Examining the relationships of electronic library individual usage and impact using partial least squares: a formative measurement model

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ABSTRACT
The conceptualisation of individual usage in Information Systems (IS) research is still undergoing debate and development. Despite several conceptualisations and substantial discussions in the literature, the use of formative indicators for constructs' (latent variables) measurement in empirical studies is still scant. In practice, many of the usage measures were conceptualised as reflective but tested as formative. The partial least squares (PLS) path modelling has in fact rarely been applied in modelling relationships between the posited success constructs in IS research. Only in the early 2000s has the approach gained attention in IS management. In attempting to bridge this gap, this paper examines the relationships between electronic library usage and individual impact where the usage measures were hypothesised as formative measures. It examines the relationships between the individual usage of electronic library for information provisioning and individual impact dimension in an IS Impact model. All of the three hypothesised causal paths among electronic library usage constructs and individual impact tested were supported by PLS.

Keywords: Electronic library; Individual usage; Individual impact; Formative measurements; Partial least squares.

INTRODUCTION

In Information Systems (IS) research, usage can be conceptualised as the use of a system (Rai, Lang and Welker 2002; Hartwick and Barki 1994) or the use of information from the system (Szajna 1993; Barkin and Dickson 1977). An electronic library covering online as well as electronic resources is one such information system. The use of electronic libraries for information provisioning is an important area for investigation because the patterns of use may reveal how and for what the electronic library system is used. However, the pattern of use is not only based on the usage of electronic libraries in the form of hours of use or frequency of use as these measures might not be sufficient in measuring the success of today's IS. Current IS technology produces contemporary electronic libraries which require more research in defining the usage context rather than depending on traditional forms of usage in terms of hours and frequency of use. Nevertheless, the conceptualisation

of individual usage in IS research is still debatable despite the extensive number of studies which used usage construct as a key success dimension in evaluating IS.

Ambrose, Rai and Ramaprasad (2006) claimed that in spite of being identified as a key IS success construct, IS usage (use or utilisation) has received perfunctory treatment in IS research. Although system usage had been reviewed many times in the 1970s (Barkin and Dickson 1977), research suggests there has been a dearth of studies focusing on system usage (DeLone and McLean 2003) as well as on the theoretical discussion of its conceptualisation (Sedera and Tan 2007) since then. Similarly, Goodhue and Thompson (1995) criticised IS usage for being inadequately conceptualised, defined, and operationalised in theory and practice. A study from Sedera and Tan (2007) indicated three main issues in usage: lack of a holistic definition, lack of a theoretical grounding, and issues associated with its measures. A more contemporary IS usage context was introduced by Ambrose, Rai and Ramaprasad (2006) viz. breadth of content, depth of content and interaction dynamism. They highlighted the importance of defining the three IS usage properties with theoretically grounded measures, and developed the usage measures which are employed in a formative mode. Despite several usage conceptualisations and substantial discussions in the IS literature, the use of formative usage constructs (latent variables) in empirical studies is also still scant. In practice, many of the usage measures were conceptualised as reflective but tested as formative.

In attempting to bridge this gap, this study examined and empirically tested the relationships among the theoretically grounded formative IS usage constructs developed by Ambrose, Rai and Ramaprasad (2006). This was done by using the hypothesised paths with the individual impact dimension in the IS Impact model developed by Gable, Sedera and Chan (2008). This paper highlights the causal paths relationships the electronic library usage measures where they were posited as formative. This is the first study addressing the causal relationships of formative IS usage constructs of individual impact dimension in evaluating IS success. Usage context was defined as the academic electronic library usage for provisioning users with knowledge and information for academic or research purposes. Electronic library usage may draw to a process leading to academic use. This study proves the usefulness of the electronic libraries in supporting the information services of academic libraries and how well they support the information needs of the target users. The academic electronic library is thus defined as online library resources maintained and monitored by the higher institution library authority to deliver resources, services and functionalities for students, academicians and researchers at the university. The term “academic electronic libraries” in this study is a holistic definition to highlight the online library resources provided by the university library such as, e-journal, e-book, e-thesis and online past exam papers, for users’ (students/academicians/researchers) studying and researching purposes. We contend that getting empirical evidence from the universities with regards to the usage of academic electronic library will be relevant for the academic community in Malaysian universities.

