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A Usability Evaluation Model for Academic Library Websites: Efficiency, Effectiveness and Learnability

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Abstract

Purpose – This paper aimed to develop a usability evaluation model and associated survey tool in the context of academic libraries. This study not only proposed a usability evaluation model but also a practical survey tool tailored to academic library websites.

Design/methodology – A usability evaluation model has been developed for academic library websites based on literature review and expert consultation. Then, the authors verified the reliability and validity of the usability evaluation model empirically using the survey data from actual users. Statistical analysis, such as descriptive statistics, internal consistency test, and a factor analysis, were applied to ensure both the reliability and validity of the usability evaluation tool.

Findings – From the document analysis and expert consultation, this study identified eighteen measurement items to survey the three constructs of the usability, effectiveness, efficiency, and learnability, in academic library websites. The evaluation tool was then validated with regard to data distribution, reliability, and validity. The empirical examination based on 147 actual user responses proved the survey evaluation tool suggested herein is acceptable in assessing academic library website usability.

Originality/Value – This research is one of the few studies to engender a practical survey tool in evaluating library website usability. The usability model and corresponding survey tool would be useful for librarians and library administrators in academic libraries who plan to conduct a usability evaluation involving large sample.

Keywords: Usability Evaluation; Library Websites; Academic Libraries

1. Introduction

As the Internet has become a major source of information, library websites are also selected frequently to obtain scholarly and educational resources in academia (Lee, Han, & Joo, 2008). A library website plays a role of an extension and augmentation of a traditional physical library, and offers a variety of library services such as electronic resource access (e.g. e-books, electronic journals, etc.), online catalogs, and online reference services. As the website serves as a key gateway to library services, evaluation of library websites has attracted increasing concern amongst researchers in the field of

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library and information sciences. As a method of website evaluation, usability test has been widely applied in various fields, in particular web and system design and human-computer interaction. Usability indicates to what extent a Website is easy to use, efficient in performing a specific task, and satisfactory for end users. In the recent years, usability evaluation also has been conducted in library communities to diagnose problems of current websites and to enhance website interface by better reflecting user viewpoints.

This study attempts to develop a usability evaluation model and corresponding survey tool for academic library websites. To date, most usability evaluation in academic libraries were limited to either inspection methods or formal experimental test. Less research applied user survey questionnaire methods in usability evaluation in library environments. Survey method is effective and efficient to collect user perceptions from a large sample while complementing predominant inspection and formal experiment methods. To implement user survey evaluation, it is prerequisite to develop an evaluation model and corresponding reliable and valid practical evaluation tool. This study not only identified the usability evaluation model but also practical evaluation tool tailored to academic library websites.

2. Literature Review

In the recent decades, usability studies have received significant attention in the field of Library and Information Science. Usability consists of multiple constructs from various perspectives, such as effectiveness, efficiency, subjective pleasure, memorability, and others, focusing largely on interface design (Jeng, 2006). The majority of research on usability studies either yields system design principles or intends to improve the design of an existing system.

Researchers identified different attributes of usability from various disciplines. For example, in his early study, Booth (1989) suggested four aspects of usability, namely, usefulness, effectiveness, learnability, and attitude. Shakel (1991) identified four usability evaluation criteria focusing on how users accomplish their tasks in using a system, learnability, flexibility, effectiveness, and user attitude. Nielsen's model (1993), which is one of the most cited in the usability engineering area, posits five attributes: learnability; efficiency; memorability; low error rate (easy error recovery); and subjective satisfaction. Another representative usability model that is proposed by the International Organization for Standardization (ISO) accounts for usability based on three main constructs, such as effectiveness, efficiency, and satisfaction. ISO

has established these three constructs as an international standard and named ISO9241-11. Other models of usability share similar perspectives while adding more constructs. For example, Brinck's (2002) definition of usability includes functionally correct, efficient to use, easy to learn and remember, error tolerant, and subjectively pleasing, while Oulanov and Pajarillo (2002) postulated efficiency, helpfulness, and adaptability as usability attributes. In his usability test study, Lee (2004) adopted multiple usability criteria like usefulness, effectiveness, satisfaction, supportiveness, and intuitiveness. More extensively, the MIT Information Services and Technology Department (2011) published a usability guideline that includes ten attributes such as navigation, language and content, architectural and visual clarity, and functionality.

