

**OPEN SOURCE SOFTWARE FEATURES AND PERFORMANCE OF KENYAN
UNIVERSITY LIBRARIES IN NAIROBI METROPOLITAN, KENYA**

**JARED OKINYI OTIENO
D53/OL/26554/2013**

**RESEARCH PROJECT SUBMITTED IN THE SCHOOL OF BUSINESS OF
KENYATTA UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF MASTERS OF BUSINESS
ADMINISTRATION (MANAGEMENT INFORMATION SYSTEMS) OF KENYATTA
UNIVERSITY**

DECEMBER, 2016

DECLARATION

Declaration by the candidate

This research project is my original work and has not been presented for a degree in any other university.

Jared OkinyiOtieno
D53/OL/26554/2013

Date

Declaration by the supervisor

This research project has been submitted for examination with my approval as University Supervisor.

Signature:

.....

.....

Dr. David Nzuki

Date

Department of Management Science – Kenyatta University

DEDICATION

This research project is dedicated to my dear mum, brothers, and sisters whose love and support have constantly challenged and inspired me to keep moving on.

ACKNOWLEDGEMENT

My first and foremost gratitude is unto the Almighty Father for His unconditional love, favor and grace that have brought me this far even unto the completion of this program. Special acknowledgement goes to my selfless supervisor, Dr. David Nzuki, for his tireless guidance, corrections, approvals, insights and encouragement throughout this research proposal. Equally important are my family members and friends whose support has been very instrumental in bringing this project the far it has come. Lastly, I would like to appreciate my spiritual fathers and brothers whose encouragement and prayers have strengthened me throughout this project. If there are no other words to say, “THANK YOU” are words I won’t get tired of saying to everyone whose effort made this project a success.

God bless all of you.

TABLE OF CONTENTS

DECLARATION.....	ii
DEDICATION.....	iii
ACKNOWLEDGEMENT.....	iv
TABLE OF CONTENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
ABBREVIATIONS AND ACRONYMS.....	x
OPERATIONAL DEFINITION OF TERMS.....	xi
ABSTRACT.....	xii
CHAPTER ONE: INTRODUCTION	1
1.1 Background to the Study	1
1.1.1 Open Source Software Features	2
1.1.2 Open Source Software and Performance of Kenyan University Libraries.....	5
1.1.3 University Libraries in Nairobi Metropolitan.....	6
1.2 Statement of the Problem	7
1.3 Objectives of the Study	8
1.3.1 General Objectives	8
1.3.2 Specific Objectives	8
1.5 Research Questions	8
1.6 Significance of the Study	9
1.7 Scope of the Study.....	10
1.8 Limitations of the Study.....	10
1.9 Assumptions of Study	10
CHAPTER TWO: LITERATURE REVIEW.....	12
2.1 Introduction	12
2.2 Theoretical Review	12
2.2.1 Diffusion of Innovation Theory.....	12
2.2.2 DeLone and McLean’s Information Systems Success Model.....	16
2.3 Empirical Review	18

2.3.1 Acquisition and Maintenance Costs of Open Source Software.....	18
2.3.2 Usability of Open Source Software in the Management University Libraries.....	21
2.3.3 Reliability of Open Source Software in the Management University Libraries.....	22
2.3.4 Scalability of Open Source Software.....	24
2.3.5 Performance of Kenyan University Libraries.....	25
2.4 Summary of the Literature Review and Research Gaps	26
2.5 Conceptual Framework	27
CHAPTER THREE: RESEARCH METHODOLOGY	29
3.1 Introduction	29
3.2 Research Design.....	29
3.3 Target Population	29
3.4 Sampling Technique and Sample Size	30
3.5 Data Collection Instruments and Procedures	31
3.6 Data Collection Procedures.....	32
3.6.1 Pilot study.....	32
3.6.2 Validity of the research Instruments.....	32
3.6.3 Reliability of the research Instruments	33
3.7 Data Analysis and Presentation.....	34
3.7.1 Descriptive Statistics	34
3.7.2 Inferential Data Analysis	35
3.9 Ethical Considerations.....	37
CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION.....	38
4.1 Introduction	38
4.2 Sample Characteristics	38
4.2.1 Respondents Composition	38
4.2.2 Library Staff Respondents by Specialization	39
4.2.3 Open Source Software Usage	40
4.2.4 Period of Open Source Software Usage	42
4.2.5 Major Library Services Frequently Used by Library Users	42
4.3 Descriptive Findings	43

4.3.1 Types of Open Source Software Currently Being Used in Kenya University Libraries	43
4.3.2 Cost-effectiveness of Open Source Software	44
4.3.3 Usability of Open Source Software	45
4.3.4 Reliability of Open Source Software	48
4.3.5 Scalability of Open Source Software.....	50
4.4 Level of Library user Satisfaction With their Library Services	51
4.5 Regression Analysis	53
4.5.1 Regression Model	54
4.5.2 ANOVA.....	54
4.5.3 Coefficients of Independent Variables	55
CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS	57
5.1 Introduction	58
5.2 Summary of the Study	58
5.2.1 Background Information.....	58
5.2.2 Cost of OSS and performance of Kenyan university libraries	58
5.2.3 OSS Usability and performance of Kenyan university libraries	59
5.2.4 Reliability of OSS and performance of Kenyan university libraries	59
5.2.5 OSS Scalability and performance of Kenyan university libraries	59
5.3 Conclusion.....	60
5.4 Recommendations	61
5.5 Suggestions for further research.....	62
REFERENCES.....	64
APPENDICES.....	67
Appendix I: Letter to Respondents.....	67
Appendix II: Questionnaire to Library Users.....	68
Appendix III: Questionnaire to Library Staff.....	71
Appendix IV: Research Approval Letter	75
Appendix V: Research authorization permit.....	76

LIST OF TABLES

Table 2.1: Cost Categories within Software Life Cycle.....	19
Table 3.1: The target population.....	31
Table 3.2: Reliability Statistics	33
Table 3.3 Metrics for the predictor variables.....	35
Table 4.1: Respondents Composition	38
Table 4.2: Level of user satisfaction	51
Table 4.3: Model Summary.....	53
Table 4.4: ANOVA.....	54
Table 4.5:Coefficients of Independent Variables.....	55
Table 4.6: Summary of the Contribution model	47

LIST OF FIGURES

Figure 2.1 Information Systems Success Model	17
Figure 2.2 Conceptual framework	28
Figure 3.1 Histogram Residual.....	36
Figure 3.2 Normal Probability plot of Residual.....	36
Figure 4.1 Respondents Composition	39
Figure 4.2: Library Staff Respondents by Specialization.....	40
Figure 4.3: OSS Usage.....	41
Figure 4.4 Period of Library services usage	42
Figure 4.5: Major Library Services frequented by library users.....	43
Figure 4.6: OSS Usage in Kenyan University Libraries	44
Figure 4.7: OSS is Easy to Use	46
Figure 4.8: Ease of Using Library Systems.....	47
Figure 4.9: User-friendliness of the current library systems	47
Figure 4.10: Reliability of current library management systems.....	48
Figure 4.11: Reliability of current library management systems.....	49
Figure 4.12: Change in Libraries' Services Delivery.....	50
Figure 4.13: Increase in Information Materials.....	50
Figure 4.14: Users' level of satisfaction with current library services	52

ABBREVIATIONS AND ACRONYMS

CUE - Commission for University Education

FTP - File Transfer Protocol

FOSS – Freed Open Source Software

FLOSS – Free/Libre Open Source Software

ILMS–Integrated Library Management System

IS – Information System

MIT - Massachusetts Institute of Technology

OSS – Open Source Software

SPSS–Statistical Package for the Social Sciences

OPERATIONAL DEFINITION OF TERMS

Acquisition Cost – Initial financial expenses incurred by university library to acquire Open Source software.

Digital library – A collection of electronic information materials maintained and managed through various library management systems.

DSpace – An open source software used by most university libraries in Kenya to manage their digital libraries or institutional repositories.

Free Software Foundation– a non-profit making organization founded by Richard Stallman to support development and maintenance of open source software products.

Koha- An open source Integrated Library Management System used by some of university libraries in Kenya to automate their library functions.

Maintenance cost - Financial expenses that a university library would annually incur to ensure proper functioning of the library system.

Open Source Initiative -An organization founded by Eric S. Raymond and Bruce Perens to promote open source software.

Open source Software – Computer application whose source code is freely made available to the public with a provision to modify and redistribute both the original application and a modified version of the same.

Performance – Quality of services provided by the Kenyan university libraries.

