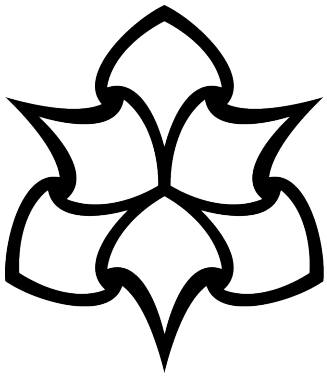

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Investigating the acceptance of mobile library applications with an extended technology acceptance model (TAM)

Hamaad Rafique [a,*], Alaa Omran Almagrabi [b], Azra Shamim [c], Fozia Anwar [d], Ali Kashif Bashir [e,f]

[a] *School of Computer Science and Technology, University of Science and Technology of China, Hefei 230026, China*
[b] *Department of Information Systems, Faculty of Computing and Information Technology (FCIT) King Abdul Aziz University (KAU) Jeddah, Kingdom of Saudi Arabia, aalmagrabi3@kau.edu.sa*
[c] *University of Jeddah,Jeddah 23218, Saudia Arabia*
[d] *Higher Colleges of Technology, Sharjah 7947, United Arab Emirates*
[e] *School of Computing, Mathematics, and Digital Technology, Manchester Metropolitan University, Manchester M15 5RN, UK*
[f] *School of Electrical Engineering and Computer Science (SEECS), National University of Sciences and Technology (NUST), Islamabad - 44000, Pakistan*

Abstract

Mobile applications are getting a great deal of interest among researchers due to their proliferation and pervasiveness, especially in the context of digital libraries of educational institutes. However, their low acceptance and usage are observed, hence, in-depth investigations are required in order to understand the factors behind low acceptance and intention to use mobile library application (MLA). Therefore, the aim of this work is to empirically explore the acceptance of MLA with a proposed model that is evolved from the technology acceptance model (TAM). The study objects to deliver empirical provision on acceptance of MLA. A self-administrated cross-sectional survey-based study was conducted to gather data from 340 users of MLA. Structural equation model (SEM) with an analysis of moment structure (AMOS) software was conducted to examine quantitative data. Results revealed that perceived usefulness and perceived ease of use are direct significant predictors with the intention to use MLA whereas system quality and habit are the influencing factors toward the usage intention of MLA. The findings help as a guide for effective decision in the design and development of MLA. Further, the outcomes can be utilized in the resource allocation process for ensuring the success of the library's vision and mission.

Keywords: Smart library, Smartphone applications, Technology acceptance model (TAM), Digital Library, mobile library

1.1. Introduction

The rapid development of wireless mobile technologies, particularly mobile applications are considered as an important tool for obtaining diverse services, namely, m-paying, m-learning, m-banking, (Rafique, Anwer, Shamim, & Minaei-bidgoli, 2018). The pervasiveness of wireless technology is encouraging the users to use technology for playing games, entertainment, reading the newspaper, social media sites and internet surfing (Rafique et al., 2018)(Huh & Kim, 2008)(Kleijnen, de Ruyter, & Wetzels, 2007). The paradigm shift of technology from the desktop to wireless technology particularly mobile applications encourage the organizations to alter their way of communication and learning (Kleijnen et al., 2007). Hence, upgrading of wired technology to wireless technology is being observed in various public and private organizations like banks, shopping malls, educational institutes, and libraries.

Libraries are the knowledge sea and are considered as a key source of information, learning, and research. Due to the advancements of information and communication technology (ICT), particularly wireless and mobile technologies, educational institutions are transforming their digital libraries to mobile library application (MLA). Digital Library (DL) is defined as "Library accessed by a user through the use of computer and web broadband at the defined place" (Zha, Zhang, & Yan, 2015). In DL, user access the library resources through a computer at a defined place and network, either from the library, home, office or e-library. Furthermore, the user does general searching through different search engines in digital libraries than traditional libraries. It depicts that, traditional libraries, as well as DL, does have temporal and spatial constraints, as it is dependent on a specific place, system, and internet for accessing library services (Rafique et al., 2018). Hence, to overcome these constraints, MLA was adopted by various libraries either in a private, public or institutional library. Therefore, MLA is defined as "accessing the digital library through the use of mobile phone and wireless network without any temporal and spatial constraints" (Zha, Zhang, Li, & Yang, 2016). MLA is considered more intelligent and quicker in accessing library resources by overcoming temporal and spatial constraints (Rafique et al., 2018)(Ali et al., 2019).

Certainly, MLA was adopted throughout the world as well as in Pakistan, However, the success of any technology depends on its adoption by the intended users (Park, Roman, Lee, & Chung, 2009). Despite the huge investment of resources in technology, particularly in the MLA domain, its low usage, ignorance and overlooking were observed by an intended user (Hong, Thong, & Tam, 2006)(Yoon, 2016). Like other regions (Europe, America) (Rafique et al., 2018)(Zha et al., 2015), with the advancement of technology, many institutes in Pakistan are now adopting MLA, namely, COMSATS University Islamabad (CUI) and Quaid-e-Azam University (QAU) etc. Besides the tremendous increase in telecom infrastructure in Pakistan, the acceptance and adaptation of mobile applications have been very slow. As reported by the Pakistan Telecommunication Authority (PTA), tele-density for mobile phone subscribers jumped to 68.2% with 118,316,916 users (Habib & Ateeq, 2014) . In order to verify the usage position of MLA among universities, pre-survey was conducted from students. It was conducted to identify the status about usage of general mobile applications during daily life routine as well as to inquire about the usage of MLA in their study period or throughout the whole day. Online survey from both universities helped to get the statistics about the usage as shown in Table 1, which illustrate that more than 85% of the students don't use MLA for their study purpose as they prefer to visit library or online search. Therefore, the aims of this study are to investigate the adoption of MLA in the context of Pakistan and to compare its adoption with other regions of world. Specifically, this study focuses on the identification of various factors causing low usage and espousal of MLA launched by COMSATS university with the name INSIGNIA ILS in 2014 by extending technology acceptance model (TAM) proposed by Davis (Davis, 1989)(Adams, Nelson, & Todd, 1992). TAM was adapted in different research fields, namely, m-shopping (Hubert, Blut, Brock, Backhaus, & Eberhardt, 2017), e-learning (Jeong, 2011), online libraries (Zhao, Deng, & Zhou, 2015), digital libraries (Zha et al., 2015), and MLA (Rafique et al., 2018) to investigate the acceptance of technology. In literature, TAM was adopted and extended with external factors on the bases of three reasons. First of all, it helps in understanding the users' perspective in the adoption of MLA. Secondly, TAM was adopted by different researchers in various domains like m-shopping (Hubert et al., 2017), e-learning (Jeong, 2011), online libraries (Zhao et al., 2015), digital libraries (Zha et al., 2015), and MLA (Joo & Choi, 2015)(Aharony, 2014). Thirdly, it helps the researcher in investigating the effect of an external factors on dependent variables. Therefore, the current research extended TAM by incorporating two external factors (habit (H) and system quality (SQ)) with the core constructs of

TAM. These factors were incorporated in this research because habits of the users usually change on the basis of system quality. Therefore, this study aims to check this effect on intention to use MLA (Hubert et al., 2017)(Jeong, 2011). Therefore, current study selected TAM as a proposed model, as it will help us in understanding the initial adoption of the implemented technology in developing country context.

