



# Adoption and Use of Open-Source Software in Academic Libraries in Ghana

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## Abstract

*The study sought to assess the adoption and use of open-sourced software (OSS) in academic libraries in Ghana, specifically, find out the types, user-friendliness, the extent of use, advantages, and limitations of OSS within the academic library domain. This study adopted the descriptive survey and mixed research approach to collect data from 12 academic libraries that have adopted open-source software for managing their resources. The purposive sampling strategy was adopted to select 10 respondents (comprising the head of libraries, head and staff of the IT units of the libraries, and heads of the other units such as electronic resources, cataloging, classification, and referencing, among others) from each of the 12 libraries. Questionnaires (consisting of both closed-ended and open-ended questions) were used to collect primary data directly from the respondents. The study revealed that Koha, DSpace, Destiny, NewGenLib, Evergreen ILS, Fedora, WordPress, and Drupal were the open-sourced software deployed and used in the libraries and provided lots of advantages to the libraries. The open-sourced software was largely found to be easy to acquire, install, update, modify, use, operate; user-friendly; and more reliable and accessible. However, the use of open-sourced software in the libraries is mitigated by some limitations which include lack of continuous training on the use of the open-sourced software and inability of the open-sourced software; lack of expertise to train and manage the software among others. These limitations need to be addressed to alleviate their negative impact on the library. The research focused on the adoption and use of OSS in academic libraries in Ghana. Although the findings of the study are similar to perceptions and practices from researchers around the world, they can not be used as a basis for generalization across other scientific disciplines and settings. The study concludes that the deployment and use of OSS in academic libraries to manage its processes and functions are speedily changing the frontiers of the libraries. It is relevant in achieving optimal efficiency at a minimal cost in the library. The management of the libraries should put measures and policies to realize these benefits and arrest the challenges faced by the use of OSS.*

**Keywords:** Software; Open-source software; Academic Libraries; Unified Theory of Acceptance and Use of Technology; Ghana

## Introduction

The deployment and use of software in academic libraries to manage its processes and functions are speedily changing the frontiers of the libraries. This software may either be Open-Source Software (OSS) or proprietary software. Proprietary software is software that costs money to acquire, and the source code of the software is restricted, unreadable, and cannot be modified, copied, or changed from its original construction (Randhawa, 2018). OSS, on the other hand, is computer software whose source code

is available under a license that permits users to copy, use, change, modify, hack, and improve the software, and redistribute it in a modified or unmodified form (Singh, 2020; Singh & Sanaman, 2012). It evolves around free sharing and collaboration of software. Thus, OSS is free for anyone to have.

Again, OSS emerged as an alternative model of software development. It has transformed the development of software and offers several attractions for libraries, especially in developing countries (Uzomba et al., 2015). Many developers around

the world are involved in the development and modifications of these programs with licenses that conform to the Open Source Definition (OSD). For the last decade, OSS has been spread rapidly in the whole software world” (Gangadhar et al., 2017). Some examples of OSS include Kalamazoo Optimist Hockey Association (Koha), Greenstone Digital Library (GSDL), Open Journal System (OJS), and DuraSpace (DSpace).

Most OSS presents an existing opportunity for libraries and a major shift in software design. OSS permits a library to participate directly in the development of its systems and services in a manner consistent with the value of librarianship. Today, there is great demand as well as challenges, and opportunities for librarians to develop a library database for worldwide access not only to bibliographic but also to the full text. Librarians are also moving with this fast development of computers using various kinds of databases, software, and library automation software packages and automating their diverse activities in the libraries, as a solution for this matter (Ebunuwele et al., 2014).

Today, OSS is being widely used in the library domain. The rapid growth of the OSS and the explosion of web technology have provided huge opportunities for library professionals at the same time. OSS is now easily available for download with their source code free of cost which provides an opportunity to save money as well as remove the dependency on proprietary software (Tetteh, 2019).