Scalability – Ability of Open Source Software to be enlarged in a manner that facilitates growth of University libraries.

Software – Computer program used to perform specific tasks.

OSS features – Unique characteristics of open source software that facilitate their usage in university libraries.

Systems Librarian – Librarian responsible for the management and maintenance of ICT services within a library.

University Library – An academic library established within a university for the purpose of supporting academic programs offered by the university.

Usability - Degree of ease with which end-users of a computer-based system can work with it.

ABSTRACT

Open Source Software is quickly gaining popularity among academic libraries in Kenya and its presence is being felt by librarians everywhere. The perceived cost-effectiveness of OSS have significantly attracted managers of Kenyan libraries whose budgetary allocation is always inadequate. However, there is a glaring lack of information relating to the performance of Kenyan university libraries in relations to the unique features of Open Source Software. It is upon this background that this study is formulated to establish how unique features of Open Source Software contribute to the performance of Kenyan university libraries. Gabriel Tarde's theory of Innovation Diffusion was reviewed alongside Delone and McLean's Information Systems Success Model to give the study a sound theoretical background. The study focused on the relationship between library performance and OSS features which included usability, cost-effectiveness, reliability, and scalability. Four research objectives and questions were used to guide this study by the use of survey research design. The study sampled six (6) university libraries within Nairobi Metropolitan in order to investigate the contributions of OSS features on the performance of Kenyan university libraries. Three groups of respondents including student-users of Kenyan university libraries, members of university teaching staff, and library staff members. Special attention was paid to System Librarians in the 6 sampled libraries since they are better placed as far as understanding of OSS usage in libraries is concerned. Performance of Kenyan university libraries was conceptualized as a function of cost, usability, reliability, and scalability of the software/library management systems in use. Both qualitative and quantitative data were gathered by the use of questionnaires and interview schedules. The collected data on the above mentioned variables were analyzed through descriptive statistics and regression analyses and the findings presented graphically through graphs, tables and pie charts. Composite indices were computed for the four features of OSS in order to facilitate better regression analysis of the dependent and independent variables. The relationship between the variables was represented in form of a linear regression model to illustrate the magnitude and direction of the relationships. The model was established to be statistically significant with an Adjusted R^2 value of 0.345. The study established strong relationship between performance of Kenyan University Libraries and features of open source software products being used to deliver various services in the libraries. Usability of library systems was established to have the strongest influence (Beta of 0.657) on the performance of university libraries. OSS cost, reliability, and scalability had -0.178, 0.22, and 0.022 relationship with library performance respectively. The negative relationship between cost of OSS and performance of university libraries shows that an increase in OSS cost elements is likely to cause to decrease library performance by 17.8%. Based on these and other insightful findings, the study recommended strategic adoption of OSS among university libraries alongside continuous improvement on library systems' usability features. Such improvements would increase usage of the library materials thereby increasing their performance. The researcher also observed the need for regular information literacy training of library users while members of the library staff to be given regular technical training on library management systems. The training will facilitate better usage and prompt resolution of system failures within university libraries in Kenya. The study is of great benefit to the managers of any kind of libraries while deciding on the kind of open source software to adopt. The research findings will also be beneficial to the library and information systems' scholars in furthering their understanding of open source software features and library performance.

CHAPTER ONE:INTRODUCTION

1.1 Background to the Study

Libraries worldwide are in a relentless move to adopt Information Technology in their daily operations through adoption of various Integrated Library Management Systems (ILMS). This aggressive move is slow but surely bringing into reality the concept of libraries without walls, commonly referred to as digital libraries. In Kenya, University libraries are leading the path into this new information management paradigm by incorporating open source software and systems such as Linux operating systems, Linux Servers, Koha, Greenstone, OPALS, Evergreen, Eprint and DSpace into their routine operations. An intriguing observation is that majority of the adopted software are based on open source licenses.

Open source software is a computer program whose source code is freely made available to the public with the freedom to modify and distribute at will. Open source software license guarantees its users access to the programming language and codes used in compiling the software. This access allows libraries of different sizes and types to modify the software as per their need. Lochhaas and Moore (2010) described Open Source software as a brain-child of Richard Stallman, a former programmer at Massachusetts Institute of Technology's (MIT) Artificial Intelligence Laboratory in the late 1970s and early 1980s. Stallman and a group of other computer programmers sought to improve and learn from each other through sharing software they developed. This collaboration extended beyond MIT lab to the external world and anybody was allowed to distribute the software and do whatever they wish.

However, the communal existence of this software community was short-lived by eventual upgrading of MIT Artificial Intelligence Lab computers to use a proprietary operating system. This change of operating system, coupled with his beliefs in computer programming freedom propelled Stallman into forming the Free Software Foundation in 1985 (Randhawa, 2008).

In order to do away with ambiguity in Stallman's description of "Free Software", the term "Open Source Software" was born in 1998. According to Lochhaas and Moore (2010), the term open source came from Palo Alto, California conference sparked by Netscape's release of its web browser's source code. An attendee of the Palo Alto conference, Eric Raymond founded the Open Source Initiative. It is this initiative that has continuously promoted worldwide education on open source, community building and creating awareness on the open source software benefits (Tramboo, 2012). The increasing popularity of OSS has caught attention of librarians to the extent of adopting it in the management of library resources. Koha is recorded as the first open source software to be used in library automation. The koha integrated library management system was created in 1999 and made available to online users in the year 2000 (Giri, 2012).

1.1.1 Open Source Software Features

As highlighted in the introductory section above, Open source software applications are computer programs that are freely available for users with an option of modifying the source code to suit the user's unique needs. Besides the freedom feature of this category of softwares, OSS are also characterized as being cost-effective, user-friendly, reliable, and scalable.

According to Ikram, Butt, and Afzal (2015), any management decisions in regard to adoption of a computer software should be based on the aforementioned features since they are they technological determinants of software's quality and functionality.

Raghunathan et al. (2005) observed that reliability of open source softwares is assured by their openness. For instance, users' free access to the software's source code facilitates multiple testing of the code thus timely identification and fixation of possible bugs. In the same way, users and contributors to an open source development promotes enhancements of the software as opposed to proprietary software in which access to source code is limited to the commercial developers. Additionally, the provision for peer reviews in OSS developments provides favorable platform upon which development insights and improvements are cultivated with proper documentation.

While evaluating performance of Open Source Operating system (Linux) against proprietary Operating System (Windows NT), Bloor Online Research revealed that Linux operating system outperformed Windows NT on three critical metrics; user satisfaction, availability, and delivery of value for the consumer's money. The two sets of software performed equally on functionality and interoperability metrics. The proprietary operating system was superior just on the dimension of application availability. These statistics point to the favorable features of OSS in regard to their adoption in an organizational setting.

On the issue of cost-effectiveness, open source software such as Linux and DSpace are reported to have a near-zero total cost of ownership due to their free acquisition and negligible maintenance costs. However, Raghunathan et al. (2005) advised that managers' concern for

quality should supersede demand for lower costs when they are faced with decision between a software's cost-effectiveness and quality of the same. The authors observed that unless OSS is of the required standard, its free nature may be of little or no benefit to the consumer since the consumer would derive negligible value from its usage.

In their research based on the use of open software in libraries, Singh and Sanaman (2012) noted that “libraries are always concerned about the cost as they often have more demands than resources and they are funded by their parent organizations with a responsibility to manage public funds wisely”. The implication in this statement is that libraries have little or no means of generating their own income. As such, they depend on their parent institutions to fund their projects. Being a non-income generating unit, libraries are likely to experience difficulty when pushing for costly projects to be financed by the institution. This financial difficulty complicates the task of managing libraries since librarians are expected to continuously deliver quality services. Managers of these libraries are therefore forced to establish the most cost-effective means of serving their patrons. The cost-free acquisition of open source software seems to be a favorable avenue to meet the patrons' needs at a lower cost compared to proprietary software (Singh & Sanaman, 2012). However, there is need to ascertain the total cost of the software ownership by the library managers. The software can be acquired freely but other costs such as its installation, user training, documentation, system support, and maintenance might be equally high.

Even though every OSS has its unique features, they have been found to support similar library functions. However, it is also important to note that there are slight variations in the way each of

the OSS supports such functions. Bibliographic database management and library transactions are noted as the functions supported by higher percentage of library OSSs. Other functions include, acquisition, serial control, local and external bibliographic databases searching by end-users online, and library portals. Other OSSs allow importation of bibliographic records from world's recognized libraries such as the Library of Congress and Oxford University library. This importation is made possible through the use of Z39.50 protocol. Since libraries worldwide are seeking to offer uniform services and also conform to international standards, Z39.50 facility has been made a necessary feature of any library-usable OSS (Dhamdhere, n.d).