Table 1: Pre-Research statistics

University	Gender	General App. Users	General App. Usage Percentage	MLA Users	MLA Usage Percentage
QAU	Male	148	53.21%	10	3.59%
	Female	130	46.76%	26	9.35%
CUI	Male	127	42.76%	13	4.37%
	Female	170	57.23%	19	6.39%

The targeted population for current research is the users of MLA from COMSATS University, Islamabad. CUI is a Pakistani higher educational university founded in 1998. Within a stipulated time, it grows to seven campuses across the country. Higher education commission (HEC) of Pakistan has graded CUI as top most educational institutes of Pakistan ("CUI Rankings and Reputation," 2018). In 2014, CUI transferred their digital library to mobile library application (MLA) by introducing mobile application named INSIGNIA ILS, to access open public access catalogue (OPAC), higher education commission (HEC) digital library and thesis repository etc. Throughout the world, huge research was performed with improvement focal point of MLA, instead of an exact examination of libraries in developing nation like Pakistan. Thus, profound look from individuals of a less developed nation is the centre, for example, Pakistan.

The primary objectives of this research are to address the following research questions in order to fill the research gap by identifying the improvement areas in mobile library application as well as the domain in a developing country.

1. What is the suitability of TAM in developing country with the focus on MLA?
2. What are the factors that affect users' intentions to use MLA in Pakistan?
3. What are the relationships between the factors that affect users' intentions to use MLA in Pakistan?

Hence, this research article will focus on the acceptance of MLA i.e. INSIGNIA ILS, as in developing country context. The government of Pakistan is investing a huge amount of money in ICT infrastructure (Habib & Ateeq, 2014). Therefore, it is a need of time to check the acceptance of technology which is provided to intended users after the massive investment. In return, it will help to rationalize the outcomes, which will lead to the improvement of technology after the usage by the prospective users. The responses of the users will be analysed in SPSS and AMOS tools for getting the deeper look of the factors which are creating the hurdles in the usage of technology.

This research study comprises of the following sections, introduction regarding the research is defined in section 1.1. Section 1.2 describes the literature review supporting the research problems. The proposed extended TAM model along with the proposed hypothesis is explained in section 1.3. A detailed discussion of the proposed methodology used to identify the influence of external factors toward the behavioural intention is presented in section 1.4. The data analysis is explained in section 1.5. Research outcomes are discussed and explained in section 1.6. In the end, research is concluded in section 1.7

1.2. Literature review

Various models such as EECM (Joo & Choi, 2015) and UTAUT (Venkatesh, Morris, Davis, & Davis, 2003) are presented in the literature to investigate the intention of people regarding technology adoption. Among these models, TAM has been extensively used for recognizing the factors affecting the acceptance of technology in a variety of contexts like USA, KSA, Korea, China, (Rafique et al., 2018)(Zha et al., 2015)(Yoon, 2016) and in various domains like m-shopping (Hubert et al., 2017), e-learning (Jeong, 2011), online libraries (Zhao et al., 2015), digital libraries (Zha et al., 2015), and MLA (Joo & Choi, 2015)(Aharony, 2014). TAM was extended from the theory of reasoned action (TRA), which says, the behaviour of an individual is determined by his/her behavioural intention (BI) whereas, BI is determined by subjective norms and attitude (Ajzen & Fishbein, 1977). TAM was proposed by (Davis, 1989) having two core factors, perceived usefulness (PU) and perceived ease of use (PEOU).

Researchers had widely used TAM to investigate the behavior of a users toward using new information systems and technology in a library setting (online library resource, digital library and MLA (Rafique et al., 2018)(Zha et al., 2015)(Yoon, 2016)(Zhao et al., 2015)(Aharony, 2014) (Miller & Khera, 2010). The research conducted in developing countries Kenya and Peru identified the factors influencing the usage of digital libraries by applying TAM (Miller & Khera, 2010). Their research acknowledged PU as the key interpreter in the usage intention of the digital library. However, PEOU was not determined as the key contributor toward the usage intention. Another study (Park et al., 2009) examined the factors affecting the users' acceptance and intention for the digital library system in an emerging country context (Botswana, Ghana, Indonesia and Nepal) and the results revealed a significant effect of PEOU on PU which resulted in increased BI toward the use of the system. Instead of the good overall effect of external factors on the intention to use, it is clear from the study that the effect of ease of use which is the mediator of six factors is just affecting at the P-value of 0.4 and it is marginal away from the least accepted value of P i.e. 0.5. The influencing factors on the acceptance of online library resources at United state are explored in (Joo & Choi, 2015) where it was found that PU and PEOU influenced undergraduates' intention to use online library resources, However, this study is not focusing graduate and PhD students, who has main concern with the research contents. Current research will certainly focus on the usage intention of research scholars who have direct interaction with the research. Similarly, (Rafique et al., 2018) supported the finding of (Joo & Choi, 2015) by reporting the influence of PEOU and PU on the intention of undergraduate students and it also studied some significant effect of graduate students toward the use of mobile library application. The study describes that usage intention of online library resources is common. Besides that, it also explains the significant positive influence of system accessibility, perceived mobility value, and satisfaction on behavioural intention in the mobile library application. However, the result demonstrated low usage of MLA among students. Besides the low usage of application among intended users, weak effect of perceived usefulness was also reported on behavioural intention with significant value of $P<0.05$, that is not showing much effect towards the acceptance. (Yoon, 2016) concluded that PEOU significantly influence PU which ultimately leads to the intention to use MLA. (Jeong, 2011) incorporated system characteristic (system quality) in TAM for measuring the behavior intention of user toward e-library through PU and PEOU in the Korean context. The result inferred the strong impact of system quality on PU and PEOU which finally leads to the behavior intention of e-library usage. However, results are representing the weak effect of system quality on dependent variable i.e. behavioural intention through the core components of TAM i.e. perceived usefulness and perceived ease of use. The effect

of system quality is much weak through perceived usefulness toward dependent variable instead through ease of use. All these studies identified various factors which are affecting the acceptance of digital, online and mobile library application. However, they also reported the low usage of digital libraries among students in various contexts.