Academic courses and curriculum designed at higher institutions vary in discipline as well as each being interdisciplinary, with a combination of theory and practice. This leads to the formation of academic communities which respectively require (or share) similar academic information, knowledge, interest and research topics. For example, Library and Information Science (LIS) students need to know foundation statistical theories to analyse research data thus the knowledge of interest here is not only on LIS but also statistics. Indirectly, the interdisciplinary concept exists among members of the academic community increasing the need for resources to obtain such academic information. Academic

information is therefore defined as information and knowledge which fulfils and satisfies the academic community's information needs provisioned by the resources provided by the academic electronic library.

The objective of the paper is to examine the relationships between the usage of information provisioning as posited by Ambrose, Rai and Ramaprasad (2006) and the individual impact (II) construct, as postulated by Gable, Sedera and Chan (2008) in the IS Impact model. This study is part of a broader research aimed at modelling the success of digital library using the Gable and colleagues' IS Impact model. According to Gbaje (2007), the term electronic library and digital library have been used synonymously. However, due to some basic differences of both, this study uses academic electronic libraries as an initiative to the digitized scholarly materials that can be accessed using networked environment provided by the higher institutions. For this reason, the term "digital library" is used interchangeably with "electronic library" in this paper. Hence for testing the paths of dimensions and indicators in influencing the usage of the system, the Digital Libraries Usage for Information Provisioning (DLUIP) was proposed using formative measurements defined by Ambrose, Rai and Ramaprasad (2006). The formative usage properties postulated and validated by Ambrose and colleagues (2006) as formative measures were content breadth, content depth and interaction dynamism. With all the formative measures and constructs, the partial least squares (PLS) path model was used in examining the relationships. The proposed formative measurement model comprised three first-order formative DLUIP measures and one second-order formative II measures. The paper is organized as follows. The following section presents a review of related work. Next, the paper focuses on the theoretical model of the formative and partial least square path models. The subsequent section discusses the methodology, followed by a discussion of the study's findings. The final section concludes the discussion with suggestions for future research in the area.

LITERATURE REVIEW

Internet Usage for Information Provisioning (IUIP) is a theoretical framework developed by Ambrose, Rai and Ramaprasad (2006), as shown in Figure 1. The framework aims at developing theoretically grounded measures of IUIP for the provisioning of information needed by clinical decision-makers where its conceptualization is based on the use of the system for the context of diagnostic decision-making. They view the IUIP construct as an evolution of the concept of IS usage where usage is conceptualised the *use of a system*. From the perspective of IS research, *use* may reflect the usability of the system. The International Standards Organisation (1994, p.10) defines usability as "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." Blandford and Buchanan (2003) once admitted there is no consensus on what the key criteria are for evaluating the usability of systems such as digital libraries. Similarly, Jeng (2005) believed that usability is an elusive concept and determined by the tasks, the users, the product, and the environment. In the literature the term "usability" has been used broadly to refer to different things and with different types of evaluation according to the nature of the digital library used (Razilan et al. 2011). This research, however, focuses on the system of digital libraries treated and used as a means to provide individual users with information at all levels that they need for academic purposes (education/academic research).

