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PLS Path Model for Testing the Moderating Effects in the Relationships among Formative IS Usage Variables of Academic Digital Libraries

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Abstract: Digital library research has developed rapidly over the past decade, and millions of dollars have been spent on building digital libraries. However, studies on the awareness of digital libraries are still scarce. Previous research indicates that many potential users may still not use or benefit from using digital libraries. Moreover, the studies on the awareness concept of digital libraries and for their longer term, is only beginning. In academia, transition from physical to digital libraries has been largely taken place in most of higher institutions in Malaysia. Owing to the Internet, Web and digital technologies, the academic library are now inevitably digital. Past researches majorly reported the usage of digital libraries and on recent studies focussing on the awareness. As far as academic digital library is concerned, studies on interacting the awareness factors in the relationships among the digital library usage constructs using formative model has not been located so far. In formative model, the measures are treated as the cause, as opposed to reflective model (where the measures are treated as the effect). Many social science researchers tend to have a priori assumption on the measures as reflective which may lead to misspecification of model. In bridging this gap, this paper attempts to examine the relationships between digital library usage and individual impact where the usage measures were hypothesized as formative measures. The relationships are tested with the incorporation of interaction effects of digital library awareness factors. The tests are performed in academic digital libraries of higher institutions in Malaysia. All of the hypothesized causal paths among digital library usage constructs and individual impact tested using partial least squares (PLS) model were supported in both of the main effects and interaction effects models. Moreover the incorporation of digital library awareness factors has shown a moderate effect size, addressing the need of such factors in moderating the relationships between the digital library usage and individual impact for academic purposes.

Key words: academic digital libraries, usage, awareness, partial least squares, interaction effects

INTRODUCTION

Digital library research has developed rapidly over the past decade, and millions of dollars have been spent on building digital libraries. However, previous research indicates that many potential users may still not use the digital libraries (Thong *et al.* 2002). Farooq *et al*. (2008) admitted that (by referring to Hansen and Järvelin, 2005), the concept of awareness of digital libraries and for their longer term, is only beginning. Through their case study of awareness of digital resources in libraries, Asemi and Riyahiniya (2007) concluded that exist a direct relationship between the scales of awareness and *use* by the user. Schmidt (2002) claimed that awareness of digital libraries has taken up many meanings and interpretations, and highly depends on the context for which it is being used. But in the context of awareness study of human computer interaction (HCI) and computer supported cooperative work, they have been existed for the past 15 years (Dourish and Belloti 1992). The study focuses on its attention to firstly examine and empirically test the relationships among the posited digital library usage constructs by using the hypothesized paths among them with the individual usage impact proposed by Gable *et al*. (2008). Secondly, the relationships were tested by incorporating interaction effects via digital library awareness factors. Hence the objective of this paper is twofold: to examine the relationships between the digital library usages for information provisioning and the individual usage impact, and to test the relationships among usage latent variables by introducing digital library awareness factors as moderating variables in the developed model.

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In IS literature, the usage of system has lead to different meanings that brought to different paradigms of research: IS for decision-making, IS implementation, IS acceptance and IS success. The aforementioned definition of usage is as use of a digital library specifies *how* and *for what* the digital libraries are used for information provisioning. Moreover the usage measures are important measures in analyzing the IS success (or the success of the digital libraries). IS success can be treated as an event in a process leading to individual impact and organizational impact (Sedera *et al*. 2006; Burton-Jones and Straub 2006; Seddon 1997). The event should be focussing on the nature of the causal relationship between the usage and the IS success. Relationships between the six main constructs of a well-known DeLone and McLean's IS Success model (1992) were tested by many researchers (Gable *et al*. 2008; Petter *et al*. 2007; Seddon 1997; Hunton and Flower 1997). As a result, the studies yielded mixed results that witnessing the evidence of causal paths. As criticized by Ballantine *et al*. (1996) and Myers *et al*. (1998); DeLone and McLean's model raised some questions toward the causal nature in which Seddon (1997) believed it needs to be supported by some model paths. To the authors' best knowledge, as far as path modelling is concerned, no prior research has been done on the interaction effects of the awareness of such system.

Internet usage for Information Provisioning:

Internet usage for Information Provisioning (IUIP) is a theoretical framework developed by Ambrose *et al*. (2006), is shown in Figure 1. The framework aims at developing theoretically grounded measure of IUIP for provisioning of information needed by clinical decision-makers where its conceptualization is based upon 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 the conceptualization of usage is for *the use of a system.* In Digital Library perspectives, the *use* may reflect the usability of the system. In literature the term usability has been used broadly and means different things to different people added with different types of evaluation to tailor with the nature of digital library used (Razilan *et al*. 2011). This research focuses on the use of digital libraries where the system is treated as a mean or medium to provision individual users with information at all levels that they need.

