Quality attributes and performance satisfaction of open source library system: A survey amongst librarians in Pakistan

Mohamad Noorman Masrek[1*], Asad Khan[2] and Truong Cong Doan[3]
[1]Faculty of Information Management,
Universiti Teknologi MARA, Shah Alam Selangor MALAYSIA
[2]Department of Library Information Science,
University of Peshawar, Peshawar, Khyber Pakhtunkhwa, PAKISTAN
[3]Department of Natural Science and Technology,
Vietnam National University, Thanh Xuân District, Hanoi, VIETNAM
e-mail:*mnoorman@uitm.edu.my (corresponding author);
asadap@uop.edu.pk; doantc@isvnu.vn
ORCID: M.N. Masrek: 0000-0002-2730-5555
A.Khan: 0000-0003-3928-7128
T.R.Doan: 0000-0002-4595-9886

ABSTRACT
Despite its widespread use, KOHA is not without complications. Quality attributes such as functionality, maintainability, user friendliness, and overall performance were frequently identified as issues in empirical studies. While attempts were made to assess the KOHA's quality attributes, the coverage or scope of the assessment was limited to only a few attributes. Furthermore, the majority of these studies were descriptive in nature, with no theoretical model or framework as a foundation. Given this gap, a study was conducted to assess KOHA's quality rating and its relationship with overall performance satisfaction. Six research hypotheses were developed and tested in conjunction with an integrated theoretical framework that combined quality attributes and performance satisfaction. A survey using online questionnaire as the data collection technique was administered to librarians or other professionals involved in the implementation of KOHA systems in Pakistan. The study revealed that while quality attributes were not rated highly, they were found to have a significant impact on performance satisfaction. Specifically, functionality, efficiency, maintainability, portability, usability, and reliability are found to have joint influence on performance satisfaction. The findings have made an important contribution from both theoretical and practical perspectives.

Keywords: Open source system; Library systems; KOHA library software; Quality attributes; Performance satisfaction

INTRODUCTION

Many libraries around the world have long recognised the need to automate library tasks such as cataloguing, circulation, procurement, and serial management. Because of its merits and massive benefits, many libraries have chosen to implement Integrated Library

Systems or Software (ILS). In addition to assisting libraries in the maintenance of data such as items, billing, and tracking various items owned by libraries, ILS assists libraries in improving their overall service quality. ILS can be used effectively to manage library patrons as well as their orders or bookings. Most ILS now offer web-based portals where library members can log in and view their accounts, renew their books, and access a variety of other services. Users can use ILS to search for a book, view the available book list, renew a book, hold a book, print an issue list, and edit his/her information (patron information), whereas library staff can store bibliographic records of library materials in a database, create a patron database, order a book, purchase a book, check the price list, and perform other functions.

Like any other types of computer based information systems, there are a number of options of acquiring ILS. The first is to develop in-house and the second is to purchase and customize commercial ILS. The advantages of developing an in-house ILS are: many of the library's unique requirements can be met; minimise the amount of procedural changes required when ILS is being implemented; develop internal resources and capabilities (i.e. expertise); and simplify system maintenance activities. However, in-house development is very time consuming compared to purchasing or customizing commercial ILS. Destiny Library Manager, Apollo™ ILS/LSP (Integrated Library System/Library Services Platform), WorldShare Management Services, Alma, Alexendria, Sierra ILS, LibAnswers are among the popular commercial ILS. These commercial software, although quite easily implemented, are quite expensive and may not be feasible for libraries operating within a tight budget. Because of this, Free/Libre/OpenSource Software (FLOSS) has become a strategic option for many libraries. KOHA, Evergreen, Biblioteq, Openbiblio, Invenio, PMB, Opals, and Newgenlib are few of the famous open source ILS.

KOHA is one of the most sophisticated ILS, free of charge and open source. Introduced in 1999, KOHA has been used by thousands of libraries around the world. Users are impressed by KOHA simply because of its features. KOHA is flexible, scalable and suitable for libraries of all kinds. KOHA's striking feature continues to evolve and expand to meet the needs of its sponsoring libraries. The freedom to select and choose from features, through the administration of system preferences, provides librarians the opportunity to configure and customize KOHA to meet their specific workflow needs.

Despite its popularity, the use of KOHA is not without complications. In empirical studies, quality attributes such as functionality, maintainability, user friendliness, and overall performance were commonly identified as some of the issues. KOHA was likely to hang and crash in terms of functionality (Chauhan, 2018; Tella and Oladeji, 2017). Libraries also reported that the cost of KOHA maintenance was very high (Chauhan, 2018; Tella and Oladeji, 2017), and that it was difficult to maintain the library's changes to the current installed version of KOHA when upgrading to future advanced versions of KOHA (Punchihewa and Kumara 2015). Because the librarians had little or no knowledge of computer programming, customising KOHA was somewhat difficult (Ann et al. 2018). According to Babu and Thomas (2017), respondents rated KOHA's user friendliness as very low. Essentially, previous empirical studies on KOHA revealed that attempts were made to assess the software's quality attributes. However, the assessment's coverage or scope was limited to only a few attributes. Furthermore, the majority of these studies were descriptive in nature and were not based on any theoretical model or framework. In most previous studies, the assessment of performance satisfaction was not inferentially linked to quality attributes. The objectives of this study are as follows:

(a) to measure the level of librarians' assessment of KOHA quality based on ISO/IEC9126 attributes; and
(b) to examine the relationship between KOHA quality attributes and overall performance satisfaction.

LITERATURE REVIEW

The Integrated Library System (ILS), also known as the Library Management System (LMS), is software that automates many library activities. According to Muller (2011), integrated library systems (ILS) are multifunctional, adaptable software applications that enable libraries to manage, catalogue, and circulate materials to patrons. When selecting ILS software, libraries must consider not only the system's performance and efficiency, but also its fundamental flexibility to readily adapt to the future demands and needs of their patrons. A good and dependable ILS improves management, control, and easy access to physical and virtual information resources, such as books, CD-ROMs, e-journals, e-books, e-databases, and repositories. It also aids in reducing time waste in the delivery of library services to users.

The KOHA integrated library system (ILS) is a feature-rich open source software package (OSS). The word KOHA is derived from New Zealand's Mori language and means "gift" or "donation." On September 6, 1999, the Horowhenua Library Trust (HLT) of New Zealand requested that the Katipo Communications company begin work on the KOHA software. On January 1, 2000, the HLT implemented the KOHA ILS for the first time and released it under a General Public License (GNU). GNU is the most well-known and adaptable type of licence for obtaining worldwide support and ensuring future advancement of frameworks. The KOHA software is written in Perl and is compatible with Linux, UNIX, and Windows operating systems. The MYSQL database is used to store data, and the Apache Web server is required to serve the KOHA modules on the web. KOHA is built with library standards and protocols like MARC 21 and Z39.50 in mind, ensuring interoperability with other systems and technologies while supporting existing workflows and tools. KOHA necessitates the use of minimal hardware resources (Sheeja, 2009). The primary goal of KOHA is to provide an integrated library management tool that covers all major functions in a library, including acquisitions, bibliographic database management, user management, transactions, serial control, online end user searching on local and external bibliographic databases, and a library portal.

