EVALUATION OF THE QUALITY OF THE INTERACTION BETWEEN USERS AND CUSTOM-MADE SOFTWARE PRODUCTS

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Abstract: In this work, we will develop a methodology based on the quality of the interaction between users and custom-made software products, aiming at the determination of the degree of users' satisfaction, that is, the usability. This approach is divided into four parts: First we will define the criterions to be used in the evaluation of the quality of software products. After these criterions have been chosen, an approach will be developed to classify them by their level of importance related to a selected area of application. The level of importance of a usability criterion will vary depending on the area of application. As a next step, a second approach will be introduced to classify usability criterions by the quality level presented by a certain software product utilized in a selected area. This classification is based on the users' opinion about the quality level a certain usability criterion related to the above software product would have. Finally a third and final approach will be set up to evaluate the usability of software products according to users' judgment. It combines the first method with the second method in such a way as to define a usability factor that will be used to evaluate the quality of the selected software product. This proposed methodology can be applied to a finished software product to evaluate its usability according to users' judgment, and can be also applied during the development of the product to ensure it will have the desired usability attributes. In a future work, we will show an application of this methodology in the evaluation of the usability of software products in Brazil.

1 INTRODUCTION

In the last years the approach of software development has been concentrated in the structural and functional features of the product. The man-machine interface is mainly centered in the performance of the product during its useful life. Quite often, in the development of a software product, the technological level presented by the product is given higher importance than the facility of its use. The immediate response to this situation is the complete dissatisfaction by the users with the software. In some cases, the software is simply abandoned by the customers. The man-machine interface, in the past neglected due to a higher emphasis in software development techniques, achieved major importance after the realization of the necessity to focus the information system in the user.

The software industry has recently shown an increased concern with the development of software methodologies that allow at the same time effective quality control of the product and the customers' satisfaction in using the product. Due to this fact, one of the most important characteristics associated with the quality presented by the software is related to the interaction between the user and the computer, the usability.

The usability can be comprehended as a major idea in the conception of the project, placing the user's needs as a main aspect of the project (Caldeira, 2000). The communication between the users and

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the system, the usability, is today regarded as important as the whole computation performed by the system. Evaluation techniques as well as usability tests should become important tools in helping the software development area to achieve a high degree of satisfaction among its users; thereby, coordinating the characteristics of the software with the users' requirement.

In this work, we will develop a methodology based on the quality of interaction between the users and the software products, developed under customer specifications, aiming at the determination of the degree of users' satisfaction, that is, the usability.

2 SOFTWARE QUALITY

The continuous improvement of the quality of products and services is at the moment the main driving focus in all the areas related to the human environment. It is highly desirable to receive and to offer products and services with high quality levels. In today's very competitive world, quality is the true differential, most of the time responsible for the long term success of a product or service. The development of high quality software is paramount for the majority of companies. The main issue to be achieved is to satisfy customers' requirements, which in some cases is not necessarily the same as the defined specifications; for that reason, in order to achieve a system with a high quality level, the first step to take is to assure that the specifications be defined according to the customer's needs (Da Silva, 2001).

During the 80's, the main objective of the software industry was to focus on the productivity increase of its products; the software quality was solely concerned with the observance of the specifications related to the product and the delivery of products on time with low costs; starting in the 90's, the emphasis related to the quality of the software was directed to characteristics such as reliability, efficiency, interaction with the users, the lack of defects, usability, etc. With the development of information technology, which is significantly helping in fulfill customer's requirements and allowing the development of a marketing-competitive information system, the importance of software products with high quality is essential to achievement of the customers' goals (Da Silva, 2001).

According to (Pressman, 1995), software quality means conformance of specified functional and performance characteristics with documented development standards and with implicit characteristics presented in all high level software.

The evaluation of the quality of software can be performed on two occasions: during the development of the software, the process phase, and after the finishing of the software, the product phase. At the process phase, the objective is to evaluate the development of the software, identifying features that could lead to problems related to the quality of the product and developing and utilizing mechanisms that could prevent such problems from occurring. At the product phase, the purpose is to evaluate the quality of the product with the intention of identifying its deficiencies and limitations related to its applicability as a final product.

According to (Fernandes , 2001), quality control is an important requirement, highly useful in the evaluation of the quality of software. This software quality evaluation is very important for the:

- Software producer: during the process phase, to ensure the high quality of the final product and to correct any possible problem before the product is released; during the product phase, to employ possible corrective and developing actions.
- Purchaser: to help in the selection of a product suitable to his requirements.
- User: to increase his confidence in the product he is utilizing.
- Seller: uses the quality of the product as a reason to sell.

