Assessing Website Usability Attributes

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A B S T R A C T

Web sites are widely used in daily life no matter for work or for entertainment, and connect with others in their social life. Usability is one of the quality factors that determine the successfulness of a web site. This study reviews existing usability standards and model from previous studies. Most of the previous works only mentioned the attribute of usability in general and no details discussion is included. There are less published works in usability guidelines that comes up with metric for easy measurement especially focusing for web site. This study identifies the major elements in web site usability from the previous studies and usability standards. It adapted Quality in Use Intergrated Measurement Model or QUIM model that include accessibility in web site usability unlike earlier work which separate between usability and accessibility. The results show effectiveness, efficiency, learnability, satisfaction and accessibility have significant impacts and highly correlated on web site usability. These attributes should needs to be consider when designing web site.

INTRODUCTION

Nowadays, humans are inseparable with the internet. Most of the desired information can be obtained easily by just at fingertips. Web sites are important nowadays in the globalized competition. Many organization using web site to share information and also as a medium of communication because it not only cost effective but also save time. Everyday new web sites are publishing in the internet and it has been growing at an exponential rate. A web site is a collection of web page. It is a medium of communication (Aaberge *et al*., 2004). It represents the brand of the organization and provides first impression about the organization to the user (Robins and Holmes 2008). If it is not well presented or poor in web design, it will make user away and give poor reputation to the organization (Tan and Tung 2003).

There are many types of web site that not only provide information but also delivery services such as online learning or e-learning, e-commerce, e-government and many more. In Malaysia there are many web sites that deliver services such MyEG, MyCoID, e-filling and other more. The intern*et al*so creates a new business environment. Nowadays, user can buy many items such as clothing, shoes, books, computer and many more only by staying at home and it can saves time, money and energy. Users only need a computer and connection to internet. There are a few examples of popular web sites in Malaysia such ebay.com.my, zalora.com.my, mudah.my, lelong.com.my and many more. The advantages using web site as medium to perform services are it easier, cheaper and faster to publish information on the internet. Therefore all information or the content in the web site must be accurate and have a good design to meet the user requirement and the most important usable. The quality of the web site can be assessed in many ways and must be ensure to give a good perspective to user so he or she will come again to the web site. Usability has assumed the importance in terms of satisfying web site user's need and expectations (Nam and Nam 2012). The aim of the research is to identify the major elements in web site usability, thereby forming a useful guideline to measure the web site usability that has major element with metric for easy measurement.

2. Literature Review:

Web site evaluation determines the quality of the website. There are many factors or characteristic to determine the quality of web site or software (Fernandez, Insfran, and Abrahão 2011) (Dubey, Rana, and Mridu 2012). Usability is among the most important factor in web site or software quality. There are many quality

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model that has usability such as McCall's Quality Model, Boehm's Quality Model, ISO 9126 Quality Model, FURPS Quality Model, Dromey's Quality Model and QUIM Quality Model (Dubey, Rana, and Mridu 2012). Many researchers adapted software usability in web site usability. There are several usability model such as Eason Model (1984), Shackel Model (1991), Nielsen Model (1993), ISO 9241-11(1998), ISO 9126 (2001) and QUIM model (2006) (A Seffah, Kececi, and Donyaee 2001)(Dubey 2012)(Dubey, Rana, and Mridu 2012).

Lack of usability element degrade user satisfaction and resulting into complaints, site abandonment, loss of current or future business, bad press, bad decisions, lost time and poor productivity. A well designed user interface is a critical factor. User will have stronger intentions to use and revisit the web portal if they found the web portal is easy to use and reduce their cognitive load beside it more useful that give the information what they want (Liu *et al*. 2010). In Human Computer Interaction (HCI) term, usability is more to usable user interface or in other word to make system easy to learn and easy to use (Leventhal and Barnes 2008). Based on ISO 9241 – 11 in HCI field, usability is defined as the "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Marsico and Levialdi 2004)(Fernandez, Insfran, and Abrahão 2011). Refer to the definition on ISO 9241 – 11, the criteria of usability are effectiveness, efficiency and satisfaction. It focuses on human interaction perspective for software product standard. This definition has 3 components that can divide such as "specified users", "achieve specified goals" and "specified context to use". Other definition on usability is defined as " how well and how easily a user, without formal training can interact with an information system of a web site" (Wang and Senecal 2008).

