

# Identification of Software Quality Characteristics on Academic Application In Higher Education Institution (HEI)

Nur Razia Mohd Suradi<sup>1</sup>, Saliyah Kahar<sup>1</sup>, Nor Azliana Akmal Jamaluddin<sup>2</sup>

<sup>1</sup>*Faculty of Communication, Visual Art and Computing, Universiti Selangor, Bestari Jaya Campus, Jalan Timur Tambahan, 45600 Bestari Jaya, Selangor Darul Ehsan, Malaysia*

<sup>2</sup>*Faculty of Defense Science and Technology, Universiti Pertahanan Nasional Malaysia, Kem Sungai Besi, 57000 Kuala Lumpur, Malaysia  
razia@unisel.edu.my*

**Abstract**— The purpose of an academic application in higher education is to ease the user in managing their daily activities using the system. Among the largest users category in higher education institutions are academicians. The system is a critical system because it is the backbone of the institution where important tasks are performed using the system. Some of the examples of academic applications are course management system, program structure management, e-course teaching evaluation, and eLearning. Different universities may have their own academic applications. In software engineering, quality of the system is a vital element to ensure the system is accepted by the user. Various software models are available representing the good quality model. This research describes the processes in identifying the quality factors for academic application based on the importance of the quality factors from the user's perspectives.

**Index Terms**— Academic Management System; Quality Model; Software Quality Characteristics; Software Quality Model.

## I. INTRODUCTION

According to [1], an academic application consists of two main categories either in-house development or commercial. Both systems need to fulfill as a quality product to ensure it satisfies the user's acceptance. However, there are limited studies on the framework or quality model focusing on academic systems.

The paper aims at addressing the aforementioned issue, and, is structured as follows: Firstly, Literature Review describes previous researches about the quality model and explanations about quality characteristics and also those used in evaluating educational organization or university application from the users' perspectives. Secondly, Methodology section provides steps in producing a list of quality factors for academic applications. Finally, the last section concludes the research study.

## II. LITERATURE REVIEW

### A. Definition of Software Quality

Several definitions of software quality have been given by

various people. According to [2], "The main mistaken hypothesis is that quality means goodness, or luxury or shininess. It varies for different things for each and every person". [3] in his book, argued that quality must be defined in terms of customer satisfaction – which is a much wider concept than "conformance to specification" definition of quality (i.e. "meeting customer needs" perspective).

[4] describes that quality is determined by the customer and must satisfy both actual and expected needs. [5] related quality control to manufacture products with the quality which can satisfy the requirements of consumers. The term quality " is important and broadly it should be interpreted as – quality of product, services, information, processes, people, system etc". [6] asserts that the word quality has many diverse meanings: quality means having all product features that are essential for customers and thus increases product satisfaction, or free from insufficiencies. In conclusion, software quality is a procedure of building the perpetual relationships by assessing, and fulfilling the user needs.

### B. Software Quality Model

Software Quality model is a set of characteristics and sub characteristics, in addition to the relationships between them that provide the basis for specifying quality requirements and evaluating the quality of a component or a system. To develop software that can fulfill the user satisfaction is not easy. There is various software quality models available as a guideline to follow. The model may be chosen based on the type of application to be developed.

Several software quality models are proposed, in order to evaluate different types of software products. The more popular quality models are:

- a) McCall's Quality Model
- b) Boehm's Quality Model
- c) FURPS Quality Model
- d) DROMEY's Quality Model
- e) ISO9126 Quality Model

The quality attributes for five main quality models above have been discussed in detail by [7]. Each main quality and sub quality characteristics are explained explicitly.

Besides the quality model to be used, other aspects of quality attributes are also essential elements of any business

success. [8] emphasized that the importance of user involvement in developing software projects.

C. *Web-based Applications (WBA) Quality Model*

Several types of research have been done recently in defining the suitable web application quality model. Many web application quality models were developed since 1994 aiming to assess web application quality characteristics. There is a variety of quality models in practice.