(Hubert et al., 2017) examined various factors for measuring the usage intention of m-shopping by conducting research work in Denmark. Their results identified a strong impact of habit on PE and PEOU. From the findings of this study, it was inferred that besides other factors integrated into TAM, the habit had a strong and positive influence on TAM core constructs toward the usage intention of mobile shopping. However, the acceptance of mobile shopping was considered very low in developed countries. Whereas, in the perspective of e-learning, the researcher found various influencing factors like individual characteristics, interface characteristics and system characteristics (Jeong, 2011) among students in Korea. The results of the study revealed that system quality is the noteworthy interpreter to both PEOU and PU which leads to the acceptance and usage of e-learning among students. Besides the positive effect of system quality, low usage of e-learning among students was concluded from the analysis. In the majority of the studies, researches identified low usage as well as ignorance of mobile application technologies among intended users.

As stated earlier, various models were used to measure the acceptance of technology/ Information Systems. Author (Venkatesh et al., 2003) extended TAM i.e. Unified Theory of Acceptance and Use of Technology (UTAUT) with concepts like performance expectancy (PE), social influence (SI), effort expectation (EE) and facilitating conditions (FC) which influence intention to use and behavioural intention in a library context. (Chang, Lou, Cheng, & Lin, 2015) integrated UTAUT model with task-technology fit (TTF) to investigate behaviour intention toward the use of MLA in universities libraries. Another researcher (Awwad & Al-Majali, 2015) implemented the UTAUT at public Jordanian University for measuring the acceptance of electronic library services. Their study identified that behaviour of a student toward electronic library depends on FC and intention to use, whereas, user intentions for library information services depends on three factors of UTAUT i.e. EE, SE and PE. However, results point out the ignorance of technologies among users, which ultimately results in low usage. In parallel to this, it was concluded that the habit of using technology totally depends on facilitating conditions. If the technology has strong FC along with the PE, then the user will definitely build a habit for using the technology for their study.

As debated in the literature review, literature extended TAM to identify the multiple influencing factors which are affecting users' behaviour in a library setting. Existing research shows that PEOU and PU are vital factors of user acceptance of digital and online libraries. Regardless of these facts, there is sparse research which is focused on MLA acceptance by undergraduate and graduate students based on external factors. This study is, therefore, address the research gap of low usage of MLA in developing country context i.e. Pakistan particularly focusing the factors habit and system quality for measuring the influence of students toward library application i.e. INSIGNIA ILS.

1.3. Proposed model and hypothesis

Based on previous research and theoretical concept, this study extended TAM in mobile library application domain by including two external variables i.e. habit and system quality. The dependent variable for this study is a behavioural intention, whereas system quality, habit, perceived usefulness and perceived ease of use were the independent variables. Graphical representation of the proposed hypothesis is presented in Figure 1.

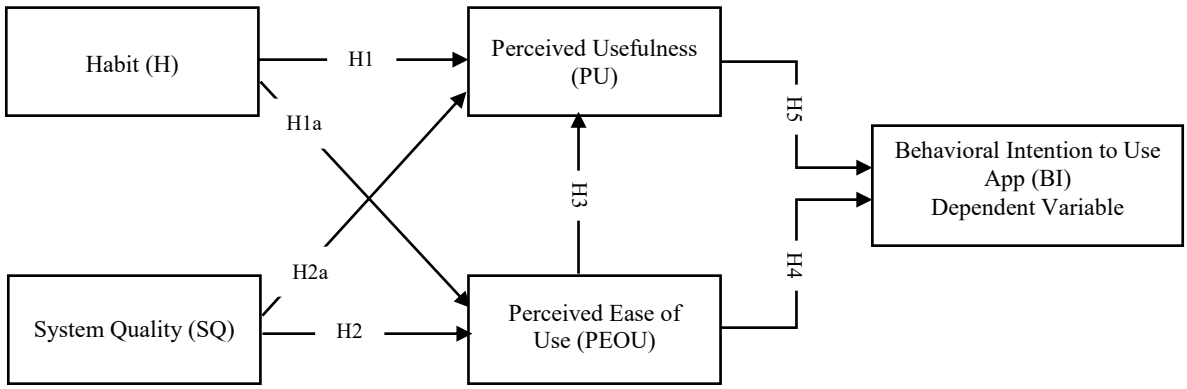

Fig 1: Research Model

1.3.1. Independent variable Habit (H)

Habit is considered as a strong indicator for emphasis and lifespan of existing behaviour (Venkatesh, Thong, & Xu, 2012). The unified theory considered habit as an influencing indicator in term of usage intentions of the mobile application while using the internet. (Venkatesh et al., 2012). Authors in (Kim & Malhotra, 2005) have discovered that prior information system usage is a strong marker of future technology. The more experienced a user is, the way better the user will use the internet and mobile applications for personal usage. It inferred that habit has a more cognitive influence on behaviour intention, as it helps in the more intensive assessment of various cost advantages that are of more considered nature (Kim & Malhotra, 2005). In addition, (Hubert et al., 2017) proposed a positive significant relationship of habit to the core constructs of TAM (perceived usefulness and perceived ease of use). Subsequently, it is proposed that

H1: Habit will have a positive significant effect on the perceived usefulness of mobile library applications.
H1a: Habit will have a positive significant effect on perceived ease of use of mobile library applications.

