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Doing e-Research with e-Library: Determinants of Perceived Ease of Use of e-Library

Main Description

The purpose of this paper is to test a model which identifies factors associated with the ease of use of online libraries. Many researchers have shown that ease of use is an important driver of intention to use and actual usage of a particular technology. The model tested incorporated important elements of the Technology Acceptance Model developed by Davis (1989) and the model proposed by Thong et al. (2002). Data was collected from 975 undergraduate and post graduate students from Universiti Sains Malaysia using a structured questionnaire. The findings of the study show that interface characteristics such as terminology ($\beta=0.406$, $p<0.01$), screen design ($\beta=0.124$, $p<0.01$), and, navigation ($\beta=0.052$, $p<0.01$) were the most influential predictors of ease of use, followed by organizational context, relevance of the system ($\beta=0.189$, $p<0.01$) and accessibility ($\beta=0.045$, $p<0.05$). Individual differences such as computer self efficacy ($\beta=0.016$), computer experience ($\beta=0.023$) were not significant with only domain knowledge ($\beta=0.205$, $p<0.01$), being a predictor of ease of use. The total variance explained was 64.8% suggesting a good model fit. Implications for system designers and the university are provided.

Keywords

Interface Characteristics
Individual Differences
Organizational Context
e-Library
e-Research
Perceived Ease of Use
Students

Doing e-Research with e-Library: Determinants of Perceived Ease of Use of e-Library

Introduction

The advent of technology has changed the way business is conducted today. The education sector is also not spared. The advent of the Internet has revolutionized the way learning is done and how knowledge is disseminated. The higher education sector is experiencing an unprecedented growth rate. This trend is largely a result of new enabling technologies that have facilitated the virtual delivery of academic programs. This has in turn led to libraries becoming key success factors in the virtual academic environment (Cahoy & Moyo, 2003). Gone are the days where the brick and mortar library was the only source of information for those endeavouring to do research. The new emerging technology that is the trend today is the use of the online or digital library to do research on a wider scale.

Akla (2002) defines the online library as a digital library that requires technology to link the resources of many libraries and information services. Akla (2002) also said that an online library can also be defined as “repositories of information product”, “computerized, networked library system”, “database accessible through the internet”, and “libraries with online catalogs”. Borgman (1999) proposed that digital libraries can be viewed as electronic collections that are much richer in content and more capable in functionality than databases or information retrieval systems. The digital library can also be visualized as a computer-based system for storing, acquiring, organizing, searching and distributing digital materials for end user access. It requires less space and the data can be made available through communication networks to anyone anywhere while facilitating searches with speed (Sharma & Viswanathan, 2001).

Thong et al. (2002) summarized from the works of Wiederhold (1995) and Barnett (1998) that the major advantages of digital libraries over paper libraries include:

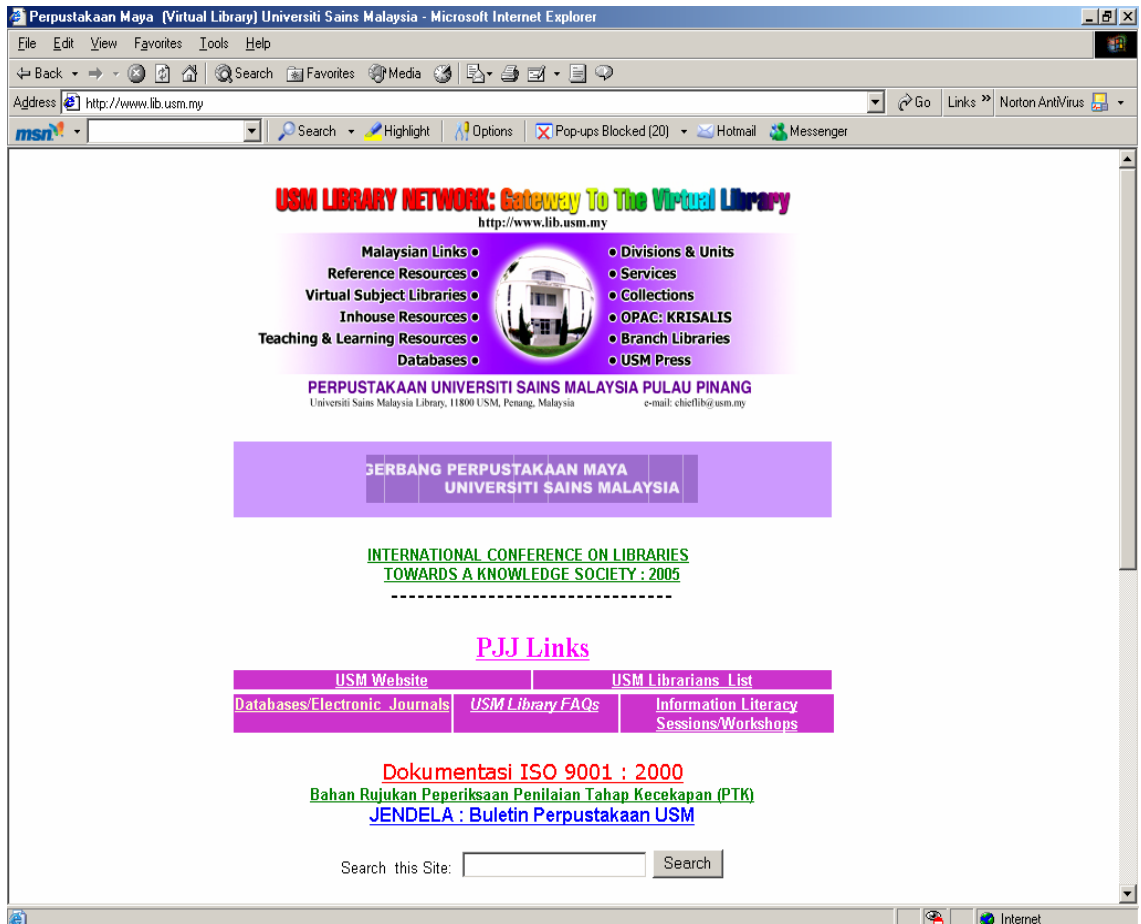
- i. it is easier to keep track of resources stored in digital form;
- ii. remote, fast and fair access of digital library collections; and
- iii. techniques for searching offer increased flexibility and power to users.

Universiti Sains Malaysia’s Digital Library

Universiti Sains Malaysia, a public higher education institution has come a long way by providing online library services for its student enrolled in various academic disciplines. The Automation Division of the USM Library is

responsible for managing the library integrated online system. The USM online library provides a huge information database through its Malaysian Links, in-house resources, databases etc. As for the databases, students can have access to various local and international databases related to any imaginable field by accessing the likes of EBSCO Host, ProQuest, Science Direct, IEEEExplore, Emerald, Inside Web, Springer Link, Global Market Information Databases, PsycARTICLE, and others. The official home page is shown in Figure 1.

Figure 1
Universiti Sains Malaysia's Digital Library



Universities world over have been investing millions of dollars in building usable digital libraries but researches have shown that potential users may still not use them (Thong et al., 2002). With all these resources invested in developing systems and improving functional performance, digital libraries can still remain unnoticed by students or are seriously under-utilized in spite of their availability (Hammond, 1994; Wood et al., 1995; Hsieh-Yee, 1996). In order to encourage university students to use the digital library, we need to understand what factors influence the intention to use the available services of these online sources.

Thus the purpose is to study the ease of use of digital library:

- i. studying the impact of interface characteristics (Terminology clarity, Screen design and Navigation clarity) on the ease of use of a digital library,
- ii. studying the impact of organizational context (Relevance and System accessibility) on the ease of use of a digital library
- iii. studying the impact of individual characteristics (Computer self-efficacy, computer experience and domain knowledge) on the ease of use of a digital library.

Theory and Hypotheses Development

Several models have been developed to investigate and understand the factors affecting the acceptance of computer technology in large organizations. Among the notable models include Technology Acceptance Model (TAM) (Davis, 1989), Theory of Reasoned Action (TRA) Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980) and Theory of Planned Behavior (TPB) (Ajzen, 1985; 1991). TAM was developed by Davis (1989) to explain the computer-usage behavior and has adopted the generic TRA model to the particular domain of user acceptance of computer technology. TAM adapted the TRA's belief-attitude-intention-behavior relationship to model user acceptance of IT. The goal of TAM was "to provide an explanation of the determinants of computer acceptance that is generally capable of explaining user behavior across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis, 1989).