1.1.2 Open Source Software and Performance of Kenyan University Libraries

According to University Libraries Standards and Guidelines developed by Kenyan Commission for Higher Education (2012), performance of university libraries should be measured with respect to the degree of their contribution to the achievement of university's vision, mission, values and goals. It is therefore imperative that any project that these libraries engage in should be geared towards achievement of the overall goal of Kenyan universities. One common goal in every institution of higher learning is to develop all-round and self-reliant citizens capable of being productive with minimal external help. That is to say, every library management system should allow its users some degree of freedom and ease to independently search the library database for individualized information needs. A library user would be more concerned about the ease with which he or she acquires the needed information rather than the cost of acquiring the software used in the library system. Since a great percentage of library success or performance is determined by the level of users' satisfaction, the effects of open software usage in these libraries should also be gauged on their friendliness to the end-users (library patrons in this case).

Singh & Sanaman (2012) described OSS as software revolution that liberates libraries from being locked in software products that might not meet their full needs. By providing for direct participation of libraries in software development, OSS allows innovation in libraries and development of computer-based systems and services that are consistent with librarianship values (Singh & Sanaman, 2012).

According to Singh and Sanaman (2012), open source software provides its users with the opportunity to continuously improve its quality through peer reviews. The reliability of open source software can therefore be assured. Additionally, libraries that are using open source software have got unlimited opportunity to directly participate in the development of their systems. Libraries can therefore undertake innovative projects in line with the established principles of librarianship rather than being restricted by any single software developer (Singh & Sanaman, 2012).

1.1.3 University Libraries in Nairobi Metropolitan

Even though most Kenyan Government services have been and are still being decentralized through the newly created County Governments, major universities in Kenya are still striving to maintain their presence within Nairobi Metropolitan. The centrality of the City has made it possible for each of the most of the University to operate a functional Campus with adequately equipped library. Some of the Universities offering vibrant library services within Nairobi Metropolitan include University of Nairobi, Kenyatta University, United States International University, Kenya Methodist University, KCA University, Moi University, Daystar University,

and Strathmore University among others. The fair representation of Kenyan university within Nairobi Metropolitan makes it a suitable location for the study.

1.2 Statement of the Problem

From general observations by Makori (2016), every Kenyan University library is using at least one open source software products in its daily operations. Whereas other universities libraries such as Kenyatta University library, Strathmore University, Technical University of Kenya, and Masinde Muliro University among several others are using koha, other universities are actively exploiting the freely available DSpace for the development of their digital repositories (Wasike, 2015). The degree to which Open Source Software products have and are continuing to permeate Kenyan university libraries begs for an empirical evaluation on specific features of OSS and their contributions to the performance of these institutions.

The glaring lack of empirically established and documented information on the unique features of Open Source Software features on the performance of these libraries puts them at risk of concentrating valuable resources on maintaining and improving inconsequential facets of the software (Palmer & Choi, 2014). It is against this background that study was carried out to qualitatively and quantitatively establish contribution of OSS unique features such as its cost effectiveness, usability, user-friendliness, scalability, and reliability on the overall performance of Kenyan University libraries.

1.3 Objectives of the Study

1.3.1 General Objectives

The general objective of this study was to establish the contributions of open source software features on the performance of Kenyan university libraries.

1.3.2 Specific Objectives

In order to achieve this end, the following specific objectives were used to guide the researcher;

- a) To establish the extent to which OSS' acquisition and maintenance costs contribute to the performance of Kenyan university libraries.
- b) To establish how usability of OSS contributes to the overall performance of Kenyan University libraries.
- c) To establish how reliability of OSS contributes to the performance of Kenyan University libraries.
- d) To establish the contributions of OSS' scalability on the performance of Kenyan University libraries.

1.5 Research Questions

In order to effectively achieve the set objectives of this study, the following questions guided the entire research process.

1. To what extent does OSS' acquisition and maintenance costs contribute to the performance of Kenyan university libraries?
2. How does the usability of OSS contribute to the overall performance of Kenyan University libraries?

3. How does the OSS reliability contribute to the overall performance of Kenyan university libraries?
4. How does the scalability of OSS contribute to the performance of Kenyan University libraries?

1.6 Significance of the Study

The study is of great significance to three groups of users; Managers of University libraries, developers of open source software, and academicians in the field of Library Management Systems. To the managers of University Libraries in Kenya, the study provides empirically established contributions of functional features on the performance of their respective libraries. As such, library managers and policy makers sound basis upon which decisions of OSS adoption can be made. Equally important is that university librarians can use the findings of this study in order to identify specific features of OSS whose improvement can positively or negatively influence overall performance of their libraries. Hence, the study has laid sound foundation upon which software-related decisions can be made to optimize utilization of the scarce resources in Kenyan University libraries.

To the community of open source software developers, the study provides invaluable insights in regard to the performance-critical features of their products. Technical improvements on such products has been simplified by the findings of this study. Software developers will concentrate their efforts and resources on developing more useable products rather than duplicating efforts on market research.

The study has incredible academic significance as it fills the knowledge gap on the contributions of Open Source Software on the performance of Kenyan University libraries. It is apparent that most of Management Information Systems studies have been focused on the corporate world. Academic application of such systems such as in academic libraries is yet to receive substantial attention. This study therefore calls attention of management scientists to the unexplored pool of knowledge in the library application of Open Source Software.

1.7 Scope of the Study

The study focused on features of Open Source Software such as their cost-effectiveness, usability, scalability, and reliability in terms of their quantitative and qualitative contributions on the performance of Kenyan University libraries. Six university libraries located within Nairobi Metropolitan area were sampled for the study.

1.8 Limitations of the Study

The study is limited to six (6) University libraries located within the Nairobi metropolitan area due to time and cost constraints of conducting the same in over 60 university libraries that are currently operational in Kenya. However, the high concentration of University campuses and libraries within Nairobi Metropolitan makes the sampled libraries adequately representative of all the university libraries in Kenya.

1.9 Assumptions of Study

Three major assumptions were made in this study. First and foremost, the study was based on an assumption that each of the selected University libraries were using at least one Open Source Software in their daily operations. It is only through this assumption that researcher expected to

collect relevant and adequate information to achieve the ultimate goal of the researcher. Equally important was the assumption that Open Source Software that were being used in the sampled libraries had unique features with some measurable contributions on the performance of the libraries. The researcher also assumed that sampled respondents could have reasonable experience and knowledge of the research topic. It was also assumed that the study would achieve at least 75% response rate.

CHAPTER TWO:LITERATURE REVIEW

2.1 Introduction

In order to effectively understand the implications and effects of Open source Software usage in the Kenyan University Libraries, it is important that we consider previous studies that have been done in regard to Open Source Software development and their applications in various types of institutions. This chapter provides a systematic of various literatures relevant to the research topic presented in the following subsections.

2.2 Theoretical Review

In order to understand the rational and process by which Open Source Software packages have been adopted in the Kenyan University libraries and even beyond, it is important for us to look at some of the proposals by dependable theorists.

2.2.1 Diffusion of Innovation Theory

Understanding the effects of open source software usage in Kenyan university libraries may not be possible without looking at the adoption trends of the same in these libraries. It is true that not all Kenyan university libraries which are currently using different kinds OSS started spontaneously. The move to use OSS in libraries might have started from a single source from which the influenced diffused to other libraries as suggested by Gabriel Tarde's theory of innovation diffusion. Diffusion of innovation theory is a change adoption theory that tries to explain how a new idea or product can be progressively adopted in a social a system. It was developed by in 1903 Gabriel Tarde, a French sociologists and then later improved by E.M. Rogers in 1962 (Robinson, 2012). The theory explains that innovations are not adopted

simultaneously by all individuals in a social system but they are in a time sequence depending on some characteristics of the innovation. Innovation in this theory is described as an idea, object, or practice which has been perceived as new by an individual or organization. For instance, the use of Open Source software in libraries qualifies to be an innovation to the Kenyan university libraries since it is practice that is hardly a decade old. This statement is justified by Rogers's emphasis that the newness of the innovation must not only be in term of new knowledge but it can also refer to the new point of view regarding the innovation (Rogers & Everett, 2003). For instance, open Source software products such as Linux operating system and koha library management software have been around for long a while but it is until recently that some Kenya university libraries are adopting them in their system. It is not uncommon to get some librarians still asking for assistance on how to install these programs. It therefore means that the OSS concept is still new our universities.