According to Egunjobi and Awoyemi (2012), the KOHA online public access catalogue (OPAC) is web-based and does not require any software to be installed on a user's machine. KOHA is currently maintained by a global network of software vendors and library innovation staff. This is living software that is updated on a daily basis by its global community (Shafi-Ullah and Qutab, 2012). According to Singh and Sanaman (2012), KOHA has won numerous awards, including the “Not for Profit section of the 2000 Interactive New Zealand award,” the 3M award for “Innovation in Libraries” in 2000, the public organisation section of “Les Trophées du Libre” in 2003, and the “Use of IT in a Not-for-Profit Organization ComputerWorld Excellence Award” in 2002. The KOHA ILS includes all of the basic modules, such as acquisition, cataloguing, patrons, circulation, serials, reports, and so on. Because of its flexibility and provision of library standards, the KOHA ILS is now the first choice of librarians all over the world.

Nowadays, OSS, particularly KOHA, has gained popularity due to its ease of use, particularly in developing countries such as Pakistan. According to Rafiq and Ameen (2010), three libraries in Pakistan were using the KOHA software, and 47.8 percent of librarians were interested in adopting it. According to Ur Rehman, Mahmood and Bhatti (2012), KOHA was first used in Pakistani libraries in 2006. According to Khan, Zahid and Rafiq (2016), ILS is largely absent in Pakistani libraries, but OSS use – particularly the KOHA ILS – is increasing. Alikoba, Kiwelu and Lwanga (2019) investigated the factors that influenced KOHA acceptance in Ugandan academic libraries. Productivity, ease of use, the free and open source nature of KOHA, peer pressure, the availability of resources, domain knowledge, awareness, anxiety, and computer literacy levels were identified as nine factors. Asim and Mairaj (2019) investigated librarians' perceptions of KOHA adoption and use in Punjab, Pakistan, and found that librarians adopted KOHA due to the availability of Web online public access catalogue (OPAC), the provision of MARC21 standards for cataloguing, and its free availability. Tella and Oladeji (2017) conducted a survey of professional and para-professional staff at selected academic libraries in Nigeria and discovered that KOHA implementation had a positive impact on the libraries and librarians.

THEORETICAL FRAMEWORK

The theoretical framework used in the study is depicted in Figure 1. The framework was created using ISO/IEC 9126 (ISO/IEC 2001) and ISO/IEC 25010 (ISO/IEC 2011). The ISO/IEC 9126 software quality model identifies six quality attributes: functionality, dependability, usability, efficiency, maintainability, and portability. The ISO/IEC 25010 quality-in-use standard, on the other hand, includes satisfaction as one of the assessment dimensions. The six quality attributes served as the study's independent variable, while performance satisfaction served as the study's dependent variable.

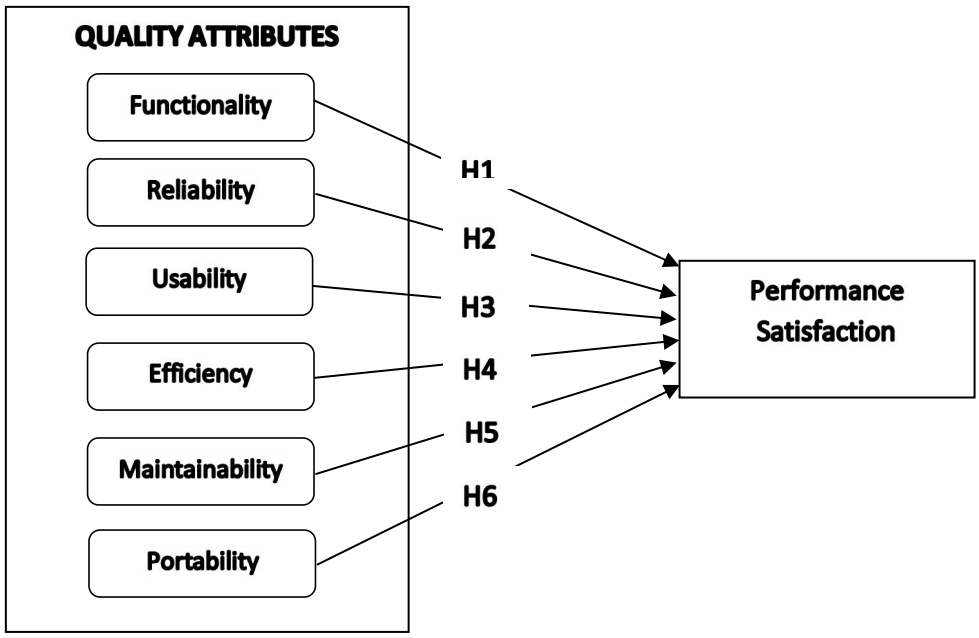

Figure 1: Theoretical Framework of KOHA's Quality Attributes and Performance Satisfaction

Performance Satisfaction

Performance satisfaction is defined as the comfort and acceptability of the KOHA system to its users and other people affected by its use (Dix et al. 1998). The famous information systems success model developed by Delone and Mclean (1992, 2003) suggested that users' satisfaction are shaped by the information quality, systems quality and service quality. Padayachee, Kotze and van Der Merwe (2010) argued that the software quality characteristics by ISO /IEC 9126 could be used as the dimensions or attributes of systems quality. The ISO/ IEC9126 defines a quality model with six characteristics namely, functionality, reliability, usability, efficiency, maintainability, and portability which are further subdivided into 22 characteristics. Past studies on digital libraries or integrated library systems including KOHA have shown that systems quality attributes have a profound impact on satisfaction (Keast 2011; Jose, 2017; Al-zahrani et al. 2019). For instance, Keast (2011) examined at the use of KOHA in Australian special libraries. The findings indicated that switching to KOHA was painless, with satisfaction scores ranging from "above average" to "strong" for most aspects of KOHA performance. Jose (2017) conducted research on library professionals' experience with KOHA. The study discovered that library professionals were pleased with KOHA's overall performance.