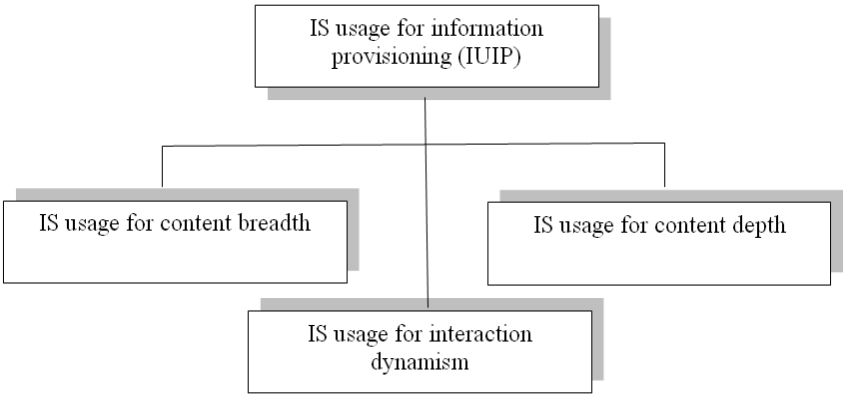


Figure 1: The properties of IUIP

In Figure 1, three properties of IUIP are shown (without the directions of arrow showing the causal relationship); usage for content breadth (CB), usage for content depth (CD) and usage for interaction dynamism (ID) were tested using formative test. The development of this framework was basically grounded by Technology-to-Performance Chain (TPC) theory. The usage construct included how the system was used to obtain or provide different types of information to satisfy the information processing needs. Each indicator measured for each dimension was selected based on the TPC theory, and the construct development was validated in accordance with the formative measurement model procedure.

Based on the limited previous studies in the area, Bawden and Vilar (2006) believed that there is evidence that expectations differ between different types of digital library users. They referred to Hill et al.'s (1997, cited in Bawden and Vilar 2006) study of University of California that found differences in users' expectations among earth scientists, information specialists, and educators. Earth scientists, for example, expected tight links between the library resources and their local data manipulation environment, while educators expected content and functionality in direct support of educational goals. Although a particular digital library may not possibly fulfil all types of users' needs, at least having the knowledge of their requirements is worthwhile in successfully implementing digital libraries. This is because the impact of usability of digital libraries would also determine the survival of digital libraries in the long run. The digital library should be viewed as a support tool in learning and teaching activities among academic users. If the system is not beneficial, they may have less preference in using it. Such negative trait, as an example of the many other traits (including positive ones), could affect individual usage of digital library.

As mentioned earlier, in IS literature the usage of the system has led to different meanings that in turn led to different paradigms of research: IS for decision-making, IS implementation, IS acceptance and IS success. The aforementioned definition of usage is as used by an electronic library specifies *how* and *for what* the electronic libraries are used for information provisioning. Moreover, usage measures are important measures in analysing IS success (for the study, it refers to the success of the digital libraries). IS success can be treated as an event in a process leading to individual impact and organisational impact (Sedera, Tan and Dey 2006; Burton-Jones and Straub 2006; Seddon 1997). The event should focus on the nature of causal relationship between usage and IS success. The relationships between the six main constructs of a well-known DeLone and McLean's IS Success model (1992) have been tested by many researchers (Gable, Rai and Ramaprasad 2008; Petter, Straub and Rai 2007; Seddon 1997; Hunton and Flower 1997). As a result, the studies yielded mixed results that witnessing the evidence of causal paths. As criticised by

Ballantine et al. (1996) and Myers, Kappelman and Prybutok (1998), DeLone and McLean's model raised some questions in the causal nature in which Seddon (1997) believed needed to be supported by some model paths. Thus, the use of digital libraries is worth investigating, such as how the system is beneficial to the individual (i.e., causal relationships between individual usages). This study attempts to gain a broader understanding of the nature of relationships between digital library usage measures (when posited as formative) and individual usage impact (as success dimension for assessing the IS success).

Research Approach

Digital library usage relationship with the success of IS, posited as formative measures is discussed to draw attention to the types of error that frequently occur in such research, notably the Type I error. This type of error will lead to a false positive when declaring a path significant when it is really non-significant. On the other hand, Type II error occurs when a false negative is obtained (a path non-significant when it is really significant). Latent constructs (or latent variables) cannot be observed directly and it must be assessed by their manifest variables (Diamantopoulos, Riefler and Roth 2008). In addition, latent constructs can be measured using reflective of formative indicators (Ambrose et al. 2006). Given the two types of measurement model, issues related to the validation of the model and the structural aspect may not gain much debate for the former but more on the latter model. Nevertheless, due to more extensive works that have been published in the social science literature such as Diamantopolous, Riefler and Roth (2008); Henseler, Ringle and Sinkovics (2009); Ringle (2009); Ringle et al. (2005); and Hulland (1999); a guideline in validating both types of model is by far accepted by many IS researchers. In viewing the comparison between these two, Table 1 provides a summary of the characteristics of formative and reflective measurement models.