2.1 Standard ISO/IEC 9126 and ISO/IEC 9126-1

The Standard ISO/IEC 9126 defines a group of characteristics that allow evaluating the quality of a software product. These characteristics were chosen in such a way as to insure, as much as possible, the lack of correlation among them. This standard was published in 1991 and in its section 1 is proposed a quality model for software.

The standard ISO/IEC 9126-1 allows the evaluation of the quality of a developed software product through the evaluation of a group of characteristics and sub-characteristics. This standard presents a group of six characteristics that should be present in any software product with high quality: It has to be functional, reliable, usable, efficient, moveable, and of easy maintenance.

2.2 Interaction Man – Computer

According to (Conçalves, 2001), "the interaction man-computer is the determining factor related to the strategy and accomplishment of a user doing his work. The use of products or information systems with poor quality related to the usability can be associated with reasons for low productivity levels and with financial failures linked to investments in the information area".

Users of computer programs evaluate the quality of a software product through the existing interaction between man and computer. It is not sufficient for a program to only display several advance functions, it is fundamental that the user be able to utilize them. To achieve that, a high degree of usability is mandatory.

It is important to realize that at the moment only a small number (around 30%) of Brazilian software corporations perform marketing research focusing on customer satisfaction (around 30%). These numbers are presented in Table 1.

Table 1: Frequency of marketing research focusing on customer satisfaction performed by Brazilian companies. Source: Quality and Productivity of Brazilian Software - 2001. (MCT/SEPIN, 2002)

Categories	**Companies**	
	Nº	**%**
All the time	130	29.5
Occasionally	173	39.2
Thinking about it	51	11.6
Utilize published data	11	2.5
Never	76	17.2
Total	**441**	**100**

3 USABILITY

The term "user friendly" was very popular in the 60's and 70's when computer manufacturers first started viewing users as more than a nuisance. This term was lately replaced by a most appropriate one, "usability". Efforts to come up with a clear and concise definition of usability have shown elusive results. The following definitions of usability show a noticeable similarity:

According to the International Organization for Standardization ISO – 9241-11, "Usability" is the extent to which a product can be used by specified users to achieve specified goals in a specified context of use with effectiveness, efficiency, and satisfaction. According to (Mayhew, 1999), usability is a measurable characteristic of a product-user interface that is present to a greater or lesser degree. According with (Nielsen, 1998), usability is the measure of the quality of the user experience when interacting with something – whether a Web site, a traditional software application, or many other devices the user can operate in some way or another.

There are several attributes which are associated with usability. The five of them traditionally associated with usability are:

Learnability: Probably the most fundamental usability attribute, indicating that the system must be easy to learn;

Efficiency of Use: Once it is learned by the user, a high level of productivity is possible to be achieved by the user.

Errors: The system should have a low user error rate. Users should make as few errors as possible and be able to easily recover from them. Catastrophic errors must not occur.

Memorability: The system should be easy to remember. Occasional users should be able to return to the system after a time and not have to learn it all over again.

Satisfaction: This attribute refers to how pleasant it is to use the system. The users should be satisfied when using the system.

As we can see in all these definitions of usability, the focus is on the user, not on the product.

Usability evaluation can be performed on any occasion in the development of a system: at the initial phase, it is useful in identifying parameters to be improved in the system; at the intermediate phase, it is useful to validate or improve the project; and at the final phase, it assures that the needs and goals of users are fulfilled by the system.

4 METHODOLOGY

The methodology proposed in this paper is related to the evaluation of the quality presented by custom-made software, based on the customers' satisfaction with the final product. This approach is divided into four parts:

a) Definition of the criterions to be used in the evaluation of the quality of software products. A total of 16 criterions will be employed by the user to evaluate the software product. These standards are the following: Online Help; Navigation, Easy to be Installed; Operation Errors Prevention; Auditability; Reuse of Input Data; Standardization; Messages; Documentation; Self-instruction; Glossary; Accuracy; Processing Time; Security; Data Recovery; Resistance to Errors.

b) Method used to classify the usability criterions by their level of importance. The purpose of this first method is to establish an approach to classify the usability criterions according to their level of importance related to a selected area of application. The level of importance of a usability criterion will vary depending on the area of application.

c) The second method has as an objective the development of an approach to classify usability criterions by the quality level presented by a certain software product utilized in a selected area. This classification is based on the users' opinion about the quality level a certain usability criterion related to the above software product would have.

d) The purpose of this third and final method is to establish an approach to evaluate the usability of software products according to users' judgment. It combines the first method with the second method in such a way as to define a usability factor that will be used to evaluate the quality of the selected software product.

4.1 Definition of the Usability Criterions

1. *Online Help*

– Online information has the potential for getting users the precise information they need faster than manuals or any other feature.