However, OSS is not widely used in many academic institutions in Africa, and this includes Ghana (Bruggink, 2003). This is due to inadequate funding, low technology penetration and knowledge of library staff, and erratic power supply contributed to the underutilization of library software (Tetteh, 2019). Also, numerous studies have been done on the adoption of software in academic libraries, however, few studies have been undertaken on the adoption and use of OSS in academic libraries in Ghana. The knowledge gap has made it difficult to assess the major types of OSS used in academic libraries in Ghana, along with a discussion on their advantages and limitations. Ray and Ramesh (2017) postulate that the value of any OSS is measured in terms of its simplicity and connectivity.

This study, therefore, sought to assess the adoption and use of OSS in academic libraries in Ghana with emphasis on the types of OSS used by the academic libraries, the number of OSS used by the academic libraries, the user-friendliness of the OSS

deployed by the academic libraries, and the extent of use of the OSS in the academic libraries. The study will further find out the advantages and limitations to the adoption and use of OSS in academic libraries in Ghana.

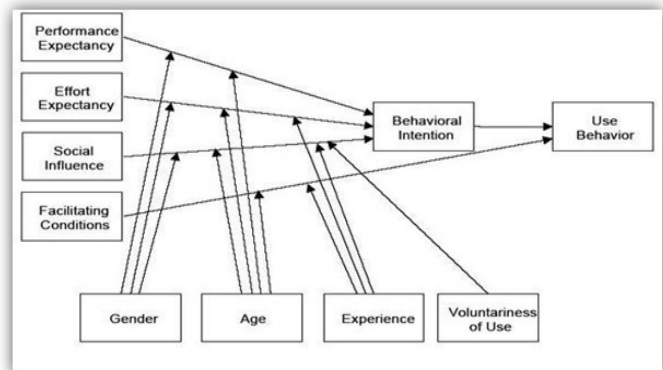
## Theoretical and Literature Review

This section presents the theoretical framework adopted for the study and the review of relevant literature relating to the adoption and use of OSS in academic libraries.

### Theoretical framework

The Unified Theory of Acceptance and Use of Technology (UTAUT) propounded by Venkatesh, Thong & Xu (2003) was adopted in this study. The UTAUT aims to explain behavioral intentions to use an information system and actual user behavior. According to this theory, four key paradigms affect the acceptance and use of any technology. These paradigms are; performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC).

**Figure 1.** Unified Theory of Acceptance and Use of Technology (UTAUT)



Source: Venkatesh et al. (2003)

According to Venkatesh et al., (2003), performance expectancy is the degree to which an individual believes that using a particular system or technology will improve work performance or would be beneficial to his/her job performance. Hence, OSS is expected by the user to offer superior performance. The performance expectancy as applied in the model is found to have a direct influence on the adoption and use of OSS. The performance expectancy sought to assess the degree to which the libraries are expected to gain from using an OSS.

Effort expectancy is the degree of ease of using a particular system or a technology. EE as a variable seeks

to provide a direct determinant of behavioral intention in the adoption and use of OSS in academic libraries. Al-Azawei et al. (2015) posit that EE as perceived ease of use has indirectly determined the actual usage of technology. Similarly, there is a direct link between EE and actual usage behavior of technology such as OSS

Furthermore, Social Influence can be defined as the degree to which an individual perceives that important others believe she or he should use the new system. Social Influence as a variable has an important influence on behavior, acceptance, and gratification. This thus determines the extent to which an individual is affected by his/her peers or others leading them to accept or use an innovation such as OSS.

Facilitating conditions define the degree to which an individual perceives that technical infrastructures can support the user to use the technology or a system. FC is a strong determinant of behavioral intention to adopt and use technology. Thus the degree to which the users believe they will get the necessary technical assistance toward the adoption and use of the OSS in academic libraries. In this case, when users realized they are been supported in the use of OSS for learning and research, they show a confident degree of gratification.

