Analysis of User Satisfaction of Academic Digital Library: An Empirical Model with Mediating Effects

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Abstract
The role of Academic Digital library (DL) in our educational system has becoming of paramount important in bringing education knowledge and information closer and faster to academic users. Moreover, through the fast-changing development of the information and communication technology, it is further positively proliferated the sphere of information diffusion. This paper aims to investigate the academic digital library effectiveness towards selected public university students in fulfilling their study needs. A total of seven latent variables proposed in building PLS model in examining the relationships between Information Quality, Service Quality, System Quality and DL Collection, and Student Satisfaction. Furthermore, it was hypothesized that the mentioned relationships were mediated by Perceived Ease of Use and Perceived Usefulness. A survey method is opted and a total of 200 students were randomly selected. The PLS model results indicated that about 76%, a satisfactory percentage of variance accounted for in the DV, is explained by the IVs. However, Service Quality was the only IV that showed no direct effect on Student Satisfaction. Moreover, findings also revealed that mediating effects might not be critical in describing the posited relationships however it might offer a new point of view in examining DL effectiveness (due to some significant results shown) and could make meaningful contribution to the literature in other research setting.
Keywords: Digital Library, Effectiveness, Student Satisfaction, PLS Model, Mediating Effects.

Introduction
The role of academic Digital library (DL) in our educational system has becoming of paramount important in bringing education knowledge and information closer and faster to academic users. Moreover, through the fast-changing development of the information and

communication technology, it is further positively proliferated the sphere of information diffusion. Digital Library has been introduced for the past three decades in many organizations especially in the higher education institutions. Explosion of information management and information system technology have brought dramatic changes in learning and library system environments. Through the passage from physical library to DL era, the use of academic digital library systems does witness the spectacular impact on academic societies' way of performing their study (Razilan, Saiful Farik, Muhammad Khairulnizam & Wan Ab Kadir, 2015). The term "digital library" has been widely used or been the most chosen term by the researchers compared to the other terms such as "electronic library", "web library", "virtual library" or even "online library" in the information science field (Masrek & Gaskin, 2016).

The growth of DL in institutions especially in higher education is vital to meet the ever-changing online demands in education. Due to this, physical resources are receiving less attention and tend to be less convenient as students incline to use electronic resources. This setting is seen as more convenient and easier with respect to information retrieval especially during the recent pandemic period compared to physical resources. The existence of digital library that making its way as an enablement system of an institution to take over the so-called physical routines, the benefits are channeled to students to get access and retrieve relevant information for academic purposes at their fingertips. Moreover, services provided by DL will be beneficial for students to accomplish their assignments via easy access; cost and money saving and as well as providing a variety of choices of electronic databases.

The main focus of this paper centers on leveraging the effectiveness of DL services used by selected university students. Anchored by the constructs of Information Quality, System Quality, Service Quality and DL Collection; an empirical model is developed to examine their relationships with Students Satisfaction. Moreover, this paper also introduced mediating factors of Perceived Usefulness and Perceived Ease of Use to test the mediation effects. In this context, this study attempted to identify the determinants of DL effectiveness by introducing mediation effects. In specific, the objectives of the study are:

- To build partial least squares (PLS) model between Students Satisfaction and constructs of Information Quality, System Quality, Service Quality and DL Collection.
- To determine the determinants of the effectiveness of academic digital library services.
- To investigate the significance of mediating effects (Perceived Usefulness and Perceived Ease of Use) on the relationships between Students Satisfaction and the four constructs (Information Quality, System Quality, Service Quality and DL Collection).