1.3.2. Independent variable System Quality (SQ)

SQ is demarcated as "users' level of getting assistance from an information system" (Jeong, 2011). SQ deals with easiness, accessibility, and acceptance of the information system (Khan & Qutab, 2016). According to (Chang et al., 2015), digital libraries offer web-based information system. Whereas, the quality of web-based services has a significant and constructive influence on the behavioural intention of students. Hence, it shows that students will only adopt the mobile library application if it is qualitative in nature. Thus, it can be inferred that system quality does have an impact on the acceptance of technology in developed states. Therefore, it is included in this study for the identification of the effect of SQ on behavioral intention through the core concept of TAM (Jeong, 2011). Thus, it is theorized that

H2. System quality will have a positive significant influence on perceived ease of use for mobile library application.
H2a. System quality will have a positive significant influence on perceived usefulness for mobile library application

1.3.3. Independent Variable Perceived ease of use (PEOU)

Defined as the "degree to which a person thinks that using a specific system would be effort-free" (Davis, 1989). Considering definition in this study, it is defined as the user feel free from the effort, i.e. both mentally and physically in using MLA. Preceding studies described the constructive relationship between PU and the intention to use. (Yoon, 2016) clarifies the significant effect of PEOU on perceived usefulness of MLA. Furthermore, (Yoon, 2016)(Sheikhshoaei & Oloumi, 2011) explored the positive effect of PEOU on the intention to use mobile library services. Based on prior research, this study projected the following hypothesis

H3: Perceived ease of use will have a positive significant effect on the perceived usefulness of INSIGNIA ILS.
H4: Perceived ease of use will have a positive significant effect on the behavioural intention to use INSIGNIA ILS.

1.3.4. Independent Variable Perceived usefulness (PU)

PU is defined as the "degree to which a person trusts that using a specific system would improve their job performance" (Davis, 1989). Prior research proved the noteworthy effect of PU on the intention to use a particular system. (Yoon, 2016) identifies the positive relationship among PU and intention to use the mobile library service. Similarly, (Xu, Gan, & Yan, 2010) states that PU has a constructive effect on the intention of using digital library services. Therefore, on the basis of this prior research, the current study projected the following hypothesis

H5: Perceived usefulness will have a positive significant effect on behavioural intention to use INSIGNIA ILS.

1.3.5. Dependent Variable – Behavioral Intention (BI)

In TAM, system acceptance is the interpreter of BI (Davis, Bagozzi, & Warshaw, 1989). Swanson defines system acceptance as a user's propensity in the direction of using a particular system (Szajna, 1996). In technology acceptance studies, user behaviour is measured by usage intentions as there is a high association among intention and behaviour (Mathieson, Peacock, & Chin, 2001). Whereas, the intention is the instant predecessor of behaviour (Szajna, 1996). Therefore, BI is selected as the independent variable in this research work. In addition to that, the literature supports the significant direct association of PEOU and PU with usage intention than usage behaviour or attitude. It itches for using BI as an independent variable in the study (Szajna, 1996).

1.4. Research Methodology

1.4.1. Questionnaire Development

The validity and reliability of a questionnaire in the quantitative study have its own importance. Therefore, to ensure the reliability and validity of the questionnaire, every construct is supported with the measurement items which were selected from appropriate literature. The survey instrument was divided into two parts i.e. demographic portion and construct related portion, with the prior concentrating on age, qualification, and

gender. The second section asked users the degree of satisfaction of ease of use, perceived usefulness, habit and system quality on a 7-point Likert scale that ranges from (1) strongly disagree to (7) strongly agree. Observed variables for both perceived ease of use and perceived usefulness were adopted from (Rafique et al., 2018), while four measurement items for habit were selected from (Venkatesh et al., 2012). Further, 4 observed variables for system quality were adapted from (Jeong, 2011). The instrument used in this study is presented in appendix A.

1.4.2. Pilot Study

Factors used in the current research were already implemented and adopted in different domains as expressed in the literature review. All the factors were rearticulated before using in this study by focusing on the concept of mobile library application (MLA). After the development of an instrument, it was judged by users to access the understandability of the instrument. Further, this evaluation determines the psychometric properties and weakness of the questionnaire. A total of 15 frequent users of MLA were randomly selected from the CUI database. During the pilot study, questionnaires were distributed to the selected users. All the participants responded to the survey. Suggestions provided by the participants were incorporated into a questionnaire before the final survey. As one of the participants suggested to include the question in demographic information section regarding age, and 2 participants suggested to alter the wording of question regarding the habit, as they think it is difficult to understand. We incorporated these suggestions into our questionnaire.

1.4.3. Data collection and Respondents

To collect data, the quantitative cross-sectional survey-based study was performed at CUI. In Semester Fall 2018, data were collected from 1st September 2018 to 25 December 2018 from the users of MLA. Library officials of CUI were requested to provide the list of frequent users of MLA along with their contact information. The provided list was then transformed to excel sheet and RAND function was applied to select the random number of users from the provided list. After retrieving the list of random users, 400 were approached by researchers. The selected respondents were requested to fill in the instrument. Afterward questionnaires were gathered from the respondents, the questionnaire went through basic pre-processing. In this, invalid responses were removed. Responses with a high percentage of the same answers against all points of the used Likert scale and those with a high percentage of missing values were dropped from the collected responses. Only 30 respondents did not return the questionnaires, whereas 9 responses were half-filled i.e. responses with a maximum missing value (reasons for the missing value might be that they were not able to correctly interpret the technical terms in few questions) and 11 responses were completely blank. Therefore, 85% responses were used in the final investigation that is 340 out of 400, as the overall sample size is greater than the optional sample size of 100-150 for reliable outcomes in structural equation modelling (Hairs, Anderson, Tatham, & Black, 1998)(Hair, Black, Babin, & Anderson, 2010)**.**The illustration of demographic evidence is shown in Table 2. The results infer that 194 (57%) were males and 146 (42.9%) were the female respondent. Most of the responses were from the students of age ranging from 20-25 years, as the majority of the application users were from undergraduate studies. Moreover, second-most high response rate (i.e. 193 respondents) was from students of post graduates i.e. MS.

Table 2: Demographic data

Demographics	Category	Frequency	Percentage%
Gender	Male	194	57.0
	Female	146	42.9
Age	20 - 25 years	185	54.4
	26 - 30 years	110	32.4
	31 - 35 years	33	10.3
	36 - 40 years	8	2.5
	Above 41	4	1.2
Qualification enrolled	BS	108	33.6
	MS	193	60.1
	PhD	20	6.3

1.5. Data Analysis

In the current research, two software's were used for data analysis i.e. Statistical Package for Social Science (SPSSv20) and analysis of moment structure (AMOS v20). SPSS was used for data coding, cleaning, assumption checking and factor analysis, whereas, AMOS was used to test the validity, reliability, discriminant validity and goodness of Fit indices in a measurement model and testing of the proposed hypothesis was performed through a structural model. The data analysis strategy is shown in Figure 2.

1.5.1. Data Screening

Data screening is a process to ensure the data cleaning before conducting further statistical analysis. It was performed to test the reliability, usability and accuracy of coded data. In this stage, data were screened to check (i) the nature of missing value, (ii) outliers, and (iii) normality of data as described below:

1.5.2. Missing value:

To check the nature of missing values in the coded data, Little's Chi-square test was applied. The results of this test depicted that, data may be presumed as missing completely at random (MCAR) as the significant value of data for Little Chi-square is 0.122 which is greater than 0.05. Therefore, to replace the missing values in MCAR nature, the researcher applied "regression imputation" technique.