Functionality

The capacity of the KOHA systems to provide functions that meet the stated and implied needs of users under specified conditions is described as functional. Functionality consists of five sub-characteristics which are suitability, accuracy, interoperability, security, and functional compliance. All of these characteristics are intended to answer questions such as, "Can KOHA perform the tasks required?" 'Is the outcome as expected?' 'Can KOHA communicate with other systems?' 'Is KOHA in accordance with standards?' 'Does KOHA protect against unauthorised access?' Positive and favourable responses to the aforementioned questions should lead to increased user satisfaction. The findings of a survey in Nigeria suggested that functionality of the KOHA systems was one of the main reasons of adoption (Tella et al. 2017). According to Albee and Chen (2012), users of open source library systems would be happier if they have more functionality. Hence, the following hypothesis is proposed:

H1: Functionality has a positive significant relationship with performance satisfaction.

Reliability

The capability of the KOHA systems to maintain its level of performance under stated conditions for a stated period of time. Maturity, fault tolerance, recoverability and reliability compliance are the four sub-characteristics of reliability. Maturity is concerned with whether or not KOHA system flaws have been eliminated over time. Fault tolerance examines whether the KOHA systems can handle errors. Recoverability refers to whether the KOHA systems can be restarted and lost data restored after a failure. Wahab et al. (2012) discovered that reliability was the best predictor of library portal satisfaction. In another study, Otione (2016) observed that the reliability of open source library systems has a significant positive relationship with library performance, which includes user satisfaction in its measurement. Based on these findings, this study proposes the following hypothesis:

H2: Reliability has a positive significant relationship with performance satisfaction

Usability

Usability denotes the capability of the KOHA systems to be understood, learned, used and provide visual appeal, under specified conditions of usage. Usability is divided into four sub-characteristics, namely, understandability, learn-ability, operability, and attractiveness.

The capability of the KOHA systems to allow the user to understand if the systems are suitable and how they can be used for specific tasks and conditions of use is known as understandability. Learnability relates to capability of the KOHA systems to enable the user to learn its application. The capability of the KOHA systems to allow the user to operate and control them is referred to as operability. Attractiveness refers to the KOHA system's ability to be appealing to the user. Masrek and Khan (2015) studied the usability of a digital library from the perspective of users and discovered that efficiency, effectiveness, learnability, and use all contribute to user satisfaction. To this end, this research proposes the following hypothesis:
H3: Usability has a positive significant relationship with performance satisfaction.

Efficiency

Efficiency is defined as the ability of the KOHA systems to provide desired performance in relation to the amount of resources used under specified conditions. Efficiency comprises of two sub-characteristics, time behaviour and resource behaviour. The ability of the KOHA systems to maintain agreed-upon response times and throughput-rates is referred to as time behaviour, whereas the ability of the KOHA systems to maintain agreed-upon performance rates and resources is referred to as resource behaviour. According to Kumar's (2016) research, the majority of respondents thought open source library systems were effective in several ways. Salma and Mini Devi (2019) found that library professionals valued KOHA's efficiency very highly in another report. Driven by these findings, we also expect that:
H4: Efficiency has a positive significant relationship with performance satisfaction.

Maintainability

Because of the widely dispersed development teams that contribute to many projects, maintainability is an important factor in the evolution of an open source system (Kapllani et al. 2020). Maintainability refers to the ability of KOHA systems to be updated, which can include corrections, enhancements, or modifications in response to changes in the environment, as well as criteria and functional specifications. Maintainability is divided into four sub-characteristics: analyzability, changeability, stability, and testability. Analyzability is the time and effort required to diagnose deficiencies or defects and identify parts that need to be replaced. The effort required for modification, fault removal, or environmental change is referred to as changeability. Stability refers to an application's ability to withstand the impact of unforeseen changes. The effort required to validate a change is known as testability. The use of open source integrated library systems in academic libraries in Nigeria was investigated by Uzomba, Oyebola, and Izuchukwu (2015), with 76 percent of respondents citing low maintenance costs as the primary reason for adoption. In line with this finding, the present study hypothesizes that:
H5: Maintainability has a positive significant relationship with performance satisfaction.

Portability

According to Njoku and Ravichandaran (2017), one of the benefits of open source integrated library systems is portability. The ability to transfer KOHA systems from one environment to another is defined as portability. The environment could consist of organisational, hardware, or software components. Portability consists of four sub-characteristics: adaptability, installability, conformance and replaceability. The ability to adapt an application to different environments without additional effort is referred to as adaptability. The effort required to install the software is referred to as its installability. Conformance refers to an application's adherence to portability standards or conventions. The ability and compatibility to use one application as a replacement for another is

referred to as replaceability. Riewe (2008) discovered from a survey that one of the reasons libraries were adopting KOHA systems was portability. Accordingly, the current study hypothesizes that:
H6: Portability has a positive significant relationship with overall performance.

METHODS

One of the most important aspects of any study's success is its methodology. The type of problem should guide the selection of an appropriate analysis technique. As a result, the survey research method and cross-sectional design were chosen after considering the research problem, the objectives, and nature of this study.

The researchers used online surveys to gather data in order to meet the study's goals and objectives. This research used a non-probability purposive sampling approach to collect data due to a lack of sampling frame. Data was collected in Pakistan between January and March 2020. The online questionnaire was created using Google forms and disseminated through social media and email. The questionnaire contained 24 questions excluding demographics and is divided into three parts (A,B and C). The questionnaire was self-created by the second author and was based on ISO/IEC 9126 and ISO/IEC 25010. The ISO/IEC 9126 (ISO/IEC 2001) software quality model was used to derive the six quality attributes, while the ISO/IEC 25010 (ISO/IEC 2011) quality-in-use model was used to develop performance satisfaction.

A cover letter describing the study's purpose was included in Part A. Part B contained demographic information of the respondents, while Part C contained questions that measure all constructs. All of the quality attribute constructs (independent variables) were rated on a five-point Likert scale, with 1 indicating very low and 5 indicating very high while for the dependent variable, the anchoring used were 1 for strongly disagree and 5 for strongly agree. As a pre-test, the questionnaire was validated by academic experts in the fields of information systems and library science. The questionnaire was also pilot tested on a small sample at the reliability scores of all constructs was found to be greater than 0.70 in the pilot test, suggesting the questionnaire was adequately reliable.

Samples or unit of analysis of the study are librarians or other professionals involved in the implementation of KOHA systems in Pakistan. A minimum observation-to-variable ratio of 5:1 is suggested by the sample-to-variable ratio, but ratios of 15:1 or 20:1 are preferred (Hair et al. 2018). This means that, while each independent variable in the model requires a minimum of five respondents, 15 to 20 observations per independent variable is strongly suggested. The minimum number of respondents based on the 5:1 ratio would be thirty (30), and the minimum number of respondents based on the 10:1 ratio would be sixty (60). According to this rule of thumb, the total number of responses collected in this study of 112 is therefore acceptable. Since a valid and reliable sampling frame could not be obtained, a non-probability purposive convenient sampling approach was used. According to Memon et al. (2017), while probability sampling is ideal in terms of sampling generalizability, it is not always sufficient or necessary. Where the purpose of research is rigorous hypothesis testing, Calder, Phillips, and Tybout (1981) have long argued that representativeness is inappropriate.