TAM proposes that the intention to adopt an information system is determined by two beliefs 1) perceived ease of use (PEU) and 2) perceived usefulness (PU). Davis et al. (1989) further proposed that this belief is influenced by external variables such as design characteristics, training, computer self-efficacy, user involvement in design, and the nature of implementation process. PU is defined as the extent to which a person believes that using a particular system or technology would enhance his/her job performance. PEU on the other hand, is defined as the extent to which a person believes that using the particular system or technology would be free from effort (Davis, 1989). Since many researchers have

successfully used the model to predict technology usage in different setting, the goal of this paper is to explore the impact of external variables on perceived ease of use only.

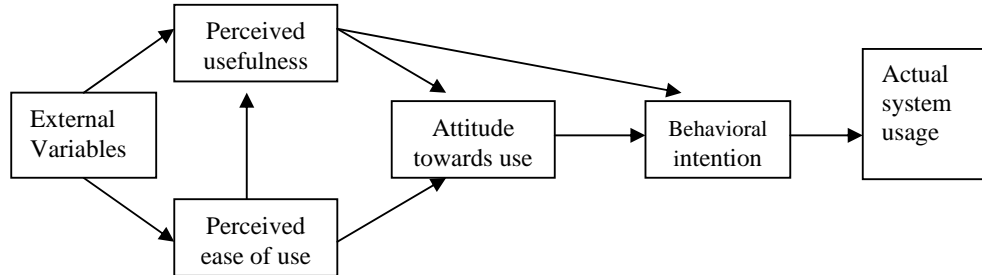


Figure 2

Technology Acceptance Model (TAM) (Davis et al., 1989)

Since many researchers have successfully used the model to predict technology usage in different setting, the goal of this paper is to explore the impact of external variables on perceived ease of use only.

Interface Characteristics

Interface characteristics refer to the interaction between the system and the users. Interface characteristics comprise terminology, screen design and navigation. According to Lindgaard (1994) terminology refers to the words, sentences, and abbreviations used by a system, screen design on the other hand is the way information is presented on the screen whereas navigation clarity is the ease with which users can move around the system. The impact of interface characteristics has been shown to influence user performance by library and information science researchers such as Meadow et al. (1995) and Rao et al. (1995). The impact of these three characteristics on the ease of use has been proven by the research on digital library by Thong et al. (2002). Based on Thong et al.'s (2002) work we proposed terminology clarity, screen design and navigational clarity were selected as the determinants of ease of use.

Terminology

Terminology is a set of words or expressions used in a particular subject. McClements and Becker (1996) suggest that when online, accessing web sites or databases, the use of correct keywords are important to provide information. Clear terminology increases the ease of use of digital libraries by providing effective communication of system instructions and responses to the users (Thong et al., 2002). To achieve terminology clarity, efforts must be made to match the system's vocabulary with users' language. Technical terms and jargons are to be avoided. If necessary, technical terms should be accompanied by clear

explanations. Talja et al. (1998), reiterated that one major problem with the digital library is inappropriately used jargons. A digital library's success depends on how users interact with the system. In a very recent study on digital library acceptance by postgraduate students in Malaysia, Goon (2004) found that terminology clarity was positively related to ease of use. Therefore, it is hypothesized that terminology clarity will have a positive impact on ease of use.

H₁: Terminology clarity will have a positive impact on perceived ease of use of the digital library

Screen Design

Screen design is a visual appearance or a general attractiveness of the site. McClements and Becker (1996) also suggest that links connecting all of the sites pages to the site's home page, identifying graphics on each page, a short hyperlink, links, limited use of graphic, short cut and user testing are desirable design elements. Rettig (1996) suggests that factors normally considered in connection with print sources, such as logic of organization, authority of the information provider, comprehensiveness of treatment, ease of use, range of search capability and availability are also related to ease of use. Todd and Benbasat (1992) and Lim et al. (1996) argued that the way information is presented on the computer screen is also capable of influencing the user's information search strategies and performance. In other related studies, Hu et al. (1999) and Liu et al. (2000) proposed that graphical user interfaces were found to enable richer interaction with users in both retrieval systems and digital libraries. However, in the recent study of Goon (2004) it was found that screen design was not a determinant of ease of use. Nevertheless, it is hypothesized that screen design will have a positive impact on ease of use.

