An Insight of Software Quality Models Applied in Predicting Software Quality Attributes: A Comparative Analysis

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Abstract

Software is crucial in giving a competitive edge to most of the organizations. Software has become main part of business products, systems and services. Software products quality was seen as a significant element in success of business. The purpose of the research is to the existing models related to software quality which is used for predicting the quality attributes in the software. SQM models selected for this study to compare are ISO 9126, Bertoa, ISO 25010, CBQM and Alvaro model. Main characteristics selected are portability, maintainability, flexibility, usability, reliability and efficiency and sub characteristics are accuracy, testability, extendibility, compatibility, understandability and performance. This study adopts secondary source of data. It was noticed that for the selected set of quality attributes characteristics, Alvaro model excel well in main characteristics as well as other sub characteristics namely understandability, accuracy and testability

Keywords: Software quality models (SQM), software quality, ISO 9126 model, Alvaro model, Bertoa model, ISO 25010 model, CBQM model

I. INTRODUCTION

Quality of software (QoS) is a procedure of constructing the stable relationships in order to assess and satisfy the requirements of user. Characteristics of software such as reusability, portability, maintainability, usability, reliability and efficiency are the collected properties that software involves in order to maintain the level of quality in the software [1]. Quality is referred as the totality of characteristics and features of service or product which bears its potential to fulfil implied or stated requirements [2] [3]. For any system of software has to meet these criteria like specification related to function what which system has to perform; specification related to quality that is how well the system functions would run and specification related to resource that is how much time it would taken [4].

Deploying quality in any product related to software is a formal attempt made to be managed throughout lifecycle of software engineering and component oriented software [5]. Quality implementation has to start with user specification of quality needs. Such approach of deploying quality leads to QoS engineering. At the same time, such discipline is referred as the application of systematic, quantifiable, continuous and disciplined approach to the maintenance and development of QoS systems and products that is QoS engineering application [6]. Attribute of quality is the software system property. Requirement of software is a need which is placed by stakeholder with specific reference to software system. Attribute of quality is all about how system runs once it deployed [7]. During architecture development, it is necessary to validate and update architecture since it has needed attributes of quality which would be performed using one or more evaluation in architecture [8].

Quality models give the fundamental for evaluating the software and provide better characteristics insight that dominates the QoS by mentioning a constant terminology for QoS and by giving support for its measurement [9]. For extending the adoption of quality model in particular domain then it must be expanded to involve the specifications of that domain [10]. QoS is a significant characteristic that affect overall development of system lifecycle cost, useful life and performance. Maximizing demands from place of market for high focus on QoS products are promising for revolutionizing good software engineering practice [11].

QoS could be classified from 3 dimensions such as characteristics of quality, QoS requirements and quality model. Characteristic of quality is the category in the attributes of QoS that bears on QoS. Requirements of qualities are about what client requires in the software namely security needs, user interface or performance [12]. Model of quality is how characteristic of quality are similar to each other and to end quality of the product. Gauging the QoS would verify if needs of the user are satisfied and decide the quality degree [13].

A. Problem Identified

Software engineering is complicated activity in problem solving with quality purpose. Quality of software product was main issue in every technology or domain and quality evaluation and specification during process of developing software is of critical significance for acquiring high quality in the software. QoS could be gauged by using characteristics of QoS [14]. QoS plays a significant role in the overall system of software success. Therefore it is viewed as a very prominent aspect for project managers, developers and users. QoS involve set of desirable factors or features are included into a product for enhancing its performance through lifetime [15]. There are numerous models in the software quality which predicts the QoS. Therefore this research intends to concentrate on
comparing the existing models in the software quality which is used for predicting the software quality attributes. This study considers these SQM namely ISO 25010, CBQM, ISO 9126, Bertoa and Alvaro model.

B. Aim

To compare the existing models related to software quality which is used for predicting the quality attributes in the software.