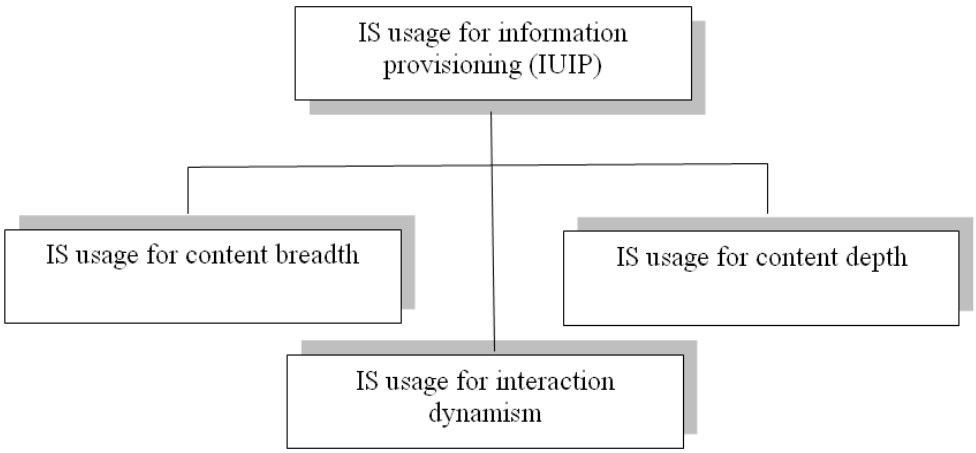

Fig. 1: The properties of IUIP.

In Figure 1 three properties of IUIP is shown (without the directions of arrow showing the causal relationship); usage of content breadth (CB), usage of content depth (CD) and usage for interaction dynamism (ID) that were tested using a formative test. The development of this framework was basically grounded by Technology-to-Performance Chain (TPC) theory. The usage constructs 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 TPC theory and the construct development was validated in accordance with the formative measurement model procedure.

Academic Digital Libraries:

The term for academic libraries represents the traditional or physical libraries of universities in Malaysia. Due to the advanced of the information and communication technology, these libraries adopt the technology to migrate from physical to digital. According to Butdisuwan (2005), the transition has made the library to be inevitably digital where in his study the Thailand academic libraries started preparing for the in-house digital collections like theses, archives and research papers serve for this purpose. In addition, the digital library concept has introduced digital resources such as e-journals, e-books and online databases. Academic libraries in Malaysia are also heading in the same direction. In recent years, besides maintaining the physical libraries, the

academic libraries are also equipped with such digital resources. Owing to the Internet and Web technologies that has brought a myriad of advances to academic libraries, Campbell (2006) once said; "The reason that the (physical academic) library is losing its supremacy in carrying out this fundamental role is due, of course, to the impact of digital technology". Using his premises, as quoted, the authors emphasize the use of the term online library resources in this paper as an initiative to academic digital libraries at higher institutions in Malaysia.

Digital library Awareness:

Asemi and Riyahiniya (2007) pointed out that scholars, students, teachers, and researchers actively seek current information through the various media available in the libraries. They emphasized that if a user was aware of one helpful resource, it would usually lead to greater use of that resource. Atilgan and Bayram (2006) examined the level of awareness of digital libraries by academic staff at Ankara University, Turkey and found that the majority of their respondents knew digital library resources existed in the university. Among the academic staff selected in their study, level of awareness distribution showed associate professors were the highest ranking group followed by assistant professors, but instructors were the last. Their study has shown that awareness of digital libraries were more prominent among senior staff. Findings from a case study conducted by Tammaro (2008) in Italy on users perceptions of digital library services indicated that users have different perceptions with regard to digital libraries and that they tend to use the services of more than one cultural institution. Her study also reveals that users often do not know how to use the libraries and are unaware of all of the services offered. Nevertheless, in overall there is a positive attitude towards digital libraries. A previous study by Brown (1994) indicated that high awareness of an information system may lead to high internet usage. In similar direction but with different settings, the researcher investigated such relationship between awareness of the digital library and the usage of the digital library system. Schmidt (2002) highlighted that awareness has taken up many meanings and interpretations, and it is highly depending on the context for which it is used. This study however focused on the level of awareness on the digital library while the usage awareness is how respondents aware of the services and functionalities that digital library can provide in terms of provisioning them with academic information to support their learning/teaching needs.

MATERIALS AND METHODS

Data and Measures:

A survey design approach was adopted and accomplished at higher institutions in Malaysia, namely University of Malaya (UM), National University of Malaysia (UKM), Putra University of Malaysia (UPM) and Science University of Malaysia (USM). These four universities had been designated as Research Universities (RUs) under the 9th Malaysia Plan (Ng 2006). Self-administered structured questionnaires were distributed to 1000 academic users (including students, lecturers and researchers). The item instruments were composed with mix type of questions where majority of them were close-ended ones. Four demographic variables were included in Section A: age, gender, race and university. The coding of each variable was as follows. Dichotomy variable was coded for gender (1=male, 2=female); age categories were ranging from 25 to 45 where the ordinal variable was assigned to $1 < 25$, $2 = 25–29$, $3 = 30–34$, $4 = 35–39$, $5 = 40–44$ and $6 \geq 45$ years. The minimum age of 24 was selected according to the regular age of undergraduates in this country were usually students are graduating from their bachelor degree at the age of 23 or 24. While respondents' ethnicity was categorized according to four nominal variable to reflect the main ethnic in Malaysia i.e. 1=Malay, 2=Chinese, 3=Indian and 4=Others (open-ended). Lastly the university was coded with the four universities participated in the survey i.e. 1=UM, 2=UKM, 3=USM and 4=UPM.