Digital Libraries

The evolution in learning environment and knowledge acquisition has brought us to embrace ever changing concept in education i.e. via online. Moreover, acquiring knowledge and methods for education are becoming more sophisticated, faster, simpler and reliable when Digital Libraries (DL) were introduced to academic world (Razilan, Wan Abdul Kadir, Fatimah and Diljit; 2009). According to Omotayo & Haliru (2020), the advantages of digital library is that it can store abundance of electronic information resources that can be access by using Internet at anywhere and anytime. Syasya and Razilan (2021) pointed out that academic DL is an online system providing access to a wide variety of academic content and services. The creation of academic DL is designated to help students to access and make productive use of digital resources and services for their academic needs. Thus, the usability of DL is subject to the context of what level of requirements to be met and how much expectation has been set up to fulfill academic needs. Omotayo & Haliru (2020) emphasized that different user groups

have differing expectations in the use of DL services as well as various motivations and factors influencing use and non-use of DLs were also identified from literature. Through usability of DL it will establish important factors like satisfaction, effectiveness, usefulness, perception and acceptance. As echoed by Omotayo and Haliru (2020), mixed understanding on the differing level of awareness, perception, acceptance and use by various respondents had been shown in the past studies. Past works had been concentrating on applying an integrated model from IS Success model and TAM model in examining the DL usage behaviors, in particular building the total effect of the posited causal relationships. However, this study attempts fill a research gap by addressing the mediated effect in which perception of the usage and usability exert indirect effects between quality features of information, service, system and collections of DL, and students' satisfaction.

Students' Satisfaction
The satisfaction of user (in this context is referring to the students) has been proven by Xu & Du (2018) where user satisfaction can help in enhancing the user's loyalty or desire in using digital library and it has also improved the user's knowledge in the digital library domain. Satisfaction implies that one has reached his expectations on something or pleasure received from others. Similarly, students might be potentially using the digital library in a more frequent manner if its performance meets their expectations. Moreover, increasing user satisfaction with digital library may have implications including recommending the digital library to others, the digital library re-using as well as the digital library engaging and integrating with them. It should be noted that system quality, service quality, and information quality are important factors in the formation of perceived usefulness, perceived ease of use, and digital libraries' affinity (Soltani-Nejad, Taheri-Azad, Zarei-Maram and Saberi, 2020).

Perceived Ease of Use
Perceived ease of use can be defined as the performance of the particular system has making the usage of the user become effortless (Davis, 1989). Perceived ease of use is defined as accessibility of the digital library platform where it plays as one of crucial factors relating to user's first impression towards the digital library and so forth lead to higher intention to use. Thus, as mentioned by Davis (1989), an application perceived to be easier to use than another is more likely to be accepted by users.

Perceived Usefulness
Perceived usefulness is defined as when user of the digital library platform feels or thinks that the existence of that service can help them in improving their academic performance (Davis, 1989). Many researchers claimed that user acceptance of digital library can be measured based on the perceived usefulness by the user (Hong, Thong, Wong and Tam, 2002; Thong, Hong and Tam, 2004; Lee, Cheung and Chen, 2005; Ramayah, 2006; Mohd Yusoff et al., 2009; Jeong, 2011). Nevertheless, there were also studies indicated that perceived usefulness is one of the key factors of satisfaction (Roca et al., 2006; Lwoga, 2013)

Information Quality
Information quality can be defined as the output or outcome that has been provided by the digital library, in which measuring the degree of information needs by the user. The way to measure the good information quality is by looking at the relevancy, accuracy, authenticity,

scope and understandability provided by the digital library platform (Sagar, 2006). According to Roca et al. (2006); Freeze et al. (2010) and Ramayah and Lee (2012), the satisfaction of online learning system is when it reached the best quality of information. That is why some past works' findings dis-covered that information quality is one of the significance key factors of users' satisfaction in digital library domain.

System Quality
Apart from the factors mentioned earlier system quality is also one of the determinants investigated in this study. System quality is mostly focusing on the system's performance of a digital library platform. If the quality of the system is bad, it might impact user satisfaction. Even it is also proven by the Information System model that system quality gives a big impact on the user satisfaction. Not only on focusing on the system's performance, system quality also measuring the interface or navigation of the digital library whether the interface suits to users' interest. According to Sagar (2006), system quality also evaluates the information processing system to give the best experience for the user.

Service Quality
Service quality can be determined by the way it is performing in terms of receiving, retrieving and delivering the information by the user as requested (Balog, 2011). According to Masrek, Jamaludin and Awang Mukhtar (2010); Balog (2011) and Samadi, Masrek and Mat Yatin (2014), the attributes that can be measure from service quality are amongst the accessibility, reliability, processing and also responsiveness. In digital library platform, the interaction might be differed from the normal or face to face interaction, so that is why it is important to have a good service in virtual in order to make user satisfy with the service provided.