C. Objectives

i. To compare the existing models in the software quality in terms of various quality attributes in the software

ii. To identify the quality attributes in CBS

iii. To determine the best and suitable software quality model among the selected characteristics for predicting the quality attributes.

D. Limitations of the Research

i. This research is restricted to CBS alone

ii. Findings of the research is limited to existing models related to software quality namely ISO 9126, ISO 25010, CBQM, Bertoa and Alvaro model

iii. This particular research adopts secondary sources of data

II. Literature Survey

Wagner et al [16] carried out a broad web survey to examine the significance of models related to quality with specific reference to software industry. Purpose of this research was to determine the major classes in the SQM that are adopted in the software industry. It was noticed that 87 per cent of the participants have adopted quality models to fulfill their needs. It was also identified that users might have for two reasons either prior SQM were not sufficient to be adopted as or adaptations is not avoidable in order to perform needed task by adopting quality models. At the same time, it was noticed that ISO 9126 SQM were not well adopted and accepted by most of the respondents. It was observed that company-related models for quality were predominantly used and adopted as quality models, it was noticed the existing ISO standards were insufficient to satisfy the practice requirements. Significance of attributes of quality is dependent on context. A high difference was seen in significance ratings of attributes in the quality that is, it differs based on needs of software systems and environments vary strongly. It was recommended that quality models must have a high capability for enhancements. At the same time, enhancements could be also be given particularly to high ratings numbers in the following areas namely quantifying quality, defining criteria for evaluation and transparent quality definition. It was suggested that support of such tasks must give a high priority in order to further enhance the quality models in the future. Next to that, attributes of quality that must be given high priority for further enhancements such as maintainability, safety, reliability, operability, performance and security. Thus it was concluded that company-related models for quality were predominantly used and adopted as quality models.

Arun Sharma, Rajesh Kumar and P.S. Grover [17] studied and surveyed several quality models for CBS and non-CBS systems and found that not all the characteristics are required while developing a quality system, as per the requirement of the user, we need to select only those characteristics and sub characteristics to it, which are of prime importance to it. These characteristics changes as per the requirement of the system output and are not universal in nature.

According to study conducted by Tomar and Thakare [18] systematically studied the SQM (Software Quality Models). Investigator had forecasted quality by developing models using various methodology, approach, techniques and algorithm. Investigator have evaluated model with the help of experiment, case study, opinions, experts and survey. This study determines approximately 70 research papers related to software quality from journals and categories researchers as per topic of research, approach of estimation, data set and study context. At the same time, outcomes of the results integrated with other knowledge gives extra guidance for suggestions in future that is helps in expanding or developing new SQM.

Bawane and Srikrishna [19] developed a novel method for assessing the quality of software in quantitative manner. Purpose of study is to develop a model for expanding the requirements of quality which was preferred by different stakeholders and for including such needs in the product when it is in the development stage. Proposed model related to quantitative quality considers a set of requirements needed for quality as input for developing an application in the software. Developed model is dynamic and permits deliverables of product to be compared with various goals by different stakeholders through metrics and measurements throughout life cycle of software development. This study also discusses case study related to proposed model. It validates the usefulness and suitability of developed model. In addition to this, this study also discussed the attribute of quality namely reusability factor that is uncovered in the ISO 9126 SQM.

Dubey et al [20] compared and reviewed the models related to quality of software. This research is a comprehensive one for enumerating various characteristics of numerous models related to qualitative of software. It was believed that, this particular research would assist the users for understanding the factors related to quality effectively. It would also assist in estimating the quality of software, definition and identification in the criteria related to software in desired manner. Users could able to understand the role and significance of models of quality in evaluating the quality of software. Likewise various models were adopted for evaluating the quality has to be examined effectively. Thus it can be understood that,
users could able to easily understand the significance and role of SQM when estimating the quality of software.