The definition of Diffusion of Innovation theory given above suggested some outstanding characteristics of innovations that drive their diffusion. Some of these characteristics include relative advantage, compatibility with other existing subsystems, and complexity of the innovation. Even though this theory has other three components such as communication channels, time and the social system, this paper will concentrate on the innovation components since the other three components are not directly link to the paper's research objective. Review of the suggested characteristics of the innovation (Open Source Software usage) will put this research in a better position to investigate the effects of OSS usage in the Kenyan University libraries. For instance, there is need for an empirical investigation into the relative advantage of OSS usage over the proprietary software.

2.2.1.1 Relative Advantage of OSS

For a new idea, practice or product to diffuse steadily within a social system, it should have some relative advantage over the previously existing idea, practice or product. Robinson (2012) defined an innovation's relative advantage as the degree to which it is perceived to be better than the idea, practice or product it replaces. Hence, the increased adoption of OSS in the Kenyan libraries would theoretically mean that OSS products are better than their proprietary counterparts. As such, their usage in these libraries should have some measurable effects. According to Rogers and Everett (2003), an innovation's relative advantage can be measured in different dimensions such as; economic effects, social prestige, user satisfaction, and convenience. The researcher, therefore, employed these four dimensions of an innovation's relative advantage as sound metrics gauge the contributions of OSS features on the performance of Kenyan university libraries.

Economic effects of OSS usage in the Kenyan university libraries should be ascertained quantitatively from multiple angles. One angle can be in terms of cost reduction in the system acquisition and the system's maintenance costs. Another economic angle upon which OSS usage can be gauged in the Kenyan libraries is the profitability of these institutions. Even though university libraries are often classified as non-profit generating units of the institution, they sometimes lose substantial information materials through improper management of the same. Hence, if the OSS systems can be used to prevent loss of these materials or increase their availability then such a system can be termed as profitable to the university libraries.

2.2.1.2 Compatibility of OSS with the Existing System

Besides being beneficial, an innovation needs to be compatible with the existing systems for it to diffuse steadily within the society. Theoretically, most of the OSS products that are being used in the Kenyan university libraries are assumed to be compatible with the existing library and university management systems. For instance, koha library management system, Linux operating system, and DSpace document management system should be compatible with both the hardware and software components of the previously existing system. As a theoretical requirement, every OSS product that is being used in Kenyan university library should increase the intra-compatibility of the entire university library system. Hence, compatibility is a feature of OSS whose contributions to the performance of Kenyan university libraries should be considered.

2.2.1.3 Complexity of the Innovation

Usability, as a feature of a system or a software by the end users highly depends on the system's complexity. Complexity is defined as the perceived degree of a product's difficulty to understand and use. It is observed that some innovations can readily be understood by most members of a social system while other innovation are complex demands extra effort from the users to understand and use effectively. This is very crucial point consider when examining effects of OSS usage in the university libraries. As suggested by S.R. Ranganathan (the father of librarianship) information are for use and any component of a system that can bar effective use of information should be avoided (Das, 2008). The impact of OSS usage in this sense should be considered in terms of its user-friendliness and contribution to the ease of accessing libraries' information materials.

2.2.2 DeLone and McLean's Information Systems Success Model

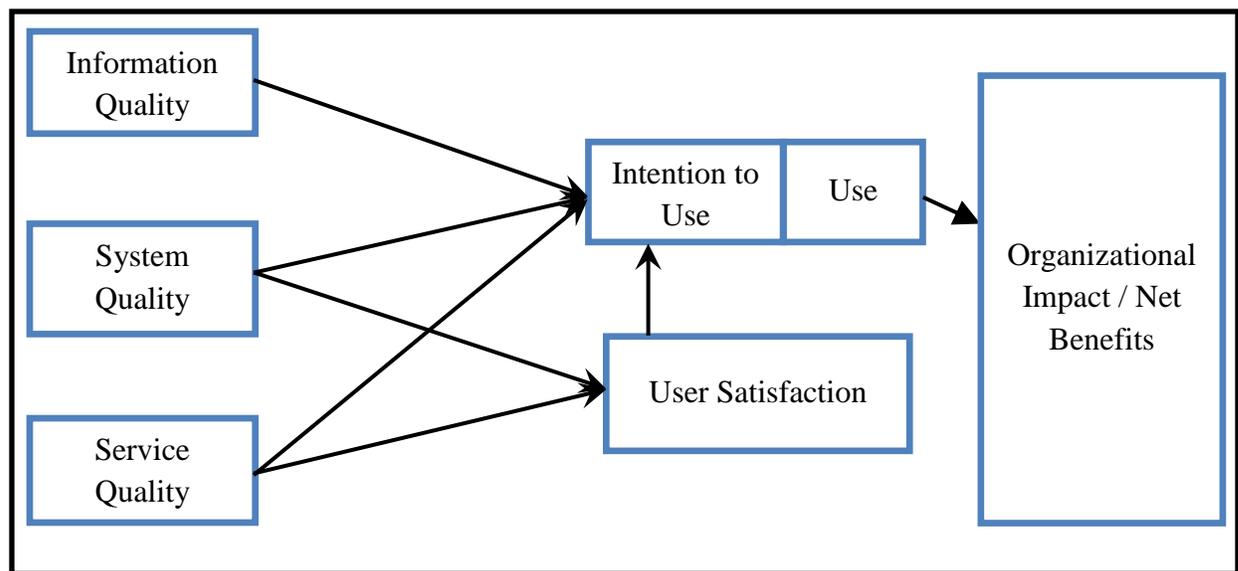
According to this multidimensional model, the overall organizational impact (net benefits) of an information system is a function of three independent variables. DeLone and Mclean (2003) explained the three independent variables to include; Quality of information provided by the system, Quality of the system, and the Quality of service provided through the system.

The overall organizational impact of the Information System is a compound of "Use" and "User satisfaction" variables, both of which are functions of the three aforementioned independent variables. On the other hand, the "Use" variable measures the individual functions for which the system is used. For instance, open source software in a library can be used to automate the technical services such as cataloguing, classification, material acquisition, and circulation (Kumar, 2014). The other functions may include digitization of library materials or management of institutional repositories. All these functions will dependent on the quality of the open source software determined by its embedded features such as usability, reliability, and scalability.

User satisfaction was gauged in two dimensions; first, the researcher focused on library staff as the technical users of the open source software. Satisfaction of this kind of users was assessed on the understandability of the open source software's technical aspects depending on the quality of information provided through the documentation of the software. The other dimension of gauging user satisfaction is by considering library patrons as the consumers of library services provided through the open source software. Here, the focus was on the timely and convenient access to library information materials availed through the system (Kumar, 2014). Richness in terms of volume and relevancy of the information provided to the library patrons was a key factor in determining the quality of service provided through the system.

It is also important to note that libraries' intention to use any specific kind of software or system depends on the perceived quality of the system and its service enhancement. The initial intention to use the software is a function of the quality of information available about the software. This perceived quality was ascertained in this research by interrogating the initial source of software's information to the systems librarians. In order to validate the perceived quality of the system (open source software in this case), DeLone & McLean IS Model demands that it be put into actual use. The net benefits or the overall organizational effects of the system (open source software) will then be assessed depending on the users' experience while using it.

Figure 2.1: Information Systems Success Model



Adapted from DeLone & McLean's IS Success Model (2003)

2.3 Empirical Review

2.3.1 Acquisition and Maintenance Costs of Open Source Software

On their report on Open Source Software's total cost of ownership, Shaikh and Cornford (2011) pointed out that open source software provides a cost-effective way through which inadequately funded institutions can acquire new and usable information systems within a constrained budget. They also argued that adoption of OSS within organizations can facilitate great savings on the organizations' operational cost. Shaikh and Cornford used Lerner and Schankerman's conceptual model of Total Cost of Ownership sought to identify all the possible costs associated with software acquisition, installation, maintenance and even migration. Through this approach, the authors were able to establish a comprehensive view of Open Source Software cost-effectiveness rather than single focus on the acquisition and maintenance costs. The study included participants with adequate experience on acquisition and usage of various Open Source Software products. Hence, they were well aware of TCO concept as it relate to Open Source Software. A total of 14 drivers of total cost of owning software were identified and grouped into five components on the basis of five broad stages of software life cycle represented in the table below;

Table 2.1 Cost Categories within Software Life Cycle

Life Cycle Stages	Cost Category
Search	Cost of up-front evaluation study
	Cost of up-front proof of concept implementation
Acquisition	Cost of software
	Cost of Customization for business needs
	Cost of Integration (to current platform)
Integration	Cost of Migration (data and users)
	Cost of Training
	Cost of Process and Best Practice change
Use	Cost of Support services - in house
	Cost of Support services – contracted
	Cost of Maintenance and Upgrades
	Software scaling (for change in user or transaction volumes)
Retire	Exit costs (in relation to hardware and software)
	Exit costs (in relation to changeover, re-training)

(Source: Shaikh & Cornford, 2011)

Acquisition cost of software is largely made up of the software’s license fee paid to the developers. However, licenses for open source products are always free thus making such products easy to acquire. Lower acquisition cost has always been mentioned as one of the

advantages of Open Source solutions. Randhawa (2008) confirmed this notion of lower acquisition cost of OSS since such applications demands no licensing fee from the interested users. Kenyan University libraries can therefore take advantage of this financial favor. Additionally, open source solutions such as Linux operating systems and servers are relatively compact and portable as compared to their proprietary counterparts. As such these OSS require hardware with less power which can be acquired at lower cost. The benefits of this cost-cutting ability of the OSS are that they can accomplish the same tasks as the costly commercial solutions.