H₂: Screen design will have a positive impact on perceived ease of use of the digital library

Navigation

Navigation features allow the site's visitors easy access to the information of interest, both internal and external to the site. They also provide the organization the ability to develop a site with restricted access or hyperlinks to other sites (Robbins & Stylianou, 2001). Klobas (1996) said that navigation is the way of finding out what relevant files or databases exist and where they are located. Dillon (2000) argued that users often become disoriented when they try to locate digital information. This was supported by Marchionini et al. (1998), who proposed that the major reason for disorientation is due to the cognitive load necessary to navigate a conceptual space with a complex structure and few

landmarks. Navigation features allow the site visitors easy access to information of interest, both internal and external to the site. They also provide the organization the ability to develop a site with restricted access or hyperlinks to other sites (Robbins & Stylianou, 2001). Digital libraries can make it easier for users to follow the logical flow and conduct more efficient searches by providing navigational aids or enhancing the amount of unique landmarks although Goon (2004) found otherwise. It is hypothesized that navigation clarity will have a positive impact on ease of use.

H₃: Navigation clarity will have a positive impact on perceived ease of use of the digital library

Individual Differences

According to Thong et al. (2002), the relationship between individual differences and information systems success was first described in a theoretical framework proposed by Zmud (1979). Individual differences consist of computer self-efficacy, computer experience and domain knowledge. Computer self-efficacy is defined as an individual judgment of one's capability to use a computer (Compeau & Higgins, 1995, p.192). Computer experience refers to computer skill and length of use. Domain knowledge refers to user's knowledge in the subject domain.

Individual differences play a major role in determining user performance on information retrieval systems (Borgman, 1987; Chen et al., 2000). Previous studies have examined the impact of various individual factors on information system adoption behavior (Igarria et al., 1995; Jackson et al., 1997; Agarwal & Prasad, 1999). However, given the advances in virtual environments, especially through far-reaching technologies such as the World Wide Web, the effects of individual differences on the use of these newer technologies may not be fully explained by theories and methods developed for earlier generations of information systems (Chen, Czerwinski & Macredie, 2000). Therefore, there is a need for empirical research to examine the effect of individual differences in the new technology environment.

According to Compeau and Higgins (1995), computer self-efficacy refers to an individual judgment of one's capability to use a computer. Meanwhile, Venkatesh and Davis (1996) discovered that computer self-efficacy has a positive impact on general computer usage behaviour.

H₄: Computer self-efficacy will have a positive impact on perceived ease of use of the digital library.

Wang et al. (1998) argued that general computer experience can affect successful interaction with personal computers, the World Wide Web, and information retrieval systems. However, Thompson et al. (1994) mentioned that within the context of information technology, both self-reported computer skill and length of use should be measured because they represent distinct dimensions of general computer experience. Therefore, more computer experience shall lead to higher level of perceived ease of use:

H₅: Computer experience will have a positive impact on perceived ease of the digital library.

According to Marchionini et al. (1990), domain experts were found to conduct faster and more focused searches than novices in a study of information seeking behavior. On the other hand, Meadow et al. (1995) argued that domain knowledge can help users separate relevant information from irrelevant ones and thus increase effective searches. Thus, this leads to the following hypothesis:

H₆: Domain knowledge will have a positive impact on perceived ease of use of the digital library.

Organizational Context

Thong et al. (2002) argued that organizational context variables were found to have significant impact on intention to use digital libraries through both perceived usefulness and perceived ease of use. Organizational context comprise relevance, system accessibility and system visibility. Relevance refers to the integrability of the system into work practice, which is how smoothly the system fits into the person's or a group's work practices (Kling & Elliott, 1994). System accessibility is defined as the ease with which people can locate specific computer systems (Kling & Elliott, 1994). System visibility originates from the concept of system observability, which is one of the key characteristics of technology innovation identified by Rogers (1995).

