency;
- Users found the software effectiveness was good;
- Users were satisfied with using the software.
- Assessment of these partial results shall be carried out through a collection of data from the internet for other users throughout the country.

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TABLES AND FIGURES

		Total Insatisfaction			Total Satisfaction		
		1	2	3	4	5	Total
1	User's ease to accomplish a task for the first time	0%	0%	30%	30%	39%	100%
2	The user's first impression upon using the system	0%	0%	9%	52%	39%	100%
3	Number of attempts in order to learn how to accomplish a task	0%	13%	17%	48%	22%	100%
4	Time required for learning how to accomplish a task successfully	0%	9%	17%	39%	35%	100%
7	Ease of learning a task	0%	0%	13%	61%	26%	100%
8	Options for different ways to accomplish the same task	17%	35%	30%	13%	4%	100%
9	Gain and productivity regarding the quick way in relation to the standard way provided	4%	22%	35%	39%	0%	100%
10	Flexibility to perform the tasks in different ways	0%	30%	35%	30%	4%	100%
11	The capability of the system to guide through its execution with hints, help, notices etc.	22%	26%	22%	26%	4%	100%
12	Briefness to successfully accomplish a task in the system for the first time	0%	0%	30%	43%	26%	100%

Figure 1 : Sample results for the 'ease of learning' metric

		Total Insatisfaction			Total Satisfaction		
		1	2	3	4	5	Total
13	Remembering how to perform a task after a certain period of time without using the system.	0%	0%	9%	35%	57%	100%
14	Ease of remembering the utilization of the system	0%	0%	4%	52%	43%	100%
15	Agility to remember how to use the system after a period of time without using it	0%	0%	4%	39%	57%	100%

Figure 1 : Sample results for the 'ease of remembering' metric

		Total Insatisfaction			Total Satisfaction		
		1	2	3	4	5	Total
16	The amount of errors caused by the system	0%	17%	22%	26%	35%	100%
17	Time elapsed before the system resumes normal operation when an error occurs	0%	4%	35%	35%	26%	100%
18	The feeling regarding the amount of errors caused by the system	0%	13%	17%	35%	35%	100%
19	The amount of errors caused by the system, resulting in some loss of information	0%	0%	13%	43%	43%	100%
20	The time spent to resume the execution of the task caused by the system	0%	17%	17%	48%	17%	100%
21	Satisfaction regarding recovery from the error by the system, undo, redo, back, save before closing etc.	0%	13%	26%	35%	26%	100%
29	The clarity of the error messages presented by the systems	4%	17%	26%	39%	13%	100%

Figure 2 : Sample results for the 'error control' metric

	Total Insatisfaction			Total Satisfaction		
	1	2	3	4	5	Total
22 System performance	0%	0%	13%	65%	22%	100%
23 The velocity for accomplishing the tasks	0%	0%	13%	61%	26%	100%
24 System productivity	0%	0%	13%	70%	17%	100%
25 Keeping the system under control	0%	9%	13%	52%	26%	100%

Figure 3 : Sample results for the 'efficiency' metric

	Total Insatisfaction			Total Satisfaction		
	1	2	3	4	5	Total
26 The amount of steps required to accomplish a task	0%	0%	13%	61%	26%	100%
27 The time taken to accomplish any task in the system	0%	0%	13%	70%	17%	100%
28 The amount of steps required to accomplish a task in the system	0%	9%	13%	52%	26%	100%

Figure 4 : Sample results for the 'effectiveness' metric

	Total Insatisfaction			Total Satisfaction		
	1	2	3	4	5	Total
5 Interaction with the system's interface	0%	0%	22%	48%	30%	100%
6 Accomplishment of tasks in the system regarding message clarity, error recovery etc.	0%	17%	39%	30%	13%	100%
30 The user's feeling for using the system as a whole	0%	0%	13%	52%	35%	100%