PROPOSAL FOR AUTOMATING THE GENERATION PROCESS OF QUESTIONNAIRES TO MEASURE THE SATISFACTION LEVEL OF SOFTWARE USERS

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Keywords: Software quality, software metrics, software users' satisfaction, quality dimension.

Abstract: The most recent concepts on software quality take into account the factors of product quality, process quality and the satisfaction level of users. Therefore, when putting forth a plan for improving a software product, special attention should be paid as to incorporate the level of users' satisfaction into the development premises. On this latter respect, well-designed surveys have proven to be a valuable tool to obtain and measure satisfaction variables. The survey-based strategies, however, present a drawback on the fact that the tasks involved in questionnaire generation are difficult to automate, which renders the entire approach almost impracticable. This work presents a proposal for automating the various stages defined in questionnaire generation, with the aim at making the measurement method be both applicable and more practical.

1 INTRODUCTION

The low quality level of business software products is a known fact both in the software industry and in the scientific community. *"Unreliable products –in general- quickly vanish from the market. Unfortunately, software products are not touched by this ideal condition"* (Ghezzi,1991). During the nineties "*...computers and software were ranked eighth and tenth among the products receiving the highest number of user complains"* (Kaner, 1998).

In the software industry, the costs related to the solution of problems caused by low quality products are significant. Several authors have presented research works on the measurement of software quality, though focused mainly on product quality and without taking into account the satisfaction of software users as a main parameter in quality measurement.

There are two viewpoints as regards software quality: one which is intrinsic to the product and often limited to the defects ratio of the product, and another wider and more recent viewpoint involving product quality, process quality and user's satisfaction. *"product quality, process quality and user's satisfaction make up the entire meaning of quality"* (Kan, 1995). Regrettably, *"software user's satisfaction has fallen to untold levels in the last ten years"* (Kaner, 1998).

In order to analyze and improve the satisfaction of software users, a measurement mechanism should be established. *"There is no way of improving whichever cannot be measured"* (De Marco, 1982). Well-designed surveys on software user's satisfaction may turn to be an appropriate way to obtain valuable data for the software industry. Through statistical techniques, such questionnaires can render information on less-satisfied quality attributes or, conversely, on those attributes considered more important by the users. With such information, the software developers may apply re-engineering techniques to the development processes, with the aim at improving the quality of the final product.

The measurement of software users' satisfaction has already been incorporated on most standards and norms on software quality, namely: IEEE, CMMi, ISO9001:2000, which emphasize the measurement of satisfaction levels of clients and final users. Therefore, those involved in software development should establish a process to obtain, monitor and publish the information on users' satisfaction, as a basic feature released by any software system to allow improving the process. All the proposals

Paparo M., Zapata S. and Inés Lund M. (2004).
PROPOSAL FOR AUTOMATING THE GENERATION PROCESS OF QUESTIONNAIRES TO MEASURE THE SATISFACTION LEVEL OF SOFTWARE USERS.
In *Proceedings of the Sixth International Conference on Enterprise Information Systems*, pages 113-118
DOI: 10.5220/0002642901130118

presented so far employ surveys to gather information on users' satisfaction levels.

Lund and Zapata (Lund, 2000) have proposed a technique for software users' satisfaction levels based on Bob Hayes' methodology on clients' satisfaction (Hayes, 1992). This technique follows the guidelines suggested by IEEE, though by adding some new concepts arisen in this disciplinary area - measurement technique guided by user, statistically reliable questionnaires -. Although these proposals have proven useful at the time of identifying users' satisfaction, all of them show a common drawback (Lund, 2001), (Lund, 2001b), (Lund, 2002): the process requires a great deal of non-automated, manual work to generate the questionnaire, which renders these methods almost impracticable.

On such a sense, this work presents a proposal for automating the various stages established to generate statistically reliable questionnaires, as a helping tool for the software developers to gather information on software users' opinions. The automation of this process shall considerably increase the applicability of the above measurement techniques.

