

A Review of Quality Models for Evaluating Quality in Open Source Software

^{1*} Harvinder Chauhan, ² Dr. Anita Ganpati, ³ Dr. Hardeep Singh

¹ Research Scholar, HPU, Shimla,

² Associate Professor, Dept. of computer Science, HPU, Shimla

³ Professor, Dept. of computer Science, GNDU, Amritsar

Available online at: www.ijcseonline.org

ABSTRACT- Open source software (OSS) projects are available in various application domains in a large number. It is difficult to choose any product/project. Quality is a big concern while choosing a software among many of the same type. To measure the quality there are many quality models around us since long. More specifically, from 2003, there has been many quality models available in OSS. But how good these quality models are, remains the question of concern. This research is intended to provide an insight in existing quality models and provide the strength & weakness of these models, thus to provide the OSS community a best suitable quality model. In this paper, the researchers have reviewed the available literature on some conventional quality models and some selective OSS quality models, and carried out a comparative study on these models. In first generation models, open source maturity model embraces the maximum quality characteristics. We concluded that Qual-OSS quality model in second generation is close to international standard organization (ISO) 25010 quality standard. The second generation models offer more tools to support the quality evaluation by considering the community characteristic of OSS.

Keywords: OSS, OSMM, ISO, Qual-OSS, Qualipso, OpenBRR, QSOS, QualOSS, CMM, OSSD

I. INTRODUCTION

The open source software is around us since long. Today, OSS are available in various application domains in a large number. Though, the quality of OSS is known to be high, but it is quite difficult to standardize the available software's quality with respect to the available quality models. Many quality models like McCall, Dromey, Boehm and ISO/IEC 9126 were already be present, long before the emergence of open source quality models [1]. There were many unique attributes who belonged to OSS, which were not included by any of these models. Community characteristics of OSS is one difference, which is a group of developers and users of OSS [2]. In this paper the researchers have listed and briefly analyzed some of the software quality models. In this study the quality models are divided into three categories. The first category includes the conventional software quality models. The second category contains the first generation of OSS quality models. The third category embrace the second generation of quality models along with ISO 25010 standard. The description of these models is also provided with. The objective of this paper is to study the existing conventional quality models and open source quality models and to come out with the best possible combinations of quality attributes, specifically in OSS. This study is proposed to assist those who want to use any of these models and also to put down a groundwork for promoting enhancement and improvement in these models.

This paper is structured as follows, in the rest part of the paper: Section 2 analyses the related works. Section 3 portrays the research method. Section 4 briefly describes

and evaluates the available OSS quality models by classifying them into three categories namely: conventional software quality models, first and second generation OSS quality models, ISO 25010 standard and a concise explanation of each is also endowed with. In Section 5, a comparative study is performed between all the existing quality models. The discussion on the comparison is also provided with. Section 6 gives the conclusion the paper and mentions future work.

II. RELATED WORKS

There are many quality models framed by the researchers, since the inception of OSS development. According to K. Haaland et al. [2], to improve the Open source software development (OSSD) process and hence to improve the OSS quality, sustained efforts are carried out by the researchers. However, the work done in the direction of improvement of OSSD process and OSS quality is very less and a lot of effort need to be done so as to come up with more standardized quality models that can be used to certify a high quality of OSS.

In a comparative study carried out by A. Adewumi et al. [3], they evaluated eight OSS quality models on the basis of their characteristics features. They also made some recommendations to overcome the limitations wherever required.

The research work carried out by J.P. Miguel et al. [1], was comprehensively elaborated. The researchers selected many quality models under which OSS quality models were part of this study. They carried out this study to figure out the strengths and weaknesses of these

models. The selected quality models were classified into two types. The ISO/IEC 25010 quality model comes under basic quality model. The other type in this category was tailored quality model. The Comparative analysis between the other basic quality models and ISO/IEC 25010 models showed that the ISO model was more inclusive in terms of the number of quality characteristics that it supported. They suggested that it may serve as a standard. The second category, i.e., tailored quality models included the OSS quality models. However, no comparison was made between the basic quality model (ISO 25010) and other OSS quality models.