Common method variance is defined by Richardson, Simmering, and Sturman (2009) as the systematic error variance shared by variables measured with the same source or method.

This systematic error variance can lead to common method bias as well as bias in estimated relationships between variables or measures. According to the literature, common method bias can be reduced using procedural and statistical remedies. The study's procedural remedies included carefully constructing scale items by defining unfamiliar terms, avoiding vague concepts by providing examples, and keeping questions specific, simple, and concise. As for the statistical remedy, this study used Harman's single factor test. All the 24 items from every construct were loaded and constraints into single factor. The total variance explained was 30.39% implying that the questionnaire was free from the issue of common method bias.

Using the SPSS software, the data is first processed for editing and coding. Before being transferred into a data file, the responses are examined for incompleteness and contradictions, as well as non-response bias and missing values. After that, descriptive statistics are used to examine the variables' characteristics. The data is then analysed using a PLS-SEM method with Smart PLS Version 3.0. The ability of PLS-SEM to estimate a series of interrelationships among latent constructs simultaneously in a model while also detecting measurement errors in the model is the reason for its use (Ramayah et al. 2018). Furthermore, PLS-SEM is capable of identifying the prediction of relationships between variables in relation to the study's goal of maximising the explained variance of the endogenous latent construct (dependent variable) for accurate model interpretations (Ramayah et al. 2018).

RESULTS

Demographic Profiles

Table 1 displays the demographic profiles of the respondents. Out of 112 people responded, 67.85 percent were men and the rest were women. In terms of highest academic qualification, the majority (55.36%) reported having obtained a Master's degree, followed by an MPhil (35.71%). Nine respondents (8.04%) stated that they have a Ph.D. In terms of the position held, 90.18 percent were librarians, while the remaining (9.82%) were non-librarians. A total of 24.11 percent said they had worked for 6 to 10 years, while 23.21 percent and 22.32 percent said they had worked for 1 to 5 years and 11 to 15 years, respectively.

Descriptive Analysis of Variables

Table 2 displays the mean scores of the respondents' KOHA quality rating. The mean score ranges between 3.57 and 3.90 on a scale of 1 to 5 (1=very low; 2=low; 3=moderate; 4=high; 5=very high). The only attribute with a mean score close to high was functionality, while reliability had a mean score slightly above moderate. Suitability, a sub-characteristic of functionality, received the highest mean score when compared to other sub-characteristics of other quality attributes. However, recoverability, a sub-attribute of reliability, had the lowest mean but was still above the moderate level. Similar to portability, performance satisfaction had a mean score of 3.80 while using different ratings (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). This score indicates that respondents are generally satisfied, but their level of satisfaction is not very high.

Table 1: Respondents Demographics

Variable	Category	Frequency	Percent
Gender	Male	76	67.85
	Female	36	32.15
Academic Qualification	Master	62	55.36
	MPhil	40	35.71
	PhD	9	8.04
	Other	1	0.89
Position	Librarian	101	90.18
	Non-librarian	11	9.82
Length of Service	1-5 years	26	23.21
	6- 10 years	27	24.11
	11-15 years	25	22.32
	16 – 20 years	14	12.50
	21 – 25 years	10	8.93
	25 years	10	8.93
Type of institution	Government	61	54.46
	Government Linked Agencies	9	8.04
	Non-Government Organization	6	5.36
	Private	36	32.14

Table 2: Descriptive Analysis of Constructs

Construct	Items	Minimum Rating	Maximum Rating	Mean Score	Overall Mean	Overall Standard Deviation
Functionality	Accurateness	1	5	3.85	3.90	0.850
	Compliance	1	5	3.83		
	Interoperability	1	5	3.91		
	Security	1	5	3.85		
	Suitability	1	5	4.08		
Reliability	Fault Tolerance	1	5	3.59	3.57	0.993
	Maturity	1	5	3.58		
	Recoverability	1	5	3.54		
Usability	Learnability	1	5	3.79	3.76	0.928
	Operability	1	5	3.70		
	Understandability	1	5	3.79		
Efficiency	Resource Behavior	1	5	3.65	3.62	0.969
	Time Behavior	1	5	3.58		
Maintainability	Analyzability	1	5	3.56	3.71	0.930
	Changeability	1	5	3.85		
	Stability	1	5	3.71		
Portability	Adaptability	1	5	3.74	3.80	0.994
	Comformance	1	5	3.78		
	Installability	1	5	3.79		
	Replacibility	1	5	3.90		
Performance Satisfaction	Comfort	1	5	3.79	3.80	0.741
	Pleasure	1	5	3.82		
	Trust	1	5	3.87		
	Usefulness	1	5	3.72		

Measurement Model

The first step in PLS-SEM analysis is to assess the measurement model's validity and reliability via convergent validity. To assess convergent validity, outer loadings (indicator reliability), average variance extracted (AVE), and composite reliability (CR) are used. All of the outer loadings of the construct's items should be greater than the recommended value of 0.708. (Hair et. al. 2017). Items with outer loadings of between 0.40 and 0.70, on the other hand, can be retained if the construct has an Average Variance Extracted (AVE) ≥ 0.5 and the Composite Reliability (CR) ≥ 0.7 (Ramayah et al., 2018). As shown in Table 3 the scores for outer (factor) loadings, Composite Reliability (CR) and Average Variance Extracted (AVE) met the aforementioned requirements. The SmartPLS output of the measurement model is shown in Figure 2.

Table 3: Factor Loading, Composite Reliability and Average Variance Extracted

Construct	Items	Factor Loading	Composite Reliability (CR)	Average Variance Extracted (AVE)
Functionality	Accurateness	0.743	0.852	0.536
	Compliance	0.752		
	Interoperability	0.734		
	Security	0.738		
	Suitability	0.691		
Reliability	Fault Tolerance	0.506	0.747	0.505
	Maturity	0.760		
	Recoverability	0.826		
Usability	Learnability	0.845	0.836	0.630
	Operability	0.777		
	Understandability	0.757		
Efficiency	Resource Behavior	0.805	0.832	0.712
	Time Behavior	0.881		
Maintainability	Analyzability	0.658	0.785	0.552
	Changeability	0.848		
	Stability	0.707		
Portability	Adaptability	0.692	0.801	0.502
	Comformance	0.717		
	Installability	0.716		
	Replacibility	0.708		
Performance Satisfaction	Comfort	0.622	0.802	0.504
	Pleasure	0.726		
	Trust	0.770		
	Usefulness	0.714		

Following the convergent validity evaluation, a discriminant validity evaluation was conducted. The extent to which the constructs under investigation are truly distinct from one another is referred to as discriminant validity (Ramayah et al. 2018). Discriminant validity is established, according to Fornell and Larcker (1981), when the square root of each construct's AVE is greater than its correlation with another construct. The results presented in Table 4 clearly show that discriminant validity is well established in this study.