It is expected that by applying this measurement technique for users' satisfaction will render the following benefits for software developers and the industry as well:

- Software developers will be able to measure the satisfaction level of their products form the users' viewpoint, because the questionnaire generated by the proposed application is brought about from the very suggestions of the users.
- Based on the results obtained, software developers will be able to improve such aspects of their software whose satisfaction expectancies are not fulfilled; they will be able to improve both the process and the product, thus encouraging a continuous improvement process.
- In general, the software industry will count with updated information on the state-of-the-art as regards users' satisfaction, and the quality attributes considered in the various software products.
- Software users will have better chances for acquiring products that may satisfy their expectancies, because –in general- the satisfaction needs are more frequently linked to satisfying the functional requirements of the application, and to the user's culture in general, rather than meeting the particular need of the users.

The following section presents briefly the measurement methodology used in this work. Section 3 describes the proposal for automatic generation of reliable questionnaires, whereas Section 4 shows the main capabilities of the proposed tool. Finally, Section 5 presents the conclusions and comments on future work.

2 MEASUREMENT METHODOLOGY

With the aim at measuring the software users' satisfaction, the method proposed by Lund and Zapata (Lund, 2000) will be used to generate a reliable questionnaire. This method is based on a phases process, as shown in Figure 1.

In the first phase, the needs and requirements of the users are determined. These are also called the quality dimensions or quality attributes of the software product under scrutiny. The relevant aspect are that these quality attributes are obtained straightforwardly from the user's response, i.e., his expectancies and desires for product quality. Hence, the method relies on the hypothesis that the user is the one in the best condition to state which are his own needs and requirements. Therefore, the user is involved throughout the entire measuring process.

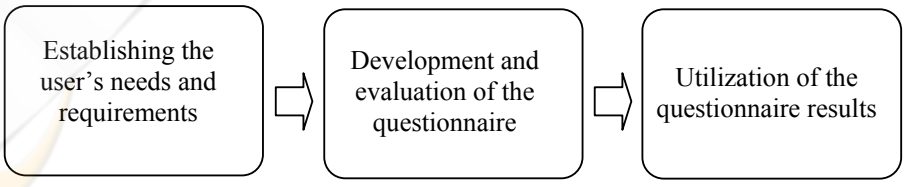

Figure 1. General process of the method for measuring users' satisfaction levels

For this initial phase, the critical incident technique is used (Flanagan, 1954), which has been widely employed in determining quality dimensions. Take account that these dimensions will be different for each software kind.

In the second phase of the proposed method, the users' satisfaction questionnaire is designed. The factors to account for in this design are the number of items or questions to include, the format for the responses, the way questions are posed, and other factors. These questions or inquiry items are selected according to the quality dimensions detected in the first phase.

This phase should warrant as well that the resulting questionnaire be trustworthy; i.e., that it reliable will measure whichever factor is desired to be gauged, an that these pondering will not be thwarted by casual errors and flaws. From the various methods available for measuring the reliability of questionnaires, the present work will rely on the formula known as Cronbach's Alpha (Cronbach, 1951), which allows to measure the reliability by using the correlation or covariance matrix of all inquiry items or questions of the questionnaire (Lund, 2001). In order to define this matrix, a preliminary questionnaire is given to software users; these preliminary data shall render an initial panorama that may lead to a definite outline of the final questionnaire, and improve its reliability range as well. If this reliability level is over 80%, it may be judged an appropriate measuring tool and, as such, trustworthy to be used in the survey of definite data on users' satisfaction for the software under evaluation.

The third and last phase involves the statistical computations of the questionnaire-collected data, aiming at attaining indexes that reflect the satisfaction levels of users as well as to knowing which quality dimensions are more satisfied; which ones are the most important factors for the client, and the like. The justification of the proposed method is met by the correct attainment of these metrics. They will allow the developer make the right decisions on the software product itself or on the development process applied. The following are some relevant indexes that can be obtained:

- More satisfied quality attributes, as per application type.
- More satisfied quality attributes, as per application type.
- Application with the highest satisfaction index, as per application type.
- Application with the lowest satisfaction index, as per application type.
- Type of application with the highest satisfaction index.
- Type of application with the lowest satisfaction index.
- Quality dimensions with higher influence on the satisfaction level, as per application type.
- Quality dimensions with lower influence on the satisfaction level, as per application type.
- Time-evolution of each index above.

Users' satisfaction is an important constitutive aspect of software quality. The measurement of the satisfaction level allows to attain not only the user's opinion, but also the indirect measurement of the quality attributes of the product, such as: reliability, performance, documenting, and the like. The results of questionnaire inquires upon users' opinions show the satisfaction level for each quality attribute for the evaluated product (Hayes, 1992) (Lund, 2000).This information is useful for re-defining the development process, as regards those aspects impinging more heavily upon non-satisfied quality attributes. This way, the survey approach turns to be a tool for decision-making on the process, and which allows as well to set forth a continuous re-engineering of both the product and process.