Digital Library Collection
As for digital library collection, it is referring to the collection of library resources provided in the digital library, which is focusing on the digital collection that only available on the UiTM Digital Library such as UiTM Institutional Repository, Khazanah Melayu and also Electronic Questions Paper System (EQPS). The usefulness of this collection towards UiTM students, awareness about the existence of such collection and usage behaviour of this digital collection can be measured using Information Search Process (ISP) model by Kuhlthau (2004, 2008). It identifies the three characteristics of user experience via affective (feelings), the cognitive (thoughts) and also the physical (actions) when using the digital library collection.

Methods
The research focus is centered on examining the level of students' satisfaction with academic DL resources and services. Thus, the quantitative is the most convenient approach for the study where survey method is opted.

Survey Instruments
The survey instrument consisted of the self-administered questionnaire which designated to measure the posited relationships of the study model. All items in the questionnaire were measured by means of 5-point Likert scale with the following, "1: Strongly Disagree" to "5: Strongly Agree".

Population and Sample
The respondents of the study consisted of postgraduate and undergraduate students of two faculties of the selected public university. The students are chosen due to reason of knowledge acquisition to fulfill their academic requirements that highly dependent on university's digital library platform. A total of 200 students from faculties were randomly selected for the study.

Theoretical Model
The proposed research model is based on reviews of articles by authors of Soltanu-Nejad et. Al (2020), Ramayah and Lee (2012), Ramayah (2006), Kulthau (2024, 2008), Davis (1989). It is composed of five constructs of independent variables (IVs): Information Quality (IQ), System Quality (SQ), Service Quality (ServQ) and DL Collection (DLC); that are posited to affect the dependent variable (DV) of Students' Satisfaction (SS) in using DL resources and services. The variables of Perceived Ease of Use (PEU) and Perceived Usefulness (PU) moderate the relationships of the four constructs with the dependent variable. All of the seven hypothesized (latent) constructs were operationalized using established measurement tool i.e. 5-point scales and their relationships are as exhibited in Figure 1. The questionnaire used for this study comprised of items whose validity and reliability have been tested.
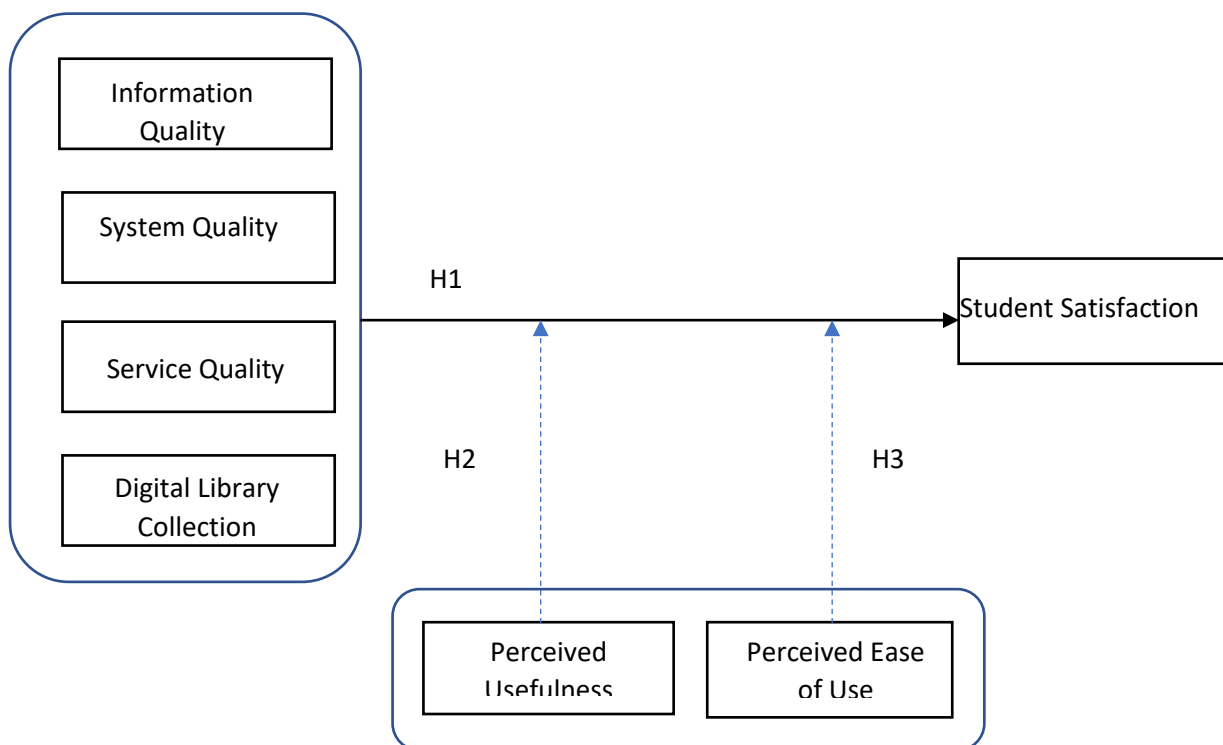

