Evaluation Metrics for a Test of Software Reliability

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Abstract. International standard for software quality evaluation, ISO/IEC 9126 defines the quality characteristics and sub-characteristics consisting of quality of the software. Also, in this standard, the quality assessment items are presented in metrics based on maturity, fault tolerance, recoverability and compliance which are sub-characteristics of reliability. However, this reliability assessment items which are presented are not applied now due to the mathematical difficulties and the problems caused by collection of data. In order to resolve these problems, this study introduces measures to develop a improved evaluation metrics of reliability quality characteristic and to measure the quality. This improves problems that include reliability assessment item of ISO/IEC 9126 as the measures to measure new reliability quality of software.

Keywords: Software Reliability, ISO/IEC9126, Quality Characteristics

1 Introduction

To ensure the reliability, one of the software quality characteristics, a way to test the effective measurement of quality is required. First, we have to classify different types and domains of software and determine which of the quality characteristics has to be ensured with a top priority per each class. Second, information on specific strategy techniques and test activity guidelines in order to verify certain quality attributes are needed. This paper mainly focuses on the aforementioned 'quality characteristics-verification technique'. The reliability quality characteristics in particular were studied among various characteristics that determine the quality of software. Specific quality assurance measures based on the international standards for software quality evaluation, ISO/IEC 9126 were referenced for the study[1]. However, when these standards were looked at closely, actual performance is time consuming and labor intensive activities of low importance such that there are many areas that require tailoring in the cases of time and resource shortage[2]. Furthermore, important implementation guide in actual application is weak. To improve these problems, this paper proposes two suggestions. First suggestion is an improved measuring method of reliability characteristic quality assessment module among the quality characteristics of software. Second suggestion is to provide the practical guidelines for developers or test experts at the software development sites, in consideration of the importance of software reliability quality characteristics and the feasibility of test activities.

2 Related Research

ISO/IEC 9126 provides instructions on software quality characteristics and measurements, and the configurations of the model are as follows:

Part	Configurations
Part 1	Quality Model
Part 2	External Metrics
Part 3	Internal Metrics
Part 4	Quality in use Metrics

Table 1. ISO/IEC 9126 Model

Quality Characteristic	Sub-characteristic
Functional	Suitability, accuracy, interoperability, security. Compliance
Reliability	Maturity, fault tolerance, recoverability, compliance
Usability	Understandability, learning castle. Interoperability, preferences, compliance
Efficiency	Time responsiveness, resource efficiency, compliance
Maintainability	Analysis, deformability, stability, testability, compliance
Portability	Application, installation, gender, co-existence, substitutability, compliance

Table 2. ISO/IEC 9126 Software Quality Model

As shown in table 1, quality models consist of concepts of external quality and internal quality. The external quality refers to the extent of requirement satisfaction when a product is used under the specific conditions. The internal quality refers to the quality of product design and actual code in order to fulfill the requirements under the specified conditions. The software quality characteristics of ISO/IEC9126 can be classified into six categories as in table 2. Each categories, then further subdivided into sub-characteristics to form detailed metrics (evaluation items) accordingly[5].

3 Improved the software quality measurement modules

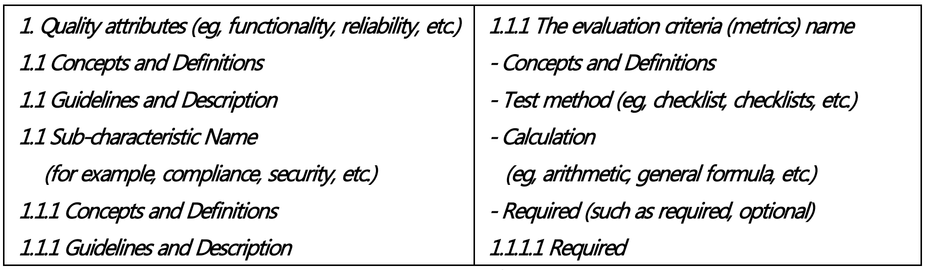
In previous section 'Related Research', specific quality evaluation and its models by NIPA[3] and TTA[4] in accordance with the software quality characteristics defined by ISO/IEC 9126 have been analyzed. A simple and practical quality measurement module will be proposed by this paper. It will contain only the essential information with advantageous features of three models mentioned above.