Among the three organizational context variables, relevance showed the strongest effect on perceived usefulness, and was greater than the effect of perceived ease of use. This is consistent with Venkatesh and Davis's (1996), who found that there is a direct effect from job relevance to perceived usefulness of a number of management information systems. In order to increase the relevance of library content to students' information needs, digital library designers should pay more attention to user requirements analysis to discover their expectations and requirements for the content of digital libraries, and then incorporate relevant materials into the systems.

The user's search effort is more likely to be more productive and effective if there is relevant information. Thus, the user will perceive the Digital Library as easy to use. As such, the following hypothesis is formulated:

H₇: Relevance of the system to the users' information needs will have a positive impact on perceived ease of use of the digital library

According to O'Reilly (1982) and Culnan (1983) and Hardy (1982), perceived accessibility was one of the important determinants of the frequency of using information sources and the selection of information channels. On the other hand, Kraemer et al. (1993) stated that greater accessibility of computer-based information contributes to greater usefulness of the information to the managers. System accessibility will also enhance user's perception of the ease of using digital libraries. Thus, the following hypothesis is formulated:

H₈: System accessibility will have a positive impact on perceived ease of use of the digital library

The research model is presented in Figure 3.

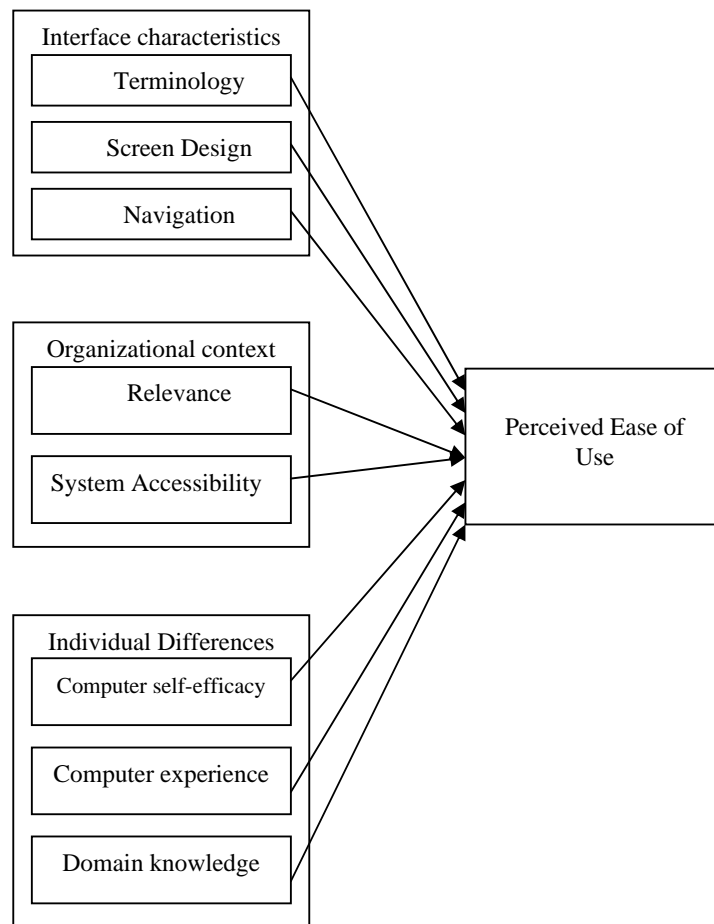


Figure 3
Research Model

Methodology and Results

The population for this study consisted of students enrolled at the Universiti Sains Malaysia. Data was collected using a structured questionnaire. A total of 975 responses were collected using a convenience sampling. Thirty six point one percent were male, while 63.9% were female. In terms of race, a majority, 48.9% were Malays, followed by Chinese (37.7%, Indians (10.5%) and others (2.9%). A total of ninety four point seven percent of the respondents were aged below 25 as the majority of them were undergraduates.

The demographic profile of the respondents is presented in Table 1.