Figure 1: The hypothesized model of the relationships between latent constructs

Analyses
Profiles of study data are presented through summary statistics such as frequency (counts and percentages). Data were analysed through path modelling using the partial least squares

(PLS) approach in the SmartPLS software (Ringle, Wende, & Will, 2005). The variance-based PLS procedure, described as soft modelling, is considered to be useful in investigating descriptive and predictive relationships (Sellin & Keeves, 1997) particularly with samples of less than 200 participants (Chin & Newsted, 1999). PLS path models are formally defined by two sets of linear equations: the inner model and the outer model. The inner model specifies the relationships between unobserved or latent variables, whereas the outer model specifies the relationships between a latent variable and its observed or manifest variables. It is useful in analysing models and theory building due to minimal demands on measurement scales, sample size and residual distribution (Chin, 1998; Wold, 1985).

Hypotheses
To test the validity of the research model as in Figure 1, the hypotheses in Table 1 are proposed.

Table 1:
Hypotheses of the study

H1a	Information quality is positively related to student satisfaction.
H1b	System quality is positively related to student satisfaction.
H1c	Service quality is positively related to student satisfaction.
H1d	DL collection is positively related to student satisfaction.
H2	The relationship between IV [i) Information quality, ii) System quality, iii) Service quality, iv) DL collection] and Student satisfaction is positively mediated by Perceived Usefulness.
H3	The relationship between IV [i) Information quality, ii) System quality, iii) Service quality, iv) DL collection] and Student satisfaction is positively mediated by Perceived Ease of Use.

Results
Demographic Profiles
The following Table 2 provides aggregate information about the respondents' profiles. For gender of study sample, 125 are female and 75 are male, which accounting for 62.5% and 37.5% respectively of the total 200 participants. The age distribution shows inclination towards the age categories of 20-24 and 25-30 years with 99 (49.5%) and 92 (46%), respectively. For confidential reason, the name of the university and faculties were not directly shared in this article. In the survey, majority of the participants were coming from Faculty A with 148 participants. The survey sample also marked the highest participation from the 3rd semester students with 70 students (35%) followed by the 4th semester with 27 students (13.5%). The result of survey by education level indicates clearly the highest participation from Bachelor degree with 86 students, accounting for 43% and followed by Master degree with 66 students, accounting for 33%.

Table 2.
Profiles of the sample study

	Frequency
Gender	
Female	125 (62.5%)
Male	75 (37.5%)
Age	
20-24 years	99 (49.5%)
25-30 years	92 (46%)
30-34 years	7 (3.5%)
35-40 years	2 (1%)
Faculty*	
Fac A	148 (74%)
Fac B	52 (26%)
Semester	
1	17(8.5%)
2	20(10%)
3	70(35%)
4	27(13.5%)
5	21(10.5%)
6	18(9%)
Others	27(13.5%)
Education level	
Diploma	47(23.5%)
Bachelor	86(43%)
Master	66(33%)
Doctorate	01(0.55%)

*Note: Due to confidentiality aspect, the name of faculties is not given in this paper.