1.5.3. Outliers:

In data screening phase outliers need to be detected. To nominate the outliers in a coded data Z-score and Mahalanobis distance D^2 tests were used at univariate and multivariate levels, respectively. If the retrieved value is 3 standard deviations far, then it is considered as an outlier at univariate level; however, if the value of D^2/DF is larger than 3-4 than it is considered as an outlier at the multivariate level (Hair et al., 2010)(Kline, 2005). So, the obtained value of coded data for the univariate outlier is within 3 standard deviations and for the multivariate level, it is below 3.1 showing the mild nature of outliers. Therefore, to generalize the result of the study, mild outliers were engaged for further analysis.

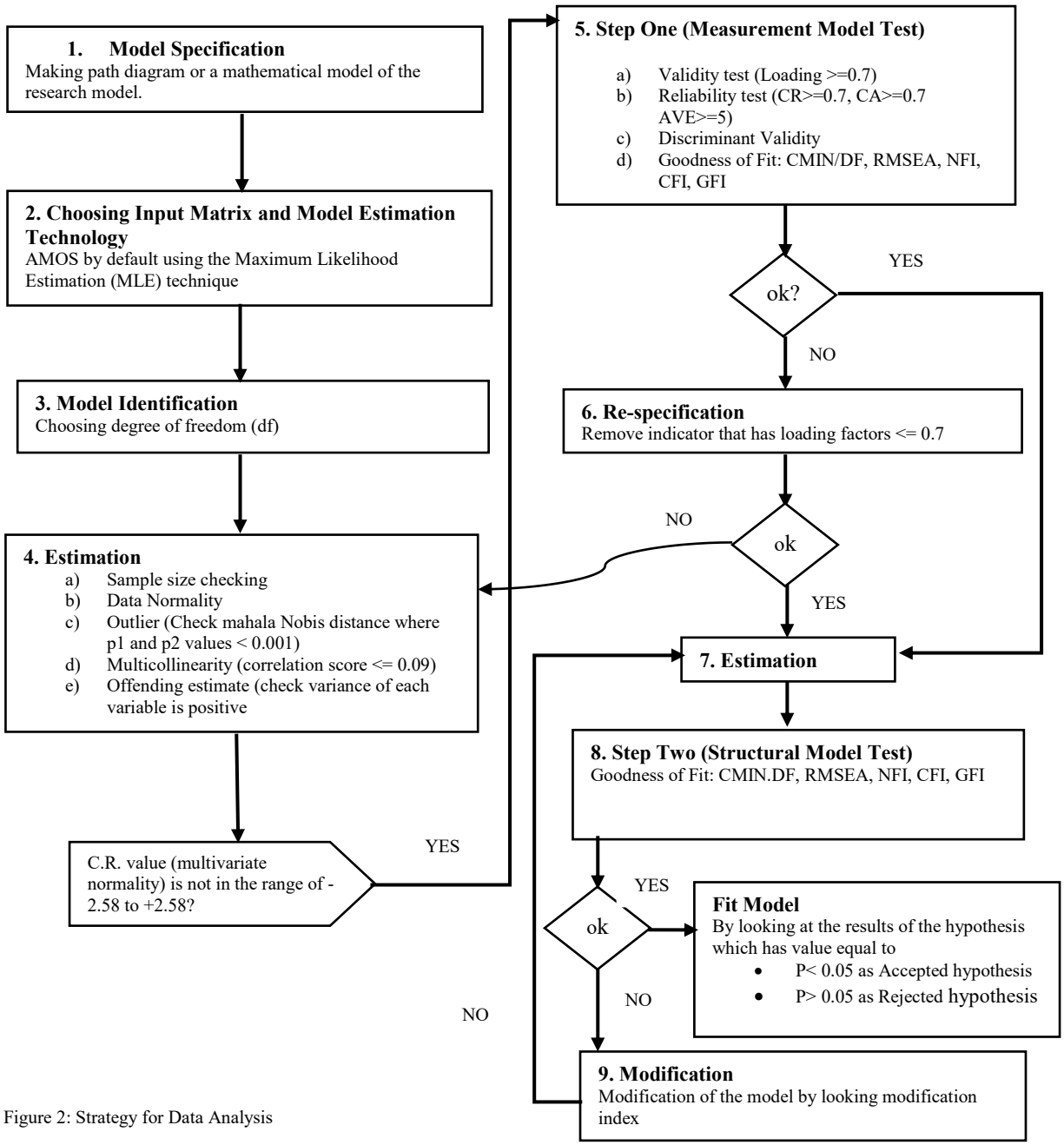

Figure 2: Strategy for Data Analysis

1.5.4. Normality:

The normality of data needs to be checked before analysis. Normality at the univariate level was checked through kurtosis and skewness, with the defined range of ±3 and ±1, respectively (Rafique et al., 2018). As

the results show the value of kurtosis and skewness less than ±1, hence, depicted results were not radically deviating. Hence, it was inferred from the results that, data is normally distributed without any problem of normality.

Later the data cleaning process and factor analysis were performed, as it helps in briefing the large pool of factors into a small set of components. Factor analysis comprised of two parts: exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). EFA was performed in SPSS followed by CFA in AMOS along with validity and reliability of construct. With the help of CFA, the proposed hypothesis was tested through structural equation modelling (SEM). This technique was used because SEM is capable enough to estimate the relationship among constructs with multiple measurement items in the multivariate environment (Li, Chung, & Fiore, 2017).

1.5.5. Structural Equation Model:

SEM was used because of multiple measurement items against constructs within the multivariate environment and for identifying the association among dependent and independent variables simultaneously instead of individual testing of relationships (Hair et al., 2010). Therefore, a two-step approach endorsed by (Gerbing & Anderson, 1993) was executed to conduct SEM analysis over data. Firstly, the analysis of measurement model (MM) was conducted for determining the relationship among observed and unobserved variables through CFA using AMOS software and in the second step, the analysis of the structural model (SM) was performed to test the proposed hypothesis for dependent and independent variables. SEM fit was determined with a coefficient parameter and goodness-of-fit indices (Hair et al., 2010)(Byrne, 2001).

