The Utilization Of Metrics Usability To Evaluate The Software Quality

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Abstract—**This article discusses about metrics that could be used in the field of software testing. The standard ISO/IEC 9126 was analysed. There is need for change of the design of academic information system at the Faculty of Materials and Science in Trnava as the current one is obsolete. Knowledge about usability metrics has been used for purpose of the proposed new design. By preparing the new application design and testing before being put into service have been saved considerable financial resources that can be invested in further development of the system.**

Quality of software; metrics; usability metrics

I. SOFTWARE QUALITY ASSURANCE

The set of standards ISO/IEC 9126 deals with the software products quality. The standards deal particularly with characteristics of quality and metrics. The standard establishes an internal, external and metrics in use for assessing of software quality.

A. Quality model

Quality model is the set of characteristics and the relationships between them which provide the basis for specifying quality requirements and evaluating quality. [1]

Quality is the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs. [1]

Attribute is a measurable physical or abstract property of an entity. [1]

Metric is the defined measurement method and the measurement scale. [1]

Internal quality is the totality of characteristics of the software product from an internal view. Internal quality is measured and evaluated against the internal quality requirements. Details of software product quality can be improved during code implementation, reviewing and testing, but the fundamental nature of the software product quality represented by internal quality remains unchanged unless redesigned. [1]

External quality is the totality of characteristics of the software product from an external view. It is the quality when the software is executed, which is typically measured and evaluated while testing in a simulated environment with simulated data using external metrics. During testing, most faults should be discovered and eliminated. However, some faults may still remain after testing. As it is difficult to correct the software architecture or other fundamental design aspects of the software, the fundamental design usually remains unchanged throughout testing. [1]

B. Internal metrics

Metrics is derived from the product itself, whether direct or indirect, is not derived from metrics of system behavior, which is a part. [1]

Applications of the internal metrics are measured by specific parameters of internal software product-measurable parameters associated with the internal organization and design the entire software product. This approach is also known as the "White Box" and it is very difficult for implementation. Internal metrics can be obtained during the implementation phases of software product development, respectively from the software documentation. [2]

Internal metrics serves to internal attributes of the software product acquisition. Internal metrics are used for measuring and examining the internal structure and design software product before it becomes executable. Internal metrics can be used in the specification or the source code of the proposed software product during the design stage or coding.

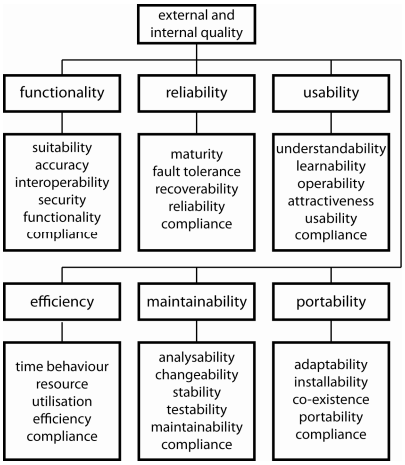

Figure 1. Quality model for external and internal quality [1]

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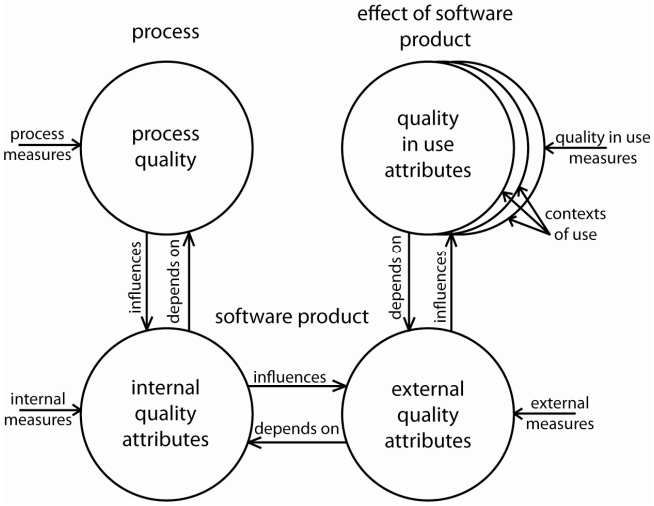

Figure 2. Quality in the lifecycle [1]

C. External metrics

External metric is the indirect metric product derived from rates of system behavior, which includes. [1]

Applications of external metrics are measured externally visible, concrete and measurable attributes of software product. This approach is known as "Black Box" - usually a measurement (testing) the specific characteristics of software product, regardless of the internal structure and architecture of software product. [2]

The external metric is used to capture the external attributes of software product. External metrics are using measurements of software products derived from measurements of the system behavior, which is the software element. External metrics are carried out through testing, implementation and monitoring of this system or software. External metric monitors the software to operate as "executable" system without knowledge of its internal structure.

ISO/IEC 9126 divides software attributes into six primary characteristics. Features are divided into subcharacteristics. This article explains usability metrics in more detail.

Metrics from ISO/IEC 9126 are divided into 6 characteristics.

Functionality: The capability of the software product to provide functions which meet stated and implied needs when the software is used under specified conditions.

Reliability: The capability of the software product to maintain a specified level of performance when used under specified conditions

Usability: The capability of the software product to be understood learned, used and attractive to the user, when used under specified conditions.

Efficiency: The capability of the software product to provide appropriate performance, relative to the amount of resources used, under stated conditions.

Maintainability: The capability of the software product to be modified. Modifications may include corrections, improvements or adaptation of the software to changes in environment, and in requirements and functional specifications.