In their research based on the use of open software in libraries, Sanaman (2012) noted that “libraries are always concerned about the cost as they often have more demands than resources and they are funded by their parent organizations with a responsibility to manage public funds wisely”. The implication in this statement is that libraries have little or no means of generating their own income. As such, they depend on their parent institutions to fund their projects. Being a non-income generating unit, libraries are likely to experience difficulty when pushing for costly projects to be financed by the institution. This financial difficulty complicates the task of managing libraries since librarians are expected to continuously deliver quality services. Managers of these libraries are therefore forced to establish the most cost-effective means of serving their patrons. The cost-free acquisition of open source software seems to be a favorable avenue to meet the patrons’ needs at a lower cost compared to proprietary software (Sanaman, 2012). However, there is need to ascertain the total cost of the software ownership by the library managers. The software can be acquired freely but other costs such as its installation, user training, documentation, system support, and maintenance might be equally high.

2.3.2 Usability of Open Source Software in the Management University Libraries

In their analysis of industry users' perception of open source software usability factors, Raza, Capretz and Ahmed (2011) observed that user-centered designs are currently being popularized in the development of Open Source Software products. The study interviewed 105 industry users of open source software. The authors also reported that OSS has more potential to realize greater software quality in comparison to their proprietary counterparts. The study was based a multiple regression analysis of four usability components and their effects on industry users' perspective on the OSS usability. The model, presented below, revealed that users' opinion on the usability of a software is greatly influenced by its attractiveness, operability, learnability, and understandability by the users.

$$OSS\ Usability = f_0 + f_1v_1 + f_2v_2 + f_3v_3 + f_4v_4$$

The $f_0, f_1, f_2, f_3,$ and f_4 in the above model represented the coefficients while $v_1, v_2, v_3,$ and v_4 represent the four usability factors of OSS.

However, the researchers noted that the voluntary nature of OSS development may impair usability features of the software. Volunteer developers of OSS may concentrate on specific areas that are of interest to them thus leaving out features demanded by novice users. This risk is quite possible in cases where the demands of novice users are not within the areas of developers' interest. Usability of software or information systems refers to the degree of ease with end-users can navigate through the system. A good software or computer-based system should allow users to navigate with minimal external help. This view was also supported by Nichols and his colleagues when they proposed that software usability should be described in terms of five main

characteristics. These characteristics include ease of learning, memorability, and users' subjective satisfaction, efficiency of use, error frequency and severity.

University Libraries Standards and Guidelines developed by Kenyan Commission for Higher Education (2012) also alluded to this description of software usability in their measurement of university performance. The commission posed that performance of university libraries should be measured with respect to the degree of their contribution to the achievement of university's vision, mission, values and goals. It is therefore imperative that any project that these libraries engage in should be geared towards achievement of the overall goal of Kenyan universities. One common goal in every institution of higher learning is to develop all-round and self-reliant citizens capable of being productive with minimal external help. That is to say, every library management system should allow its users some degree of freedom and ease to independently search the library database for individualized information needs (Odongo, 2012). A library user would be more concerned about the ease with which he or she acquires the needed information rather than the cost of acquiring the software used in the library system. Since a great percentage of library success or performance is determined by the level of users' satisfaction, the effects of open software usage in these libraries should also be gauged on their friendliness to the end-users (library patrons in this case).

2.3.3 Reliability of Open Source Software in the Management University Libraries

Ullah and Morisio (2013) defined software reliability as the *probability of failure free operation of a computer program in a specified environment for a specific period of time*. This definition is in tune with the kind of a system required by any busy university library. The critical nature and

demand for reliable service delivery among Kenyan University Libraries dictates that their services should be supported by failure-free systems. As such, maximum efforts should be directed at establishing whether Open Source Software that are currently being used in these libraries meet the reliability requirements of a suitable Library Management System.

Ullah and Morisio (2013) took an experimental approach in analyzing usability of five open source software projects. The five OSS included in the study's sample were Apache HTTP Server, Mplayer OS X, Eclipse software development environment, ClamWin Free antivirus, and Firefox internet browser. A 3-step approach was employed to gather, filter, and analyze bugs resulting from the sampled applications. The research also sought to ensure consistency across multiple versions of the applications. This was achieved by analyzing reliability of multiple release versions of each software. Software reliability models of "time between failures" and "fault count" techniques were used to measure the reliability patterns of the software. According to Ullah and Morisio (2013), intervals of successful operations of a system is useful parameter in determining the software's reliability. Another useful parameter in the measurement of software reliability is the number of faults encountered by the system in a given period of time. For instance, users of library management systems can estimate reliability of their system by enumerating the number of the system's breakdown in a weekly, monthly, quarterly, semi-annually, or on annually. The magnitude of such incidences can then be compared by the performance of an identical system.

Even though the specific Software products included in this study are not majorly employed in the daily operations of Kenyan University Libraries, the reliability findings of the study are quite relevant to the study.

2.3.4 Scalability of Open Source Software

Outside the library setting, scalability of open source software can best be illustrated by the ever growing content of Facebook website. According to an online research on the bulging size of Facebook servers, researchers revealed that the social media giant is leveraging on open source systems to its massive scalability (Thusoo et al., 2010). The three open source software applications that have been instrumental in fostering scalability at Facebook are Hadoop, Scribe, and Hive. The research on Facebook's data warehousing and analytics infrastructure points out to the great scalability potential of properly nit open source software products. If open source software products are capable of handling up to 60 terra bytes of new data being loaded everyday on Facebook servers then no amount of library resources can be exhaust the scalability of open source systems. Even though one can argue from Ranganathan's point of view that library is a growing organism, the growth of library electronic resources cannot grow at the same rate as social media platforms. Contributors of library resources are relatively few compared to the entire world's population who are continuously posting multimedia contents on their Facebook pages.

According to Randhawa (2008), open source software products such as Linux mail servers and database offer multiple scalability options. Among the scalability options are clustering and load balancing functionalities embedded in Linux mail servers and databases. University libraries as well as other organizations can take advantage of these functionalities in order to scale up their services and ensure future growth. The integration of Zebra indexing engine into Koha version 3.0 released in 2005 added scalability options to koha which is the most popular open source Integrated Library Management System (ILMS) across the globe. According to Uzomba (2015),

Zebra a powerful indexing tool embedded in koha to make it more viable and scalable to suit the needs of libraries of all classes. Bash (2015) reported that the Zebra feature has given scalable ability to holds huge bibliographic records totaling to tens of millions. Scalability of open sources software products seems to be assured by the increasing support coming from individuals and corporate entities.

2.3.5 Performance of Kenyan University Libraries

University libraries play significant role in the facilitation of higher education in Kenya as well as ensuring life-long learning among Kenyan. Besides promoting the realization of academic goals of their mother institutions, university libraries have opened their doors to the general public in the dissemination of knowledge and fostering research. The adoption of Open Source Software such as DSpace has enabled a number of Kenyan University libraries to limitlessly avail their institutional repository the community of researchers, both locally and internationally. Besides these impressive developments, a clear guideline on how to measure performance of these libraries is still missing. In his study on the practices and performance of university libraries in Kenya, Kavulya (2003) considered university libraries' performance on availability of resources. He pointed out that inadequacy in terms of funds, information materials, equipment, and staff are key determinants of library performance.