[9] suggested seven constructs in developing a quality model in a study on the e-service quality of government portals involving transactions. The constructs consist of citizen centricity, transaction transparency, technical adequacy, usability, complete information, privacy and security and usefulness of information.

[10] proposed WBA content quality model. Content quality is a very important issue that must be taken into consideration when talking about the quality factors of WBA. Content quality is commonly thought of as a multi-dimensional concept with varying characteristics and attributes.

A quality model recommended by [11] is targeted for healthcare domain focusing on patients satisfaction. This research was conducted in India and aimed to optimize resources and cost, which benefited patients and related interest groups/stakeholders such as families, payers, insurers, government and society at large.

According to [12], he proposed an ISO9126-based quality model for evaluating B2C e-Commerce applications. The quality factors involved are usability, functionality, efficiency and reliability.

An object-oriented (OO) model has been suggested by [13] as software quality model specially for Malaysian telecommunication industry. The model follows the approach introduced by McCall and Boehm and benchmarking KADS model where the first level is characteristics, the second level is sub-characteristics and the third level is metrics.

Quint2 model has been proposed by [14] to evaluate the quality of software. This model is a modified version from Quint model. Quint2 model is an extension of ISO 9126 model. The Quint2 model adds 11 sub-characteristics to the existing sub-characteristics of ISO 9126 [15].

[16] discussed WBA quality model considering five quality characteristics related to the WWW domain, their sub characteristics (sub-factors), and a checklist which can be used by all IS professionals as vital issues to be addressed when creating quality web applications. These characteristics are visibility, intelligibility, credibility, engaging the visitor, and differentiation.

Another model reported by [17] is based on three dimensional quality model which consists of quality aspects, features and phases. These three elements are presented by a three-dimensional cube. The model focuses on how to organize quality aspects of web applications and web sites.

SERVQUAL model as described by [18] contains five dimensions and twenty two items used to measure different elements of service quality based on customers' expectations before a service encounter and their perceptions on the actual service delivered. The five dimensions are tangibles, reliability, responsiveness, assurance and empathy.

D. *Enhancement of ISO9126*

This section describes the proposed quality model using ISO 9126 as a basis. Most of the web quality models have their origins in ISO 9126 model, which is the framework provided for software. Although the ISO 9126 model is not

proposed for WBA quality evaluation, the characteristic quality in ISO 9126 makes it one of the popular quality models referred to in WBA.

In general, ISO/IEC 9126-1 describes the quality model, 9126-2 outlines external metrics, 9126-3 explains internal metrics, and 9126-4 summaries quality in use metrics. Out of these, ISO/IEC 9126-1 is the international standard and 9126-2, 9126-3, and 9126-4 are technical reports.

[19] recommended a new generic conceptual of an object-oriented (OO) framework multi-attribute quality model (MAQM) which scientifically categorizes quality characteristics and sub-characteristics based on different perspectives and usages of web applications leveraging the characteristics of ISO 9126 model. A comparative study for WBA quality model is also done by [20] by focusing on the model developed using ISO 9126.

[21] proposed a software quality model emphasizing user's perspectives on three characteristics, which are functionality, reliability and performance.

Another WBA quality model presented by [22] discusses the inter-connection of the developer, visitor and owner in achieving a good WBA. The research focused on three quality factors (QF), namely maintainability, portability and reusability from the developer view and then is was broken down to address user and owner concern.

A model known as SQuARE (Software product Quality Requirements and Evaluation) is developed within the ISO/IEC25000 standards series. This new approach is perceived as the new generation of software quality models [23] and is being used for the breaking down of the end-users perspectives to software components requirements. Basically, this model focuses more on the requirement phase.

Another model suitable for COTS-based (Commercial off the shelf) system is introduced by [24]. The model is more concerned on the user of the system namely the stakeholder and quality of end product and the processes involved.