It is worth mentioning that, the use of OSS in academic libraries has to do with the holistic use of the software. Therefore, the choice of UTAUT as the grounded theory for this study aims at studying holistically, human behavior in the use of technology. UTAUT, is, therefore, seen as a comprehensive model that can be used for analyses based on the basic constructs, that is performance expectancy, effort expectancy, social influence, and facilitating conditions.

### **Concept of open-source software**

Open-source software is computer software that has a source code available to the general public for use as is or with modifications (Fuggetta, 2003). This software typically does not require a license fee (Gupta & Yadav, 2018). There are OSS applications for a variety of different uses such as office automation, web design, content management, operating systems, and communications (Cripps, 2011). OSS is unique in that it is always released under a license that allows users to access, modify and redistribute the source code (Ballhausen, 2019). Source code is a specialized language that allows software developers to create and modify computer programs (Jin, 2019; Brosgol, 2019). If you do not have legal access to the source code, then

the program cannot be changed or moved to a different kind of computer (Ballhausen, 2019).

The key fact that makes OSS different from proprietary software is its license (Laurent, 2004). As copyright material, the software is almost always licensed (Fink et al., 2020). The license indicates how the software may be used (Duan et al., 2017). Duan (2019) posits that OSS is unique in that it is always released under a license that has been certified to meet the criteria of the Open Source Definition. These criteria include the right to:

- Redistribute the software without restriction;
- Access the source code;
- Modify the source code; and
- Distribute the modified version of the software

### ***The use of Open Source Software in Academic Libraries.***

One of the promising full-featured software for integrated library systems (ILS) currently being used by libraries all over the world is the OSS (Kamble & Raj, 2012). An ILS is a system of keeping track of the operations of a library - payroll, expenses, purchases, and most importantly, keeping track of the various media being checked out by the librarians' patrons (Tella et al., 2017). OSS is built using library ILS standards and uses the OPAC (open public access catalog) interface (Randhawa, 2018).

RajKumar & Krishnan (2011) posit that OSS is flexible as it allows users to be able to choose solutions suitable for their needs. OSS offers its users greater freedom to purchase other products, avoiding lock-in to particular manufacturers (Ahammad, 2019). Freedom from a single vendor and the freedom to modify your software (Segall, 2021; Fu, 2014). The peer-review process and community standards, plus the fact that source code is out there for the world to see, tend to drive excellence in design and efficiency in coding (Tetteh, 2019)

Randhawa (2018) investigated OSS usage in libraries and found that integrated sources such as Koha can be used to handle almost every function of the library and no wonder majority of libraries have adopted it. Upasani (2016) states that modern libraries need to stay technologically active to provide different value-added services to their research community. Libraries need to hold library management systems and digital technologies as smart tools for providing advanced services to their users (Ray & Ramesh, 2017). Libraries should collaborate with computer experts to become technologically sounder in using

OSS (Upasani, 2016; Ray & Ramesh, 2017)

Libraries are now completely dependent on Information and Communications Technology (ICT) for providing various services to the users (Vijayakumar et al., 2016). The extent of the use of OSS was encouraging due to its perceived benefits. Baeza-Yates and Ribeiro (2011) also mentioned that Asian governments are considered OSS as a boost for their economies and a way to increase technological innovation in the region. The findings brought to bear that; the majority of the library staff were found using the OSS.

### ***Advantages of Deploying Open Source Software***

The adoption and usage of OSS in academic libraries have several advantages (Hanumappa et al., 2014). Some of the known advantages include ease of availability and access, cost-effectiveness, server and software maintenance, ease of operations for users (end-users and staff), consortia approaches, and networking and internet support (Sarma, 2021; Upasani, 2016). Libraries prefer OSS to proprietary software due to the lost cost of acquisition (Tetteh, 2019). The cost also has to do with the low cost of maintaining OSS (Wan, 2007). Hanumappa et al., (2014) and Muir (2005) found that in comparison, implementing OSS had a cost advantage over commercial software.