Section B contains the measurement items related the three main constructs of DLIUP were as postulated by Ambrose *et al*. (2006). Each of the measurement items 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, as posited by Gable *et al*. (2008) with similar rating scales. A total of 11 items measuring the digital library awareness was proposed using five-point scales from "1=strongly unaware" to "5=strongly aware".

Data Analysis:

smartPLS version 2.0 M3 (Ringle *et al*. 2005) is used to perform the analysis of the PLS path model (Wold 1982; Chin 1998; Chin *et al*. 2003) as well as for producing comprehensive statistical tests. It includes assessing the indicators validity, checking for collinearity problem and estimation of the path modeling relationships. *smartPLS* is Java-based, an independent-platform and a free software that capable of graphically analyzing PLS model by performing its related statistical analysis including bootstrapping (resampling method), a method to handle missing values and choice of analyzing reflective and formative indicators. The software is selected based on review made by Temme *et al*. (2006).

Research Model and Hypothesis:

Using the framework by Ambrose *et al*. (2006), the three DLUIP constructs are defined as follows. The breadth of content (CB) construct is the extent of usage to 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 to which the 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, interaction dynamism (ID) is defined as follows. The extents of usage to which the academic users use the digital library to retrieve, receive, solicit, and contribute information. The following figure shows the conceptual model of moderating effect.

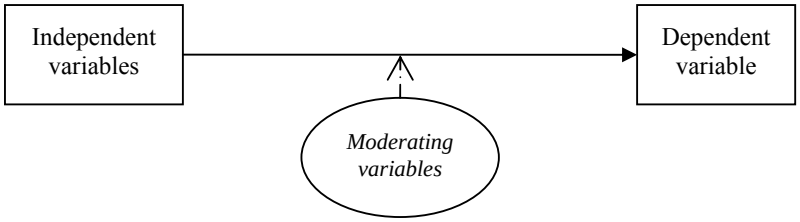

Fig. 2: Conceptual model of moderating effect.

The moderating effect on the relationships between independent and dependent variables is as shown in Figure 3. The hypothesized causal paths model of the tested relationships between the DLUIP and Individual Impact is as presented in Figure 4.

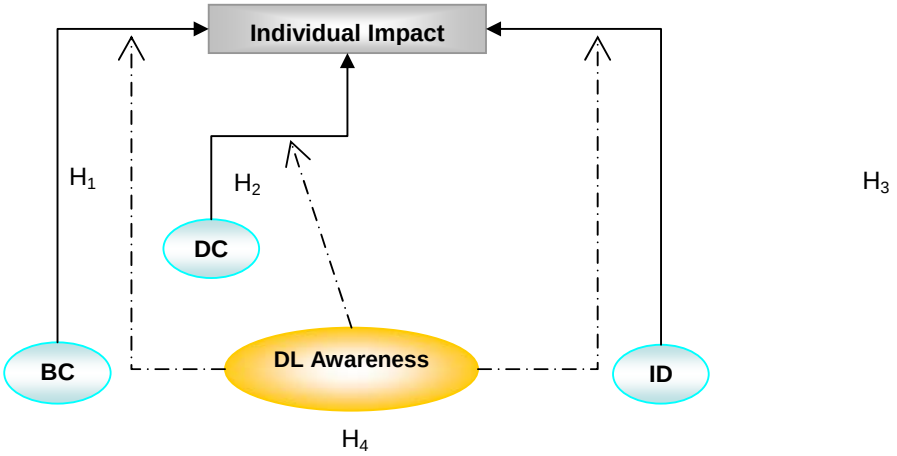

Fig. 3: The theoretical relationships among DLUIP properties and the individual impact dimension.

Based on the theoretical relationships in Figure 4, three hypotheses formulated for the main effects model, as follows:

The first hypothesis states the relationships (the direct effects) between the Breadth of Content (BC) construct and Individual Impact is positive.

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

The second hypothesis states the relationships (the direct effects) between the Depth of Content (DC) construct and Individual Impact is positive.

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

The third hypothesis states the relationships (the direct effects) between the Interaction Dynamism (ID) construct and Individual Impact is positive.

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

For the interaction effects model, an additional hypothesis is formulated that deals with the moderating effects between the digital libraries awareness and Individual Impact.

***H_4**: Digital libraries awareness positively moderates the DLUIP-Individual Impact relationship.*

Noted that the theoretical relationships the moderating effects of this study (Figure 4) highlights the moderating effect of the digital libraries awareness (moderator variables) on the marginal effect of DLIUP properties (the latent variables) based on a model that includes the product indicator approach (similar with the study by Chin *et al*. (1996)).