E. *Discussion on quality attributes*

Table 1  
A comparative study based on quality attributes among the basic model

Characteristics	Model					Frequency
	McCall, 1977	Boehm, 1978	Dromey, 1995	FURPS, 1992	ISO9126, 1991	
1. Correctness	/					1
2. <b>Reliability</b>	/	/	/	/	/	5
3. <b>Efficiency</b>	/	/	/		/	4
4. Integrity	/					1
5. <b>Usability</b>	/		/	/	/	4
6. <b>Maintainability</b>	/		/		/	3
7. <b>Testability</b>	/	/				2
8. Flexibility	/					1
9. <b>Portability</b>	/	/	/			3
10. <b>Reusability</b>	/		/			2
11. <b>Interoperability</b>	/	/				2
12. Human Engineering		/				1
13. <b>Understandability</b>		/			/	2
14. Modifiability		/				1
15. <b>Functionality</b>			/	/	/	3
16. Performance				/		1
17. Supportability				/		1
<b>Total</b>	<b>11</b>	<b>8</b>	<b>7</b>	<b>5</b>	<b>6</b>	

A comparative study among five basic models is discussed

below. All 17 main characteristics of quality attributes are shown in Table 3. The attributes are marked as ‘/’ if they exist in a particular model. The value in the last row in the table represents the number of matching characteristics for each quality model.

Referring to Table 1, there are 17 characteristics. Only one characteristic is common to all quality models, namely ‘reliability’. The ‘efficiency’ characteristics are shared with four other quality models except in FURPS model whereas ‘usability’ characteristics exist in four models except in Boehm’s quality model. The column frequency shows the number occurrence of these characteristics in all five basic models.

*F. Refinement of characteristics for educational applications*

This section describes quality characteristics to be used in evaluating educational organization or university application from the user’s perspective.

Table 2  
List of selected characteristics in general

Characteristics	McCall	Boehm	Dromey	FURPS	ISO9126	Frequency	Remark
1. <b>Reliability</b>	/	/	/	/	/	5	✓
2. <b>Efficiency</b>	/	/	/	/	/	4	✓
3. <b>Integrity</b>	/					1	Not selected since only appear in one model
4. <b>Usability</b>	/		/	/	/	4	✓
5. <b>Maintainability</b>	/		/		/	3	✓
6. <b>Testability</b>	/	/				2	✓
7. <b>Flexibility</b>	/					1	Not selected since only appear in one model
8. <b>Portability</b>	/	/	/			3	✓
9. <b>Reusability</b>	/		/			2	✓
10. <b>Interoperability</b>	/	/				2	✓
11. <b>Human Engineering</b>	/	/				1	Not selected since only appear in one model
12. <b>Understandability</b>	/				/	2	✓
13. <b>Modifiability</b>	/					1	Not selected since only appear in one model
14. <b>Functionality</b>	/	/	/	/	/	3	✓

Based on Table 2, all the frequency values except for the value frequency of one will be chosen as a basis. The total selected characteristics are ten. Table 2 will be the basis of characteristics chosen. A preliminary study has to be done

to gather viewpoints from various users. Users are the people who used the educational application directly. Users consist of academicians, while developers represent the technical experts. From this result, the software quality characteristics and sub-characteristics for the educational institution may be added or removed.

*G. Web application quality*

Most web applications share common quality characteristics such as e-commerce, e-government or educational applications. According to [25], the most common quality characteristics of the web applications have been summarized and ranked as shown in Table 3.

Table 3  
Ranking of web application quality factors. Adopted from [26].

Quality Factor	Rank
Efficiency	1
Security	2
Usability	3
Traceability	4
Availability	5
Scalability	6
Functionality	7
Customizability	8
Recoverability	9
Consistency (Data)	10

From Table 3, quality factors such as traceability, customizability and recoverability are not directly referred to the above selected characteristic as discussed in Table 2. Recoverability is part of Reliability characteristics and Customizability is under Maintainability characteristics. Only four quality factors are added to the current characteristics. The lists of final characteristics are shown as in Table 4 and the aforementioned work has been presented by [27].