There is a small body of research on investigating usability evaluation in library settings, since library evaluation has focused more on usage, service quality, and collections. Some examples of usability evaluation are introduced in relation to library websites. Eliasen, McKinstry, Fraser and Babbitt (1997) investigated users' resource selection while using a library homepage based on user experiments on website prototypes. Their study is one of early attempts to assess the usability of library websites based on formal usability test. Hammill (2003) evaluated the usability of the Florida International University (FIU) Libraries website (http://www.fiu.edu/~library), based on multiple evaluation categories such as navigation, clarity of vocabulary, and visibility of the website. Using a formal usability test and post-hoc questionnaire, she attempted to measure how efficiently participants make uses of the FIU Libraries' website, and to what extent they feel satisfaction. In her study, she suggested not only quantitative measures of efficiency like number of clicks to complete each task but also qualitative analysis based on user comments and open question data. Lee (2004) tested the usability of a research center library website (www.keris.re.kr) in Korea. The uniqueness of their study lies in that they applied a mixture of methods of observation and formal usability test, including heuristic evaluation, laboratory usability testing, and remote usability testing. From the usability evaluation, they were able to discover user interface problems in the current system, and reached library website improvement strategies from the findings. Jeng's usability model (2006), which is one of widely mentioned in library website usability evaluation, incorporates four usability constructs - ease of use, satisfaction, efficiency, and effectiveness - into digital library settings. Her model

identified four constructs and sub-attributes of usability from thorough reviews of previous representative usability models, and also suggested specific measures for each construct.

In academic libraries, there are a few of evaluation tools customized to academic library settings. Association of Research Libraries (ARL)'s LibQUAL+™ is one of representative evaluation tools developed to assess service quality on the basis of SERVQUAL framework (Cook & Heath, 2001). LibQUAL+ employed the gap theory of service quality like other SERVEQUAL-based evaluation frameworks. Extending LibQUAL+, recently, DigiQUAL project developed a service quality model reflecting digital environments. (Kyrillidou & Giersch, 2005). These evaluation frameworks specialized for academic libraries has limited to assessment of service quality. Although there are many attempts to assess usability of digital libraries, few usability evaluation models focused on the website of university libraries. In particular, although ISO 9241-11 has widely applied to different types of information systems, it is not introduced sufficiently as a way of user survey method for assessing library website usability in universities.

These efforts in library website usability evaluation have greatly helped to enhance the library website design reflecting users' actual uses of the system. However, in terms of usability test method, usability tests in library website evaluation have been limited mostly to formal usability test, which is usually conducted in labs with a limited number of subjects. In particular, few usability tests employed survey methods in library settings. This is partly because the survey method is not widely introduced for usability evaluation in library and information science field. Also, there is few evaluation survey tool directly applicable to measuring the usability of library websites. These limitations of current usability tests in library settings indicate a need for developing a usability evaluation method based on survey questionnaire for library websites.

3. Evaluation Framework

3.1 Evaluation constructs to be measured

In practice available usability models and guidelines differ in term of structure, content, elements, and terminology as reviewed in the previous section. This study intends to develop an evaluation tool to evaluate the usability of academic library website on the basis of user survey method. According to ISO 9241-11 (1998), usability is defined as the extent to which a product can be used by users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. As the definition shows, three constructs are used to account for usability in this standard, namely

effectiveness, efficiency, and satisfaction. In this study, a definition for each construct is following: 1) Effectiveness refers to the completeness at which users achieve specified goals; 2) efficiency refers to the resources used in completing a task; and 3) satisfaction reveals positive attitudes toward using the system (ISO, 1997).

Satisfaction would be a potentially controversy issue in designing usability evaluation research. Many usability models posit satisfaction as a parallel attribute to other usability attributes. ISO model also regarded satisfaction comparable to the other elements, effectiveness and efficiency. However, there is a concern whether satisfaction could be a comparable element in usability model because it is usually dependent on other different factors. When it is used as a measure for evaluation, satisfaction is usually affected by different performance and non-performance factors that may confound evaluation of information systems (Al-Maskari & Sanderson, 2010). That is, satisfaction can be interpreted as a subsequent result of other different factors and users' perceptions or experiences. For example, in case of system usability, a user who perceived a system effective and efficient would tend to feel more satisfactory to his/her uses of the system (Joo & Lu, 2011). Since dependency relationship exists between satisfaction and effectiveness and efficiency, it would be inappropriate to posit these three evaluation elements in theoretically parallel in terms of assessing usability. Addressing this possible dependency relationship, Joo (2010) investigated the relationship between satisfaction and effectiveness and efficiency, and empirically proved the existence of extremely high correlation between satisfaction and effectiveness (Pearson r=.889) and between satisfaction and efficiency (Pearson r=.736) and satisfaction and efficiency (Pearson r=.736). Based on these findings, he claimed that measuring satisfaction could be replication of other usability elements in assessing usability because satisfaction is dependent on other usability attributes such as effectiveness and efficiency. Considering this strong dependency of satisfaction on effectiveness and efficiency, the authors decided to exclude the construct of satisfaction in order to bring up a more parsimonious framework. By dropping satisfaction measurement, we were able to come up with a more economic evaluation tool that will be less demanding for users to answer the questionnaire. In this way, the study adopted only two usability constructs, effectiveness and efficiency, from ISO 9241 in evaluating the usability of library websites. Instead, learnability has been selected as an additional construct. There are several studies that identify