Advances such as cloud computing and the flexibility of modifying OSS functionalities make OSS more relevant to academic libraries (Tetteh, 2019). OSS helps the deployment of OPAC in academic libraries (Singh, 2020; Ahammad, 2019) and electronic reprints of all resources to encourage scholarship and collaboration (Thompson, 2015). OSS is ubiquitously available and democratizes the use of software applications irrespective of the type, size, or area of the library (Tetteh, 2019), with complete open documentation and source code (Đurković et al., 2008).

Libraries using OSS systems can discuss the problems with existing users and software experts, and this consortia approach will benefit all (Rathee, 2020). Professionally, OSS encourages librarians to be collaborative and innovative (Upasani, 2016), allowing for sharing and support for agile development of systems for OSS that can add value to the library and its patrons (Rathee, 2020). Also, the base product on which OSS is developed is free or without major licensing costs (Upasani, 2016). However, the enhancements and customizations of the OSS system are reflected in the consulting cost of tailoring the

product to the library's needs (Khan & Sheikh, 2022)

Most OSS is web-based software (Segall, 2021). This allows for free desktop clients or thin client access, thus freeing up the libraries from server maintenance requirements (Tetteh, 2019). Outside vendors can manage all the upgrades, backups, and general system maintenance while local library staff focuses on other projects in the library (Fu, 2014). Libraries in consortia can benefit by sharing library materials and services as well as systems (Antwi & Frimpong (2020). This benefits the library and the patrons who have access to a wider variety of resources (Upasani, 2016).

Finally, OSS provides support services (Sato, 2010) such as forums, wikis, and listservs which help address user issues more economically (Smirnova et al., 2022). The development of OSS is based on open standards around communication. This makes the OSS more adaptive and interoperable (Letowski et al., 2020). This provides for ease in operations and management, intuitive navigation, and extensive permissions for both users and staff accounts (Tetteh, 2019).

### ***Limitations of Open Sourced Software***

Despite the benefits derived from the adoption of OSS in academic libraries, literature has established some limitations. Some of the common barriers relate to the lack of internal technical support and expertise, lack of documentation (Steinmacher et al., 2015), no knowledge of available options to implement OSS or no knowledge of specific OSS products (Choi & Pruett, 2019; Steinmacher et al., 2015). Macredie and Mijinyawa (2011) posit that some centers find some difficulties in obtaining the support and information necessary for the successful deployment of OSS. Similarly, Rafiq (2009) opines that libraries in advanced and developing countries also encounter some difficulties in obtaining support and documentation for OSS. Due to this professionals and experts in special libraries preferred proprietary library software to OSS because of the ease of use of the proprietary software (Rafiq, 2009).

Libraries are concerned with low-quality OSS code and a lack of internal employees (Dalling & Rafferty, 2013), and library budget constraints to OSS adoption (Rafiq & Ameen, 2009). Budget limits and a lack of internal staff are factors beyond respondents' control, but they undoubtedly resemble library difficulties (Choi & Pruett, 2019; Steinmacher et al., 2015).

In the view of Kamble and Raj (2012), OSS needs

support and technical expertise to use and maintain, and because the software is often self-contained, it costs more to sustain. In most cases, a commercial software provider will reply to consumer requests for assistance immediately (Steinmacher et al., 2015; van Rooij, 2007). If the library fails to do it internally, then they are at the mercy of disjointed developers (Hanumappa et al., 2014).

## Methodology

This study adopted the descriptive survey research method. In the view of Creswell (2014), survey research provides quantitative or numerical data of descriptions of trends, attitudes, and opinions of a population by studying a sample of that population from which the researcher can generalize and make inferences from the results of a sample to a population by using questionnaires or structured interviews for data collection. It enables researchers to elicit information from a defined population about their knowledge, feelings, opinions, attitudes, and self-reported behavior. The mixed-method approach was applied in this research. This enabled the researchers to collect both qualitative data and quantitative data from the respondents sequentially. The decision to use the mixed research for this study is based on the view of McKim (2017) that it increases the perceived quality of the research, especially when the qualitative study follows the quantitative and provides validation for the findings.