Table 4  
List all characteristics for academic application

No	Characteristics	Origin Model
	Characteristics	All basic model
1.	Reliability	
2.	Efficiency	
3.	Usability	
4.	Maintainability	
5.	Testability/Maintainability	
6.	Portability	
7.	Reusability	
8.	Interoperability/Functionality	
9.	Understandability/Usability	
10.	Functionality	
11.	<b>Security</b>	Web Application
12.	<b>Traceability</b>	Quality
13.	<b>Availability</b>	
14.	<b>Customizability</b>	

III. DEVELOPING QUALITY FACTOR AND SUB-QUALITY FACTORS FOR ACADEMIC APPLICATION

Using the following list of characteristics as in Table 4, a preliminary study has been conducted in determining the accurate characteristics of the academic application.

*A. Steps for developing a software quality characteristics*

- a) Study a renowned quality model and understand each characteristic for each model
- b) Do a comparative study for five basic software quality models. A list of common characteristics attribute is

identified.

- c) Compare the list of characteristics attribute in step 2 with an attribute in web quality model.
- d) Choose a group of knowledgeable and experts familiar in HEI application.
- e) Rank each quality factor based on the importance
- f) Rank each sub-quality factor within each quality factor based on the importance
- g) Remove from or add a new quality factor to the list.
- h) A list of quality factor and the sub-quality factor is produced.

#### IV. CONCLUSION

This study describes the processes or steps in identifying quality characteristics for the academic application. The quality characteristics and sub-characteristics have been identified based on the five basic models and web application model. There are two contributions by this study, namely the comparative analysis of existing quality models and identification of the quality characteristics of academic systems. Future research in this field may be conducted in the real academic application.