Won Jun Sung et.al.,[20], in their study formulated a quality model abstracted from four main & ten sub characteristics of quality. The model formulated, provided a criteria for measuring quality in order to select OSS.

In another study carried out by Ruediger Glott et.al[21], identified some differences among the first and second generation quality models. They investigated that the first generation models were having few metrics and were based on some manual work as perceived by the researchers /users while second generation models were based on tools and large number of metrics.

A review on open source quality and how to achieve quality in OSS by Mark Aberdour [22], asserted that community is the key factor to achieve high quality in OSS projects. Code modularity and Rapid release cycle can add to achieve high quality in OSS. The two quality characteristics may be included in quality models for assessing the quality of OSS.

III. RESEARCH METHODOLOGY

The study, reviewed and identified from literature that when and how the first open source software came into sight. The researchers further investigated the various conventional software quality models like McCall's quality model and ISO 9126. The researchers studied twenty related publications. This study classifies the software quality models in three categories. The researchers selected two of the conventional software quality models, four first generation, three second generation OSS quality models and ISO 25010 as standard. The researchers examined the quality characteristics of these models and then, compared them with the help of a table. The description of models reviewed is in the sections that follows.

IV. EVALUATION OF CONVENTIONAL / OPEN SOURCE SOFTWARE QUALITY MODELS

The existing OSS quality models were classified into three categories

A. Conventional software quality models.

The term quality can be defined with various viewpoints. Garvin [6],[7], has suggested numerous views of quality. Among them, the most noteworthy were: (i) User's view : Developing the software as per the user's requirements. The quality attributes like performance, reliability, usability and maintainability are the main concerns. (ii) Manufacturing view : Developing the software as per specifications and develop it according to best processes. Thus the good quality of product can be achieved by selecting the right processes to manufacture/develop it. (iii) Product view : It focuses on developing the software with desired quality characteristics. To achieve a good quality of software many approaches are carried out. There are two major approaches: Quality management and Quality model. The first approach of quality management is more flexible and presents qualitative view on quality, the second approach represents a more stiff and quantitative eminence structure view[8]. Many trends of quality models exist. One trend among them emphasizes on processes or capability levels here, quality is measured in terms of capability level. The research by McCall et.al [9], focuses on one more view of quality models. They selected a set of attributes/metrics used to uniquely review quality by making quality a quantifiable perception. These include the McCall model [9], the Boehm model [10], [11], and the ISO 9126 product quality standard [12], where ISO 9126 is based on Boehm's and McCalls model's. The numerous quality models that exist today, are derived from ISO 9126 quality model [1],[3]. The ISO 9126 quality model was proposed in 1991 to standardized quality practices in software development. The structure of ISO 9126 is by large, similar to previous models, McCall and Boehm, though there are some major differences like the functionality, functional & non functional requirement characteristics[4]. As in figure 1, the ISO 9126 software quality model recognizes six main quality characteristics namely: Functionality, usability, reliability, efficiency, portability & maintainability. These six quality characteristics are further divided into Twenty seven sub categories. ISO 9126 quality model is quite suitable to be used in quality evaluation of e-learning since it is extensively used in the software engineering population and has been personalized to different domains and contexts and is easy to use and understand by its users [19].