Table 1: Characteristics of Formative and Reflective Measurement Models

	Characteristic	Formative measurement model	Reflective measurement model
1.	Nature of relationships (theoretically)	• From indicators to construct • Indicators *define* the construct	• From construct to indicators • Indicators *manifest* the construct
2.	Impact of changes	• Indicators cause the construct thus changes in the indicators should change the construct • On the other hand, changes in the construct not necessarily change the indicators	• Indicators are reflections of the construct thus changes in the indicators should not cause changes in the construct • However, changes in the construct should change the indicators
3.	Indicators interchangeability	• No, because indicators are in different theme	• Yes, because indicators may share a common theme
4.	Indicators' covariation	• Indicators do not necessarily covary • Low correlations are expected (to avoid multicollinearity)	• Indicators are expected to covary • Should be highly correlated with each other
5.	Nomological net of the construct indicators	• Should differ • Same antecedents and consequence are not required	• Should be similar • Indicators are required to have the same antecedents and consequence

As this paper focuses on the formative measures, only this type of measurement is discussed next.

Formative Measurement

Interdependencies between indicators and constructs portrayed in a path model can be defined and assessed via two measurement models: formative and reflective. The former model assumes the direction of relationships is from the indicators to the latent constructs. On the other hand, the latter is formed with the assumption of relationships from the latent construct to the indicators. Chin (1998) reminded that failure of paying attention to the direction of the relationship between measures (indicators) and construct will result in a misspecification of the measurement model. According to Diamantopolous, Riefler and Roth (2008), the model was first proposed by Curtis and Jackson (1962) where they disputed that measures with a positive correlation were regarded as a necessary condition. For $i = 1,...,n$ of indicators, the model specification is as follows:

$$\eta = \sum_{i=1}^{n} \beta_i x_i + \delta \qquad (1)$$

where,
η is the latent construct,
β_i is the regression coefficient,
x_i is the i-th indicator and
δ is the error term associated with the construct.

Equation (1) describes the linear relationships of the dependent variable (the latent construct, η) with indicators (x_i) as explanatory variables, as in the multiple regression model. In diagram form, Equation (1) is as depicted in Figure 2. It exhibits the specification of the dependency relationship in a first-order formative model. Formative model clearly indicates that the measurement error δ, is associated at the latent construct level. The direction of relationship shows that it is from the indicators to the underlying latent construct, and each indicator is error-free in the conventional sense (detailed in Edwards and Bagozzi (2000)).

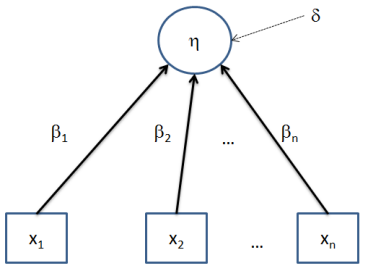


Figure 2: First-order Formative Measurement Model

Partial Least Squares Path Model

The relationship between indicators and latent constructs, and that between different constructs have long been discussed in many areas in social sciences including IS and marketing. Bollen's (1989, p. 65) once reminded that "...researchers in the social sciences assume that indicators are effect indicators (*reflective*). Cause indicators (*formative*) are neglected despite their appropriateness in many instances". His statement implies the nature of model paths that exist in relationship between constructs and indicators, and

between constructs that have been overlooked by many researchers. It could lead them to false findings due to misspecifications of the model.

This study proposed the Partial Least Squares (PLS) path modelling for assessing the digital library usage model. Tenenhaus et al. (2005) presented an in-depth discussion on PLS, its extension and estimation as compared to structural equation modelling (SEM), whilst Marcoulides, Chin and Saunders (2009) provided a special issue in comparing PLS and SEM based on papers submitted to MISQ. The PLS path modelling estimation algorithm has two stages. The first stage encompasses an iterative procedure of ordinary least squares (OLS) regressions to calculate the weights of the indicators until the convergence achieved. The second stage is estimating the inner and outer model coefficients and it is a non-iterative process. Chin (1998) indicated that sometimes PLS path modelling is said to be SEM. However, the main aim of PLS is to minimize the residual variance of the endogenous latent variables. According to Chin, Marcolin and Newsted (1996), SEM, i.e. causal modelling, is rapidly becoming a predominant technique for analysing data among IS researchers. PLS was said to be a more appropriate statistical approach especially when it precluded conditions as required by LISREL (covariance-based technique) i.e., non-normality and small sample size. This means PLS is capable of modelling the latent constructs under the conditions of non-normality and small sample size. Moreover, the PLS algorithm has become increasingly popular in IS research, as well as in other disciplines like marketing (Albers 2010).