Each application type of business software (Laudon, 2000) calls for a tailored-type user's questionnaire. This individual approach is important to obtain a greater specificity both in user's responses and from the analysis from the inquiry results. The survey process is a delicate, expensive and difficult-to-replicate task, which demands an ensured reliability of all its measurement instruments and components.

3 PROPOSAL FOR AUTOMATIC GENERATION OF RELIABLE QUESTIONNAIRES

This proposal does not intend to cover the entire systematization of the measurement process, but only the stages linked to the design and concretion of the questionnaire, namely the first and second phases of the process of Figure 1. This is so because a former application —SUSE: Software User Satisfaction Evaluator— that systematizes the third phase has already been developed (Lund, 2002). SUSE is in the testing phase, and it integrates the parts of questionnaire responses, their processing, and the presentation of results or indexes. Therefore, the proposal presented here is a complement of the former application with which the entire method is thus completed.

The current proposal is intended to help in satisfying the expectancies of developers around the

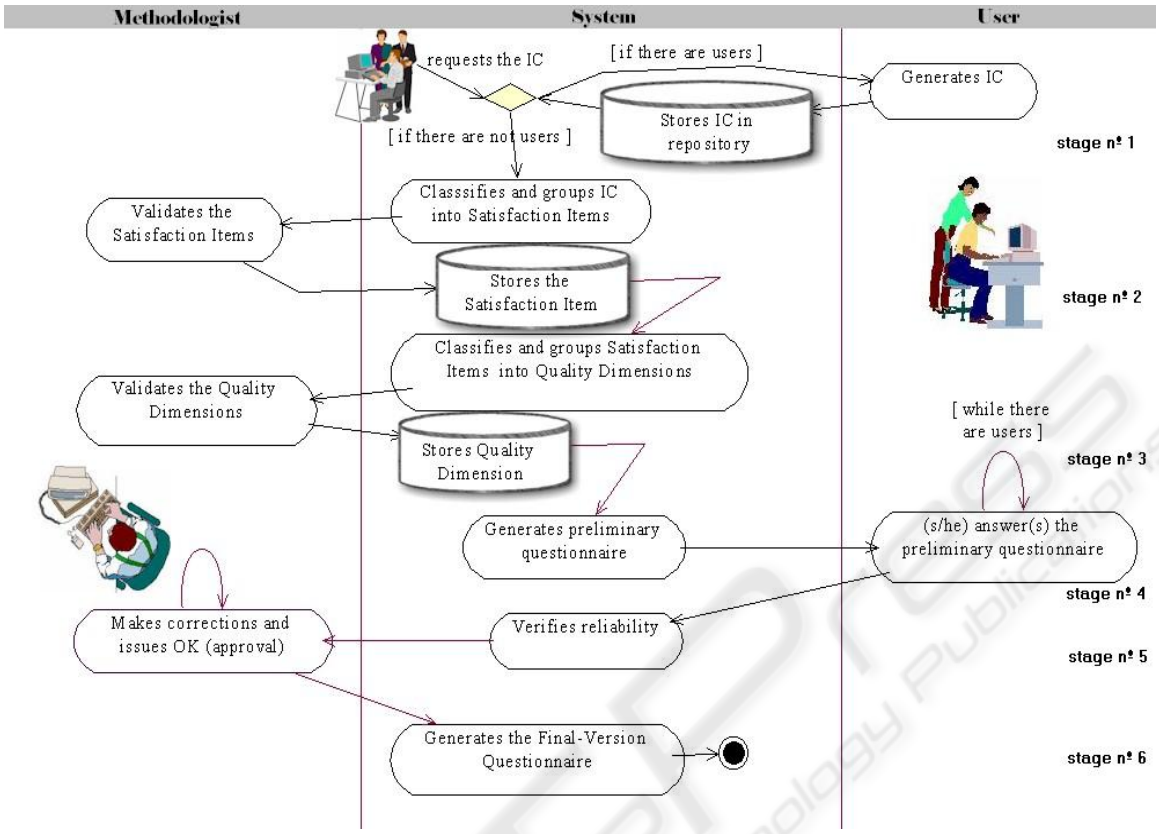

Figure 2: Questionnaire Generation Process

world. Therefore, the web is the most proper technology for measuring software users' satisfaction levels from their own workplaces, wherever they may be at, and thus compile the most diverse and complete information to this respect, with the additional possibility of relating the information from both users and developers throughout the world.