1.6. Results and Discussion:

The purification of items is of great importance. Therefore, the transparency of the observed variables was performed through EFA. In EFA Kaiser-Mayer-Olkin (KMO) and Bartlett's test of sphericity were conducted which is presenting KMO = 0.901 and the value of Bartlett's test was $p < 0.001$, evidencing the sample appropriateness (Hutcheson & Sofroniou, 1999). Factor construction was conducted in EFA using principal component analysis (PCA) with results showing the measurement items having factor loading higher than 0.7 were engaged. As (Hair et al., 2010) endorsed that factor loading higher than 0.7 is measured excellent, whereas, factor extraction was done with the eigenvalue greater than 1. Hence on the bases of this, six factors were extracted and explaining 70.01% of the overall variance. After conducting EFA, CFA was performed using SEM using AMOS for the verification of recognized factors.

1.6.1. Measurement model (MM)

Measurement model (MM) was implemented for checking the loading of observed variables (items) over latent variables (constructs/factors) (Rafique et al., 2018)(Chandio, Irani, Zeki, Shah, & Shah, 2017). MM was evaluated using CFA and validation of MM was performed with discriminant and convergent validity and reliability (Hair et al., 2010). Data in Table 3 revealed that the composite reliability of each factor is above 0.7, which is higher than the threshold value of 0.7 (Straub, Detmar and Boudreau, Marie-Claude and Gefen, 2004) defining the strength of reliability. Values for factor loading and average variance extraction (AVE) is also presented with the values greater than threshold values recommended by (Hair et al., 2010) i.e. 0.7 and

0.5, respectively. Discriminant and convergent validity were assessed on the contrast of covariance/variance among relationship and latent variable inside measurement items (Cheung & Lee, 2010)(Fornell & Larcker, 1981). Whereas, in Table 4, acceptable values for discriminant validity is represented (Straub, Detmar and Boudreau, Marie-Claude and Gefen, 2004). Recommended cut of and threshold values for fit indices (Byrne, 2001) along with statistical fitness of MM with the assistance of three sorts of fit indices used in SEM (incremental, absolute and parsimonious) are presented in Table 7. A statistical representation of data shows the data adequacy of the model through MM. The reliability of the questionnaire was measured with the help of Cronbach's Alpha with a cut off value of 0.7 as recommended by (Nunnally & Bernstein, 1967).

Table 3: Construct reliability and Convergent validity

Constructs	Items	Factor Loading	Composite Reliability	AVE	Cronbach's Alpha
Perceived Usefulness (PU)	PU1	0.93	0.80	0.70	0.930
	PU2	0.90			
	PU3	0.89			
	PU4	0.88			
	PU5	0.87			
Perceived Ease of Use (PEOU)	PEOU1	0.97	0.97	0.80	0.970
	PEOU2	0.89			
	PEOU3	0.95			
	PEOU4	0.90			
	PEOU5	0.96			
	PEOU6	0.96			
System Quality (SQ)	SQ1	0.80	0.89	0.82	0.910
	SQ2	0.75			
	SQ3	0.77			
	SQ4	0.90			
Habit (H)	H1	0.79	0.92	0.80	0.860
	H2	0.92			
	H3	0.89			
	H4	0.83			
Behavior Intention (BI)	BI1	0.82	0.88	0.75	0.890
	BI2	0.88			
	BI3	0.86			

CR: composite reliability; AVE: average variance extracted

1.6.2. Structural Model (SM)

Causal relationships were evaluated in SM using AMOS with statistical support of coefficient of determination (R^2) and path coefficient. R^2 helps in the elucidation of estimate supremacy of constructs,

whereas, proposed hypothesis was strengthened with path coefficient. Values of R^2 and path coefficient elaborate the data support towards the hypothesized model (Lee, 2010)**.** SM provides the support for casual relationships that were measured with the fit indices as was done in MM. the representation of fit indices along with the cut off value is presented in Table 7 (Hair et al., 2010)**,** with the statistical acceptance of SM toward the data.

Table 4: Discriminant Validity

Constructs	PU	PEOU	SQ	H	BI
Perceived usefulness	**0.70**				
Perceived ease of use	0.35	**0.80**			
System quality	0.32	0.16	**0.78**		
Habit	0.30	0.30	0.43	**0.59**	
Behavior Intention	0.28	0.36	0.36	0.40	**0.75**

Diagonal values are AVE and off-diagonals are inter-construct squared correlations.

The output generated by SM for the causal relationships of the proposed hypothesized model has presented in Table 5 and Figure 3 with the significant values of all paths are between 0.001 or 0.05. Results inferred the significant acceptance of all the factors toward behavioural intentions for using MLA. Habit directly influences perceived ease of use and perceived usefulness, and system quality influenced perceived ease of use and perceived usefulness. Further, core constructs of TAM (perceived usefulness and perceived ease of use) are influencing behavioural intention toward the use of mobile library application. AMOS result shows the powerful significant effect of all the factors used in this study. As H has positive significant effect on PU and PEOU (H1: $\beta = 0.451$, $P<0.001$: H1a: $\beta = 0.501$, $P<0.001$), while SQ had a powerful influence on PE and PEOU as well (H2: $\beta = 0.491$, $P<0.001$: H2a: $\beta = 0.480$, $P<0.001$). PEOU had an effect on PU and BI (H3: $\beta = 0.506$, $P<0.001$: H4: $\beta = 0.388$, $P<0.001$) while PU has positive and significant influence on BI (H5: $\beta = 0.344$, $P<0.001$). This is evaluated through squared multiple correlations that BI explained 42.3% variance, 39.8% variance by PEOU and 40.1% variance is explained by PU. In addition to the testing of the proposed hypothesis, the direct, indirect and total effect of all the variables were also calculated as represented in Table 6.

Table 5: Hypothesis Testing

Hypothesis	B Values	t-values	Status
H1: H → PU	0.451***	9.823	Accepted
H1a: H → PEOU	0.501***	8.863	Accepted
H2: SQ → PEOU	0.491***	5.576	Accepted
H2a: SQ → PU	0.480***	7.456	Accepted
H3: PEOU → PU	0.506***	8.360	Accepted
H4: PEOU → BI	0.388***	6.916	Accepted
H5: PU → BI	0.344***	5.349	Accepted

Note: Significant at ***: p<0:001

The perfect representation of data through the proposed model is important. Therefore, it was measured with three types of fit indices: absolute fit measure (χ^2, adjusted-goodness of fit (AGFI), root mean square error of approximation (RMSEA) and goodness-of-fit-index (GFI)), Parsimonious fit measure (comparative fit index (CFI)) and incremental fit measure (normed fit index (NFI)) in both analyses i.e. MM

and SM. As in Table 7, all the obtained fit indices meet the suggested ranges like CMIN/df = 1.300, RMSEA= 0.023, GFI = 0.951, AGFI = 0.90, CFI = 0.992 and NFI = 0.947 (Hair et al., 2010).