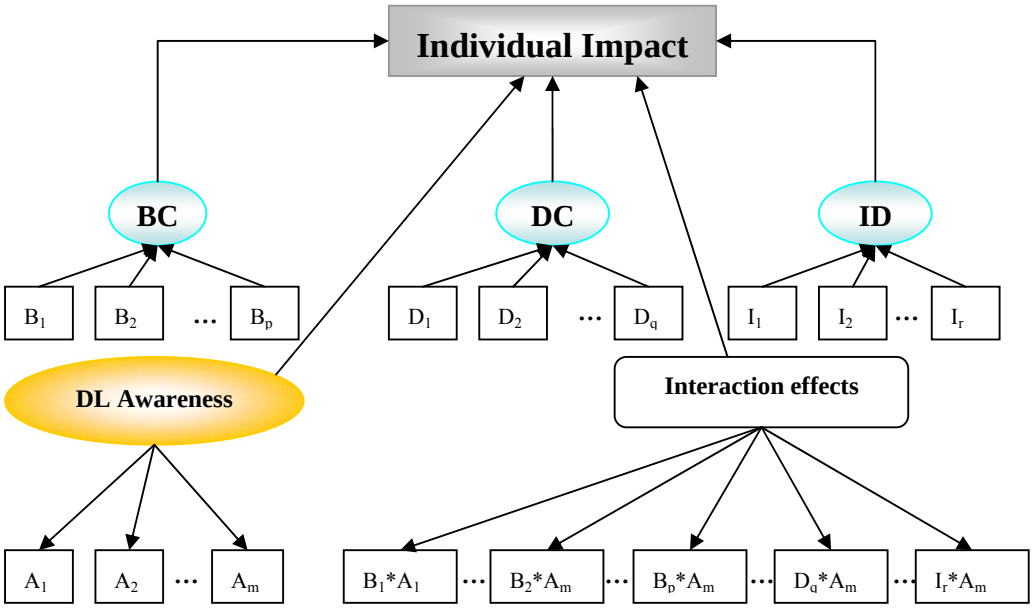

Fig. 4: Hypothesized relationships of the formative constructs for DLIUP properties and Individual impact dimension with moderating variables, as defined in *smartPLS*.

In Figure 4, BC_i (i=1,...,p), DC_j = (j=1,...,q) and ID_k (k=1,…,r) represent the DLUIP constructs with their respective indicators. The moderating variable of A_l (l=1,…,m) represents the indicators of DL Awareness. Recent modelling research in economics has shown growing interest in modelling the marginal effects of the dependent variables rather than the point estimates of the interaction effects (Elhorst 2011). The aim is to comply with the PLS estimation procedure to estimate the underlying interaction constructs. Moreover according to Jaccard *et al*. (1990), the standard linear model estimates the coefficient of the interaction variables which are derived from the product of the moderator variables and the independent variables (in this study they refer to the latent variables). The estimates can be used in testing for the significance and the sign (the nature of the relationship) that the independent variable varies with the moderator variables (based on the underlying hypothesis of the population). The theoretical relationships as in Figure 4 transform into *smartPLS* software.

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. Thus the type of error will lead to a false positive when declaring a path significant when it is really non-significant. A 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 *et al*. 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 validation 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 like Diamantopolous *et al*. (2008), Henseler *et al*. (2009), Ringle (2006b), Ringle *et al*. (2009) and Hulland (1999); guidelines in validating both types of model is by far accepted by many IS researchers.

Partial Least Squares Path Model:

The relationship between indicators and latent constructs, and relationship 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 the relationship between constructs and indicators, and between constructs that have been overlooked by many researchers. It could lead them to false findings due to

misspecification of the model. The PLS path model has become increasingly popular in marketing (Albers 2010). It is a methodology that allows estimating complex cause-effect relationships using empirical data (Ringle 2006a). PLS was said to be the more appropriate statistical approach especially it precludes 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.

Results:

From a total of 1000 questionnaires distributed in the survey, 959 responded which resulting in a response rate of 94%. Of the 959 participants, about 78% of them are students (undergraduates and postgraduates), and 22% are university's staff (lecturers/researchers). It is composed by 43.9% male and 56.1% female. The highest portion of the study subjects is below 25 years of age (60.8%), 25-26 years (13%) and 35-39 years (9%). University undergraduates' age are commonly between 19-23 years and the majority of respondents are undergraduates thus this category of age is the dominant subjects of this 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. But, the results obtained may not serve the essence of the internal consistency of the measurement items. This is due to reason that the study applied formative measurement model where the model assessment is not like as it is employed in the reflective mode. Previous studies (Edwards and Bagozzi 2000; Bollen and Lennox 1991; Fornell 1982) had demonstrated that reflective indicators used in measuring latent constructs by positively correlated items. However, for formative indicators there is **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 questionnaire measurement items administered to the study sample.