Portability: The capability of the software product to be transferred from one environment to another.

D. Usability metrics

Usability metrics measure the extent to which the software can be understood, learned, and operated, attractive and compliant with usability regulations and guidelines.

Many external usability metrics are tested by users attempting to use a function. The results will be influenced by the capabilities of the users and the host system characteristics. This does not invalidate the measurements, since the evaluated software is run under explicitly specified conditions by a sample of users who are representative of an identified user group. For reliable results a sample of at least eight users is necessary, although useful information can be obtained from smaller groups. Users should carry out the test without any hints or external assistance.

Metrics for understandability, learnability and operability have two types of method of application: user test or test of the product in use. [1]

- Understandability metrics
- Learnability metrics
- Operability metrics
- Attractiveness metrics
- Usability compliance metrics

Each metric should include at least the following information:

- Metric name
- Purpose of the metrics
- Method of application
- Measurement, formula and data element computations
- Interpretation of measured value
- Metric scale type
- Measure type
- Input to measurement
- ISO/IEC 12207 SLCP Reference
- Target audience

E. How to measure usability

Usability methods are often conducted to discover problems in the use of a system, preferably before it is released for use by the user. These qualitative studies often generate better insight but usability metrics are more useful to track metric goals. [3]

1) Effectiveness

- Percent of tasks completed
- Ratio of successes to failures
- Workload
- Number of features or commands used

TABLE I. MEASURED TIMES IN SECONDS FOR 5 USERS, 5 TASKS AND 2 DESIGNS. (PART 1)

	T_1D_1	T_1D_2	T_2D_1	T_2D_2	T_3D_1	T_3D_2
U1	62	52	126	113	365	317
U2	75	50	154	132	425	386
U3	45	42	114	110	345	302
U4	38	35	107	105	338	298
U5	67	61	131	125	413	400
Tavg	***57,4***	***48***	***126,4***	***117***	***377***	***341***

TABLE II. MEASURED TIMES IN SECONDS FOR 5 USERS, 5 TASKS AND 2 DESIGNS. (PART 2)

T_4D_1	T_4D_2	T_5D_1	T_5D_2	Tcd1	Tcd2
39	42	214	161	***806***	***685***
54	68	224	175	***932***	***811***
34	45	207	172	***745***	***671***
42	43	200	149	***725***	***630***
62	65	256	183	***929***	***834***
46,2	***52,6***	***220***	***168***	***827***	***726,2***

II. USABILITY METRICS APPLICATION AT CHANGING THE DESIGN OF APPLICATION

The academic information system (AIS) is in use at the Faculty of Materials Science and Technology.

It is used by all interested persons - pedagogues, researchers, students and other staff. AIS is an application running in the web environment. However the system does not meet the demands placed on modern and functional design. The current system falls behind in the areas of design control, usability and accessibility.

The proposal for a new design has been created that uses modern technology and latest knowledge in the field of applications design, virtual laboratory implementation and the development of large information systems. [4]

Before putting into operation, it is necessary to measure the usability of the new system using properly designed metrics. There are described the basic methods of measuring and assessing of the system usability in this article.

The primary purpose is to identify "performance of users" using the set of test. There are 5 tasks. Tasks are variously difficult. According to available information and past experience, were chosen 5 users who will perform various tasks on both AIS designs. These are users who have never worked even with one system.

A. Description of the tasks

- Task 1: Send an email from the AIS to the specified mail address.
- Task 2: Print the learning schedule and print the teachers learning schedule for the selected year and semester.
- Task 3: Comprehensive examination reports filling to be carried out at the end of the semester.
- Task 4: Print evaluation of the success of individual subjects for the semester.
- Task 5: Find the phrases in the help of AIS.
- Task 6: Change personal settings of the application – appearance adaptation, turning on selected portlets.

B. Measurement method

It was measured the time of each user, needed to perform of specific tasks. The resulting times are shown in Table 1. Part of Table 1 is the calculated average task completion time and overall time of completion of the tasks by individual users.

$$\bar{x} = \frac{x_1 n_1 + x_2 n_2 + \ldots + x_k n_k}{n} = \frac{1}{n}\sum_{i=1}^{n} x_i n_i$$

$$Z = 1 - \frac{T_{U_1 D_2}}{T_{U_1 D_1}} \cdot 100,$$

where T_1D_1 means 1st task in 1st design,

T_c = total time of individual tasks completion of individual users,

T_{avg} = average time for task completion

In order to objectively appreciate the appropriateness of the deployment of new applications design, it is necessary to calculate the average improvement/deterioration in the various tasks for specific designs. Values are in Table 2.

TABLE III. MEASURED AVERAGE TIMES IN SECONDS FOR 2 DESIGNS AND CALCULATED IMPROVEMENT IN %.

	D_1	D_2	Z
T_1	57,4	48	***16,38%***
T_2	126	117	***7,44%***
T_3	377	340,6	***9,70%***
T_4	46,2	52,6	***-13,85%***
T_5	220	168	***23,71%***

III. CONCLUSION

By testing of AIS usability, we have achieved verification of the suitability and urgency implementation of new design software that will meet the demands of the modern system.

It was found that the updated design is not sufficient and it is necessary to redesign some problematic components. The biggest disappointment is the printing of evaluation, where was even an aggravation. At the beginning was set the target to accelerate the work with the system to 15%, but this limit achieved only 2 types of tasks.

The verification through testing was achieved significant financial savings, as identified gaps can be introduced even before the system into operation. Using information from users of the system and using other metrics, we found that it is possible to create a design with the required parameters.

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