Hoq, on the other hand, described libraries as organic combination of people, collections, and buildings aimed at assisting users in the transformation of information into knowledge and applying the gained knowledge in users' specific needs (Hoq, 2015). Therefore, the purpose of libraries is to enable access to information and its dissemination to the relevant individuals and

organization. In this regard, performance of university libraries can be measured in terms of users' satisfaction with overall library services such as access and dissemination of the library information materials. Hence, a library that provides easy access to large volume of materials portrays superior performance than libraries whose collections are hardly accessible. On dissemination, university libraries need to install sound systems through which information materials can be disseminated to users in an efficient and convenient manner.

2.4 Summary of the Literature Review and Research Gaps

Theoretically, adoption of OSS among Kenyan university libraries might have been influenced by some expected positive effects of the same on the performance of the libraries. According to Tarde's diffusion of innovation theory, the aggressive adoption of OSS products by Kenyan university libraries might have been propelled by factors such as perceived relative advantage of the OSS over their proprietary counterparts, their compatibility with the previously existing systems, and degree of complexity of the OSS to the library users (Rogers & Everett, 2003). Even though these factors seems viable enough to drive the software revolution in the management of Kenyan university libraries, their certainty needs to be established by looking at the effects this revolution has made on the performance of these libraries.

Delone and McLean's Information Systems Success Model provides a sound foundation upon which effects of OSS usage on the performance of Kenyan University Libraries can be evaluated. For instance, quality of the information and other library services supported by the OSS products can be used to gauge the specific effects of OSS on the overall performance of the libraries involved. OSS products have been cited by different researchers as being costs-

effective, user-friendly, and scalable. Randhawa (2008), for instance, contended that OSS products such as Linux operating system and databases are both cost-effective and scalable enough to support daily activities of various institutions, including libraries. However, his proposal was lacking empirical backing. A study by Sanaman also missed out on the data to establish the true cost of OSS products. The researcher only made a general observation on the need for cost-effective library management system since majority of libraries are financially deprived (Sanaman, 2012). The glaring lack of empirical information on actual effects of OSS usage, especially in the Kenyan University Libraries makes it important for this study to be carried out to bridge the current knowledge gap.

Even though a great deal of studies has been done concerning OSS products and their adoption in business organizations, there is a glaring lack of information regarding the contributions of OSS features in university libraries. The Kenyan scenario is especially wanting given that most of the available literatures are foreign to our situation. Kenya is a developing country and is bound to have unique technological needs as opposed to European countries where majority of these researches are based (Amollo, 2013). As much as these sources have tried to narrate the adoption of open source software products, library-related products have not been covered. For instance, one can hardly find information in the use of Debain server while the software has been used in the hosting of koha integrated library system (Alves, Reais, & Alves, 2012). Therefore, there is need for more research and publications giving undivided attention to these library-related open source software products.

2.5 Conceptual Framework

Contributions of OSS features on the performance of University libraries were measured by four main features of good software. The features include acquisition and maintenance costs, usability, reliability and scalability of the software. Since daily operations of Kenyan University libraries are currently based on Open source software, these four features of the software interact to holistically impact on the overall performance of the libraries under study.

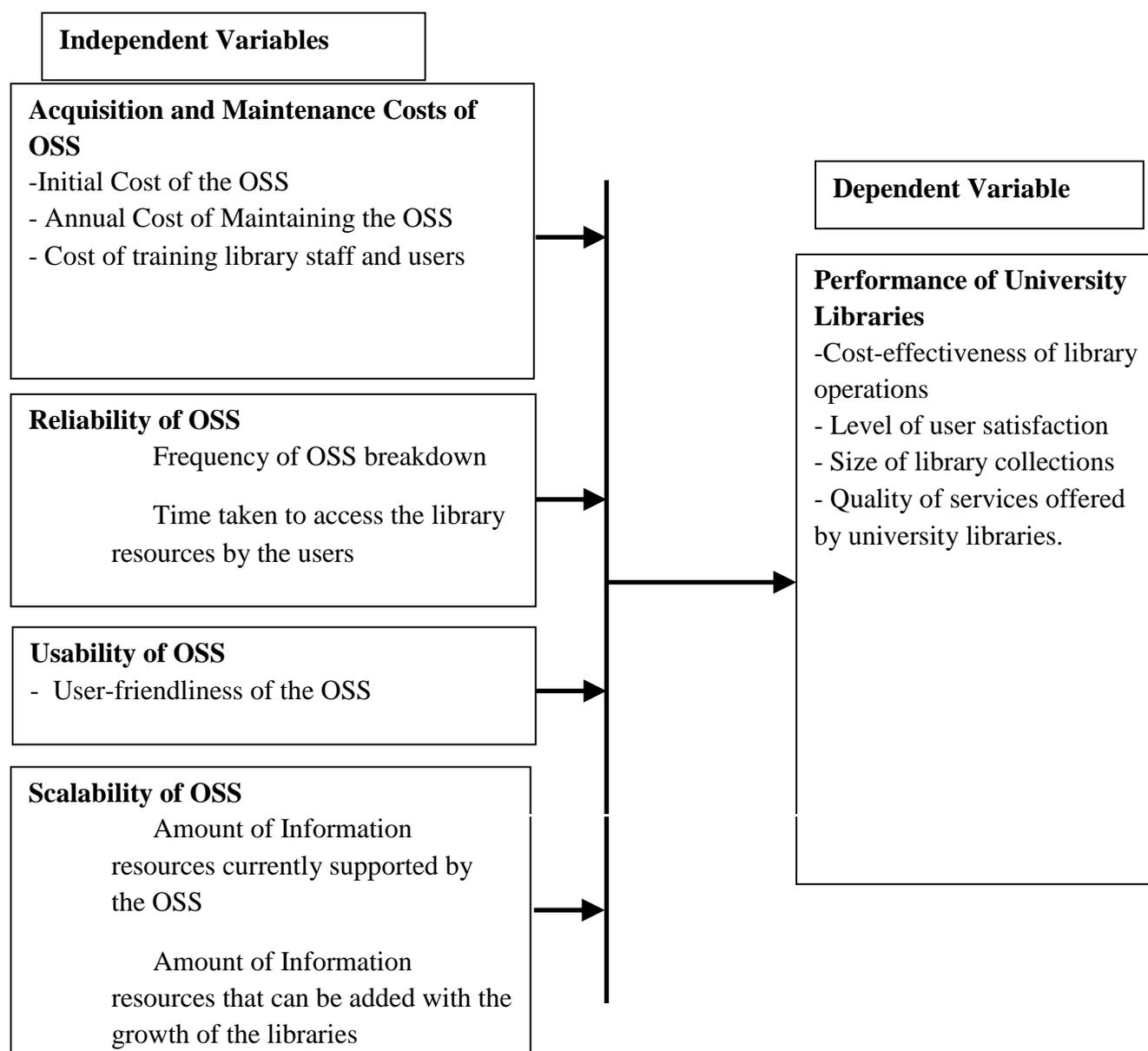


Figure 2.2: Conceptual framework (Source: Researcher, 2016)

CHAPTER THREE:RESEARCH METHODOLOGY

3.1 Introduction

Methodology refers to the techniques that shall be used in conducting the research. This chapter there outlines the kind of research techniques that were employed plus the detailed outline of all the processes that were taken from the identification of study scope to the analysis of data.

3.2 Research Design

Survey research design was used to undertake this project. Since the study required answering series of questions of “how” and “why” descriptive survey was most appropriate. The study involved administration of questionnaires and interviewing of three groups of stakeholders of Kenyan university libraries within Nairobi metropolitan. The centrality of Nairobi Metropolitan has been it an attractive location for major University in Kenya. Majority of these Universities have functional campuses and libraries within the Nairobi Metropolitan. Therefore, survey on OSS features and performance of Kenyan University libraries could be effectively accomplished within the said location.

3.3 Target Population

The researcher’s target population consisted of six (6) university libraries located within Nairobi Metropolitan Area since majority of Kenyan university have campuses in this area. The targeted population represented both public and private universities. The researcher conducted a preliminary survey to establish whether the above mentioned university libraries are currently using any kind of open sources software. These libraries included Kenyatta University,

University of Nairobi, Daystar, KeMU, KCA, and United States International University libraries.

3.4 Sampling Technique and Sample Size

The researcher employed purposive sampling technique to get the most relevant respondents whose understanding of the subject matter was adequate enough to inform the study. In this case, the researcher started by identifying some of the key players in the automation of Kenyan university Libraries. In accordance with the requirements stipulated by Commission for Higher Education in Kenya, Systems Librarian is the key player in the management of University Libraries' ICT section. Other respondents (student users of the library and members of the universities' teaching staff) were sampled as indicated in the table below.