learnability as a key attribute of the usability (Brink et al., 2002; Guenther, 2003; Nielson, 1993). Based on Nielson's usability model (1993), learnability refers to how easy it is for casual users to learn a system. Thus, this study decided to develop a measurement instrument that covers three usability constructs including effectiveness, efficiency, and learnability.

3.2 Measurement items

A document analysis was applied to come up with initial measurement items for library website usability. An initial set of measurement items was extracted from related literature in usability studies. The authors reviewed previous literature in three domains: Firstly, most widely cited usability models were reviewed to identify measurement items, such as in Nielson's usability attributes (Nielson, 1993), ISO 9241-11 standards (ISO, 1998), and Shackel's model (Shackel, 1991); Secondly, some practical usability test manuals were utilized to generate initial measurement items (Nielson & Mack, 1994; Ray, 2002); Lastly, several empirical usability evaluation studies were chosen in various disciplines (Kim, 2005; Zazelenchuk, 2002; Bevan & Macleod, 1994; Jeng, 2005; Joo & Lee, 2011). All the chosen measurement items were modified to reflect the unique features of academic library websites. In this way, twenty six items were initially generated in relation to the three constructs of effectiveness, efficiency, and subjective satisfaction.

The initially identified 26 items were reviewed twice by one expert and twelve actual users respectively. The expert, who has worked at an interface-design consulting company and has manifold experiences in usability tests for years, was invited to review and update the items. She suggested excluding duplicate or irrelevant eight items to achieve parsimony of the evaluation tool. Accepting her suggestion, eighteen items were finally selected in three subscales, effectiveness, efficiency, and learnability, for evaluating library website usability. Additionally, the selected 18 items were reviewed by twelve actual users of the University of Wisconsin-Milwaukee (UWM) libraries, including one professor and eleven students. Through the reviews of actual users, the wordings of items were refined to be easily understood by common users. Table 1 presents the final items in three subscales (codes are used in an italic font to represent the each item).

4. Methodology

To validate the identified usability evaluation tool, a survey was administered to undergraduate and graduate students and faculty users at the University of Wisconsin-Milwaukee. The items were listed randomly

Table 1. Subscales and corresponding measurement items for academic library website usability

Subscale	Code	Item
Effectiveness	eft1	I can usually complete a search task using the UWM library website.
	eft2	I am successful in general in finding academic resource(s) using the UWM library website.
	eft3	Overall, the UWM library website is useful in helping me find information.
	eft4	I usually achieve what I want using the UWM library website.
	eft5	The resources I obtain from the UWM library website are usually useful.
	eft6	UWM library website usually covers sufficient topics that I try to explore.
Efficiency	efy1	It is easy to find the academic resources that I want on the UWM library website.
	efy2	The UWM library website is easy to use in general.
	efy3	I can complete a resource finding task quickly using the UWM library website.
	efy4	The UWM library website is well designed to find what I want.
	efy5	It is easy to perform searches on the UWM library website.
	efy6	I get the results of searches quickly when using the UWM library website.
Learnability	lrn1	It was easy to learn to use the UWM library website.
	lrn2	The terminologies used on the UWM library website are easily understandable.
	lrn3	The UWM library website offers easy-to-understand menus.
	lrn4	The UWM library website has appropriate help functions.
	lrn5	The UWM library website provides well-organized help information for new users.
	lrn6	It does not take a great deal of effort for new users to become proficient with the UWM library website.

to reduce a bias from the order of questions in the survey questionnaire. The survey was announced in seven classes, including three graduate courses and four undergraduate courses at the UWM, and students and lecturers in those classes were invited to fill out an online web survey. In this way, the final number of valid responses reached 147. Four respondents who had never used the UWM library website were excluded from the analysis because the questionnaire intended to measure a user's actual experience of library website uses.