Table 1: Reliability of instrument measures.

Dimension	Number of items	Cronbach Alpha
Content breadth	7	0.910
Content depth	5	0.903
Interaction dynamism	4	0.854
Individual impact	4	0.815
Awareness factors	11	0.911

PLS assessment of pure formative measures and constructs comprises of assessing the measurement model (outer) and the structural model (inner). Figure 6 and 7 show 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 for main effects and interaction effects models, respectively.

The formative construct validation of the study is performed by the guidelines given by Urbach and Ahlemann (2010), Henseler *et al*. (2009), Diamantopoulos *et al*. (2008) and Diamantopoulos and Winklhofer (2001). Bollen (1989) and Bagozzi (1994), as cited in Henseler *et al*. (2009), 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 re-sampling method, i.e. bootstrapping (Efron 1979; Efron and Thibshirani 1993). Bootstrapping results of 200 samples produced by the PLS path model indicated the all of the weights of the formative indicators were significant in both models; the main effects and the interaction effects model.

The following results present the main effects model of the path model without taking into consideration the moderating variable, the DL Awareness, as discussed in Razilan & Diljit (2012).

The Main Effects Model:

In the main effects model, all of the path coefficients were significant at 95% level except CB (at 80%). All of the three hypotheses are supported resulting that the three properties of DLUIP have a positive influence on the individual. The coefficients of CB (β_1) and CD (β_3) showed significant and strong positive relationships with II with 0.344 and 0.315, respectively (see Figure 6). The ID coefficient posed a significant but only a 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 blindfolding approach (Chin 1998). The Q^2 value suggests an index of the goodness of reconstruction by model and parameter estimations (Andreev *et al*. 2009) which measures to extent the model's prediction is successful (Urbach and Ahlemann 2010). The $Q^2 > 0$ confirms the presence of predictive relevance. Overall, the three constructs account for more than half (about 53%) of the variation in the II.

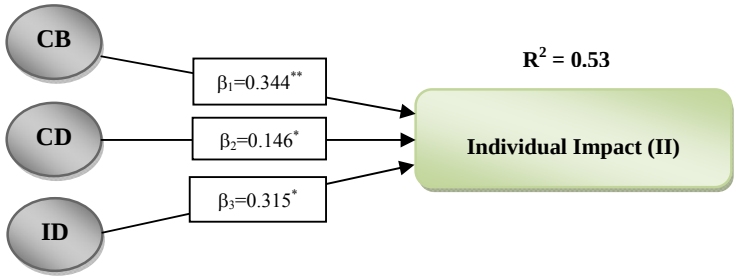

Fig. 5: Results of the main effects model.
*Note: *p-value < 0.05, **p-value < 0.20*

With the extension of the previous work of Razilan & Diljit (2012), the following elaborates the results of using interaction effects.

The Interaction Effects Model:

Awareness factors are used as the interaction effects in moderating the relationships between the three properties of DLUIP and Individual Impact dimension. All of the four hypotheses formulated are supported in this study. The results are as shown the following figure.

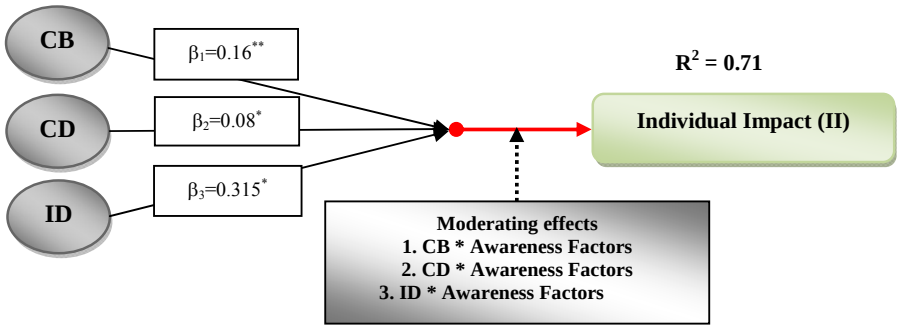

Fig. 6: Results of the moderating effects model.
*Note: * p-value < 0.05, ** p-value < 0.10*

The results (see Figure 7) show a total R^2 of 0.71 for the model with moderating effects as compared to 0.53 in the main effects model (see Figure 6). The results also indicate an interaction effect of 0.59, giving the effect size, f^2 = 0.254 that represents the effects between moderate and large (Cohen 1988). Chen *et al*. (2011) also reported that a study by Galletta *et al*. (2006) on a web design variables (site breadth and content familiarity) have shown interaction effects on usability. The Q^2 of the model is 0.3275 which indicates the evidence of predictive relevance when incorporating the moderating factors. The coefficient for *CB* decreases from 0.344 (see Figure 6) to 0.16 (Figure 7). The main effects model shows a higher standardized beta (for the three dimensions) with a smaller R^2 (0.53); which is inline with Chin *et al*. (1996).