3. Review of Usability Model:
Eason Model (1984):
Eason Model is proposed by Kenneth Eason (1984) and published his model in an early issue of Behaviour and Information Technology. Eason Model has 3 aspect, task, user and system. For task it has 2 sub attribute that is frequency and openness. User has 3 sub attributes that is knowledge, motivation and discretion. System has ease of learning, ease of use and task match. Eason Model cannot measure usability without considering users and their target task. Eason model sees usability as the result of several interacting variables or "multi - variate". (Leventhal and Barnes 2008)(Madan and Dubey 2012).

Shackel Model (1986):
Shackel Model was developed by Brian Shackel. In this model, it has 4 attributes that is effectiveness, learnability, flexibility and attitude. Shackel Model does not weight the dimension, recognizing that the importance of each of these may different from project to project. Shackel model emphasizes measurement of a number of human factors, relating to human performance and attitude (Leventhal and Barnes 2008) (Madan and Dubey 2012).

Nielson Model (1993):
Nielson Model was developed by Jakob Nielson. The main model is system acceptability and usability is part of usefulness as figure 2. Other attribute that contribute to the main model are utility, usefulness, practical acceptability and social acceptability. Under usability it has 5 attributes such as easy to learn (learnability), efficient to use (efficiency), easy to remember (memorability), few error and subjectively pleasing (satisfaction). Nielson Model focus on acceptability that mean if the system is not useful such as did not meet the user requirement, it will not accept it either it usable or not. The model is based on user interface usability in the context of a software engineering project. Nielsen emphasizes usability as part of a larger set of system characteristics. Same with Shackel Model, Nielson Model also does not weight the dimension, recognizing that the importance of each of these may different from project to project.

ISO 9241 – 11 (1998):
ISO 9241 is an international standard for guidance on usability based on process oriented. Nielson and Shneiderman are among the committee members in the development of ISO guidelines. For ISO 9241 – 11 has 3 attributes that are effectiveness, efficiency and satisfaction. ISO 9241 – 11 are put together from a different usability viewpoint. Effectiveness describes the interaction from the process viewpoint, efficiency which focus on results and resources involved and satisfaction which is a user viewpoint (Abran *et al*. 2003)(Services, Court, and Wcv 2006)(Madan and Dubey 2012). ISO 9241-11 has objective measures of usability (Yen 2010). The disadvantage of this model is that it is to abstract (Ahmed Seffah *et al*. 2006) (Hussain and Ferneley 2008).

ISO 9126 (2001):
ISO 9126 is an international standard for the evolution of software quality model from the product perspective. The approach was quality model of the product and initially published in 1991 and refined over the next ten years by ISO's group of software engineering experts. ISO 9126 divided into 4 parts which address

respectively to the quality model, external metrics, internal metrics and quality in use metric. The internal and external metrics are functionalities, reliability, usability, effectiveness, maintainability and portability (Abran *et al*. 2003). Under usability it has 5 attributes such as understandability, learnability, operability, attractiveness and usability compliance (Abran *et al*. 2003) (Services, Court, and Wcv 2006)(Madan and Dubey 2012). The advantage of ISO 9126 model is it provide a framework for making trade-offs between software product capabilities and the attribute are applicable to any kind of software including computer programs and provide consistent terminology for software product quality. The disadvantage of ISO 9126 was unclear architecture at the detail level of the measures, overlapping concepts, lack of a quality requirement standard, lack of guidance in assessing the results of measurement and ambiguous choice of measures (Yen 2010).