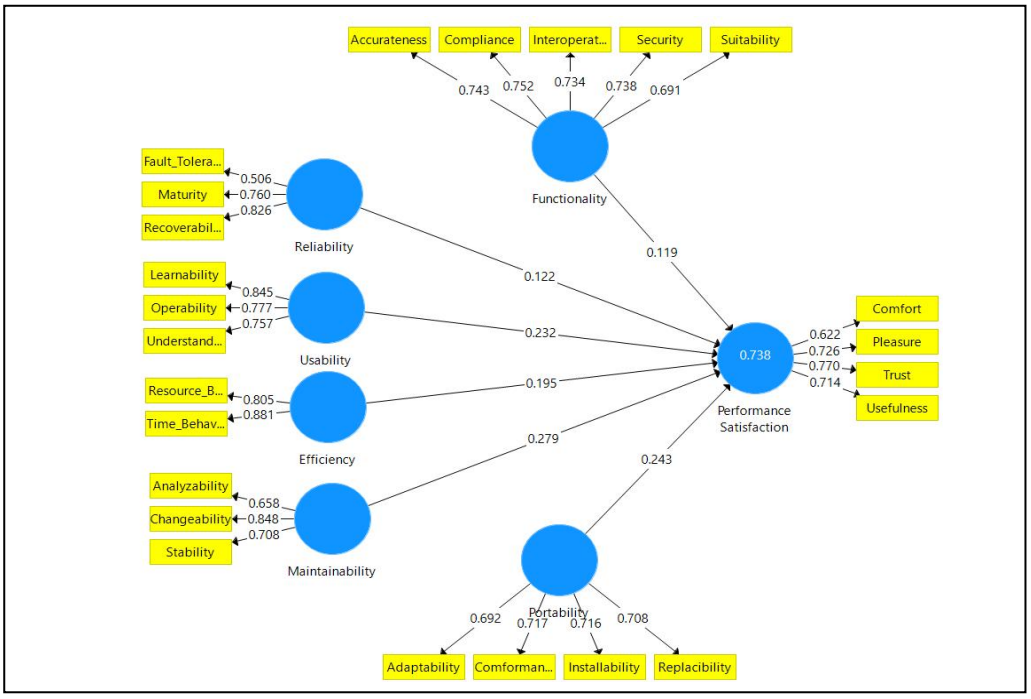

Figure 2: SmartPLS Output of the Measurement Model Assessment

Table 4: Discriminant Validity Assessment Based on Fornell and Larker (1981)

	Functionality	Reliability	Usability	Efficiency	Maintainability	Portability	Performance Satisfaction
Functionality	**0.732**						
Reliability	0.474	**0.711**					
Usability	0.475	0.417	**0.794**				
Efficiency	0.470	0.275	0.598	**0.844**			
Maintainability	0.380	0.318	0.377	0.374	**0.743**		
Portability	0.316	0.380	0.484	0.388	0.432	**0.708**	
Performance Satisfaction	0.562	0.510	0.679	0.622	0.628	0.636	**0.710**

Structural Model

Following the completion of the measurement model assessment, the structural model assessment was performed and the SmartPLS output is shown in Figure 3. This entails investigating the model's predictive capabilities as well as the relationships between the constructs (Hair et al. 2017). A lateral collinearity test is performed prior to the model's predictive capabilities, with VIF values of 5 or higher indicating a potential collinearity issue. Furthermore, in order to investigate the structural model relationship, estimated path coefficients must be obtained, with standardised beta values closer to +1 representing a strong positive relationship and standardised beta values closer to -1 indicating a strong negative relationship (Hair et al. 2017). To obtain the overall model structural relationship, the t-value must be compared to the critical values from the standard normal distribution. This is to determine whether or not it is significant. The critical value on a one-tailed test for significance levels of 0.05, 0.025, 0.01 is 1.645, 1.96, and 2.33 respectively. The value of R^2 and Q^2 are used as indicators of the model's overall predictive strength. R^2 values of 0.19 denote weak strength, 0.33 denote moderate strength, and 0.67 denote substantial

strength (Chin 1998). The value Q^2 of should be greater than zero according to the Stone (1974) and Geisser (1975) predictive relevance criteria. Following the evaluation of the relationship, Cohen's f^2 is used to determine the level of effect size (Cohen 1988). Small, medium, and significant effect sizes are represented by f^2 values of 0.02, 0.15, and 0.35, respectively, according to a set criterion. Table 5 shows that at the 0.05, 0.025, and 0.01 levels, the t-values are significant; R^2 implies considerable strength; Q^2 is greater than zero, and the effect size is either weak or moderate. Given these results, all hypotheses are supported.