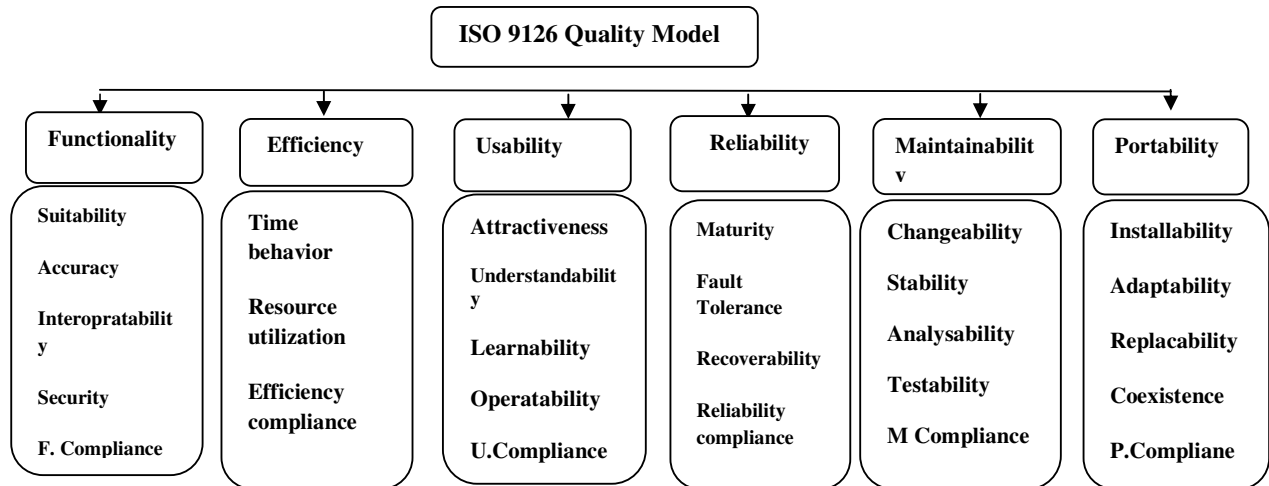


Figure 1 : Categories and subcategories of the ISO 9126 quality model

The ISO 9126 quality model gives the three views of quality namely : internal, external and quality in use. These three viewpoints gives emphasis on fixed measures of intermediate product quality, the behavior of the code at the time of execution and software product quality.

B. First Generation OSS quality models

As per the study, the conventional quality models have not included various important aspects which are very much important to OSS. The description of some of the important OSS quality models is as follows i) Capgemini OSS maturity model Comprises of product and application pointers. This model Can be renewed regularly through responses from customers .It was under a non- free user license[16].

ii) OSSM Navica was offered under an academic license [16].

iii) Qualification and Selection of Open Source software (QSOS) model, framed by ATOS .It was provided under the GNU Free Documentation License[16].

iv) Open Business Readiness Rating, OpenBRR, is available under non-commercial –share A like license[16]. A comparative analysis between OSMM Capgemini, OpenBRR, and QSOS models are conducted by [13]. There are many similarities between OpenBRR and OSMM Navica models , but the OpenBRR model appears more perspective. These models are founded upon the manual work, supported by assessment forms.

Till 2010,there were many OSS quality models but none of them had a wide acceptance even though QSOS was showing a little growth in popularity[14]. The OSMM Capgemini model was not much popular among the open source community. For the OSMM Navica model ,their were many problems like the web resources were no longer available and the OpenBRR community

composed of an discarded web site which is frequently engaged. OpenBRR assessment model is quite significant explore it further, even though there are certain limitations in it ,like lack of community [15]. The companies like FreeCode used this model highlights OpenBRR's role.

C. Second Generation OSS quality models

i) QualiPSO-OMM[16] :The main purpose to devise open source maturity model (OSMM) is to aid in building faith in expansion processes of companies using or producing OSS products. The certification for quality was not easy to acquire for Open Source Software produced by globally stretched out individuals or virtual teams who often functions without a good infrastructure and / or proper tool environment.. As it is a simple model but organized as an evolutionary model having three levels viz ,basic, intermediate and advanced, OMM can also be useful for companies .

ii) QualOSS [17]: The QualOSS model was designed with a focus to provide robustness and evolvability to the OSS. The main function was to provide the quality evaluation of OSS projects. The characteristics related to the product quality include: reliability, maintainability, transferability, operability, performance, functional suitability, security and compatibility. The community related characteristics were also included in QualOSS they are: maintenance capacity, sustainability & process maturity.

iii) SQO-OSS[18]: SQO-OSS, stands for Software Quality Observatory for Open source software. The SQO-OSS model was developed with a main focus to provide an automated tool support. This model provides sustained quality tracking system and automated metrics collection that ensures that judgments are made with relatively current data.