The analytical outcome of the study is producing the statistical output of the PLS regression with accordance to Hulland (1999) recommendations: (1) evaluation of the measurement (outer) model (2) evaluation of the structural (inner) model. The former tested the validity and reliability of the measures; whilst the latter, the structural model was assessed by estimating the paths between the constructs of the study model, determining their significance and evaluating the predictive strength of the model.

Model Evaluation: The Measurement Model
The first stage is evaluation of the measurement model where it is for determining whether the questionnaire responses actually measure their corresponding latent variables. Hulland (1999) reckoned (1) the reliability of individual survey items (2) the convergent validity of measures associated with individual constructs (3) the discriminant validity between constructs. The following Table 3 presents the acceptance threshold of all tests mentioned above.

Table 3:
The PLS measurement model criteria of the validity tests

Convergent Validity Tests	Discriminant Validity Tests
Loadings > 0.70	Average Variance Extracted (AVE) > Square of the inter-construct correlations
Composite Reliability (CR) > 0.70	No substantial cross-loadings
Average Variance Extracted (AVE) > 0.50	

Convergent Validity Tests

Formative scales were used in this study. As seen in Table 5, the tests are established with results meeting the required thresholds. Internal consistency is demonstrated when the reliability of each measure in a scale is above 0.70 (Brown, 2006; Kline, 2011). Both Cronbach Alpha and Composite reliability values > 0.70 which over the threshold value by Nunally (1978) and Hair et al. (2006). Moreover, by the examination of factor analysis, the results had been established with loadings of each manifest variables > 0.60 loaded to their respective latent variables. AVE values > 0.50 had also being fulfilled, as reckoned by Fornell and Larcker (1981). All the results of convergent validity tests and Cronbach alpha are as shown in Table 4.

Table 4: Measurement model results (factor loadings, descriptive statistics, Cronbach Alpha, composite reliability and AVE).

Variables	Items	Factor Loadings	Mean	Std. deviation	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Digital Library Collection	DLC1	0.712	4.175	0.674		0.871	0.63
	DLC2	0.860	4.14	0.671			
	DLC3	0.743	4.22	0.694	0.803		
	DLC4	0.850	4.17	0.657			
Information Quality	IQ1	0.809	4.275	0.685	0.760	0.863	0.677
	IQ2	0.773	4.275	0.700			
	IQ3	0.883	4.305	0.665			
Perceived Ease of Use	PEU1	0.852	4.270	0.589		0.899	0.747
	PEU2	0.866	4.165	0.615			
	PEU3	0.875	4.270	0.646	0.831		
Perceived Usefulness	PU1	0.818	4.320	0.614		0.883	0.716
	PU2	0.860	4.205	0.695	0.801		
	PU3	0.859	4.315	0.675			
Service Quality	SERVQ1	0.754	4.145	0.651		0.922	0.627
	SERVQ2	0.782	3.955	0.695			
	SERVQ5	0.801	4.035	0.764			
	SERVQ6	0.823	4.065	0.641	0.901		
	SERVQ7	0.825	4.12	0.69			
	SERVQ8	0.797	4.025	0.628			
	SERVQ9	0.761	4.065	0.671			
System Quality	SQ1	0.768	4.105	0.696		0.942	0.620
	SQ2	0.712	4.000	0.693			
	SQ3	0.784	4.235	0.714			
	SQ5	0.747	4.125	0.714	0.932		
	SQ6	0.792	4.160	0.703			
	SQ8	0.812	4.195	0.622			
Student's Satisfaction	SS1	0.811	4.175	0.681		0.897	0.593
	SS2	0.739	4.11	0.639			
	SS3	0.790	4.215	0.591			
	SS4	0.820	4.16	0.644			
	SS5	0.827	4.165	0.698	0.862		
	SS6	0.713	4.025	0.717			
	SS7	0.818	4.245	0.66			
	SS8	0.741	4.135	0.63			
	SS9	0.805	4.175	0.674			
	SS10	0.804	4.25	0.646			