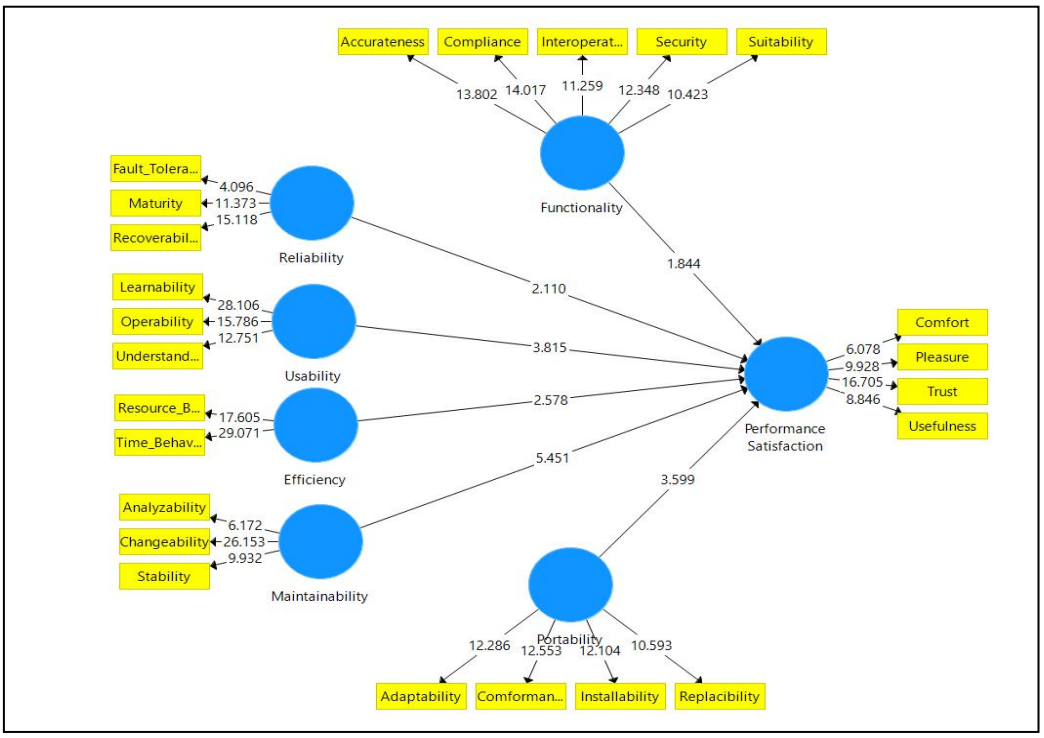

Figure 3: SmartPLS Output of the Structural Model Assessment

Table 5: Path Coefficient of Model Hypothesis Test

	β	t value	P Values	f^2	R^2	Q^2	Results
H1: Functionality → Performance Satisfaction	0.119	1.844	0.033	0.034	0.738	0.331	Supported
H2: Reliability → Performance Satisfaction	0.122	2.110	0.018	0.040			Supported
H3: Usability → Performance Satisfaction	0.232	3.815	0.000	0.106			Supported
H4: Efficiency → Performance Satisfaction	0.195	2.578	0.005	0.084			Supported
H5: Maintainability → Performance Satisfaction	0.279	5.451	0.000	0.214			Supported
H6: Portability → Performance Satisfaction	0.243	3.599	0.000	0.150			Supported

DISCUSSION

As previously stated, the goal of this study was to accomplish two research objectives. Six research hypotheses were developed and tested in conjunction with an integrated theoretical framework that combined quality attributes and performance satisfaction. The following is a discussion of the research outcomes as they relate to the research objectives.

Findings related to first objective: Based on the findings of the descriptive analysis, the librarians rated the quality attributes slightly higher than the moderate level. Functionality has the highest score of the six quality attributes, followed by portability and usability. Maintainability, efficiency, and reliability are the other three quality attributes ranked in ascending order. The respondents did not rate any of these quality attributes as highly or very highly. When compared to the findings of previous studies (Punchihewa and Kumara 2015; Babu and Thomas 2017; Tella and Oladeji 2017; Chauhan 2018; Ann et al. 2018) some similarities and consistencies could be observed.

Out of the five sub-characteristics of functionality, suitability was the only one which being rated as high by the respondents. Perhaps because the KOHA system is open source and freely available, and the functions it provides are very well suited to the needs of libraries, respondents rated this aspect highly. Despite being rated slightly lower than suitability, interoperability surpassed the moderate level score. KOHA supports interoperability protocols such as OAI-PMH and Z39.50, allowing records from other information systems to be imported. The system also allows to import and export bibliographic records and in a variety of formats, including ISO 2709 and MARC XML. Respondents gave equal ratings to security and accuracy, which is also slightly higher than the moderate level. Members of the KOHA community group receive security updates on a regular basis that fix bugs or irregularities. This would ensure that the KOHA systems produced accurate outputs. As previously stated, the KOHA system also complies with other standards such as SIP2, ILS-DI, SRU, and JSON, as indicated by the respondents' ratings of the compliance aspect.

Previous research has highlighted KOHA's advantages in terms of portability and usability. Several authors have even stated that these are among the critical factors influencing the KOHA's adoption. According to the findings of this study, all four sub-categories, namely adaptability, conformance, installability, and replaceability, were rated slightly higher than the moderate level. Comparably, the three sub-categories of usability, which are learnability, operability, and understandability, received comparable ratings. One plausible explanation for the slightly higher ratings is that KOHA is completely web-based. To use the system, all users need is a browser. Users do not need to install applications on their workstations because the software is centralised on a server. The system can be accessed from any location and on any device, desktop or tablet. Furthermore, the presence of KOHA Live CD which is freely available on-line simplifies the installation process on the different platforms (Biju, Jasimudeen and Vimal 2012). However, the fact that the mean scores for both portability and usability do not meet or exceed the four-point value indicates that respondents have higher unmet expectations.

The ratings for maintainability, efficiency, and reliability also convey a strong message about how users perceived the quality attributes of KOHA. While respondents generally thought KOHA was relatively easy to maintain, efficient, and reliable, the responses clearly show that there were still challenges. However, Amando et al. (2018) pointed out that many of the librarians involved in KOHA implementation and maintenance lacked computer programming skills. As a result, any issues that arose during maintenance

activities, such as bug analysis and changing or upgrading to newer versions, could not be resolved. Network connectivity, which Amando et al. (2018) also identified, could also contribute to the instability of the KOHA systems. In terms of efficiency, which was measured from the perspectives of resource behaviour and time behaviour, the respondents' expectations remained unmet. However, hardware capabilities such as network performance (Jose 2017; Amando et al. 2018) may play a role in the respondents' ratings.

Reliability, which measures quality in terms of fault tolerance, recoverability, and maturity, has the lowest mean score when compared to the other ISO/IEC 9162 quality attributes, despite being rated slightly higher than the moderate level. Because KOHA is an open source system, its features and functionalities will evolve over time. Faults and bugs are considered unavoidable when using KOHA systems, but the presence of the KOHA community has aided and will continue to improve the software's maturity. According to Kamble (2012), open source promotes software reliability by allowing for independent peer review and rapid evolution of source code. However, Kavulya (2011) reported that KOHA was unreliable for RFID integration, and manufacturers who attempted to implement RFID with KOHA reported some issues.

Findings related to second objective: The results of this study's measurement model or confirmatory factor analysis clearly show that all of the sub-categories fitly loaded into the respective quality attributes. All four ISO/IEC 25010 satisfaction metrics yielded comparable findings. Further examination of the structural model revealed that, despite not being highly ranked, each and every quality feature, including functionality, efficiency, maintainability, portability, usability, and reliability, has a considerable influence on performance satisfaction. According to the data, when the rating of these quality qualities rises, so will the rating of performance satisfaction. Our findings are almost identical to previous studies on digital libraries (Samadi, Masrek and Mat Yatin 2014; Samadi and Masrek 2015; Masrek and Khan 2016; Masrek and Gaskin 2016; Alzahrani et al. 2019). However, most previous studies combined the aforementioned attributes into three constructs drawn from the information systems success model: information quality, systems quality, and service quality (Delone and Mclean 1992; Delone and Mclean 2003). Performance satisfaction has always been a reliable indicator of the effectiveness of software or even information systems. Many theories, models, or frameworks for evaluating effectiveness would include satisfaction as a construct. The ISO/IEC 25010 standard is no exception.