Each item was measured by seven-point scale (strongly disagree; disagree; somewhat disagree; neutral; somewhat agree; agree; and strongly agree). Table 2 summarizes the demographic information of the respondents in the survey.

The collected responses were analyzed statistically to ensure the reliability and validity of the identified evaluation model. Two statistical analyses were employed: first, the reliability of measurement items was analyzed using corrected item-total correlation and alpha coefficient (DeVellis, 2003); second, construct validity, which indicates the extent to which an item accurately measures the associated construct (DeVellis, 2003), was examined based

Table 2. Demographic information of respondents

	Category	Frequency	Percentage
Age	18 – 24	63	42.9%
	25 – 30	49	33.3%
	31 – 40	22	15.0%
	41 – 50	10	6.8%
	51 – 60	3	2.0%
Gender	Female	77	52.4%
	Male	70	47.6%
Status	Undergraduate	62	42.2%
	Graduate	80	54.4%
	Professor/Lecturer	5	3.4%
Level of computer skill	Intermediate level (know one or two programs well, need some help)	44	29.9%
	Advanced level (know a number of programs, including advanced functions, learn easily)	69	46.9%
	Expert level (know a number of programs, including advanced functions, able to provide help)	34	23.1%
Use frequency	Daily or Almost Daily	40	27.2%
	Once or Twice a Week	49	33.3%
	Once or Twice a Month	46	31.3%
	Once or Twice a Year	12	8.2%

on a factor analysis.

5. Results

5.1 Descriptive statistics of item responses

For the eighteen items, descriptive statistics were investigated including mean, standard deviation, skewness, and kurtosis. Table 3 presents the descriptive statistics for item responses. Overall, a mean value of responses of all 18 items was 4.76, and the standard deviation was 1.45. When investigating by subscale, the effectiveness subscale items showed relatively higher means than the others. The data achieved a normal distribution with skewness and kurtosis values between -1 and 1. In terms of skewness, all the items turned out negatively distributed as the mean values were higher than four. For kurtosis, most items showed negative except *eft1* to *eft5*. Although the overall data showed negative skewness, the distribution was close to normal distribution, which reveals the measurement items are

Table 3. Descriptive statistics of responses for the measurement items

Item	Mean	Std. Deviation	Skewness	Kurtosis
eft1	5.11	1.43	-.93	.59
eft2	5.14	1.38	-.89	.78
eft3	5.17	1.37	-.87	.51
eft4	4.99	1.33	-.716	.17
eft5	5.35	1.35	-1.00	.95
eft6	4.77	1.43	-.45	-.14
efy1	4.65	1.36	-.37	-.01
efy2	4.73	1.43	-.43	-.60
efy3	4.58	1.40	-.49	-.10
efy4	4.38	1.52	-.29	-.50
efy5	4.61	1.53	-.59	-.16
efy6	4.67	1.44	-.53	-.21
lrn1	4.93	1.47	-.49	-.28
lrn2	4.94	1.45	-.52	-.35
lrn3	4.59	1.46	-.35	-.28
lrn4	4.54	1.34	-.03	-.33
lrn5	4.25	1.35	-.04	-.38
lrn6	4.35	1.50	-.19	-.57

appropriate to discriminate the differences of measurement in each construct.

5.2 Reliability of item responses

To examine the reliability of instrument, discriminant of each item, internal consistency, and item convergence were evaluated. Table 4 presents corrected item-total correlation coefficients (A and B), Cronbach alpha if deleted (C and D), and Cronbach's alpha by subscale and by total scale (E and F) respectively.

To evaluate the item discrimination, the corrected item-total correlation coefficients were computed using SAS. The column (A) and (B) in Table 4 present the corrected item-total correlation coefficients by total scale and

Table 4. Discrimination of each item, reliability of scale, and reliability analysis if deleted