Discussion:

The conceptualization of usage in the field of information system has received much debate in the last three decades. However, this study conceptualized individual usage of digital libraries as usage for information requirements. This concept is grounded in the work Ambrose *et al*. (2006) where they proposed usage as an evolution of IS Usage.

From the PLS model, Individual Impact for information provisioning construct was found to explain about 50% of the variance from the three hypothesized dimensions viz. breadth of content, depth of content and interaction dynamism. The R^2 = 53% might show only a moderate predictive strength of the DLUIP. However, the three dimensions of DLUIP showed positive relationships with the DLUIP construct, as identified in the theoretical frame of IUIP. Developed as a formative construct, the DLUIP measures were significant in explaining the individual usage of academic digital library. The awareness factor (moderator factor) was introduced in the model to investigate the direct and indirect relationships of a certain endogenous latent variable, as suggested by Helm *et al*. (2009) and Henseler *et al*. (2009). The awareness concept of digital library perhaps is only the beginning, as claimed by Hansen and Järvelin (2005). Nonetheless, after using awareness factors as *moderator variables*, the coefficient of determination, R^2 of the DLUIP construct increased to 71%.

This shows that the model fits the study data well with meaningful path coefficients (weights) with greater predictive strength as compared to the initial model. After incorporating the moderating variables, all the three path coefficients, breadth of content, depth of content and dynamism of interaction constructs yielded positive relationships with the individual usage impact construct. The results also indicated that all indicators used in measuring the individual usage impact construct were of a confidence level of 95% and 90%. There were no indicators dropped in the model due to two reasons. First, no major concerns which related to multicollinearity were aroused because all of the Variance Inflation Factor (VIF) values was found to be less than 3.0. Second, all of the indicators were of a confidence level of 95% and they were all maintained. Additionally, the indicators in the measurement model were conceptually justified (refer to Ambrose *et al*. 2006). Due to confidence considerations, none of the indicators were removed.

Awareness factor is seen to play a significant role in determining individual usage as it showed a high path coefficient (0.590). Pedhazur (1997) stressed that the acceptable lower limit of the path coefficient value was 0.05 but reinstated that the preferable one was above 0.10. In contrast, Chin (1998) recommended it to be at least 0.20. However, since there is no rigid consensus with regards to this issue, this study adhered to the former. The study found that the inclusion of interaction effects to moderate the effects of relationships between the postulated independent and dependent variables increased the model's coefficients of determination (the R^2). The findings provide useful information in regards on under the observed circumstances (the impact on individual usage on digital library) an awareness intervention has a greater effect on the individual impact.

Conclusion:

This paper contributes to a growing research of using formative measurements in evaluating the performance of the digital library. The test on incorporating the moderating factors in the relationships between digital library usage and individual impact is presented in this paper. The digital library usage measures are conceptualized as formative based on the IUIP theory. The hypothesized relationships of the moderating effects, as postulated in Figure 7 only focus on the digital libraries awareness factors effect on the marginal effect of the defined latent variables. All of the variables in the model are posited as formative (Ambrose *et al*. 2006; Gable *et al*. 2008). Future study may include exploring of more than one moderating effects that may have a greatest effect on the observed phenomenon, in specific in the digital library domain. Since research on awareness in the context of the digital library is just a beginning (Razilan *et al*. 2011) and it may reveal a motivating aspect in the tested formative measures relationships.

REFERENCES

Albers, S., 2010. PLS and success factor studies in marketing. In Vinzi, V.E., W.W. Chin, J. Henseler, and H. Wang (Eds.). *Handbook of Partial Least Squares: Concepts, Methods, and Applications.* Berlin: Springer, 1409-1425.

Ambrose, P.J., A. Rai and A. Ramaprasad, 2006. Internet usage for information provisioning theoretical construct development and empirical validation in the clinical decision-making context. *IEEE Transactions on Engineering Management*, February, 53(1): 112-129.

Andreev, P., T. Heart, H. Maoz and N. Pliskin, 2009. Validating formative Partial Least Squares (PLS) models: Methodological review and empirical illustration. In the Proceedings of the 13th International Conference on Information Systems (ICIS), December 15-18, Phoenix, Arizona. pp: 1-17.

Asemi, A. and N. Riyahiniya, 2007. Awareness and use of digital resources in the libraries of Isfahan University of Medical Sciences, Iran. *The Electronic Library*, 25(3): 316-327.

Atilgan, D. and O. Bayram, 2006. An Evaluation of Faculty Use of the Digital Library at Ankara University, Turkey. *The Journal of Academic Librarianship*, 32(1): 86-93.

Bagozzi, R.P., 1994. Structural equation models in marketing research: Basic principles. In Bagozzi R.P., (Ed.). *Principles of marketing research*. Oxford: Blackwell: 317-385.

Ballantine, J., M. Bonner, M. Levy, A. Martin, I. Munro and P.L. Powell, 1996. The 3-D Model of Information Systems Success: The Search of the Dependent Variable Continues. *Information Resources Management Journal*, 9(4): 5-14.