Quality in Use Integrated Measurement (QUIM) (2006):

QUIM or Quality in Use Integrated Measurement developed by Ahmed Seffah *et al* in 2006. QUIM is a consolidated model for usability measurement and metrics. It combines various standard and model such as ISO 9241 and ISO 9126 and unified into a single consolidated, hierarchical model. It outlines methods for establishing quality requirements as well as identifying, implementing, analysing, and validating both process and product quality metrics. This model appropriated for novice users that have little knowledge on usability. It also can be applied by usability experts and non-experts. QUIM model consists of 10 factors and subdivided into 26 criteria or measurable criteria, and finally into specific metrics consists 127 specific metrics. The 10 factors consists Efficiency, Effectiveness, Satisfaction, Learnability, Productivity, Safety, Trustfulness Accessibility, Usefulness and Universality. The model is used to measure the actual use of working software and identifying the problem. In QUIM model associates factors with criteria and metrics in a clear and consistent way. It also usable generally and can adapt in specific context of use. The limitation of this model, it is not optimal yet and needs to be validated (Ahmed Seffah *et al*. 2006) (Hussain and Ferneley 2008) (Khalili 2012).

4. Research Methodology and Hypotheses:

QUIM model are used in this study as the basic and modified it focusing on web site usability. In this study, only five (5) attribute are used from QUIM model that are Effectiveness, Efficiency, Learnability, Satisfaction and also include Accessibility. The five (5) usability attributes are selected because it that has been use frequently in the previous models and previous studies as above (Dubey and Rana 2010). This study used QUIM model because it also include Accessibility to measure usability. Accessibility also important attribute because it refer how easy the web site to access and it give impact to web site usability. The attributes also focus on web site usability as the main attributes. Each attribute has it own characteristics.

The proposed research predicts that Effectiveness, Efficiency, Learnability, Accessibility and Satisfaction are positively associated with the usability of Universiti Malaysia Pahang (UMP) web site. The following are the brief description for each attributes:

Efficiency	– the way a web site supports user in carrying out their tasks and capability of the web site to enable users to expend appropriate amounts of resources in relation to the effectiveness achieved in a specified context of use.
Effectiveness	– refer to how good a web site is at doing what it is supposed to do and the capability of the web site to enable users to achieve specified tasks with accuracy and completeness
Learnability	– refer to how easy a web site is to learn to use. It is the capability of the web site to enable users to feel that they can productively use the web site right away and then quickly learn other new (for them) functionalities.
Accessibility	- refer to how easy the user to access the web site and the capability of web site to be used in terms of response time (loading page) to each task that perform by user and by users with some type of disability (e.g., visual, hearing, psychomotor).
Satisfaction	– refer to subjective response how users comfort to use the web site and their positive attitude after use the web site.

Below are the attributes for web site usability with sub criteria. Each attribute has it own characteristics. The sub criteria are presented in table 1. The attributes are directly measureable at least one specific characteristic. This measurement reflects in questionnaire that distributed in pilot study to evaluate the web site usability.

Table 1: Relations between usability attribute and characteristics for web site.

Attribute / Characteristics	Efficiency	Effectiveness	Satisfaction	Learnability	Accessibility
Time behaviour	√				
Resource utilization	√				
Attractiveness			√		
Likeability			√		
Flexibility		√	√		√
Minimal action	√		√	√	√
Minimal memory load	√		√	√	√
Operability	√		√	√	
User guidance			√	√	√
Consistency		√		√	√
Self-descriptiveness				√	√
Feedback	√	√			
Accuracy		√			
Completeness		√			
Readability					√
Controllability					√
Navigability	√	√			√
Simplicity				√	√
Familiarity				√	
Loading time	√				√
Effectiveness of help web site		√			
Effectiveness of the user documentation		√			
Response time	√				√
Completeness of description		√		√	√

The main purpose of this research is to test the proposed research for web site usability. Only five attributes use in this model including accessibility because to see the web site usability in general opinion and not focus on specific area. Higher education web sites are chosen to evaluate the proposed usability model. Evaluating web site usability is of significant importance to the success of higher education web sites (Broberg 2011). Higher education web sites often contain important information about academic resources, campus events, and administrative policies. These sites also provide information on college services such as the college library, campus bookstore, and course registration system. As college web sites take on significant and increasingly important roles, it is imperative that these sites be user-friendly.

For the instrument for this study, questionnaire from Computer System Usability Questionnaire (CSUQ) (Lewis 1995) were adapted and also include a few question that refer to the item constructs that used in(Poelmans *et al*. 2008) (Theng and Sin 2012) (Milis *et al*. n.d.). CSUQ was developed by James Lewis at IBM in 1995. It uses 19 questions on a 7-point scale of "Strongly Disagree" to "Strongly Agree" plus N/A. CSUQ is satisfaction questionnaires and all statement in CSUQ is worded positively. CSUQ is suitable for usability study in a non-laboratory setting.