Subscale	Item	Corrected item-total correlation by total scale (A)	Corrected item-total correlation by subscale(B)	Cronbach's alpha if deleted by total scale (C)	Cronbach's alpha if deleted by subscale (D)	Cronbach's alpha by subscale (E)	Cronbach's alpha for the overall items (F)
effectiveness	eft1	.526	.717	.952	.913	.920	.952
	eft2	.670	.837	.950	.896		
	eft3	.720	.788	.949	.903		
	eft4	.662	.821	.950	.898		
	eft5	.582	.760	.951	.906		
	eft6	.649	.710	.950	.914		
Efficiency	efy1	.780	.797	.948	.932	.940	
	efy2	.802	.858	.948	.924		
	efy3	.742	.782	.949	.933		
	efy4	.783	.828	.948	.928		
	efy5	.775	.817	.948	.929		
	efy6	.796	.841	.948	.926		
Learnability	lrn1	.745	.813	.948	.910	.927	
	lrn2	.727	.797	.949	.912		
	lrn3	.741	.812	.949	.910		
	lrn4	.708	.741	.949	.919		
	lrn5	.608	.773	.951	.915		
	lrn6	.675	.788	.950	.913		

subscale respectively. The corrected item-total correlation coefficient indicate item discrimination, which measures the extent to which the item is able to discriminate those with high subscale scores from those with low scores (Havercamp, 2009). As a rule of thumb, it could be acceptable when the value of the corrected item-total correlation is 0.5 or higher (Anastasi & Urbina, 1997). First, corrected item-total correlation coefficients by total scale were examined, which represented in the column (A) of Table 4. All the correlation coefficients turned out adequate ranging from 0.526 to 0.802, which represents all the items have moderate or high correlation with the overall scale. Then, the item discrimination was evaluated by subscale. The corrected item-total correlation coefficients by subscale were presented in the column (B) in Table 4. The corrected item-total correlation coefficients were between 0.710 and 0.821 for the items belonging to the effectiveness subscale. For the efficiency subscale, corrected correlation coefficients were between 0.782 and 0.858. For the leanability subscale, the corrected correlation coefficients were between 0.741 and 0.813.

The internal consistency, which represents the reliability of evaluation, was examined using Cronbach's alpha. A scale is internally consistent to the extent that its items are highly correlated with one another, and the Cronbach's alpha index can be used to examine the internal consistency of items (Havercamp, 2009). High internal consistency indicates that all of the items on the scale are measuring the same fundamental construct (Havercamp, 2009). The cut-off criterion for Cronbach's alpha is usually .85 (Aiken, 1997). The internal consistency reliability coefficients were examined in two levels, by total scale and by subscale, in this study. The Cronbach's alpha coefficient turned out 0.952 for the entire items, which is higher than the criterion of 0.85. That is, the internal reliability for the overall items is acceptable. Then, three separate Cronbach's alpha scores were computed for the three subscales separately. Each subscales exhibited adequate Cronbach's alpha well over .85. As shown in Table 4, alpha's for effectiveness, efficiency, and learnability subscales turned out .920, .940, and .927 respectively.

5.3 Construct Validity of the Measurement Instrument

This study then examined the construct validity of the instrument using a factor analysis. Based on the hypothetical framework, the study attempted to validate whether the three subscales, effectiveness, efficiency, and learnability, could be explained properly by the eighteen measurement items. The results of the factor analysis show that the three factors

accounted for 75.36% of the total variance at an eigenvalue of 1.026. The screeplot in Figure 1 shows a steep slope between the second and the third components, and the first three factors are appropriate to account for the three constructs of interest. Both the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity addressed the level of statistical significance (KMO measure of sample adequacy=0.921; Bartlett test: χ^2=2259.07, p<0.01).

Table 5 indicates a component matrix rotated by using the Varimax method with Kaiser-normalization. The factor loadings were examined to determine which items belong to which identified factors. The Construct 1, named as "effectiveness," consists of *eft1, eft2, eft3, eft4, eft5,* and *eft6*, the Construct 2, named as "efficiency," consists of *efy1, efy2, efy3, efy4, efy5,* and *efy6*, and Construct 3, named as "learnability," consists of *lrn1, lrn2, lrn3, lrn4, lrn5,* and *lrn6*. This structure between constructs and items confirms that the hypothetical evaluation model suggested in this study is valid in evaluating the three constructs of library usability. That is, this result reveals that the usability evaluation tool was appropriately constructed with operationalized items to measure the three constructs of usability in the context of academic library websites. The three constructs of usability, efficiency, effectiveness,