Bollen, K., 1989. *Structural equations with latent variables*. New York: Wiley.

Bollen, K.A. and R. Lennox, 1991. Conventional wisdom in measurement: A structural equation perspective. *Psychological Bulletin*, 110(2): 305-314.

Brown, J.M., 1994. The global computer network: Indications of its use worldwide. *International Information & Library Review*, 26: 51-65.

Burton-Jones, A. and W. Straub, 2006. Reconceptualizing system usage. *Information Systems Research,* 8(4): 342-367.

Butdisuwan, S., 2005. Digital Library: A Transition for Academic Libraries in Thailand. *American Library Association Annual Conference*, June 23-29, Chicago, IL, USA.

Campbell, J.D., 2006. Changing a Cultural Icon: The academic library as a virtual destination. *EDUCAUSE Review*, Jan/Feb, 41(1): 16-31.

Chen, J.V., L. Lin, D.C. Yen and K-P. Lin, 2011. The interaction effects of familiarity, breadth and media usage on web browsing experience. *Computers in Human Behavior*, 27: 2141-2152.

Chin, W.W., 1998. Issues and opinion on structural equation modelling. *MIS Quarterly*, 22(1): vii-xvi.

Chin, W.W., B.L. Marcolin and P.R. Newsted, 2003. A partial least squares latent variable modelling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic mail adoption study. *Information Systems Research*, 14(2): 189-217.

Chin, W.W., B.L. Marcolin and P.R. Newsted, 1996. A PLS Latent Variable modelling approach for measuring interaction effects: Results from a Monte-Carlo Simulation study and Voice mail emotion/adoption study. In *Proceedings of the 17th International Conference on Information Systems*, J. J. DeGross, S. Jarpenpaa and A. Srinivasan (Eds.), Dec. 16-18, Ohio.

Cohen, J., 1988. *Statistical Power Analysis for the Behavioral Sciences* (2nd Ed.) Hillsdale, New Jersey: Lawrence Erlbaum Associates.

DeLone, W.H. and E.R. McLean, 1992. Information Systems Success: The Quest For The Dependent Variable. *Information Systems Research*, 3(1): 60-95.

Diamantopoulos, A. and H.M. Winklhofer, 2001. Index Construction with Formative Indicators: An Alternative to Scale Development. *Journal of Marketing Research*, 38(2): 269-277.

Diamantopoulos, A., P. Riefler and K.P. Roth, 2008. Advancing formative measurement models. *Journal of Business Research*, 61(12): 1203-1218.

Dourish, P. and V. Bellotti, 1992. Awareness and coordination in shared workspaces. In the Proceedings of the conference on computer supported cooperative work Toronto, Canada, New York, Oct. 31-Nov. 4, NY: ACM Press: 107-113.

Edwards, J.R. and R.P. Bagozzi, 2000. On the nature and direction of relationships between constructs and measures. *Psychological Methods*, 5(2): 155-174.

Efron, B., 1979. Bootstrap methods: Another look at the jackknife. *Annals of Statistics*, 7(1): 1-26.

Efron, B. and R. Tibshirani, 1993. *An Introduction to the Bootstrap*. New York: Chapman Hall.

Elhorst, J.P., 2011. Spatial panel models. Available at: http://www.york.ac.uk/media/economics/documents/seminars/2011-12/Elhorst_November2011.pdf

Farooq, U., C.H. Ganoe, J.M. Carroll, I.G. Councill and C.L. Giles, 2008. Design and evaluation of awareness mechanisms in CiteSeer. *Information Processing and Management*, 44: 596-612.

Fornell C., 1982. *A Second Generation of Multivariate Analysis*. New York: Praeger.

Gable, G.G., D. Sedera and T. Chan, 2008. Re-conceptualizing information system success: the IS-Impact Measurement Model. *Journal of the Association for Information Systems*, 9(7): 377-408.

Galletta, D.F., R.M. Henry, S. McCoy and P. Polak, 2006. When the wait isn't so bad: The interacting effects of website delay, familiarity, and breadth. *Information Systems Research*, 17(1): 20-23.

Geisser, S., 1975. The predictive sample reuses method with applications. *Journal of the American Statistical Association*, June, 70(350): 320-328.

Hansen, P. and K. Järvelin, 2005. Collaborative information retrieval in an information-sensitive domain. *Information Processing and Management*, 41: 1101-1119.

Helm, S., A. Eggert and I. Garnefeld, 2009. Modelling the impact of corporate reputation on customer satisfaction and loyalty using PLS. In V. Esposito Vinzi, W.W.Chin, J. Henseler and H. Wang (Eds), *Handbook of partial least squares: Concepts, methods, and applications*, Berlin: Springer.

Henseler, J., C.M. Ringle and R.R. Sinkovics, 2009. The use of Partial Least Squares Path modeling in international marketing. *Advances in International Marketing*, 20: 277-319.

Hulland, J., 1999. Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, 2(20): 195-204.