The findings discussed the importance of addressing quality attributes in order to ensure that the KOHA systems remain relevant and accepted by libraries worldwide. Given that KOHA is an open source project, it is the responsibility of KOHA stakeholders to continue addressing quality attributes. Since the release of the KHA, the KOHA communities have made significant contributions to the advancement and sophistication of the KOHA systems. Many libraries and librarians who encountered difficulties or problems while using KOHA benefited from their contributions. Given the findings of this and previous studies (Punchihewa and Kumara 2015; Babu and Thomas 2017; Tella and Oladeji 2017; Chauhan 2018; Ajab Mohideen, Sheikh and Kaur 2022), librarians involved in KOHA implementation should also contribute to KOHA communities. Aside from being an end-user, they must also upgrade to become a member of the development team. In order to achieve this, they must acquire programming skills. As KOHA users, they have the advantage of knowing exactly which quality aspects require improvement and enhancement.

CONCLUSIONS

Many libraries around the world have adopted open source systems in order to improve service delivery and reduce operating costs. The purpose of this study is to measure the level of librarians' assessment of KOHA quality based on ISO/IEC9126 attributes. In addition, it also examines the relationship between KOHA quality attributes and overall performance satisfaction. The findings revealed that, while the quality attributes were not rated highly, they were found to have a significant impact on performance satisfaction. Performance satisfaction was found to have a significant positive relationship with functionality, efficiency, maintainability, portability, usability, and reliability.

The findings have made a significant theoretical and practical contribution. Prior to the conduct of this study, there was no empirical-based framework for assessing open source library systems based on ISO/IEC 9126 and ISO/IEC25010. The framework used in this study can be validated further with different KOHA users or open source library systems. From a practical standpoint, the study's instrument can be used to assess the effectiveness of library systems implemented in libraries.

The current study is not without limitations. This study's sample was limited to users in Pakistan. As a result, the findings are not intended for population generalisation but are adequate for theory generalisation. More research with larger sample sizes is required. Furthermore, the data collection had a cross-sectional time horizon. Longitudinal data collection should be considered for future research because it will provide richer and more information.

ACKNOWLEDGEMENT

No grant from any public, commercial, or non-profit funding agency was offered for the conduct of this research.

REFERENCES

Ajab Mohideen, Z., Sheikh, A. and Kaur, K. 2022. Developing an open source mobile app in library services: the case of a national university in Malaysia. *Digital Library Perspectives*, Vo. 38, no. 3: 283-300.

Albee, B. and Chen, H.L. 2012. Public library staff's perceived value and satisfaction of an open source library systems. *The Electronic Library*, Vo. 32, no. 3: 390-402.

Alikoba, E., Kiwelu, J.E.M. and Lwanga, E. 2019. Factors Influencing the acceptance and use of KOHA library software in academic libraries in Uganda*. International Journal of Librarianship and Information Science,* Vol. 4: 1- 21.

Alzahrani, A., Mahmud, I., Ramayah, T., Alfarraj, O., and Alalwan, N. 2019. Modelling digital library success using the DeLone and McLean information system success model. *Journal of Librarianship and Information Science,* Vol. 51, no. 2: 291 - 306.

Amando, A.A., Martyns, E.G., Bibot, N.S., and Dajab, N.D. 2018. Challenges of full implementation of KOHA in University of Jos Library. *International Journal of Academic Library Information Science*, Vol. 6, no. 4: 122-126.

Asim, M., and Mairaj, M. 2019. Librarians' perceptions about adoption and uses of the Koha integrated library software in Punjab, Pakistan. *The Electronic Library*, Vol. 37, no. 4: 624-635.

Babu, H. and Thomas, P.J. 2017. Use of Koha in India: problems and prospects. *IASLIC Bulletin,* Vol. 62, no. 4: 243-249.

Biju, V.V., Jasimudeen, S. and Vimal, K.V. 2012. A study on managing Koha open source library management systems using live CD. Paper presented at the *National Conference on Emerging Trends in User Expectations for Next Generation Libraries,* Kuppam (India), 24-26 February, 2012 Available at: https://core.ac.uk/download/pdf/11889647.pdf

Calder, B.J., Phillips, L.W., and Tybout, A.M. 1981. Designing Research for Application. *Journal of Consumer Research*, Vol. 8, no.2: 197-207.

Chauhan, K. 2018. Evaluation in use of KOHA Library Management Software in OPJGU, Sonipat. *Library Philosophy and Practice* (e-journal). 2070. Available at: https://digitalcommons.unl.edu/libphilprac/2070/.

Chin, W.W. 1998. Issues and opinion on structural equation modeling. *MIS Quarterly,* Vol. 22, no. 1: 7-16.

DeLone, W.H., and McLean, E.R. 2003. The Delone and Mclean model of information systems success: A ten-year update. *Journal of Management Information Systems*, Vol. 19, no. 4: 9–30.

Delone, W.H. and Mclean, E.R. 1992. Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, Vol. 3: 60-95.

Dix, A., Finlay, J., Abowd, G., and Beale, R. 1998. *Human-Computer Interaction.* Upper Saddle River, NJ: Prentice Hall.

Egunjobi, R.A. and Awoyemi, R.A. 2012. Library automation with Koha. *Library Hi Tech News*, Vol. 29, no. 3: 12 – 15.

Fornell, C. and Larcker, D. F. 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research,* Vol. 18, no. 1: 39–50.

Geisser, S. 1975. The predictive sample reuse method with applications. *Journal of the American Statistical Association,* Vol. 70, no. 350: 320-328.

Hair, J. F., Black, W. C., Babin, B. J., and Anderson, R. E. 2018. *Multivariate data analysis* (8th ed.). United Kingdom: Cengage Learning.

Hair, J., F., Hult, T.M., Ringle C., and Sarstedt, M. 2017. *A primer on partial least square structural equation modelling (PLS-SEM).* Sage Publications.

ISO/IEC (2001). *ISO/IEC 9126. Software engineering - Product quality*. ISO/IEC.

ISO/IEC 25010 (2011). ISO/IEC 25010:2011, Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models

Jose, J. 2017. Awareness and adoption of KOHA (OSS) among library professionals in Ernakulum. *International Journal of Current Research*, Vol. 9, no 12: 62079-62090.

Kamble V.T. 2012. Open source library management and digital library software. *DESIDOC Journal of Library Information Technology*, Vol. 32, no. 5: 388-392.