Table 1
Demographic Profile of Respondents

Variables	Frequency	%
Gender	352	36.1
Male	623	63.9
Female		
Race		
Malay	477	48.9
Chinese	368	37.7
Indian	102	10.5
Others	28	2.9
Program of study		
Undergraduate	874	89.6
Masters	96	9.8
Ph.D.	5	0.5
Age		
19-20	160	22.7
21-22	354	50.3
23-24	153	21.7
>=25	37	5.3
Computer usage experience		
< 1 year	26	3.7
1-2 years	84	11.9
3-4 years	145	20.6
5-6 years	198	28.1
7-8 years	99	14.1
9-10 years	67	9.5
> 10 years	85	12.1

Frequency of e-library usage		
More than once a day	133	18.9
About once a day	95	13.5
2 or 3 times a week	125	17.8
About once a week	135	19.2
About once in 2 weeks	151	21.4
About once a month	42	6.0
Less than once a month	23	3.3

Instrumentation

The questionnaire used was adapted from Davis (1989) and Thong et al. (2002). The questionnaire was divided into two sections. The first section was used to collect information about the profile of the respondents whereas the second section was used to collect data on the ten constructs used in this study.

The descriptive statistics and the corresponding Cronbach alpha values for reliability are presented in Table 2. The reliability analysis showed that the coefficient obtained for all constructs were well above the 0.7 acceptance level (Nunnally & Bernstein, 1994), indicating a sufficiently reliable measurement.

Table 2

Descriptive of the Major Variables with Corresponding Reliabilities

Variable	Mean	Standard deviation	No. of Items	Cronbach's alpha
Terminology	4.322	1.231	2	0.85
Screen design	4.353	1.238	2	0.83
Navigation	3.900	1.308	1	-
Relevance	4.357	1.113	2	0.77
System Accessibility	4.270	1.363	1	-
System Visibility	4.640	1.359	1	-
Computer self efficacy	4.645	0.907	8	0.86
Computer experience	4.070	1.611	1	-
Domain knowledge	4.364	1.179	2	0.87
Perceived ease of use	4.499	1.097	4	0.88

Table 3
Intercorrelation of major variables in the study

	1	2	3	4	5	6	7	8	9	10
1. Terminology	1.000									
2. Screen	0.62**	1.000								
3. Navigation	-0.18**	-0.15**	1.000							
4. Relevance	0.53	0.53**	-0.26**	1.000						
5. Accessibility	0.54**	0.52**	-0.04	0.54**	1.000					
6. Visibility	0.23**	0.14**	-0.24**	0.23**	0.15**	1.000				
7. Self Efficacy	0.39**	0.40**	-0.30**	0.39**	0.32**	0.32**	1.000			
8. Experience	0.19**	0.19**	0.01	0.14**	0.06*	-0.03	0.09**	1.000		
9. Domain	0.60**	0.52**	-0.13**	0.50**	0.51**	0.20**	0.45**	0.12**	1.000	
10. Ease of Use	0.71**	0.61**	-0.11**	0.57**	0.55**	0.25**	0.38**	0.18**	0.61**	1.000

**p < 0.01, *p < 0.05

The results from the correlation analysis (Table 3) do not indicate any serious problem of multicollinearity.

Results

A standard regression analysis was used to test the hypotheses generated and the results is presented in Table 4.

Table 4
Regression Analysis Results

Variable	Standardized Beta
Terminology	0.406**
Screen design	0.124**
Navigation	0.052**
Relevance	0.189**
System Accessibility	0.045*
Self efficacy	0.016
Computer experience	0.023
Domain knowledge	0.205**
R ²	0.648
Adjusted R ²	0.645
F value	219.97**

** p<0.01, *p<0.05

The findings of the study show that interface characteristics such as terminology ($\beta=0.406$, $p<0.01$), screen design ($\beta=0.124$, $p<0.01$), and, navigation ($\beta=0.052$, $p<0.01$) were positively related to ease of use of the digital library. These gives support for H₁, H₂ and H₃ of the study.

As for organizational context, relevance of the system ($\beta=0.189$, $p<0.01$) and accessibility ($\beta=0.045$, $p<0.05$) were also found to be significantly related to ease of use of the digital library which gives support to H₄ and H₅ of the study.

As for the individual differences, computer self efficacy ($\beta=0.016$) and computer experience ($\beta=0.023$) were insignificant whereas domain knowledge ($\beta=0.205$, $p<0.01$) was positively related to ease of use of the digital library. Thus H₆ and H₇ are not supported whereas H₈ is supported.