Model Evaluation: The Structural Model

Following to the framework of PLS based structural equation modeling (PLS-SEM), the study sample was increased to 500 using bootstrapping technique for the purpose of estimating the measurement model parameters and structural model path. The resampling of 500 samples was used on basis of bootstrap routine by Chin (1998). The focal point of criterion in evaluation structural model is the level of variance explained of the dependent construct (SS), R^2 is 0.759. Hence the figure indicates that the model explained about 76% of the construct variance. The value of 76% defines that about three quarter of the student's satisfaction can be explained by the model, while the other one quarter is driven by factors not captured by the posited factors. Moreover, the values of structural path coefficients are as recommended by Hair et al. (2006) and, Wetzels, Odekerken-Schröder and Van Oppen (2009) which is at least 0.1. Both Table 5 and 6 exhibit the significance testing results of the structural (inner) model's direct and indirect effects.

Table 5:
Path coefficients of the direct effects of the structural model

Relationship	Path coefficient
Information Quality -> Student's Satisfaction	0.109^{sig}
Service Quality -> Student's Satisfaction	0.037^{nsig}
System Quality -> Student's Satisfaction	0.156^{sig}
Digital Library Collection -> Student's Satisfaction	0.385^{sig}

Note: sig-Significant, nsig-Not significant (at 5% level of significance, bootstrap = 500).

Table 6:
Path coefficients of the indirect effects of the structural model

Relationship	Paths coefficient
Information Quality -> Perceived Ease of Use -> Student's Satisfaction	0.017^{nsig}
Information Quality -> Perceived Usefulness -> Student's Satisfaction	0.092^{nsig}
Service Quality -> Perceived Ease of Use -> Student's Satisfaction	0.040^{nsig}
Service Quality -> Perceived Usefulness -> Student's Satisfaction	-0.003^{nsig}
System Quality -> Perceived Ease of Use -> Student's Satisfaction	-0.001^{nsig}
System Quality -> Perceived Usefulness -> Student's Satisfaction	0.157^{sig}

Digital Library Collection -> Perceived Usefulness -> Student's Satisfaction	0.317 sig
Digital Library Collection -> Perceived Ease of Use -> Student's Satisfaction	0.169 sig

Note: sig-Significant, nsig-Not significant (at 5% level of significance, bootstrap = 500).

Both Table 5 and 6 indicate shaded cells of hypothesized relationships which are significant at 5% level of significance. In Table 5, the direct relationships examined by the model show that the posited constructs of IQ (β=0.109, p<0.05), SQ (β=0.156, p<0.05) and DLC (β=0.385, p<0.05) possess direct effects on SS. However, ServQ demonstrated no significant effects. Hence, the hypotheses of H1a, H1b and H1d have been supported whereas hypothesis H1c has been rejected.

In the relationships between the IVs and DV when the moderator effects of PU and PEU are considered, the results are as displayed in Table 6. Latent variables of students' perception on usefulness and usability, PU and PEoU, are detected in mediating the posited relationships with the following results: SQ $\rightarrow$ PU $\rightarrow$ SS (β=0.157, p<0.05) and DLC $\rightarrow$PU $\rightarrow$ SS (β=0.169, p<0.05) and DLC $\rightarrow$ PEoU $\rightarrow$ SS (β=0.317, p<0.05). The table also exhibits that there is no evidence of indirect effects between ServQ and SS, and the rests of the hypothesized relationships. Hence, hypotheses of H2ii), H2iv) and H3iv) have been supported.