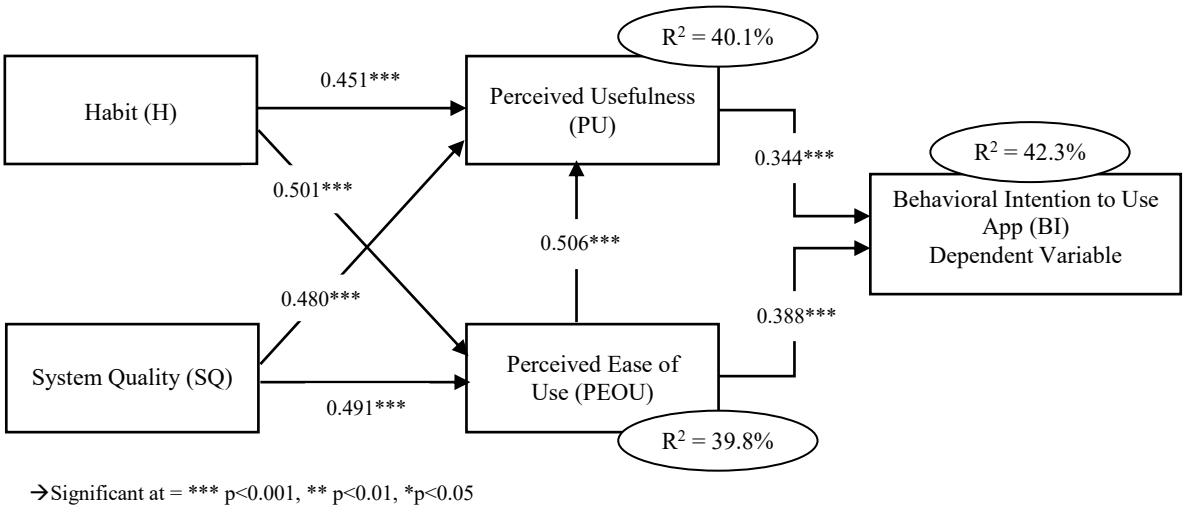

Figure 3: Results of the analysis

Table 6: Direct, Indirect and Total effect in a revised model

Factors	**Effects on**								
	Perceived ease of use (R^2 = 39.8%)			Perceived Usefulness (R^2 = 40.1%)			Intention to Use (R^2 = 42.3%)		
	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Habit	0.501	-	0.501	0.451	0.253	0.704	-	0.087	0.087
System Quality	0.491	-	0.491	0.480	0.248	0.739	-	0.085	0.085
Perceived ease of use	-	-	-	0.506	-	0.506	-	0.174	0.174

All values are significant at P < 0.001

The remaining portion will discuss the outcomes of the proposed hypothesis individually. All the hypothesis is listed below

H1: H → PU**, H1a:** H → PEOU**, H2:** SQ → EOU**, H2a:** SQ → PU**, H3:** PEOU → PU**, H4:** PEOU → BI**, H5:** PU → BI

H1: H → PU, H1a: H → PEOU

A critical ratio value of the proposed hypothesis is higher than threshold value i.e. 1.96. Estimated result is supporting H1 with values (β = 0.451***, CR = 9.823 and P = 0.001), stating the strong positive significant influence on PU to the use of INSIGNIA ILS mobile library application. The current result is in line with the

existing study (Venkatesh et al., 2012)(Hubert et al., 2017). Whereas, results for the hypothesis H1a in parametric estimation is (β = 0.501***, CR = 8.863 and P = 0.001) proving the strong significant influence of habit on PEOU. As the user has a habit of using INSIGNIA ILS it will make MLA easy to use for users. Therefore, the hypothesis which states that habit has a direct significant influence on PEOU is strongly supported with the significant influence on ease of use. In the consequences of this analysis, these results support the existing studies (Venkatesh et al., 2012)(Hubert et al., 2017).

H2: SQ → EOU, H2a: SQ → PU

It is hypothesized that system quality will have a positive influence on PEOU and PU in H2 and H2a, respectively. For these hypotheses, the critical ratio value is higher than the given threshold value. The estimated results for proposed hypothesis H2 are (β = 0.491***, CR =5.576 and P = 0.001) and is supporting the proposed hypothesis with a strong significant positive influence on PEOU. Whereas, the parametric result for the hypothesis SQ on PU is (β = 0.480***, CR = 7.456 and P = 0.001) and hence the hypothesis that system quality has a positive significant influence on PU was verified. Conclusively, the obtained results are in support with prior research study (Jeong, 2011) and proving the support of SQ on PU in INSIGNIA ILS context.

H3: PEOU → PU

The relationship among PEOU and PU states the significant relationship with (β = 0.506***, CR = 8.360 and P = 0.001). As the critical ratio value supper pass the threshold value, therefore, proposed hypothesis H3 is strongly supporting the positive influence of PEOU on PU. The significant research finding of the current research supports the existing work (Rafique et al., 2018).

H4: PEOU → BI

The estimated results for hypothesis 4 show the significant, positive and strong influence on behaviour intention to use INSIGNIA ILS (β = 0.388***, CR = 6.916 and P = 0.001). The strong and positive relation of PEOU on BI toward the use of INSIGNIA ILS is proved with the value of critical ratio that is higher than cut off value. Decisively, the results are in favour of prior research (Rafique et al., 2018)(Sun & Mouakket, 2015).

Table 7: Summary of fit indices

Absolute fit measure							Parsimonious fit measure	Incremental fit measure
	CMIN	Df	CMIN/Df	GFI	RMSEA	AGFI	CFI	NFI
Acceptable fit			<3	≥0.90	<0.5	≥0.09	≥0.90	≥0.90
Obtained fit MM	340.001	260	1.307	0.950	0.025	0.921	0.992	0.948
Obtained fit SM	338.010	260	1.300	0.951	0.023	0.90	0.992	0.947

H5: PU → BI

Hypothesis 5 is defined as “PU will have a significant positive influence on behavioural intention toward the usage of INSIGNIA ILS”. The projected outcomes of PU on BI states that (β = 0.344***, CR = 5.349 and P = 0.001) defining the significant influence among PU and BI. It is hence predicted that usefulness is defined as an important criterion for the acceptance of MLA i.e. INSIGNIA ILS. This result is in parallel with the existing research (Rafique et al., 2018)(Yoon, 2016).