V Kumar, Arun Sharma, Rajesh Sharma and P.S. Grover [21] conducted a detailed survey for quality factors, complexity, reusability, maintainability, and dependability for components and component based systems. They found out using soft computing techniques that reusability and maintainability are two very important aspects for quality. But they say that it cannot be concluded that one particular soft computing technique is better than another is not appropriate. It may be true for one characteristic by considering one set of inputs and data sets but may not be true for the same with different inputs.

Miguel et al [22] reviews models related to quality of software for evaluating the products of software. General models to assess the quality of software are less and they are complicated to adopt in particular cases. Apart from these, range in the models of tailored quality was applicable for small domain as well as it was emerged from the basic model ISO 9126. Open or free source models were based on community members’ participation. At the same time, models related to tailored quality were developed from basic models it involves particular domain and choose the sub features and features which has to be considered. Such model would be developed based on specific product of from any perspective of user domain. Thus such models also have some drawbacks. From reviewing all models, it noticed that they fail to focus on communication since it is one of factors in quality. In present scenario, there is necessity in components of quality for communications in complex systems and at all levels.

Pandey and Dubey [23] studied about the SQM and techniques for estimation for evaluating the software quality. In the present scenario, quality of software was considered as main concerned and more significant in software industry. There are numerous techniques and methods adopted for determining errors and faults at initial stage of software at development state. Conventional model rely on historical and old data therefore they won’t give clear data in such models. Thus it is necessity for SQM which has to be reusable, clear and flexible property is compulsory. After noticing all estimating techniques related to SQM, it was found out that there is no single techniques related to estimation satisfied all the software quality requirements. This research would assist the users to realize quality models as well as estimation techniques. In addition to this, this research would be helpful for investigators to know about various areas and perspective in the predicting the quality of software product. Thus it can be concluded that there is a need for SQM which has to be clear, reusable and flexible property is compulsory.

III. Research Methodology

This particular research adopts research approach as qualitative one. Murphy and Dingwall [24] pointed out that research approach of qualitative investigation is based on emerging descriptions of social phenomena. Such approach would be on the basis on numerous methods and approaches that would be very real and interactive but applicable related to its subject matter. Such type of approach would be flexible to employ in carrying out a research. Descriptive research design was followed in this research. Such design is nothing but the type of design in the research, analysis of data, design that would be utilized in any research. Investigators in the educational field would adopt any one of these techniques namely survey, observations, interview and portfolio for gathering data. Such data were utilized for recommending particular strategies to deploy or enhance strategies related to research [25]. Descriptive research plays a significant part in research of education. It was mentioned by Reason [26] that the data could be gathered in two ways namely primary and secondary sources of data. Primary data would be obtained for 1st time and they are mostly provided in the original characters and raw form. Such data are gathered by these methods such as direct and indirect personal investigation; research through local’s reports, questionnaire and so on. This study does not adopt primary collection of data but adopted secondary source of data. Secondary data would be not original that is it would be obtained from other sources. Such data would be gathered from official publications, research publication published by economists, research workers and so on, trade journals, peer reviewed or referred journal, newspaper, pamphlets, official and semi-official publications, scholarly journal and more.

IV. Discussion

Table 1: Comparing various SQM in terms of characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>ISO 9126 Model</th>
<th>Bertoa Model</th>
<th>ISO 25010 Model</th>
<th>CBQM Model</th>
<th>Alvaro Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintainability</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Portability</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Usability</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Flexibility</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reliability</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Efficiency</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Accuracy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Extendibility</td>
<td>X</td>
<td></td>
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<tr>
<td>Testability</td>
<td>X</td>
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<tr>
<td>Compatibility</td>
<td>X</td>
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<tr>
<td>Understandability</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Performance</td>
<td>X</td>
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</tbody>
</table>

Table 1 depicts the comparison various SQM in terms of characteristics. This study selected 6 main characteristics and sub characteristics for predicting the QoS. Main characteristics are maintainability, portability, usability, flexibility, reliability and efficiency and sub characteristics are accuracy, extendibility, testability, compatibility, understandability and performance. x mark in the table denotes the characteristics that support to predict the attributes of quality in SQM.