OBJECTIVES AND METHOD

The main aim of this paper is to cast light on the use of electronic library (as initiative for academic digital library) at higher institutions in Malaysia by examining the relationships between the usage of the system to the provision of information needs (with respect to academic and as well as to academic research) and its impact on individual. The outcome of the study may lead to the determination of the suitability (the dimensions and indicators) in influencing the usage of digital libraries for information provisioning (called as DLUIP). The DLUIP properties consist of three dimensions postulated and validated by Ambrose, Rai and Ramaprasad (2006) as formative: content breadth, content depth and interaction dynamism. With all formative measures and constructs, partial least squares (PLS) path modeling was used in assessing the DLUIP properties with the formative validation test.

The study focuses on the academic users usage of the electronic library throughout their learning process at the university. In order to capture the essence of the study, a survey design approach was adopted. The survey was conducted at higher institutions in Malaysia, namely University of Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Putra Malaysia (UPM) and Universiti Sains Malaysia (USM). These four universities had been designated as Research Universities (RUs) under the 9th Malaysia Plan. According to the Ministry of Higher Education Malaysia, RU status would enable them to become world-class leaders in innovation, design and research via the agreed yearly grant funded by the Malaysian government. These RUs were selected due to two reasons. Firstly, they have been established for more than 40 years. Secondly, being established for more than four decades, these RUs possess extensive library collections and repositories, including the online library resources. The URLs for the online library resources used for the study are as follows: UM (http://www.umlib.um.edu.my), UKM (http://www.ukm.my/library), USM (http://www.lib.usm.my/equip-usm/custom/home.jsp) and UPM (http://www.psasir.upm.edu.my/). These web pages are all password-protected sites where only registered

university students and staff can login and have access to the resources provided by the electronic libraries.

Data and Measures

Data was collected via self-administered structured questionnaires which were distributed to 1020 academic users (comprising students, lecturers and researchers). Massive increase has been witnessed in academic research among the higher institutions' researchers and this include their outputs in terms of scientific journals. Since researchers are also acquiring new knowledge and new information, the use of academic digital libraries is crucial in reading up on past studies, findings and issues. The item instruments were composed with mixed types of questions where majority of them were close-ended questions. Four demographic variables were included in Section A: age, gender, race and university. The coding of each variable is as follows. Dichotomy variable was coded for gender (1=male, 2=female); age categories ranged from 25 to 45 where 1 < 25, 2 = 25–29, 3 = 30–34, 4 = 35–39, 5 = 40–44 and 6 ≥ 45 years. The minimum age of 24 was selected according to the regular age of graduating undergraduates in this country. Race was categorised according to the main ethnicities in Malaysia i.e., 1=Malay, 2=Chinese, 3=Indian and 4=Others. Lastly the university was coded numerically as the four universities participated in the survey i.e., 1=UM, 2=UKM, 3=USM and 4=UPM.

Section B containing the measurement items related to the three main constructs of DLUIP. Each of the measurement item in this section was measured using a five-point scale items, ranging from "1=strongly disagree" to "5=strongly agree". Individual Impact (II) dimension was measured with four formative measures with similar rating scales.