The population for this study was the 12 academic libraries in Ghana that have adopted OSS for managing their resources. The purposive sampling strategy was adopted to select 10 respondents from each of the 12 academic libraries. These respondents comprise the head of libraries, head, and staff of the IT units of the libraries, and heads of the other units such as electronic resources, cataloging, classification, referencing, and collection development among others. Thus, 120 library staff served as respondents for this study. Questionnaires (consisting of both closed-ended and open-ended questions) were used to collect primary data directly from the respondents. The Statistical Package for Social Sciences (SPSS) v23.0 was used to analyze the data collected from the respondents.

## Presentation of Findings

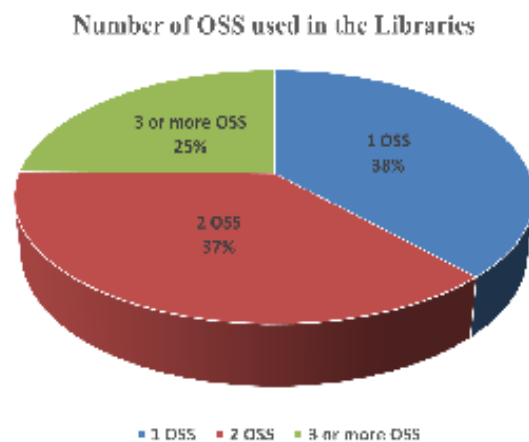
This section presents the findings from the data analysis. This includes the use (number and types of OSS, user-friendliness of the OSS, and extent of use

of the OSS), advantages, and limitations of the use of OSS.

### *The use of open-source software*

The respondents were asked to indicate the number of OSS used in the library and the user-friendliness of the OSS adopted and used in the library. Concerning the number of OSS adopted by the libraries, it was established that the majority of the respondents (43 respondents representing 38%) indicated that their libraries have deployed and use only “One (1)” OSS. Another significant number of the academic libraries (42 respondents representing 37%) were found to have deployed “Two (2)” OSS while 28 (25.8%) represented the least categories of the respondents affirming that they use “more than two” OSS in the library. The responses on the number of OSS adopted by the libraries are summarized in the figure below.

**Figure 2.** Number of OSS used in the libraries



The study further established that the two major OSS used by the academic libraries are DSpace and KOHA. The other OSS mentioned are destiny OSS, NewGenLib (New Generation Library), Evergreen ILS, Fedora, WordPress, and Drupal.

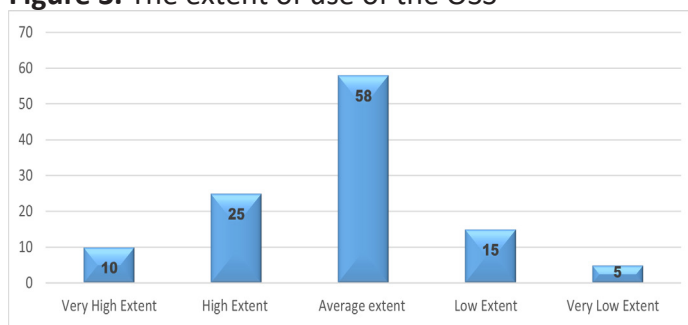
Respondents were asked to confirm whether the OSS can handle all the functions and processes of the library. It was established that a greater percentage of the respondents 71 (63%) affirmed that, the OSS adopted by the library can handle all the functions and processes of the library. However, 22 (19%) responded otherwise by indicating no. It can be extrapolated from this finding that the OSS can handle almost all the functions and processes of the library.

Also, the study established that a considerable number of the respondents (51: 45%) affirmed that

the OSS adopted by the libraries are user-friendly. This was followed by 20 (18%) who indicated to a moderate extent. Other responses are as follows; to a small extent 19 (17%), to a large extent 18 (16%); and to a very large extent 5 (4%).