3.1 Automatic process for questionnaire generation

The process is divided into six stages, each of which entails one part of the total questionnaire generation process. The stages can be automated, manual or combined; see Figure 2.

- "Generation of Critical Incidents" performed through a web form to be completed by the real users who have had a sizable number of interactions with the software product. It will be requested to enter 5 to 10 positive incidents and 5 to 10 negative ones. These will be stored in the system's repository.
- "Generation of Satisfaction Items": by recovering the critical incidents from the repository inquiry, the system will classify and sort them automatically according to the similarities in the responses. The methodologist will then validate these satisfaction items thus generated, which will be stored in the repository.
- "Generation of Quality Dimensions": by recovering the satisfaction items, the system will process and will sort them automatically into quality dimensions. Then, the methodologist will validate the process and will store the attained quality dimensions.
- "Generation of the preliminary questionnaire": in this stage, several activities are carried out, such as the "generation of questions", that arise from the satisfaction items, and are written with an neutral tone; the "generation of the questionnaire introduction"; and, finally, "the development of the preliminary questionnaire" itself, which is made up of an introductory descriptive text, and of the attained dimensions and items. This questionnaire is e-mailed to some users, whose responses are latter stored. These tasks are assisted by a graphical software

–which is a component part of the system- that gives support to the methodologist in building up the preliminary questionnaire. It allows as well –via web interface- to store and post-process the results of the preliminary questionnaire.

- "Verification of the results of the preliminary questionnaire": this stages entails performing automatically the computations for the reliability analysis of the questionnaire. Upon such results, the methodologist will decide on the items to remain incorporated for each dimension, i.e., the statistically reliable items.
- "Generation of the final questionnaire": after sorting out those items deemed unnecessary to measure the quality level, or to change the dimension items, the final questionnaire will be generated automatically, i.e., the final product of the process presented herein.

The software developer wishing to measure the satisfaction level reached by its product will need, first, to register himself as such into the web application, and to register the product to be evaluated. Then, the developer will have to determine the reliable questionnaire the he will use in inquiring the users. He will have two options for determining this questionnaire: (a) to choose one from the pre-defined questionnaire library that the application will show; or (b) to generate a new questionnaire by suing the proposal presented herein. The new questionnaire thus generated will also be incorporated into the library of predefined questionnaires. Such library questionnaires will be classified according to application type.

Once the definite questionnaire has been determined, the web application will automatically enable the inquiry module for the users, and will the results form such inquire (questionnaire responses). Once the deadline for answering and sending the questionnaire had expired, the satisfaction indexes will be calculated and published.

4 SUSE (SOFTWARE USER SATISFACTION EVALUATOR)

The users' satisfaction measuring tool linked to the proposal herein stated is currently undergoing the testing stage. Figure 3 depicts the outline of SUSE .

SUSE is a web-based tool integrated by two frames. The left frame shows the various options that describe its functionality. The right frame is used to unfold the information and to interact with the user. Figure 3 shows the information on the private indexes associated to a software system called "Claims System". The processed information corresponds to a time segment, and the attained indexes are: functionality, technical support, ease of use, ease to learn, and on-line assistance.

Through the indexes generated by the tool, the user' satisfaction level of the chosen item can be displayed, as well as the importance level that is given to such an item. The result form combining all these values will render the information to decide upon the quality dimensions that should be priory improved.

SUSE interface of Figure 3 also feature the option "Create a new questionnaire" that displays the guideless to let the software users enter the Critical Incidents. These are then analyzed and processed according to the present proposal, finally reaching at the desired questionnaire.

5 CONCLUSIONS AND FUTURE WORK

The current work progresses toward the objective of automating the entire measurement process on software users' satisfaction. To reach such an aim is crucial for an effective application of these questionnaire-based measurement techniques. The main contribution of the present work lies on he clear definition and relations stated for the various stages composing the automatic generation process of a reliable questionnaire.