The first part of the research contains demographic profile of respondents including gender, age, internet usage duration and internet experience. The questionnaire assesses web site usability by asking participants to compare their expectations against what they actually find on the web site. The items of the constructs such as Effectiveness, Efficiency, Learnability, Accessibility and Satisfaction are used. A five-point Likert-type scale ranging from (1) "strongly disagree" to (5) "strongly agree" was used to answer the questions in the 32 item of the questionnaire. Since some items in the questionnaire were developed adapted from CSUQ and a few are additional, a pre-test was required. Students and staff from TATI University College (TATIUC) were listed to complete the preliminary questionnaire of 32 items. A pilot test was conducted to test the research model and questionnaire.

Pilot Study:

A pilot study was conducted to identify consistency of the questions and an understanding of the respondents to the questionnaire. 82 respondents were involved in this pilot study. Table 2 shows the activity and survey agenda.

Table 2: Activity and Survey Agenda.

Activity	Session Duration
Phase I : Introduction to Research Experimentation	
Description on Research Procedures	5 minutes
Phase II : Experimental Implementation	
Respondents explore the web site and solve the given task	30 minutes
Filling out Post-Experiment Questionnaire	30 minutes
Summary, Question and Answer (non formal)	15 minutes

In this section, the descriptive statistics, regression analysis results to test the research hypothesis are presented. Data analysis is conducted using SPSS 18.0.

Experimentation and Results Analysis:
Descriptive statistics:

The major descriptive statistics are discussed accordingly. Most of the participants were male (51.2%) and female (48.8%). More than 92.7% of the participants are student and other 7.3% are employees in government sector (2.4%) and private sector (4.9%). Since most of the participants are student, about 93.9% were below 24 years of age. These also reflect to the education level, more than 92.7% of participants are diploma student from TATIUC. 36.6 % has internet experience between 1 – 3 years and 35.4% has internet experience more than 6 years. Most of the participant spend 5 to 9 hours (32.9%) using internet per day. More than 50% of the participants never visit the web site.

Hypothesis Testing:

Five attributes were used for proposed research in context of web site usability such as Efficiency, Effectiveness, Learnability, Accessibility and Satisfaction. Below are the hypotheses for all proposed attributes:
H1: Efficiency will have a significant and positive effect on web site usability.
H2: Effectiveness will have a significant and positive effect on web site usability.
H3: Learnability will have a significant and positive effect on web site usability.
H4: Accessibility will have a significant and positive effect on web site usability.
H5: Satisfaction will have a significant and positive effect on web site usability.

To examine the measurement scale reliability and initial construct validity of the web site usability measurement scale. First, descriptive statistics and initial reliability estimates were computed using Cronbach's alpha. To test either the questionnaire reliable to use or not to provide the formal questionnaire to respondents and analyse the responses statistically, so measuring reliability is conducted. By measuring the scale's reliability based on the value of Cronbach's Alpha, the value must be more than 0.5 ($p > 0.5$) (Downing and Liu 2011). Cronbach's alpha, the variance extracted from all constructs and the descriptive statistics of mean and standard deviations of all items in the questionnaire. The average variance extracted, which is used to measure the discriminated validity of each construct is only accepted when it is more than 0.5 ($p > 0.5$). Reliability of attribute in the questionnaire using Cronbach's Alpha is 0.939 using 22 items. Cronbach 's Alpha was used to check reliability of each attribute. For the whole questionnaire for the survey is reliable because the results is above .5. All attributes in the questionnaire is more than 0.5. Table 3 shows the Cronbach's Alpha for each attribute.

Table 3: Cronbach's Alpha for each attribute reliability.

Attribute	Cronbach's Alpha
Efficiency	.746
Effectiveness	.820
Learnability	.640
Accessibility	.781
Satisfaction	.818

The significance level of the correlation coefficient of the model shown in table 4 demonstrates that all five (5) hypotheses derived from the research were supported. All attributes; efficiency, effectiveness, learnability, accessibility and satisfaction are important and have significant impact to web site usability. Table 4 shown the correlations using Spearman. Spearman's correlation coefficient is used to measures the strength of association between two variables and nonparametric. This study used Spearman's correlation because it more appropriate for measurements taken from ordinal scales (Andy Field 2013)(Korfiatis, García-Bariocanal, and Sánchez-Alonso 2011).