The researchers again sought to find out the extent to which the libraries use the OSS for information provision and supporting library activities. The extent of use was measured in terms of the degree or frequency of usage. It was revealed that the majority of the respondents from the library (58: 51%) indicated that the extent of use of the OSS is remarked as an “average extent” of usage. This is shown in the figure below.

**Figure 3.** The extent of use of the OSS



The finding from the chart again showed that 25 respondents representing 22% indicated that the extent of use is “high extent” and 15 (13%) respondents indicated a low extent. It was also established that 10 (9%) and 5(4%) of the respondents indicated a very high extent and very low extent respectively.

### ***Advantages of open-source software in academic libraries***

One of the objectives of the study was to find out the advantages of the OSS adoption in the libraries. It was revealed that the majority of the respondents (52: 43%) had a positive impression of the OSS and that the OSS is advantageous to the libraries and supported library activities, a considerable number of the 44 (37%) had a moderate impression while 24 (20%) thus disagree and strongly disagree put combined had a negative impression.

The study again sought to find out the advantages that the libraries derived from the adoption and use of OSS. Some of the advantages outlined by the respondents are as follows;

- It is cheaper to acquire and install OSS
- Updating OSS is easy
- It is easy to modify OSS
- OSS is more reliable

- It is easy to access OSS
- Obtaining and managing an OSS license is easy and simple
- There is a consortium of users for most OSS. This enables libraries using OSS to discuss issues and problems with existing users and software experts,
- Support is available for OSS
- The capability to integrate or consolidate server, service, application, and workstation management for powerful administration
- There is the ease of operations and use of OSS
- Libraries can use several OSS applications together to effectively build a customized solution from among the best-of-breed OSS for their patrons

These responses from the respondents clearly show that OSS adoption and usage in libraries are advantageous to the libraries.

### ***Limitations of open-source software***

One of the principal aims of the study is to find out some of the limitations that plagued the use of OSS for undertaking activities in the library. The respondent outlined the following as the major limitations the libraries face in the adoption of OSS.

- Lack of continuous training on the use of the OSS.
- Any update of the OSS makes it difficult for the library staff to use
- The current training of the library staff does not involve expertise in handling computers, networks, and OSS
- It's not all OSS that have all the modules or components required by the library and for the management of the functions or activities of the library
- Most often, an OSS is accessed using thin clients, so patrons often come to expect ubiquitous access to the system
- Any breakdown would require some troubleshooting, which is often beyond the expertise of library staff
- There is a lack of expertise to train and manage the software,
- Some OSSs are vulnerable to malicious users and not user-friendly as compared to proprietary software.

These findings or comments from the respondents mean that the use of OSS in the library is mitigated by some limitations that assiduously need to be addressed to alleviate its negative impact on the running of the activities in the library.

## Discussion of Findings

The study established that most of the academic libraries have adopted and used at least 2 OSS in the academic libraries. Likewise, all the academic libraries use at least OSS. This finding is refreshing as information dissemination and provision are made possible using the OSS. Furthermore, the use of the DSpace in the libraries enabled them to manage the institutions' repository while the KOHA was used by the libraries for the processing of library materials such as cataloging, classification, ordering of materials, circulation, and many more.

The study further established that the OSS adopted and used by the libraries can handle almost all the functions and processes of the library. These findings support the works of Randhawa (2018) who investigated the OSS and libraries, the study found that integrated sources such as Koha can handle almost every function of the library and no wonder majority of libraries have adopted it. This supports the performance expectancy of the UTAUT which mentions that a technology such as the OSS will be deployed and adopted if the users believe the system or technology would be beneficial to their job performance. Hence, the expected benefit of the OSS drives the libraries to adopt and use them.