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#### REFERENCES

- [1] Azilayati Osman, "Academic application," 2017
- [2] P. B. Crosby, "Crosby, P. B., Quality is free : the art of making quality certain, New York : McGraw-Hill, 1979.,," 1979.
- [3] W. E. Deming, W. E. Deming, , Out of the crisis : quality, productivity and competitive position, Cambridge Univ. Press, 1988. 1988.
- [4] Arman Vallin. Feigenbaum, A. V. Feigenbaum, Total quality control, McGraw-Hill, 1983. 1983.
- [5] Kaoru Ishikawa, Ishikawa, K., What is total quality control?: the Japanese way, Prentice-Hall, 1985. 1985.
- [6] Joseph M. Juran, J. M. Juran, Juran's Quality Control Handbook, McGrawHill, 1988. 1988.
- [7] Nur Razia Mohd Suradi, Saliyah Kahar, and N. A. A. Jamaludin, "A REVIEW ON SOFTWARE QUALITY ATTRIBUTES FOR WEB-," in *International Conference on Engineering and Applied Science Purwokerto, Indonesia*, 2016, vol. 1, pp. 181–191.
- [8] L. Constantine, R. Biddle, and J. Noble, "Usage-centred design and software engineering: models for integration," *Proc. 2003 Int. Conf. Softw. Eng. Portland, Oregon*, pp. 106–113, 2003.
- [9] D. Bhattacharya, U. Gulla, and M. P. Gupta, "Journal of Enterprise Information Management Emerald Article: E-service quality model for Indian government portals: citizens' perspective E-service quality model for Indian government portals: citizens' perspective," *J. Enterp. Inf. Manag.*, vol. 25, no. June 2016, pp. 246–271, 2012.
- [10] B. A. Albuquerque AB, "E-commerce websites: a qualitative evaluation In: 11th i," *Int. WWW Conf. proceedings. Hawaii ACM Press.*, p. 294–300., 2002.
- [11] M. Azam, Z. Rahman, F. Talib, and K. J. Singh, "A critical study of quality parameters in health care establishment Developing an integrated quality model Mohammad," *Int. J. Health Care Qual. Assur.*, vol. 25, no. 5, pp. 387–402, 2012.
- [12] L. A. Al-safadi and R. A. Garcia, "ISO9126 Based Quality Model for Evaluating B2C e-Commerce Applications – A Saudi Market Perspective," vol. 3, no. 2, pp. 8–15, 2012.
- [13] A. H. Nor Fazlina and M. K. Hassan, "Designing Software Quality Measurem for Telecommunication Industry Using Object- Oriented Technique," *Int. J. Comput. Electr. Autom. Control Inf. Eng.*, vol. 7, no. 10, pp. 1296–1301, 2013.
- [14] F. Niessink, "Software Requirements, Functional and Non-Functional Software Requirements,," 2002.
- [15] C. Calero, J. Ruiz, and M. Piattini, "A web metrics survey using WQM," in *Web Engineering*, no. July 2004, 2004, pp. 147–160.
- [16] F. Ricca and L. Chao, "Special Section on web systems evolution," *Int J Softw Tools Technol Transf.*, vol. 11:419, no. 6, 2009.
- [17] R. Ramler, E. Weippl, M. Winterer, W. Schwinger, and J. Altmann, "A quality-driven approach to web testing," *Ibero-american Conf. Web Eng. ICWE 2002*, vol. 1, pp. 81–95, 2002.
- [18] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "A Conceptual Model of Service Quality and Its Implications for Future Research," *J. Mark.*, vol. Vol. 49, no. 4, pp. 41–50, 1985.
- [19] D. Nabil, A. Mosad, and H. A. Hefny, "Web-Based Applications quality factors: A survey and a proposed conceptual model," *Egypt. Informatics J.*, vol. 12, no. 3, pp. 211–217, 2011.
- [20] N. Kumar and R. Dadhich, "Quality Models for Web-based Application : A Comparative Study," *Int. J. Comput. Appl.*, vol. 125, no. 2, p. 8887, 2015.
- [21] A.-B. A. Bassam, M. H. Selamat, M. A. Jabar, J. Din, and S. Turaev, "Users' perspective of software quality," *SEPADS'11 Proc. 10th WSEAS Int. Conf. Softw. Eng. parallel Distrib. Syst.*, no. August 2016, pp. 84–89, 2011.
- [22] D. Nabil, A. Mosad, and H. A. Hefny, "Web-Based Applications quality factors: A survey and a proposed conceptual model," *Egypt. Informatics J.*, vol. 12, no. 3, pp. 211–217, 2011.
- [23] W. Suryn and A. Abran, "ISO/IEC SQuaRE: The Second Generation of Standards for Software Product Quality," *Int. Assoc. Sci. Technol. Dev. - IASTED*, pp. 1–11, 2003.
- [24] A. Rawashdeh and B. Matakah, "A New Software Quality Model for Evaluating COTS Components," *J. Comput. Sci.*, vol. 2, no. 4, pp. 373–381, 2006.
- [25] R. Djouab and M. Bari, "An ISO 9126 Based Quality Model for the e-Learning Systems," *Int. J. Inf. Educ. Technol.*, vol. 6, no. 5, pp. 370–375, 2016.
- [26] Behkamal, B., Kahani, M., & Akbari, M. K. (2009). Customizing ISO 9126 quality model for evaluation of B2B applications. *Information and Software Technology*, 51(3), 599–609. <http://doi.org/10.1016/j.infsof.2008.08.001>
- [27] Nur Razia, M. S., Saliyah, K., & Nor Azliana, J. (2017). A Quality Model for Academic Management System in Higher. In *Postgraduate Research Excellence Symposium (PgRES2017)* (pp. 1–6). Universiti Malaya (UM).