Discussion And Implication
The findings of PLS results indicated that a good deal of support has been found for the proposed study model where a satisfactory percentage of the variance accounted for in the DV is explained by the IVs. There is a strong and positive relationship between the posited IVs and Students' Satisfaction. However, results also implied that not all the postulated relationships were imperative for which Service Quality was not significant for this study. The quality of service, as claimed by Hashim et al. (2022), is a performance that needs to be evaluated to make sure that the service achieves customer satisfaction that they have experienced. As being discussed earlier, this construct measures including accessibility, reliability, processing and responsiveness. The four measures, when compared to the incipient development of DL about two (or more) decades ago, the technology is now already at maturity level and not surprisingly, keeps on advancing. For example, having good experience in accessing DL via high-speed internet is common to most of us in the era of network fiber offering 5G around us! Processing is also another angle with no doubt, hardware processing power, smarter devices, datafication, artificial intelligence technologies, and artificial intelligence automation are all here to streamline DL system workloads to optimize students' academic needs. Results of the model also indicated that introducing mediators of Perceived Usefulness and Perceived Ease of Use might not be critical in describing the relationships between the proposed IVs and satisfaction of using DL. Nevertheless, it might offer a new point of view in examining DL effectiveness (due to some significant results shown in Table 6) and could yield meaningful contribution to the literature in other research setting.

The conducted research shows the importance of being aware on the perspective of whether or not information/data in a digital library meets the expectations and requirements of the students. Management involvement is necessary when the effectiveness of DL implementation is concerned. Findings of this study may guide university librarians to understand students' needs and challenges with respect to digital libraries resources and

references, which may help them to improvise their services accordingly. The main implication is for library management to adopt new emerging technology to tailor with the fast-moving environment of requirements in education. They need to efficiently adopt any latest technology in digital library systems to offer richer data and services to students. Mentang, Qashlim, Sarjan (2021) stressed that an integrated library information system (digital library) should at least contain information and every journal source. Also, as echoed by Ravelli & Mataloni (2022), the Digital index is needed to collect every library data in a digital library system. They emphasized on linking digital resources to a database's cataloguing record and indexing system, which (digital index) is an important component to optimize the search engine.

Digital librarians should be aware with students' needs and interest to militate against of being an old-school online library. This study revealed that information quality, system quality and DL collections play big roles in determining the effectiveness of DL. Effectiveness of a DL is observed through their satisfaction. Thus, digital library itself needs to be improved in order to get positive results from the satisfaction of digital library users.

The study results provide important explanations of the factors determining the students' satisfaction in using university's DL. It shall be useful to mention such limitations for the benefit of future studies. Firstly, this study only considers only sample from two faculties of one public higher institution for which results may differ according to type of university or faculties. Secondly, study background of students may not diversify enough as it only considered non-technical faculties. Thus, the study analyses, results and interpretation have been carried out by considering this pool of population only, which may have influenced the model estimates. However, this case study can be considered as baseline scenario in applying PLS model to describe the posited relationships. Thirdly, time constraints of conducting the survey where students were approached during a certain period of time with accordance to their availability might impact the way they responded to the questionnaire.

Conclusion

This paper has attempted to investigate the effectiveness of DL towards the varsity students by addressing the moderating effects of user perceptions of usefulness and usability on their satisfaction in using the academic DL resources. This study has empirically developed and estimated a formative partial least squares model by introducing seven latent variables in which two of the constructs were moderators in testing the mediating effects between Information Quality, System Quality, Service Quality and DL Collection (IVs) and Student Satisfaction (DV). It has been found that mediating effects may not be essential in explaining the posited relationships. Nevertheless, this study offers a new point of view in examining DL effectiveness and shall make meaningful contribution to the literature where the proposed model might be used as an eye opener for library management to understand deeper on students' needs and expectations of using university's DL, and so forth to plan ahead the necessary actionable strategies. Technology today is evolving at a rapid pace and we are witnessing the enabling technology moving with faster change and progress. Hence, it might be high time to consider a digital library system with latest technology or have an integrated architecture from various digital library platforms and online sources. Enhancing DL should embed technology that can revolutionize the way of academic life. The core scheme should take into account on how to provide appropriate recommendations that potential to help students to be more productive in learning.

The study explores on the current situation of students with respect to their satisfaction on DL offered by the university. It is basically potential for future research due to reason that the role of DL is becoming vital in serving the student needs through their academic journey at the university. Within the context of postulating the relationships and identifying the factors influencing their satisfaction, future research should increase the number of samples and as well as to diversify the study background, meaning to sample students from variety of faculties. This may give better perspective on accounting the essence of satisfaction from students, for example from non-technical and technical backgrounds.

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