These shown all the attribute are support the hypothesis because the result of correlation is significant at the level 0.01 (P<0.01). Learnability (.719) is the highest value in correlation. Effectiveness is .695, Accessibility is .624, Satisfaction is .600 and Efficiency is .493 in Spearman's Correlation. This shown that all attribute give affect to web site usability including Accessibility (.624) that evaluates whether information can be accessed efficiently and easily. All correlation variables indicated a positive relationship with each other and significant at a 0.01 level. This study was proposed that usability could be modelled with efficiency, effectiveness, learnability, satisfaction and include accessibility as attributes in web site usability (A Seffah, Kececi, and Donyaee 2001)(Dubey 2012)(Dubey, Rana, and Mridu 2012).

The model tested by regression analysis. Linear regression analysis model were run to test the element in the model. Based on the table 5, the R Square is .649. R Square (R^2) is a measure of amount of variability in one variable that is shared by the other (Andy Field 2013). The hypothesis accepted because the result more than 0,05 (p.0,05). All the attributes are significant and positive effect to web site usability.

Table 4: Spearman's Correlations.

Correlations				
				Usability
Spearman's rho	Efficiency	Correlation Coefficient		.493**
		Sig. (2-tailed)		.000
		N		82
	Effectiveness	Correlation Coefficient		.695**
		Sig. (2-tailed)		.000
		N		82
	Learnability	Correlation Coefficient		.719**
		Sig. (2-tailed)		.000
		N		82
	Accessibility	Correlation Coefficient		.624**
		Sig. (2-tailed)		.000
		N		82
	Satisfaction	Correlation Coefficient		.600**
		Sig. (2-tailed)		.000
		N		82

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5: Linear regression model summary.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.806[a]	.649	.626	.599

a. Predictors: (Constant), Satisfaction, Efficiency, Learnability, Accessibility, Effectiveness

Discussion:

Based on the results, it shows that effectiveness, efficiency, learnability, satisfaction and accessibility have significant impacts and highly correlated on web site usability. Learnability is most significant determinant that directly affects web site usability. It shows that the web site is easy to use although most of the respondents are first time used the web site. When users feel they are in control and know what they want or need to do, it will reflect either the web site is usable or not. The web site should be easy to learn so that the users can accomplish the required task. The second attribute that has high correlation is effectiveness. Effectiveness for the web site must be consider because it focus on either the web site can give what the user want or not. Accessibility also gives impact to web site usability. Accessibility element should be considered to determine the usability of a web site because it influences the user and reflects the success of a web site. If the web site is difficult to access like the page takes time to load, navigation, consistency and other sub criteria. Accessibility influences to user satisfaction and effect the usability of the web site. It also can reflect to efficiency either the user can complete the task or not within in short time. Accessibility also refers to the requirement W3C (World Wide Web Consortium) in developing web site such as there has option to resize the font size or chance the background color. This function can make using   Cascading Style Sheets (CSS). CSS was developed by W3C that enabled web designers and publishers to establish a coherent style for a web site without burdening every page with formatting code. Web sites that use CSS more compatible with any web browser and will load faster. Beside that, user satisfaction is just one important dimension of web site usability. All the attributes that have been mention have correlation with satisfaction. If one of the attributes did not meet the user expectations while using the web site, user will feel disappointed. It shows that the web site is not usable enough. Although the respondents are not students or staffs from UMP, but the result from the study proved that UMP web site is very usable to everyone and have the entire element that needed in web site usability.

Conclusion:

The intention of this study is to propose a few attributes in QUIM model and adapted it in proposed research to see either it can be applied and give effect in the context of web site usability or not. This study examined the measurement of web site usability using the proposed research hypothesis that has Effectiveness, Efficiency, Learnability, Accessibility and Satisfaction as attributes in web site usability. The data was analysis using Spearman's Correlation and linear regression. The result of the study seems to fulfil the objectives when it clearly identified that all attributes are important and have positively significant affects to the web site usability.

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