University	Target population				Total
	Systemslibrarian	Other library staff	University Teaching staff	Students	
UoN	1	4	5	15	25
KU	1	4	5	15	25
KEMU	1	4	5	15	25
Daystar	1	4	5	15	25
USIU	1	4	5	15	25
KCA	1	4	5	15	25
Total	6	24	30	90	150

Table 3.1: Target population

(Source: Researcher, 2016)

3.5 Data Collection Instruments and Procedures

In order to acquire the necessary information for the study, the researcher made use of both interview schedule and questionnaires to collect data from the identified sample.

3.6 Data Collection Procedures

The researcher will interview one systems librarian from each of the sampled library. This gave a total of 6 respondents who were interviewed. The researcher then administered semi-structure questionnaires to the rest of the respondents.

3.6.1 Pilot study

A preliminary study was carried out to ascertain the feasibility of the final study. The feasibility study also focused on discovering and correcting possible bottlenecks that might hinder successful completion of the main study. Kenyatta University's Kitui Campus library was selected for the piloting since it is one of the top Kenyan university libraries and the researcher is a staff member in the said library. Hence, carrying out a pilot Kenyatta university library was both convenient and somewhat representative of the target population. The researcher interviewed Kenyan University's Systems Librarian before administering semi-structure questionnaires to three (3) other members of the library staff, five (5) members of the university's teaching staff, and ten students in the same university. Data from the pilot study was then analyzed using descriptive and inferential statistics to assist researcher in assessing the efficacy of his variables and data collection tools.

3.6.2 Validity of the research Instruments

Logical validity criteria was used to establish the suitability of the instruments for the study. Kothari (2004) defined logical validity as a measure of the degree to which a research instrument represents all the facets of the study topic. Validity of any data collection tool is an essential criterion for evaluating the quality and acceptability of research findings. For this study, a test re-test was done and the items that failed to measure the intended variables were modified.

Irrelevant components were discarded in the final research instruments. Consultations and discussions with supervisor was also done to reinforce the data collection tool's validity. Finally, face validity was undertaken to confirm clarity and unambiguity of the questions.

3.6.3 Reliability of the research Instruments

According to Kimberlin & Winterstein (2008), reliability of a research instrument refers to the ability of the concerned instrument to give consistent measurements of the research problem. In this study, Cronbach's alpha (also known as reliability coefficient) was used to objectively ascertain the reliability of the formulated questionnaires. A reliability coefficient of 0.626 (presented in Table 3.2 below) was acceptable in assessing reliability for multi-item scales as recommended by Best & Kahn (2005). According to Best & Kahn (2005), a reliability coefficient of 0.6 and above is sufficient for an instrument. Since the reliability coefficients of 0.626 and 0.718 (presented in Table 3.2 below) falls within the permissible range, the researcher considered the instrument adequately reliable for the study.

Reliability Statistics				
Cronbach's Alpha	Part 1	Value	.626	
		N of Items	6 ^a	
	Part 2	Value	.718	
		N of Items	5 ^b	
	Total N of Items			11

Correlation Between Forms		.555
Spearman-Brown Coefficient	Equal Length	.714
	Unequal Length	.715
Guttman Split-Half Coefficient		.699

Table 3.2: Reliability Statistics (Source: Researcher, 2016)

3.7 Data Analysis and Presentation

Data analysis refers to a process of editing, coding classification and tabulation of collected data (Kothari, 2004). Both the quantitative and qualitative data were analyzed by the use descriptive and inferential statistics to establish the correlations between OSS features and performance of University Libraries in Kenya.

3.7.1 Descriptive Statistics

Descriptive statistics were analyzed and findings were then presented in frequency distribution tables, graphs and pie charts. Statistical Package for Social Sciences (SPSS) was very instrumental in performing these analyses. The data collected through the interviews and questionnaire from Systems Librarians in the sampled university libraries were analyzed separately to capture in-depth perspectives on the impact of open source software in their respective libraries. Qualitative data was organized using the objectives, and presented in narrative form to facilitate the researcher's discussion of the findings.

3.7.2 Inferential Data Analysis

Multiple linear regression analysis was employed to facilitate analysis and manipulation of inferential statistics of the study. A regression model below, was constructed to illustrate the statistical relationships between the dependent and independent variables;

$$Y = f_0 + f_1x_1 + f_2x_2 + f_3x_3 + f_4x_4$$

Where;

Y represents Performance of Kenyan University libraries, f_0 , f_1 , f_2 , f_3 , and f_4 represent coefficients of OSS features represented by x_1 , x_2 , x_3 , and x_4 . The researcher used multiple responses from the questionnaires to compute composite indices for the four features of Open Source Software shown in Table 3.3 below;

OSS Features / Predictor Variables	Metrics
Usability	System User Friendliness
	Ease of Use
	Easier Search And Retrieval
Reliability	Faster Service Delivery
	Rich And Relevant Info Materials
	Ease of Access
	Problems Are Solved Promptly
Scalability	Increased Info Materials
	Quality Info

Table 3.3 Metrics for the predictor variables (Source: Research data, 2016)

3.7.2.1 Regression Diagnostics

Regression model constructed above was taken through two diagnostic procedures in order to ascertain its linearity and does not violate significant statistical principles. The first procedure involved plotting a histogram residual shown in Figure 3.1 below.

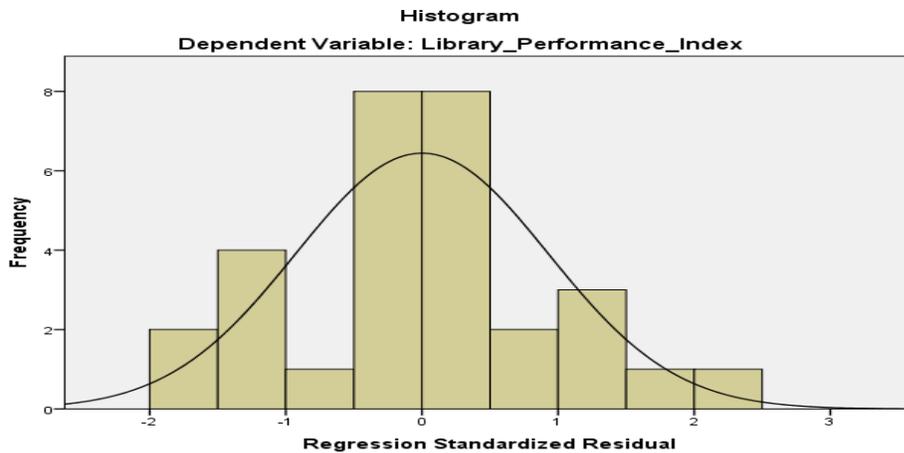


Figure 3.1 Histogram Residual (Source: Researcher, 2016)

A normal probability plot of the residual was then used to confirm uniformity of the model's residuals. Figure 3.2 shows that constructed model is adequately reliable to guide research inferences. The dependent variables are normally distributed without any observable outliers.

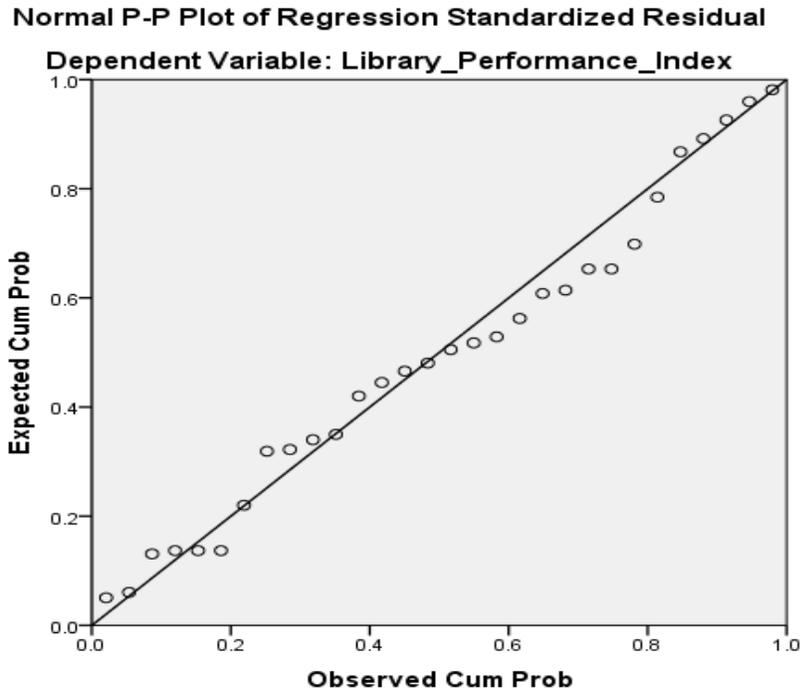


Figure 3.2 Normal Probability plot of Residual (Source: Researcher, 2016)

3.9 Ethical Considerations

The researcher upheld high ethical standards throughout this research project and every ethical concern pertaining to the research was given maximum attention possible. The research ensured that critical information from individual institutions was treated with utter confidentiality. Some of the measures to integrity of the research project included seeking permission from relevant authorities and individual respondents from whom data was collected. The researcher was also committed to ensure that all the respondents were protected from any physical or emotional harm as far as the study was concerned.