This model takes source code as main element to

determine the quality of the software .This model also considers open source community. Thus, this model considers those factors which are based on community. Hence, The model evaluates quality in product and community perspective. The product quality and community quality have three sub characteristics each. They

are: maintainability ,reliability ,security and mailing list quality, documentation quality, developer base quality respectively.

D. ISO 25010

The ISO 9126 model replaced with ISO 25010 model in 2010 which was further modified in 2011[7]

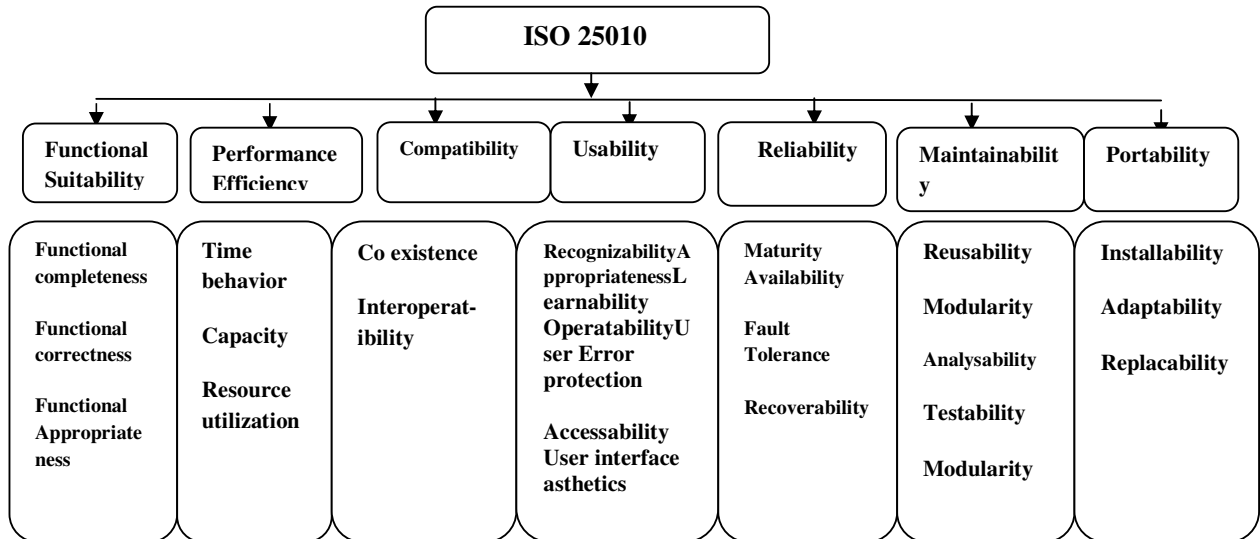


Figure 2 : Categories and subcategories of the ISO 25010 quality model

The major extension in ISO 25010 with respect to ISO 9126 is the inclusion of computer system and quality in use as per system point of view [6].In ISO 25010 product quality factors have been added combining internal and external quality factors that was in ISO 9126 quality model. Instead of six characteristics as in ISO 9126 ,eight characteristics are provide in ISO 25010 model. Usability, compatibility and security

characteristics has been introduced in ISO 25010.As Shown in figure 2,Security characteristic added in this model has five sub categories namely: confidentiality, integrity non-repudiation, accountability and authenticity. Till today a research effort continues to provide an OSS quality model which is suitable for these kind of software

V. COMPARATIVE STUDY AND DISCUSSION OF OSS QUALITY MODELS

In the table 1, the quality characteristics of software are taken which are then compared with each quality model[3].