2. *Navigation*

– Is the facility to move from one screen to another screen.

3. *Easy to be Installed*

– Is the capacity of the software in interacting with the user during installation in a simple and easy way.

4. Operation Errors Prevention

– Is the capacity presented by the software in continuing working through errors made by the users. In addition to having a good error messages, the system should also provide good error recovery.

5. *Auditability*

– Is the capacity shown by the software in following the logic associated with the design of a system during its development and the reasons underlying any possible modification in the original design.

6. *Reuse of Input Data*

– Is the ability shown by the software in requiring the inputting of data only once during the software operation by the user.

7 *Standardization*

– This specifies how the exchange of information from the software to the users should appear. According to Nielsen, J. (1993a), one of the major objectives of standards is to have interface consistency.

8. *Messages*

– The messages should be simple and as objective as possible and easy to understand. Error messages should be linked to online help with further explanation of the error and possible solutions.

9. *Documentation*

– The ideal scenario would be to have a system so easy to use that no further documentation is needed to complement the user needs in operating the software. Since this goal cannot always be met, a model of documentation should be provided. This model should allow the user to easily locate the information related to a specific need, to understand the information and to carry out, without further trouble, a procedure as described in the documentation.

10. *Self-instruction*

– The system should allow for the user to easily learn with demonstrative lessons.

11. *Glossary*

– Provision by the software of a glossary with an explanation of each of the important terms relating to a user's application and translation of those terms into whatever language the user specifies.

12. *Accuracy*

– Is the precision presented by software products in developing their tasks.

13. *Processing Time*

–Is the time a software product takes to complete a specified task. It is also the number of tasks of various kinds that can be completed by a software program within a give time limit.

14. Security

– Is the capacity presented by the software in avoiding non-authorized users access to the system and in displaying error messages in cases where the use of certain options is restricted.

15. *Data Recovery*

– Is the capacity presented by the software in not loosing all or part of the existing data in the occurrence of errors.

16. *Resistance to Non-catastrophic Errors*

– The system should provide enough information to allow non-catastrophic-errors to be corrected easily by the user and have no effect other than to slow down to some extent the user's transaction rate.

4.2 An Approach for Classifying Usability Criterions by their Priority Level

Generally, not all usability criterions can be given equal weight in a given design project. So, it is necessary to formulate the priorities on the basis of the analysis of the users and their everyday jobs. For example, messages would be especially important for engineering's software, and standardization would be of great importance for software to be used in library work. This approach has two objectives:

- To classify usability criterions according to their priorities in relation to selected areas;
- To show that the priority of the criterions vary according to the selected area.

In order to verify the existence of priority variation shown by usability criterions in relation to different areas of application, a questionnaire or survey form is used. This questionnaire is based on the users' opinion about the priority a certain criterion will have in their areas of interest.

The employed questionnaire contains all the 16 usability criterions defined in Section 4.1, evaluated by selected users according to the following options: (1) High Importance (HI); (2) Average Importance (AI), (3) Low Importance (LI); (4) Without Importance (WI). Weights were initially associated with each level of importance, as presented in Table 2 below:

Table 2: Weights Associated with Each Level of Importance

Option Number	Weigh of option i (Wh_i)	% of the answers obtained by option i
(1) High Importance (HI)	6	
(2) Average Importance (AI)	4	
(3) Low Importance (LI)	2	
(4) Without Importance (WI)	0	
Total	—	100%

After the evaluation of the 16 criterions by the users, the level of importance that each one of these 16 criterions has, according to each one of the selected areas, is calculated. Equation (1) shows the calculations for each one of the 16 criterions:

$$LI_{j,k} = \sum_{i=1}^{4} Wh_i \times PA_{i,j,k} \qquad (1)$$

$LI_{j,k}$ – Level of Importance of criterion number *j* in relation to selected area *k*.

Wh_i – Weight of option number *i*.

$PA_{i,j,k}$ – Percentage of the answers obtained by option number *i* in the evaluation of criterion number *j* in relation to selected area *k*.

For each one of the selected areas, the final level of importance of criterion *j* will be classified according to the interval levels (weight) presented in Table 3.

Table 3: Interval Levels (weight) used in the classification of each one of the 16 usability criterions by their priority levels

Classification	Interval Levels (weight)
High Importance (HI)	6.0 ├── 4.5
Average Importance (AI)	4.5 ├── 3.0
Low Importance (LI)	3.0 ├── 1.5
Without Importance (WI)	1.5 ├──┤ 0.0

For example, suppose that criterion number 2, navigation, evaluated in relation to the civil engineering area, presented a final weight of 4.2; then, according to Table 3, it will be classified as having average importance to the civil engineering area.