The attainment of a reliable, practical, technologically up-datable, and with world-wide application capability as that offered by the extension of the application SUSE to measure users' satisfaction levels, may turn to be a valuable asset for the quality improvement of general-type and business software, as well as for the continuing improvement of software development processes.

Although software applications to measure users satisfaction based on surveys exists, does not ensure the statistical reliability of questionnaires. In addition, the questionnaires are not generated from the perspective of the user, as proposed by this work.

A drawback to overcome is the resistance of developers to expose their products to evaluation. On this account, the developer should be given full privacy warranty, and absolute discretion on the attained results, despite the fact that such results will be included in the global computation son quality levels. Effort should be put as well on encouraging

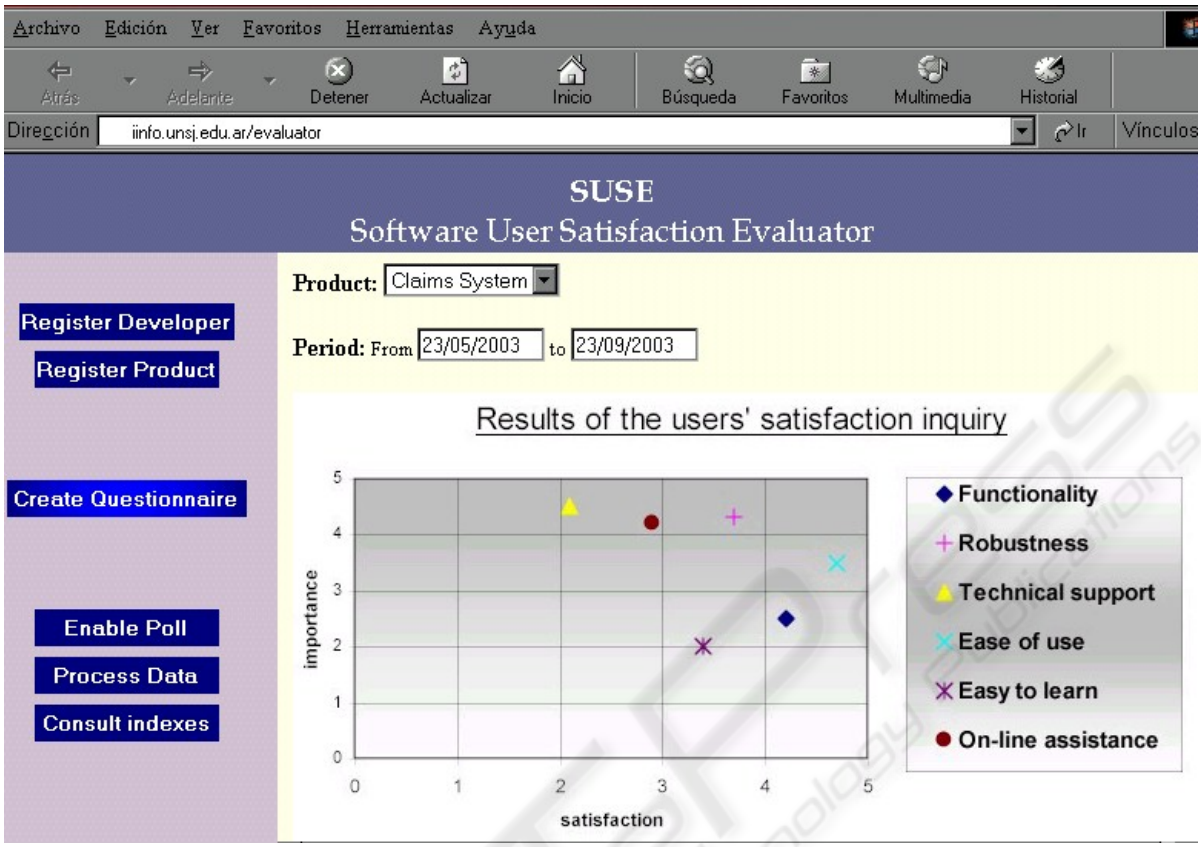

Figure 3: Interface of SUSE

the users to accept and respond the questionnaires on the various software products under scrutiny.

At present, the proposed application is in its advanced design stage, with a definite completion scheduled for year's end. The current work is included within the project "Improvement in the quality level of the software development process used in local organizations", undertaken and funded by the Institute of Informatics, National University of San Juan, Argentina.

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