The F value (219.97, d.f. = 8, 966) was significant at the 0.01 level and the total variance explained was 64.8% suggesting a good model fit. The variables ranked in order of their influence would be terminology, domain knowledge, relevance, screen design, navigation and system accessibility.

Discussion and Implications

Interface characteristics were found to be strong predictors of ease of use. Terminology clarity was found to be the most influential predictor which suggests that clear terminology is the factor that must be paid greatest attention. This finding supports the research of Thong et al. (2002), who suggested that clear terminology increases the ease of use by providing effective communication. They also suggested that to increase terminology clarity there should be a match between the vocabulary of the system and the vocabulary of the users. The idea here is that the audience is the most important factor in the decision to use whatever terminology selected. As at the end of the day the users are the ones who determine whether the system is effective or otherwise. The terminology used must be easily understood and also has to be consistent throughout. The designers of the digital libraries should make an effort to reduce the confusion that may arise when the general users log on to the system. Thong et al. (2002) suggested that the designers conduct a focus group interview to further understand and clarify the terminology that will be used to increase clarity. Screen design was also found to be a significant predictor of ease of use which is similar to that of Thong et al. (2002). Screen design is very much related to the arrangement of the contents in logical groups. These include layout, colour schemes, and format of paragraphs, icons, buttons, font size, and line spacing (Thong et al., 2002). This consistency should be maintained at all times and across all screens. Navigational clarity was weakly correlated to the ease of use which was similar to the findings of Thong et al. (2002). The design should take into consideration the ease of navigation among the different services provided. Proper cues (help screens) and so forth should be incorporated to help users who get into trouble while navigating the increasingly complex web of digital libraries.

Both system relevance and accessibility were found to have a direct impact on the perceived ease of use of the digital library. The users' search effort is more likely

to be productive and effective if there is relevant information in the digital library. Thus students are more likely to find the digital library easy to use if the resources in the digital library relate well to their study needs. This would facilitate the research work of post-graduate students who wish to have access to electronic journals and books. This finding is also similar to the study of Thong et al. (2002). System accessibility also influences the perceived ease of use of the digital library according to the present study. With more accessibility students would find it to be easier to use as they become more accustomed to the system compared to if there is not much accessibility. This finding also supports the findings of Thong et al. (2002).

This study also found domain knowledge to be a good predictor of perceived ease of using digital library. This result is consistent with the study conducted by Thong et al. (2002). Domain experts could conduct faster and more focused searches than novices as they are able to separate relevant information from irrelevant responses and increase effective searches. If end-users possess domain knowledge, they are more likely to find the digital library easy to use. They are also more likely to use the digital library more often in their research. However, computer experience and self-efficacy did not have much impact on the perceived ease of using a digital library in this study. Although computer skill and length of use, being dimensions of general computer experience may not be related to digital libraries directly, they can help users learn how to use new systems more easily. Thus, computer experience should lead to a higher level of perceived ease of use of digital library. The results of this study clearly contradicted with the findings of Thong et al. (2002).

Limitations

As with many other research studies, this study also has some limitations. The first limitation relates to the representativeness of the sample. The use of a convenience sampling may limit the generalizability of the findings. The second limitation is that we have used single item measures for system accessibility, system visibility and navigation as such it was not possible to test for the reliability of the measure used.

Conclusion

This study has identified the significant components of interface characteristics, organizational context and individual differences impact on ease of use. It is hoped that the findings of this study will be incorporated by people who build digital libraries. Factors such as exclusion of technical terms and jargon to enhance ease of use of digital libraries should be taken into consideration. Clear terminology to provide effective communication of system instructions and responses to users should be given priority by organisers of digital libraries. Navigational clarity should also be given importance by the technical designers.

What comes out of the whole research is that although the design is the domain of computer scientists, care must be taken to incorporate the input of the behavioural scientists in terms of the interface characteristics so that the acceptance of the digital library can be increased. There should be a concerted effort to maintain a balance in all three areas to enhance the usage of digital libraries so that the millions of dollars invested is put to use by the end-users.

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