Data Analysis

The Statistical Products, Services and Solutions (SPSS) was used to perform descriptive analysis, while the PLS path model was analysed using the smartPLS version 2.0 M3 (Ringle et al. 2005). This was for the purpose of performing PLS path modelling (Wold 1982; Chin 1998; Chin, Marcolin and Newsted 2003) and producing comprehensive statistical tests. It includes assessing the indicators' validity, looking for indications of collinearity problem (for further checking) and estimating the path modelling relationships. SmartPLS is Java-based, an independent-platform and a free software that is capable of graphically analysing the PLS model by performing related statistical analyses including bootstrapping (resampling method), method to handle missing values and analyzing reflective and formative indicators. The software is selected based on the review by Temme, Kreis and Hildebrandt (2006). All the survey data was earlier coded in SPSS and then saved in text file as it is the only input data format that can be accepted by smartPLS.

Hypothesis

Based on the framework by Ambrose, Rai and Ramaprasad (2006), the three DLUIP constructs are defined as follows. The breadth of content (CB) construct is *the extent of usage which the academic users use the digital library to meet their information needs across different disciplines related to their learning or teaching tasks*. Whilst for the depth of content (CD) construct, it is defined as *the extent of usage which academic users use the academic digital library for their different needs related to the level of detail information required*. The information required is either in the form of detailed information or crude information, depending on the users' interest. The last construct, ID is defined as follows: *the extent of usage to which the academic users use the digital library to retrieve, receive, solicit, and contribute information*. Figure 3 shows the hypothesised causal paths of the tested relationships.

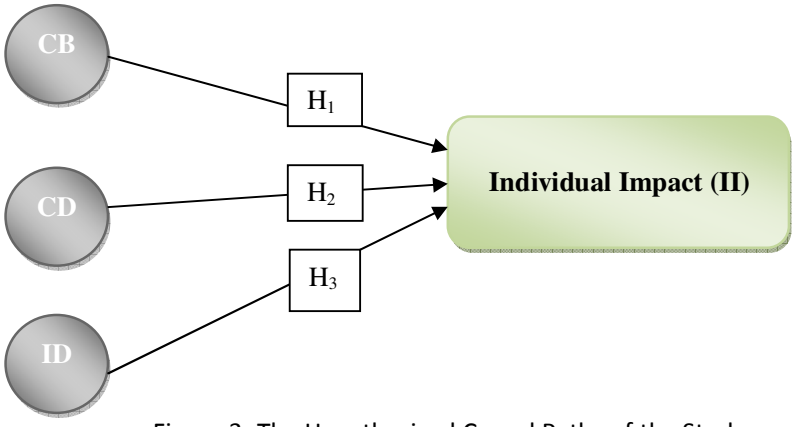


Figure 3: The Hypothesised Causal Paths of the Study

The tested relationships are formulated from the three hypotheses as given below:

H_1: There is a positive relationship between the Breadth of Content construct and Individual Impact.

H_2: There is a positive relationship between the Depth of Content construct and Individual Impact.

H_3: There is a positive relationship between the Interaction Dynamism construct and Individual Impact.

FINDINGS

From a total of 1020 questionnaires distributed in the survey, 959 responded which resulted in a response rate of 94%. Of the 959 participants, 78% of them were students (undergraduates and postgraduates), and 22% were university staff (lecturers/researchers). 43.9% of the respondents were male and 56.1% female. The highest portion of the subjects was below 25 years of age (60.8%), while the other portions were 25-26 years (13%) and 35-39 years (9%). University undergraduates' ages are commonly between 19-23 years and the majority of the respondents were undergraduates; thus this category of age formed the dominant group of the study.

In Table 2, the values of internal consistency reliability for all of the dimensions shown are all above 0.80. Nunnally (1978) once noted that usually the value of 0.70 and above was preferable. However, the results obtained may not serve the essence of the internal consistency of the measurement items. This is because the study applied a formative measurement model where the model assessment was not like that employed in the reflective mode. Previous studies (Edwards and Bagozzi 2000; Bollen and Lennox 1991; Fornell 1982) had demonstrated that reflective indicators were used in measuring latent constructs by positively correlated items. However, for formative indicators there was no pattern of intercorrelation expected (or required). Thus this section merely serves as part of the preliminary analysis report of constructs which are measured by the questionnaire measurement items administered to the study sample.

In addition, Table 2 presents the summary statistics for all of the research indicators of the three constructs hypothesised in the model and are presented by the median and standard deviation.