Reliability is the potential of component for maintaining a specified performance level, when adopted under particular conditions. Usability is the component ability to
be learnt, understood, configured, used and executed when it is adopted under particular circumstances. Maintainability is the ability to determine a fault inside the component of software [4]. Performance is the potential for predicting the exposure of time of an application relying on the architecture of software, processed hardware and data amount and so on. Compatibility is the potential to combine elements of software with others [7].

Accuracy is the software product capability for giving the agreed or right outcomes or effects with required precision degree. Testability is the ability of product in the software for enabling modified software for validation. Understandability is the ability in the product of software for enabling the user for understanding whether software is appropriate and how it could be adopted for specific use conditions and tasks. Extendibility is the ability of expanding products of software to new specification changes or other domains [6]. Efficiency is the potential of a component for providing suitable performance in terms of number of resources used. Portability is all about how well product of software could able to be adapted to modifications in its circumstances or with its needs. Flexibility is the effort needed to change an operational program [2].

A. ISO 9126 Model

ISO 9126 model was on the basis of Boehm and McCall models. ISO 9126 models involve 2 major parts involves external and internal quality attributes and attributes of quality in use [27]. Attributes of internal quality is the properties in the system which could be estimated without executing whereas on the other hand external quality is referred as the properties of system which could be assessed by noticing at the time of its execution. Users would experience such properties when the system is in maintenance and operation [28]. ISO 9126 model would excel in QoS characteristics such as usability, efficiency, accuracy, maintainability, flexibility, portability and reliability. This model does not excel in these characteristics such as performance, understandability, compatibility, testability and extendibility.

B. Bertoa Model

Bertoa model defines a set of attributes of quality attributes for effectively estimating commercial off-the-shelf (COTS) components. Such components could be adopted by firms of software development for building more complicated software [29]. Bertoa model perform well in main characteristics of attributes of quality. At the same time, when seeing in sub characteristics it perform well in accuracy, testability and understandability.

C. ISO 25010 Model

ISO 25010 model developed based on the model of ISO 9126. The major goal of this model is to give guidance in developing the products of software with evaluation and specification of requirements of quality [30]. Similar to the ISO 9126, it also excels in main characteristics except flexibility and usability other than in sub characteristics it excels in compatibility and performance.

D. CBQM Model

CBQM (Component based quality model) have been constructed that supports the characteristics of quality which is appropriate for libraries of external component; components of COTS, pre-built component and open source components linked with component oriented development [31]. CBQM model would able to predict the following characteristics of quality such as maintainability, usability, portability, efficiency, reliability in the main characteristics. In the sub-characteristics CBQM model would excel in extendibility, performance and compatibility.

E. Alvaro Model

Alvaro method comprised of framework for certifying the components in the software for establishing the elements in the components of quality [32]. Such framework has 4 modules. Components of quality models for the need of identifying the characteristics which has to be taken into consideration; framework for certification of technical need that identifies the techniques that would used for evaluating the features given by such model; process of certification that explains a set of techniques which certifies and evaluates the components of software with the goal of expanding a well-defined standard for certifying the component and frame involving the metric [33]. Alvaro model would perform well in main characteristics and in sub-characteristics would predict the quality characteristics are accuracy, understandability and testability.

V. CONCLUSION

From the above analysis, it was noticed that ISO 9126 model, Alvaro model and Bertoa Model would predict all main quality characteristics selected in this study. At the same time, it was noted that for the selected set of quality attributes characteristics, Alvaro model excel well in main characteristics as well as other sub characteristics namely understandability, accuracy and testability. Followed to that, Bertoa model, ISO 25010 model, CBQM model and ISO 9126 model. This study would be extended by collecting primary sources of data through surveys to identify the best SQM to predict attributes of quality.

VI. REFERENCES