4.3 An Approach for Classifying Usability Criterions by the Quality Level Presented by a Chosen Software Product

This approach has the objective of classifying usability criterions by the quality level presented by a certain software product utilized in a selected area. This classification is based on the users' opinion about the quality level a certain usability criterion related to the above software product would have.

The employed questionnaire for this evaluation also contains all the 16 usability criterions defined in Section 4.1, evaluated by selected users according to the following evaluation options: (1) Very Good (VG); (2) Good (G); (3) Average (AV); (4) Poor (P); (5) Very Poor (VP); and (6) Non-existent (NE).

Weights were associated with each one of the above listed evaluation options, as presented in Table 4 below.

Table 4: Weights Associated with Each Evaluation Options

Option Number	Weight of Option i (Wh_i)	% of the answers obtained by option i
(1) Very Good (VG)	10	
(2) Good (G)	8	
(3) Average (AV)	6	
(4) Poor (P)	4	
(5) Very Poor (VP)	2	
(6) Non-existent (NE)	0	
Total	—	100%

After the evaluation of the 16 criterions by the users, the quality level that each one of these 16 criterions has, according to the analyzed software product related to a selected area is calculated. Equation (2) shows the calculations for each one of the 16 criterions.

$$QL_{j,k} = \sum_{i=1}^{6} Wh_i \times PA_{i,j} \qquad (2)$$

$QL_{j,k}$ – Level of Importance of criterion number *j* based on the quality level presented by the software product under analysis. The software product is related to a selected area k.

Wh_i – Weight of option number *i*.

$PA_{i,j}$ – Percentage of the answers obtained by option number *i* in the evaluation of criterion number *j*.

For the software product being analyzed from selected area *k*, the final level of importance of criterion *j* will be classified according to the interval levels (weight) presented in Table 5.

Table 5: Interval Levels (weight) used in the classification of each one of the 16 usability criterions based on the quality level presented by the software product under analysis

Classification	Interval Levels (weight)	
Very Good (VG)	10.0	—— 8.0
Good (G)	8.0	—— 6.0
Average (AV)	6.0	—— 4.0
Poor (P)	4.0	—— 2.0
Very Poor (VP)	2.0	—— 0.0
Non-existent (NE)	0	

4.4 An Approach for Classifying the Quality of Software Products by the Users' Satisfaction

This approach has the objective of classifying the usability level of a software product according to users' satisfaction. It combines both approaches presented in sections 4.2 and 4.3 in the determination of a usability level, which will be used to classify a software product by its interaction with its users.

Equation (3) shows the calculations utilized in determining the usability level of software products.

$$U = \sum_{j=1}^{16} \left(LI_{j,k} \times QL_{j,k} \right) \Big/ SLI_k \qquad (3)$$

Here, $$SLI_k = \sum_{l=1}^{16} LI_{j,k}$$

U – Usability level of the analyzed product.

$LI_{j,k}$ – Level of Importance of criterion number *j* in relation to selected area *k*.

$QL_{j,k}$ – Level of Importance of criterion number *j* based on the quality level presented by the software product under analysis. The software product is related to a selected area k.

SLI_k = Sum of the Levels of Importance of all 16 criterions in relation to selected area *k*.

The analyzed software product from a selected area *k* will be finally classified according to its usability value obtained from equation (3). Table 6 gives the final classification obtained by the analyzed software product based on its usability level.

Table 6 – Final Product Classification based on its Usability Levels

Usability Levels	Products Classification
$0.0 \le U \le 2.5$	Poor Usability
$2.5 < U \le 5.0$	Average Usability
$5.0 < U \le 7.5$	Good Usability
$7.5 < U \le 10.0$	Excellent Usability

5 CONCLUSION

The methodology proposed in this paper is related to the evaluation of the quality presented by custom-made software, based on the customers' satisfaction with the final product. This method was divided into four parts:

First we defined the 16 criterions to be used in the evaluation of the quality of software products. After these criterions had been chosen, an approach was used to classify them by their levels of importance related to a selected area of application. The level of importance of a usability criterion will vary depending on the area of application. As a next step, an approach was developed to classify usability criterions by the quality level presented by a certain software product utilized in a selected area. This classification is based on the users' opinion about the quality level a certain usability criterion related to the above software product would have. Finally an approach was established to evaluate the usability of software products according to users' judgment. It combines the first method with the second method in such a way as to define a usability factor that will be used to evaluate the quality of the selected software product. This proposed methodology can be applied to a finished software product to evaluate its usability according to users' judgment, and can be also applied during the development of the product to ensure it will have the desired usability attributes.

In a future work, we will show an application of this methodology in the evaluation of the usability of software products in Brazil.

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