Table 2: Summary Statistics and Reliability

Construct	Indicators	Median	Standard deviation	Cronbach α
Content Breadth	I obtain academic information of my study.	4	0.780	0.901
	I obtain full text article as requested.	4	0.789	
	I obtain full text article from alternative resource.	4	0.779	
	I obtain information as requested.	4	0.778	
	I obtain information as suggested.	4	0.775	
	I obtain internal resources.	4	0.757	
	I obtain worldwide resources.	4	0.785	
Content Depth	I obtain detailed information	4	0.804	0.903
	I obtain abstracted information	4	0.764	
	I obtain current information	4	0.795	
	I obtain archived information	4	0.784	
	I obtain high quality information	4	0.820	
Interaction Dynamism	I search for academic information.	4	0.835	0.854
	I request for academic information.	4	0.859	
	I reuse academic information for other tasks.	4	0.835	
	I share academic information with colleagues	4	0.915	
Individual Impact	I have learnt much through the presence of the online library resources (electronic library).	4	0.844	0.815
	The electronic library improves my awareness of academic tasks.	4	0.889	
	The electronic library improves my learning/teaching effectiveness.	4	0.854	
	The electronic library increases my academic knowledge.	4	0.822	

PLS assessment of pure formative measures and constructs comprises assessing the measurement model (outer) and the structural model (inner). Figure 4 shows the results of the PLS path model of the tested formative measurement model of the relationships between digital library usage indicators and constructs, and individual usage impact.

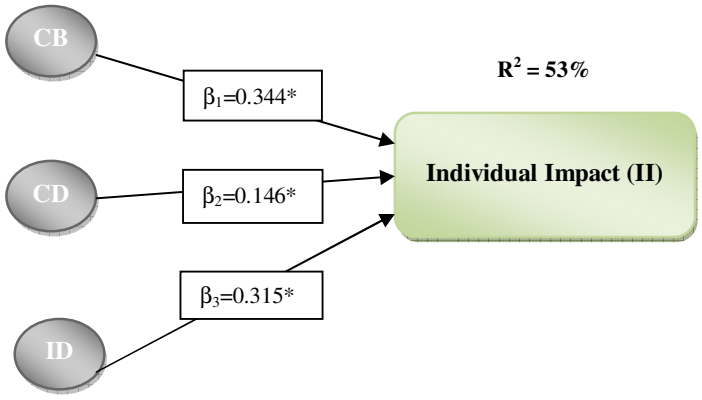
Assessment of the Measurement Model (Outer model)

The formative construct validation for the study was performed by guidelines given by Urbach and Ahlemann (2010), Henseler, Ringle and Sinkovics (2009), Diamantopoulos, Riefler and Roth (2008) and Diamantopoulos and Winklhofer (2001). Bollen (1989) and Bagozzi (1994) stressed that the concepts of reliability (i.e., internal consistency) and construct validity (i.e., convergent validity) are both **not** meaningful when measures are employed in a formative mode. However, two main assessments for the outer model are indicator validity and construct validity (Urbach and Ahlemann 2010). In smartPLS the significance of indicators is obtained using the re-sampling method, i.e., bootstrapping (Efron 1979; Efron and Thibshirani 1993). Bootstrapping results produced by the PLS path model indicated that all of the weights of the formative indicators were significant at 95% of confidence. In addition, all the weights showed positive relationships with their respective constructs. The collinearity diagnostics procedure indicated that all of the variance inflation factors (VIF) were below 3.0. The analysis was run separately using SPSS as smartPLS does not provide such results. Moreover, the interconstruct correlations were less than 0.71 as recommended by MacKenzie, Podsakoff and Jarvis (2005). Since all of the postulated measures and constructs were conceptually justified and theoretically

validated, the nomological validity was established based on the theoretical considerations.