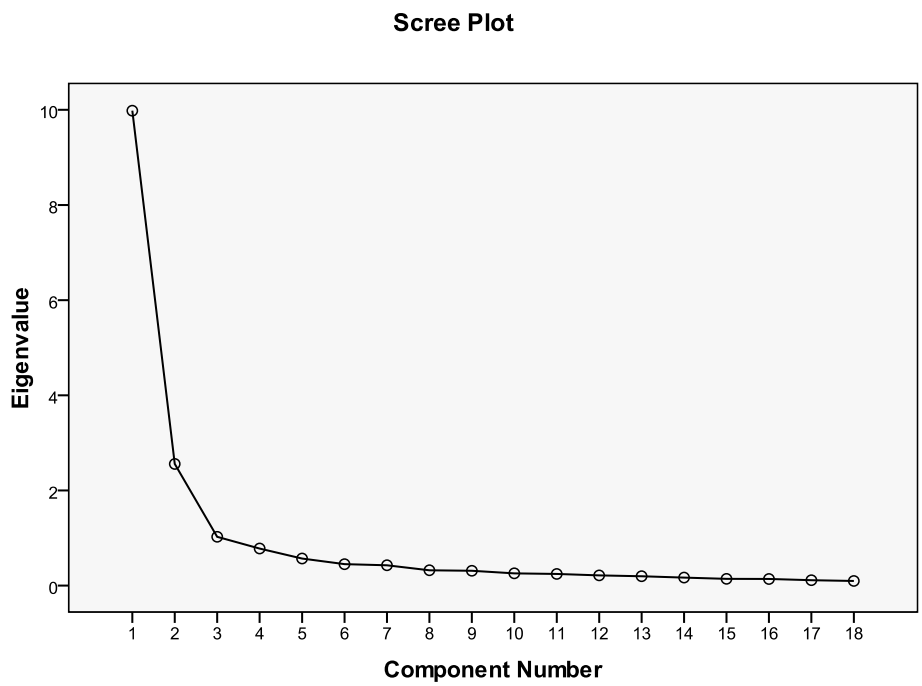

Figure 1. Screeplot of factor analysis

Table 5. Structural construct of usability evaluation tool (rotated component matrix of factor analysis)

	Construct		
	Construct 1	Construct 2	Construct 3
eft1	.871		
eft2	.843		
eft3	.760		
eft4	.749		
eft5	.731		
eft6	.729		
efy1		.848	
efy2		.839	
efy3		.838	
efy4		.791	
efy5		.771	
efy6		.723	
lrn1			.763
lrn2			.758
lrn3			.740
lrn4			.724
lrn5			.708
lrn6			.686

and learnability, and each contained six to seven measurement items in this factor analysis model.

6. Discussion and Conclusion

The purpose of this study is to engender the usability evaluation model for academic library websites. Based on literature review and expert consultation, this study identified eighteen measurement items to gauge the three attributes of the usability, effectiveness, efficiency, and learnability, in the context of academic library websites. The usability evaluation tool was then validated with regard to data distribution, reliability, and validity. The empirical examination of the instrument using 147 actual users proved the measurement items are adequate to be applied in the academic

library website usability evaluation.

This study brought some insights into the library website usability evaluation in both methodological and practical aspects. This study is one of the few studies that suggested measurement tools for library website usability evaluation. In the field of libraries, usability evaluation of websites has exclusively relied on usability test experiment (formal usability test), heuristics methods or expert inspection although a user questionnaire survey is easy to conduct and involves a large sample. Since few measurement tools have been validated and directly available, the user survey method has not been widely utilized in the evaluation of library website usability. The present study followed a standardized method of validating the measurement items derived from psychometrics studies. The methodology in this study could serve as an example to develop a measurement instrument in other services in the discipline of library and information sciences. As to the practical contribution, the study proposed the measurement items to evaluate the main three usability attributes of academic libraries, effectiveness, efficiency, and learnability, directly applicable to the field. These measurement items will be able to help librarians and administrators conduct website usability evaluation involving large samples in academic library communities.

However, this study also has some limitations. Although the usability consists of various attributes discussed in literature reviews, the measurement tools suggested in this study covers only three amongst them. In addition, the number of samples in the study is needed to be extended to better represent the entire users of the UWM library. Since the limited number of sample, the study could not apply a confirmatory factor analysis, which enables the investigators to further examine the structural relationships between constructs and associated items.

These limitations illustrate a further study that develops an extended evaluation model to cover more usability attributes such as memorability, flexibility, error tolerance, adaptability, and helpfulness. Also, the future study needs to enlarge the sample size not only to better generalize the validation of the measurement tool but also to further ensure the structural validity of the items. In particular, a structural equation modeling with large sample size will enable to conduct a confirmatory factor analysis which offers more critical analysis to ensure the construct validity.

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