Characteristic	McCall	ISO 9126	Cap-Gemini OSMM	Navica OSMM	Open-BRR	QSoS	QualiPso OSMM	Qual-OSS	SQO OSS	ISO 25010
Accuracy		Y								Y
Adaptability										Y
Analyzability		Y								Y
Attractiveness		Y								Y
Changeability		Y								Y
Correctness	Y									Y
Efficiency	Y	Y	Y	Y	Y			Y	Y	Y
Flexibility	Y									
Functionality		Y						Y		Y
Human Engg.										
Installability		Y								Y
Integrity	Y									Y

Interoperability	Y		Y	Y				Y		Y
Maintainability	Y	Y	Y	Y	Y	Y		Y	Y	Y
Maturity		Y								Y
Modifiability								Y	Y	Y
Operability		Y	Y		Y		Y			Y
Performance		Y	Y	Y				Y		Y
Portability	Y	Y								Y
Reliability	Y	Y	Y			Y	Y	Y	Y	Y
Resource utilization		Y								Y
Reusability	Y									Y
Security			Y		Y		Y	Y	Y	Y
Stability		Y						Y		Y
Suitability		Y	Y	Y				Y	Y	Y
Supportability		Y	Y	Y						Y
Testability	Y	Y								Y
Transferability			Y	Y						Y
Understandability		Y								Y
Usability	Y	Y	Y	Y	Y					Y

Table 1. Comparison of quality models On the basis of their characteristics

Y –signifies the presence of quality characteristic in the model.

After reviewing the literature, we identified that there are 30 characteristics which are important for open source software quality. The key points of these quality models is as follows : The second generation models offer more tools to support the quality evaluation .The Qual-OSS quality model in second generation is close to ISO 25010 quality standard. From the table it can be observed that the efficiency characteristic is common in all the models except QSoS and QualiPso models. The human engineering characteristic is missing in all the quality models. The maintainability characteristic is common among all generation models .Resource utilization characteristic is missing in all models except ISO 9126 & ISO 25010 quality models. Another point to note is that, the reliability characteristic is present in all second generation models, but missing in first generation models with exception to ISO 9126. Usability characteristic is considered in conventional software quality models under this study and in ISO 9126 & ISO 25010 models. The McCALL's quality model includes 11 quality characteristics while ISO 9126 includes 20 characteristics in conventional software quality models category . In first generation models OSMM model embraces the maximum quality characteristics.

In all the OSS quality models, the quality is evaluated by considering the OSS community .However in ISO standards there is no provision for this. As observed, better tool support is provided in second generation models. It considers three key perspectives of OSS quality likewise, the product, its community and community's view about it.

VI. CONCLUSION AND FUTURE WORK

This paper presents a Comparative analysis of ten existing quality software quality models in which two are conventional models, seven are OSS quality models and one ISO/IEC standard quality model. The motivation stemmed from the review of the literature. In order to carry out the detailed study, the existing quality models were compared with each other including ISO 9126 and ISO 25010 standards. The study revealed that the second generation models provide better tool support in comparison to first generation OSS quality models. This comparative study revealed that OSMM was the most comprehensive model in the first generation category as it covers major quality characteristics. ISO 9126 is a standard that covers maximum characteristics for evaluation of software quality. The conclusion from the study therefore is that, the CapGemini OSMM model from first generation of OSS quality models can be upgraded ,while QUAL-OSS model from second generation may be further modified for better quality evaluation as per the ISO 25010 Standard. The ISO 25010 Model remains the industrial standard as it covers maximum quality characteristics.

The Future work may be taken up with comparing more existing quality models and quality characteristics emerging in OSSD. Further real world open source software/products may be taken up for study by comparing and evaluating them with various OSS quality models.

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