Assessment of the Structural Model (Inner model)

The structural model or inner model is assessed via the examination of the path coefficients. Based on Henseler, Ringle and Sinkovics (2009), contradicting algebraic signs of paths that are against expectations are not considered to support the a priori formed hypotheses. He also stressed that structural paths whose signs are in keeping with a priori postulated algebraic signs, provide a partial empirical validation of the theoretically assumed relationships between the latent variables. All of the path coefficients were significant at 95% level. The coefficients of CB (β_1) and ID (β_3) showed significant and strong positive relationships with II at 0.344 and 0.315, respectively. The CD coefficient posed a significant but only moderate positive relationship with $\beta_2 = 0.146$. Furthermore, the PLS model of the tested paths showed the evidence of predictive relevance with $Q^2 = 0.4367$. In smartPLS, the predictive relevance is calculated using Stone-Geisser's nonparametric test (Geisser 1975; Stone 1974) and employed using a blindfolding approach (Chin 1998). The Q^2 value suggests an index of goodness of reconstruction by model and parameter estimations (Andreev et al. 2009) which measures the extent the model's prediction is successful (Urbach and Ahlemann 2010). The value of $Q^2 > 0$ confirms the presence of predictive relevance. Overall, the three constructs account for more than half (about 53%) of the variation in the II.



*Note: * p<0.05*

Figure 4: Results of the Partial Least Squares Path Model of the Tested Paths among DLUIP Constructs

DISCUSSION AND CONCLUSION

The aim of the paper is to examine the relationships of digital library usage as an information provider (of IUIP theory) with individual impact dimension (of IS Impact model) when posited as a pure formative measurement model. The study was conducted using academic electronic library which, to some extent, might not fully characterise the concept of digital library *per se*. Thus the results of the analysis obtained were presented in full understanding of the limited applicability of the system. The PLS model derived fits the study data reasonably well. Using academic respondents from four research universities in Malaysia and employing the partial least squares path model, the empirical results of the

hypothesised relationship among individual usage impact dimension were obtained where all of the three hypotheses were supported. The data set used in the study allowed the verification of positive relationships with the model, with moderate predictive strength. In other words, the measures allowed explaining about half of the variation in individual impact dimension.

As far as the formative measurement of usage construct is concerned, this paper pioneers such research in investigating the posited relationships. To the best of our knowledge, there has been no study in the context of electronic libraries, as well as digital libraries, that has examined the relationships between user's usage and its impact using formative measurement model. Individual Usage Impact for information provisioning construct was found to explain 53% of the variance from the three hypothesised dimensions viz. breadth of content, depth of content and interaction dynamism. The R^2 = 53% might show only a moderate predictive strength of the IUI. The interpretation of R^2 is as similar in regression analysis (Chin 1998). However, the three dimensions of DLUIP showed positive relationships with the IUI construct, as identified in the theoretical frame of IUIP in Ambrose, Rai and Ramaprasad (2006) in the context of clinical decision making. Following their call for empirical research, this article extends their study to a context of electronic library to evaluate the external generalizability of the IUIP construct. A key context for the use of the electronic library is the support of acquiring knowledge by academic individuals at higher institutions. The findings confirm the positive relationships between the usage measures and individual impact.

The study contributes significantly in the literature of using formative measurements for the posited relationships in the context of academic electronic library. The study findings furthermore indicate that all of the formative measures are of a 95% confidence. As emphasized by Henseler, Ringle and Sinkovics (2008), paths that possess an algebraic sign contrary to expectations do not support the a priori formed hypotheses. Due to this reason, none of the measures were removed.

The results may serve as a predictive purpose for implementing (or improving) the architecture of electronic library in higher educational institutions. Emphasis should be given on the underlying architecture of the electronic library as a base to tailor for various types of information that capable of supporting user's usage interests. Clearly the architecture of scholarly contents stored in digital objects establishes clear boundaries on the individual impact. The academic library managers may consider the extent of the usage measures to meet user's academic information needs across different faculties and departments.

Despite the limitation of using only public universities, this study would serve as an avenue for future research in confirming the tested paths in establishing the causal paths relationships as an extension of the IS Impact model (to assess the success of electronic and digital libraries). In a different setting, such relationships can be tested by incorporating moderating factors, such as awareness of digital libraries. Research on awareness in the context of digital library is still in its infancy (Razilan et al. 2011) and it may reveal a motivating finding in the tested formative measures relationships. Another interesting opportunity for future study is to test and confirm the nature of the relationships of the usage for information provisioning theory with other types of systems.

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