Hunton, J.E., and L. Flower, 1997. Information Technology in Accounting: Assessing the Impact on Accountants and Organizations. In S.C. Sutton (Eds.). *Advances in Accounting Information Systems*, Greenwich, CT: JAI Press: 3-34.

Jaccard, J., C.K. Wan and R. Turrisi, 1990. The detection and interpretation of interaction effects between continuous variables in multiple regressions. *Multivariate Behavioral Research*, 25: 467-479.

Myers, B.L., L.A. Kappelman and V.R. Prybutok, 1998. A comprehensive model for assessing the quality and productivity of the information systems function: toward a theory for information systems assessment. In: E.J. Garrity and G.L. Sanders (Eds.). *Information Systems Success Measurement*. Hershey: Idea Group Publishing: 623-656.

Ng, Su-Ann., 2006. RM100mil for varsities. The Star Online, Friday, October 20. Available at: http://thestar.com.my/news/story.asp?file=/2006/10/20/nation/15784403&sec=nation

Nunnally, J.C., 1978. *Psychometric theory*. 2nd Ed. New York: McGraw-Hill.

Pedhazur, E.J., 1997. *Multiple Regressions in Behavioral Research: Explanation and Prediction*. Fort Woth: Harcourt Brace College Publishers.

Petter, S., D. Straub and A. Rai, 2007. Specifying Formative Constructs in Information Systems Research. *MIS Quarterly*, December, 31(4): 623-656.

Razilan, A.K. and S. Diljit, 2012. Examining the relationships of electronic library individual usage and impact using partial least squares: a formative measurement model. *Malaysian Journal of Library & Information Science*, August, 17(2): 1-15.

Razilan, A.K., W.D. Wan Ab Kadir, S. Mohd Sazili and S. Diljit, 2011. Faktor-faktor Kesedaran Terhadap Perpustakaan Digital di Institusi-institusi Pengajian Tinggi di Malaysia. *Informika: Jurnal Peradaban Informasi dan Ilmu,* 1(1): 103-120.

Ringle, C.M., 2006a. Segmentation for Path Models and Unobserved Heterogeneity: The Finite Mixture Partial Least Squares Approach, University of Hamburg Research Paper on Marketing and Retailing No. 35, Social Science Research Network (SSRN). Available at *http://ssrn.com/abstract=1586309*

Ringle, C.M., 2006b. PLS Path Modeling Using SmartPLS: Some Advances, University of Technology Sydney (UTS), School of Marketing Research Seminar Series, 2006. Available at https://www.tu-harburg.de/t3resources/hrmo/img/Publications/UTS-Marketing2006.pdf

Ringle, C.M., O. Götz, M. Wetzels and B. Wilson, 2009. On the Use of Formative Measurement Specifications in Structural Equation Modeling: A Monte Carlo Simulation Study to Compare Covariance-Based and Partial Least Squares Model Estimation Methodologies, Published in: Research Memoranda from Maastricht (METEOR), Munich University Library, Available at http://mpra.ub.uni-muenchen.de/15390/

Ringle, C.M., S. Wende and A. Will, 2005. SmartPLS 2.0 (M3) beta. Hamburg, Germany. Available at http:// www.smartpls.de

Schmidt, K., 2002. The problem with 'awareness': Introductory remarks on 'awareness in CSCW'. *Computer Supported Cooperative Work*, 11: 285-298.

Seddon, P.B., 1997. A respecification and extension of the DeLone and McLean model of IS Success. *Information Systems Research*, 8(3): 240-253.

Sedera, D., F. Tan and S. Dey, 2006. Identifying and evaluating the importance of multiple stakeholders perspective in measuring ES-Success. In the Proceedings of the 14th European Conference on Information Systems, June 12-14, G□thenburg, Sweden: 1-12.

Stone, M., 1974. Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society*, 36(2): 111-133.

Tammaro, A.M., 2008. User perceptions of digital libraries: a case study in Italy. *Performance Measurement and Metrics*, 9(2): 130-137.

Temme, D., H. Kreis and L. Hildebrandt, 2006. PLS Path Modeling - A Software Review. Sonderforschungsbereich 649: Ökonomisches Risiko, Humboldt-Universität zu Berlin, Wirtschaftswissenschaftliche Fakultät, discussion paper. Available at *http://sfb649.wiwi.hu-berlin.de/fedc/discussionPapers_en.php*

Thong, J.Y.L., W.Y. Hong and K.Y. Tam, 2002. Understanding user acceptance of digital libraries: What are the roles of interface characteristics, organizational context, and individual differences?. *International Journal of Human–Computer Studies*, 57: 215-242.

Urbach, N. and F. Ahlemann, 2010. Structural Equation Modeling in Information Systems Research Using Partial Least Squares. *Journal of Information Technology Theory and Application*, June, 11(2): 5-40.

Wold, H., 1982. Soft Modelling: The Basic Design and some Extensions. In K.G. Jöreskog and H. Wold (Eds.), *Systems Under Indirect Observation, Part II*, Amsterdam: North-Holland Publishing.