Kapllani G., Khomyakov I., Mirgalimova R., Sillitti A. 2020. An empirical analysis of the maintainability evolution of open source systems. In: Ivanov V., Kruglov A., Masyagin S., Sillitti A., Succi G. (eds) *Open Source Systems. OSS 2020. IFIP Advances in Information and Communication Technology*, 582. Springer, Cham.

Kavulya, J.M. 2011. *Integration of Koha library management system and RFID technology: a review of prospects for modern university libraries in Kenya*. Nairobi: Finesse Publishing Ltd.

Keast, D. 2011. A survey of Koha in Australian special libraries: open source brings new opportunities to the outback. *OCLC Systems and Services: International Digital Library Perspectives*, Vol. 27, no. 1: 23-39.

Khan, M.T., Zahid, A. and Rafiq, M. 2016. Journey from library management system (LMS) to Koha by government college university libraries, Lahore. *Pakistan Journal of Information Management and Libraries,* Vol. 17, no. 1: 184-190.

Kumar, G. 2016. Open source software for integrated library systems relative appropriateness in the indian context. Phd Thesis. School of Social Sciences Mahatma Gandhi University, Kottayam, Kerala. Available at: http://eprints.rclis.org/40166/1/Open%20Source%20Software%20for%20Integrated%20Library%20System_compressed.pdf.

Masrek, M.N. and Gaskin, J.E. 2016. Assessing users satisfaction with web digital library: the case of Universiti Teknologi MARA, *The International Journal of Information and Learning Technology,* Vol. 33, no.1: 36 – 56.

Masrek, M.N. and Khan, A. 2015. Usability assessment of web digital library: A survey among undergraduate students. *Journal of Information and Knowledge Management* Vol. 5, no. 2: 46-56.

Memon, M.A., Ting, H., Ramayah, T. and Chuah, F. 2017. A review of the methodological misconceptions and guidelines related to the application of structural equation modeling: a Malaysian scenario. *Journal of Applied Structural Equation Modelling,* Vol. 1. no.1: 1-14.

Muller, T. 2011. How to choose a free and open source integrated library system. *OCLC Systems and Services: International Digital Library Perspectives*, Vol. 27, no. 1: 57–78.

Njoku, I.S. and Ravichandran, R. 2017. Use of open source technology for effective academic library services in Nigeria. *Library Philosophy and Practice (e-journal).* 1686. Available at: https://digitalcommons.unl.edu/libphilprac/1686/.

Otione, J.O. 2016. Open source software features and performance of kenyan university libraries in Nairobi Metropolitan, Kenya. Masters Thesis. Kenyatta University, Kenya. Available at: https://ir-library.ku.ac.ke/bitstream/handle/123456789/18875/Open%20source%20software.....pdf?sequence=1&isAllowed=y.

Padayachee, I., Kotze, P. and van der Merwe, A. 2010. ISO 9126 External systems quality characteristics, sub-characteristics and domain specific criteria for evaluating e-learning systems: *Proceedings of South African Computer Lecturers' Association (SACLA) Conference 2010,* Pretoria, South Africa, 3-5th June 2010

Punchihewa, C.N.D. and Kumara, A.D.B.. 2015. Open source software adoption for library management: Issues and challenges. *2nd PhD Colloquium National Institute of Library and Information Sciences (NILIS),* University of Colombo, Sri Lanka, 12 November 2015.

Rafiq, M. and Ameen, K. (2010). Adoption of open source software in Pakistani libraries: a survey. *Information Age*, Vol. 4, no. 3: 35-38.

Ramayah, T, Chuah, F, Ting, H, Cheah, J. and Memon M.A. 2018. *Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 3.0: An updated and practical guide to statistical analysis* (2nd edition). Pearson.

Richardson, H.A., Simmering, M.J., and Sturman, M.C. 2009. A tale of three perspectives: examining post hoc statistical techniques for detection and correction of common method variance. *Organizational Research Methods*, Vol. 12, no. 4: 762–800.

Riewe, L.M. 2008. *Survey of open source integrated library systems*. Master's Theses. 3481. DOI: https://doi.org/10.31979/etd.4g7r-uudd. Available at: https://scholarworks.sjsu.edu/etd_theses/3481/.

Salma, M.S. and Mini Devi, B. 2019.. Perception of library professionals of the university libraries in Kerala towards Koha, the integrated library management systems. *ILIS Journal of Librarianship and Informatics,* Vol. 2, no. 2*:* 27-38.

Samadi, I. and Masrek, M.N. 2015. Assessing digital library effectiveness of selected Iranian universities. *Journal of Information and Knowledge Management*, Vol. 5, no. 2: 31-45

Samadi, I. Masrek, M.N. and Mat Yatin, S.F. 2014. The effect of individual characteristics and digital library characteristics on digital library effectiveness: a survey at University of Tehran, *World Applied Sciences Journal*, Vol. 30: 214-220.

Shafi-Ullah, F. and Qutab, S. 2012. From LAMP to Koha: case study of the Pakistan legislative assembly libraries. *Program: electronic and information systems,* Vol. 46, no.1: 43-55.

Singh, M. and Sanaman, G. 2012. Open source integrated library management systems: comparative analysis of Koha and NewGenLib. *The Electronic Library*, Vol. 30, no. 6: 809-832.

Stone, M. 1974. Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society: Series B (Methodological),* Vol. 36, no. 2: 111-133.

Tella, A. and Oladeji, T.I. 2017. Empirical investigation on impact of Koha on library services in selected academic libraries in Nigeria. *Annals of Library and Information Studies*, Vol. 64: 113-115.

Tella, A., Dina, N., Olayani, O.T., Memudu, S.A., and Oguntayo, S.A. (2017). Assessment of the use of Koha library software in four selected university libraries in Nigeria. *Journal of Applied Information Science and Technology*, Vol. 10, no. 2: 1-14.

Ur Rehman, A., Mahmood, K. and Bhatti, R. 2012. Free and open source software movement in LIS profession in Pakistan. *Library Philosophy and Practice*, 852. Available at: https://digitalcommons.unl.edu/libphilprac/852/.

Uzomba, E.C. Oyebola, O.S., and Izuchukwu, A.C. 2015. The use and application of open source integrated library system in academic libraries in Nigeria: Koha example. *Library Philosophy and Practice,* 1250. Available at: https://digitalcommons.unl.edu/ libphilprac/1250/.

Wahab, S., Othman, A.K., Abas, M.K., Hassan, N., Malek, M.A., and Razali, N.M. 2012. The effectiveness of digital library portal towards users' satisfaction: views of Malaysian university students. *International Journal of Advancements in Computing Technology,* Vol. 4, no. 13: 85-93.