The current study supported TAM by presenting the two essential motivational constructs of TAM

(PEOU and PU) as a strong interpreter toward behaviour intentions (Rafique et al., 2018). The conclusion of this study revealed the strong significant impact of PEOU than PU on behavioural intentions. As cited above, results explain the stronger impact of PEOU than PU toward the behaviour intention. Hence, this study is consistent with the existing studies (Rafique et al., 2018)(Chandio, Irani, Zeki, & Shah, 2017) by revealing that, ease of use has more influence on MLA as compared to usefulness.

The findings of the extended model explained the positive effect of habit on PU as well as on PEOU, system quality on PU and PEOU. The results of current research also depict the strong relationship of habit on PEOU and PU of MLA and system quality also shows a strong and significant relationship on PEOU and PU of MLA, while results show that habit and system quality describe the impression on BI of MLA through core construct of TAM (i.e. PEOU and PU). Hence, according to the results generated from the study revealed that, habit is the strongest predictor of PEOU which leads to the strong influence of PEOU on PU. Besides habit's strong influence on PEOU, it also has a significant influence on PU and SQ has a positive influence on PEOU and PU as well. Based on these results, the study supports the prevailing discovery of TAM and offers peripheral validity for the new technological relative setting (MLA). All the peripheral factors used in the current study support the technology in developing countries, which exemplifies that intended users are adopting MLA within their educational arena in order to get access to various research articles, books and for other services.

The verdicts of the current study fuel the TAM implementation in developing countries such as Pakistan. This study provides practical and theoretical implications, which helps in an increased perception of MLA toward acceptance. The findings will help as a guideline for MLA development. It also contributes to the development of mobile library services in research fields. Besides that, it will provide suggestions toward digital libraries. The results of this study presented that habit; system quality and perceived ease of use must be considered while promoting MLA usage.

1.7. Conclusion

The enormous advancement of technology in the educational sector, particularly in library services is changing the trend of users toward the usage of the library. This study helps in clarifying and understanding the behaviour of users toward the adoption and use of MLA. This rapid change in behaviour toward the use of technology totally depends on various factors, hence the proposed model provides elementary information for the improvement and understanding of MLA usage intentions. The findings of this study provide in-depth knowledge and useful guideline which will help designers and developers of MLA for improving the usage of MLA experience. Our results explain that Habit, SQ, PEOU, and PU are significantly important in MLA usage. Hence, developers must keep these factors and core construct of TAM (i.e. PEOU and PU) in priority for developing the application. There is always a limitation of generalizability; therefore, this research is not exempted from it. The results cannot be generalized in another context. Mediating and moderating variables will be considered in future as they strengthen the hypothesis of the research model.

1.8. Limitations and Future Work

First and far most limitation of the current study is its generalizability of the results. This research was conducted in a region which is constantly growing in a mobile phone penetration rate, and besides that, data were collected from the university which has a high penetration rate for mobile phones. Therefore, the results of this study cannot be generalized on the other countries which are not advanced in technology. Secondly,

most of the data were collected from postgraduate students with an average age of 26 years, therefore, our audience was educated. Hence, the results of this study might not be the same for the audience who are using general or public libraries or to those people who are less educated and much older. Thirdly, our research specifically targeted MLA i.e. INSIGNIA ILS. In future, our proposed model can be used and extended to check the acceptance of technology in variety of different domains e.g., Government of Punjab, Pakistan is constantly investing huge amount of money in technology sectors like e-health, e-learn Punjab, e-ticketing, e-complaint cell and e-challan and lot more (Rafique et al., 2018). Therefore, there is a need to investigate the acceptance of those technologies which are consuming a vast amount of budget to facilitate the intended users. Finally, our research included habit and system quality as a predictor, which are integrated into TAM because of its theoretical perspective nature. Future research will help us to identify other factors in e-service quality which might help in improving the applications according to the user's perspective. E-service quality is of vital importance and it yet needs to be explored.

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APPENDIX A

Perceived Usefulness

Variables	Statements	References
PU1	Using INSIGNIA ILS in my academia would enable me to access the library more quickly	(Rafique et al., 2018)
PU2	Using INSIGNIA ILS would improve my academic performance.	(Rafique et al., 2018)
PU3	Using INSIGNIA ILS would make it easier to search library shelves	(Rafique et al., 2018)
PU4	Using INSIGNIA ILS will enhance my effectiveness in searching relevant contents.	(Rafique et al., 2018)
PU5	I would find INSIGNIA ILS useful in my library search	(Rafique et al., 2018)

Perceived Ease of Use

Variables	Statements	References
PEOU1	Learning to use INSIGNIA ILS would be easy for me.	(Rafique et al., 2018)
PEOU2	I would find it easy to get INSIGNIA ILS to do what I want to do	(Rafique et al., 2018)
PEOU3	My interaction with INSIGNIA ILS would be clear and understandable.	(Rafique et al., 2018)
PEOU4	I would find INSIGNIA ILS to be flexible to interact with.	(Rafique et al., 2018)
PEOU5	It is easy to become skillful at using INSIGNIA ILS.	(Rafique et al., 2018)
PEOU6	I find INSIGNIA ILS easy to use.	(Rafique et al., 2018)

Habit

Variables	Statements	References
H1	The use of the mobile Internet for using INSIGNIA ILS has become a habit for me.	(Venkatesh et al., 2012)
H2	I am addicted to using my smartphone for INSIGNIA ILS.	(Venkatesh et al., 2012)
H3	I must use my smartphone for INSIGNIA ILS.	(Venkatesh et al., 2012)
H4	Using the INSIGNIA ILS with my smartphone has become natural to me.	(Venkatesh et al., 2012)

System Quality

Variables	Statements	References
SQ1	I would find it easy to get access to the INSIGNIA ILS.	(Jeong, 2011)
SQ2	The INSIGNIA ILS is accessible 24 h a day, 7 days a week	(Jeong, 2011)
SQ3	The layout and system design of the INSIGNIA ILS is friendly.	(Jeong, 2011)
SQ4	I feel comfortable using the functions and services that are provided by the INSIGNIA ILS.	(Jeong, 2011)

Behaviour Intention

Variables	Statements	References
BI1	I intend to continue using INSIGNIA ILS during my study period.	(Davis, 1989)
BI2	I will always try to use INSIGNIA ILS in my educational life.	(Davis, 1989)
BI3	I plan to continue using INSIGNIA ILS frequently.	(Davis, 1989)