Improvement summaries on the basis of the related research are as follows:

First, make weight assignments and required/optional choices available for the quality characteristics and sub characteristics as seen in the documents by the NIPA.

Because each classified software has quality characteristics of different importance and needs tailoring according to the available resources of each project.

Second, increase the utilization by creating a compressed table similar to the quality evaluation table of evaluation module by TTA. In order to do that, unnecessary elements such as complex mathematical functions have to be eliminated and main check points of evaluation items and related computations should be summarized in simple formats. Third, provide actually useful information in carrying out the test. The 'technique' section of TTA is necessary in testing but has rather weak contents such that the test methods should be reinforced. If document review is necessary, then the particular document should be known. Therefore, a specific document to check each evaluation items should be clearly indicated by providing a list of outputs from an well organized references of test methods and main check points generally incorporated in software development projects. Last, integrate them in the form of an evaluation tool and provide necessary items, functions and formulas for the tool. To evaluate, not only the absolute result (number between 0 and 1, or Yes/No) but the target quality has to be specified to be able to determine whether the product passes quality evaluation or not. Figure 1 below shows the generalized structure of the improved reliability quality characteristic quality evaluation module proposed by this study.



1. Quality attributes (eg, functionality, reliability, etc.)	*1.1.1 The evaluation criteria (metrics) name*
1.1 Concepts and Definitions	*- Concepts and Definitions*
1.1 Guidelines and Description	*- Test method (eg, checklist, checklists, etc.)*
1.1 Sub-characteristic Name	*- Calculation*
(for example, compliance, security, etc.)	*(eg, arithmetic, general formula, etc.)*
1.1.1 Concepts and Definitions	*- Required (such as required, optional)*
1.1.1 Guidelines and Description	*1.1.1.1 Required*

Fig 1. Improved Quality Evaluation Module for Reliability Quality Characteristic

4 Experiments and Evaluations

There have been slight difficulties in applying the improved reliability measurement module proposed by the paper to the actual project. First of all, it took considerable amount of time to collect and derive the resulting data since each project generally took three to five months. There also were many constraints to test the same project once with the proposed module and another time with the other measurement tools which should have been applied under the exactly same conditions. Therefore, tests were conducted under the condition of developing business unit programs with relatively small MM commitment, LOC with medium or less difficulties, and moderate level FP. This module is verified by application to the actual project. Quantified test results with or without the improved module were analyzed to determine how differently the reliability has appeared in each case.

Sub-characteristic	NIPA	TTA	Proposed Algorithm
Maturity	90.6	97.69	99.42
Error tolerance	97.7	91.04	97.17
Resilient	96.19	96.4	95.35
Compliance	99.93	95.1	99.03
Problem diagnosis / resolution	98.4	92.64	93.05
Incidence of defects	91.2	98.17	92.18
Prevention of erroneous operation	90.82	93	98.66
Recoverability	91.8	91.53	98.41
Average	94.58	94.45	96.66

Table 3. Adaptation Result of Improved Reliability Evaluation Module

5 Conclusion

The proposed reliability quality measurement module in the paper is in accordance with the quality model of ISO/IEC 9126. Both tools of NIPA and TTA are also in accordance of the same model, however, we would like to demonstrate the superiority of the proposed tool. Two modules presented in the related research have been applied to the actual project in identical conditions and the results were compared quantitatively. Specific guidelines are proposed in this paper to be utilized by summarizing the developmental life-cycle-specific test activities and techniques most generally used. It is a new reliability quality measurement method. It improved the problems involved with the reliability evaluation items of ISO/IEC 9126 and provides an environment in which the reliability of project or source code of high quality is easily attained compared to existing methods or tools. It also does not depend on any specific development methodology or model, but could be applied in general purpose to any program developments or projects through the tailoring or required/optional choices.

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