The friendliness of a software or program is a key contributor to determining the extent of its use. Concerning the UTAUT, if a system is easy to use it means, there is a propensity that users will use it the more. Likewise, if the OSS employed by the library management is user-friendly, then there is the likelihood that, the extent of its use will increase. It can be inferred from this finding that the OSSs are user-friendly as perceived by the majority of the users in the library. These findings are inconsistent with the works of RajKumar and Krishnan (2011) who explored the effectiveness of OSS in which flexibility and freedom were emphasized as critical advantages of the OSS for libraries. This supports the effort expectancy as a variable of the UTAUT that seeks to provide a direct determinant of behavioral intention in the adoption and use of OSS in academic libraries. Al-Azawei et al. (2015) posit that effort expectancy as perceived ease of use has indirectly determined the actual usage of technology. Similarly, there is a direct link between effort expectancy and actual usage behavior of technology such as OSS.

Concerning the extent of use of the OSS, the findings indicated that the degree or extent of usage of the OSS by the libraries is encouraging with an average

to a high extent. These findings could be attributed to the respondents' claim of usefulness and user-friendliness of the OSS. This finding did not support the study of Baeza-Yates and Ribeiro (2011) in which it was found that the extent of use of the OSS by the library staff was found high.

The adoption of OSS by the libraries was found to have several advantages and benefits for the libraries as expounded by the respondents. As elucidated by Venkatesh et al. (2003), Performance Expectancy (PE) is the degree to which an individual believes that using a particular system or technology will improve work performance then they will continue to use it. With this study, the users of the OSS believe that the OSS adopted by the library management is advantageous. The finding supports the works of Hanumappa et al., (2014) in which it was found that the use of OSS is coupled with several advantages and one of the topmost is the ease of availability and access. It is also consistent with the works of Ray (2017) whereby it was revealed the OSS adopted for the running of the activities of the library performed phenomenal roles, for instance, OSS is considered cost-effective and can be customized to suit the interest of the adopter. Similar findings were found in the works of (Upasani, 2016).

Aside from the benefits or advantages of the adoption of OSS, the study discovered some limitations as posited by the respondents. Prominent to the limitation outlined by the respondents is the lack of expertise or staff to effectively operationalize the OSS and the limitation of some functionalities or modules of some of the OSS. These limitations assiduously need to be addressed to alleviate their negative impact on the running of the activities in the library. This finding is consistent with the works of Satheesh (2012) which brought about numerous limitations of the OSS used in the library such as open-source does not come with support and a lack of technical know-how on the part of the users. It also supports the work of Maltikarjun (2011) where the majority of the respondents agreed on the limitations of the OSS used in the library. Also congruent with the works of (RajKumar & Krishnan, 2011) in which lack of funding was found to mitigate the works of the OSS. As the facilitating condition of the UTAUT can promote the adoption of OSS, the absence of this facilitating condition can equally be a limitation to the adoption and use of OSS.

## Conclusion

The deployment and use of OSS in academic libraries to manage its processes and functions are

speedily changing the frontiers of the libraries. It is relevant in achieving optimal efficiency at a minimal cost in the library. As evident in this study, Koha and DSpace was the main OSS deployed and used in the academic libraries. The other OSS mentioned are destiny OSS, NewGenLib (New Generation Library), Evergreen ILS, Fedora, WordPress, and Drupal. The study again established that the OSSs were extensively used at the academic libraries and provided lots of advantages to the academic libraries by supporting all the operations and activities of the libraries. The OSSs were largely found to be easy to acquire, install, update, modify, use, operate; user-friendly; and more reliable and accessible.

Despite the benefits derived from the use of the OSS at the academic libraries, it had some challenges which include lack of continuous training on the use of the OSS and inability to access some of the modules and functionalities of the OSS; lack of expertise to train and manage the software, breakdown which requires special expertise, vulnerable to malicious users and not user-friendly as compared to the proprietary software. Therefore, the management of the library should put measures and policies to arrest the challenges faced by the use of OSS.

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