CHAPTER FOUR: DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter presents results and analysis of data on perceived contributions of Open Source Software features on the performances of the six university libraries that were sampled for the study. The data were collected by the use of structured questionnaires and interview schedule. A combination of tables, graphs, and frequency distribution tables are used to present the findings.

4.2 Sample Characteristics

4.2.1 Respondents Composition

The study focused on two broad categories of respondents. The first group included library users and library staff members formed the second group of the respondents as shown in Table 4.1.

		Student	Teaching staff	Library Staff	Total
Institution	UoN	11	2	5	18
	KU	13	5	5	23
	KeMU	11	2	5	18
	Daystar	13	2	4	19
	USIU	15	4	5	24
	KCA	15	3	5	23
Total		78	18	29	125

Table 4.1: Respondents Composition (Source: Research data, 2016)

From Table 3.1 (Chapter 3 of this study), the study achieved response rate of 83.3 %. That is, there was an actual response of 125 respondents compared to 150 expected respondents shown in

Table 3.1. Graphical presentation of the respondents' composition is presented in Figure 4.1 below.

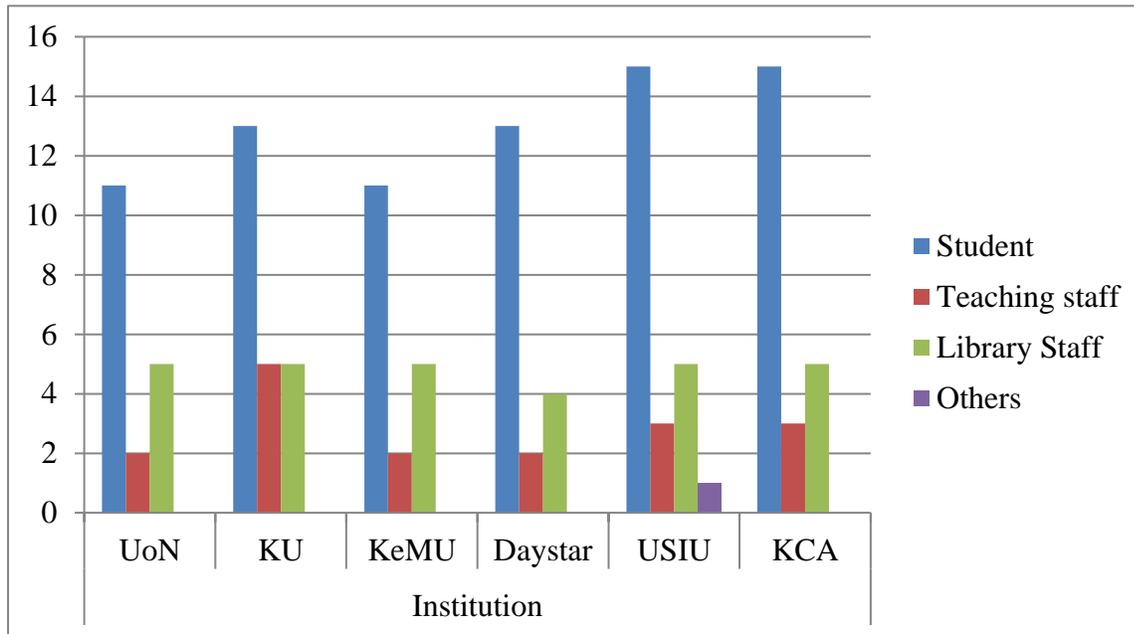


Figure 4.1 Respondents Composition (Source: Research data, 2016)

From the Figure 4.1 above, student users of university libraries were the majority of the research respondents. Response from members of library staff was also impressive compared to the teaching staffs' response rate.

4.2.2 Library Staff Respondents by Specialization

Most of library staff respondents were specialists in library automation by 32% followed circulation (Figure 4.2, below). 17% of the members of the library staff interviewed indicated circulation as their area of specialization. A number of library staff members have specialized in Information Literacy Training and Research, Cataloging, and User-Support services of the library. According to Samuels and Griffy (2012), the fact that majority of these respondents had

knowledge in library automation indicates that they had adequate information and expert view of the software that were in use in their respective.

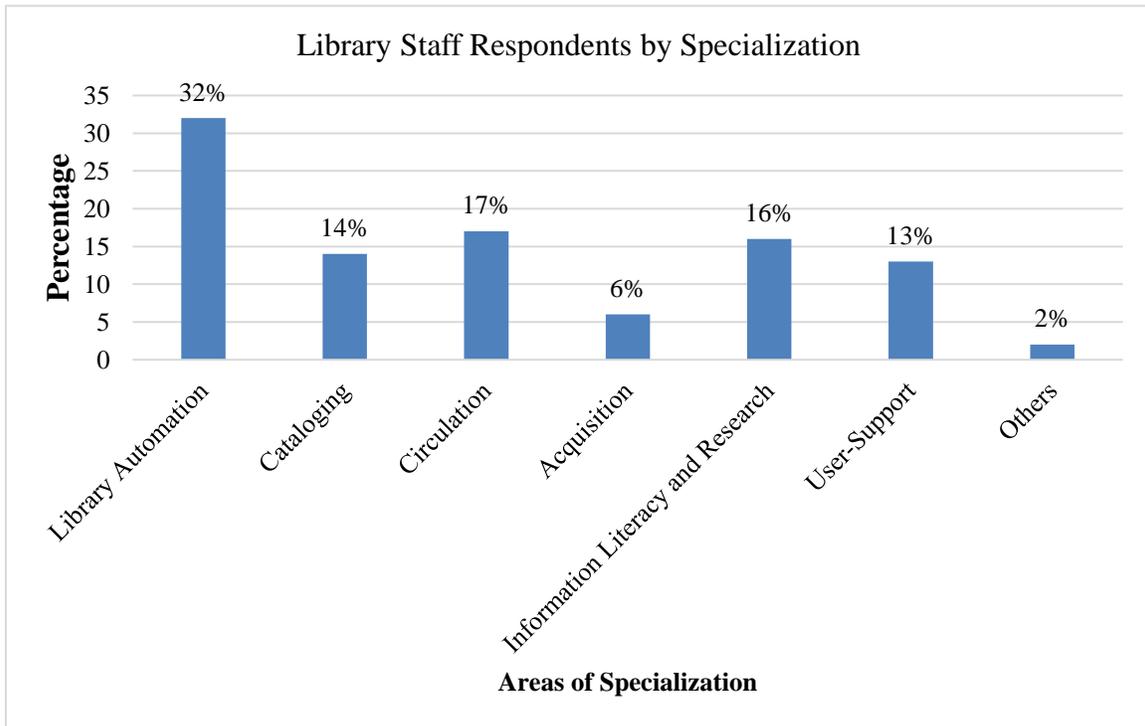


Figure 4.2: Library Staff Respondents by Specialization (Source: Research data, 2016)

It is also important to note that the other areas of specialization such as cataloging, circulation, acquisition, information literacy and research, and user support also offered the respondents opportunity to interact with their respective library systems (Macharia, 1994). Generally, library staff respondents were adequately informed to give credible information on the contribution of open source software in the performance of their university libraries.

4.2.3 Open Source Software Usage

As reported by Makori and Mauti (2016), many information management institutions (including university libraries across the globe) have adopted open source source systems such as koha and

Dspace as strategic knowledge management assets. For instance, koha and Dspace have gained popularity worldwide as premium library automation and tools for integrating information management services. Additional free and open source products such as Evergreen, Openbiblio, and Emilda are being used to automate and integrate information management by various Kenyan University libraries. Whereas Dspace is being used in all for the sampled university libraries, only three of the libraries (Kenyatta University, KCA, and KeMU libraries) are currently using koha. University of Nairobi and USIU libraries are using V-Smart and SirsiDynix systems respectively for the integration of the Information Management practices (Makori and Mauti, 2016).

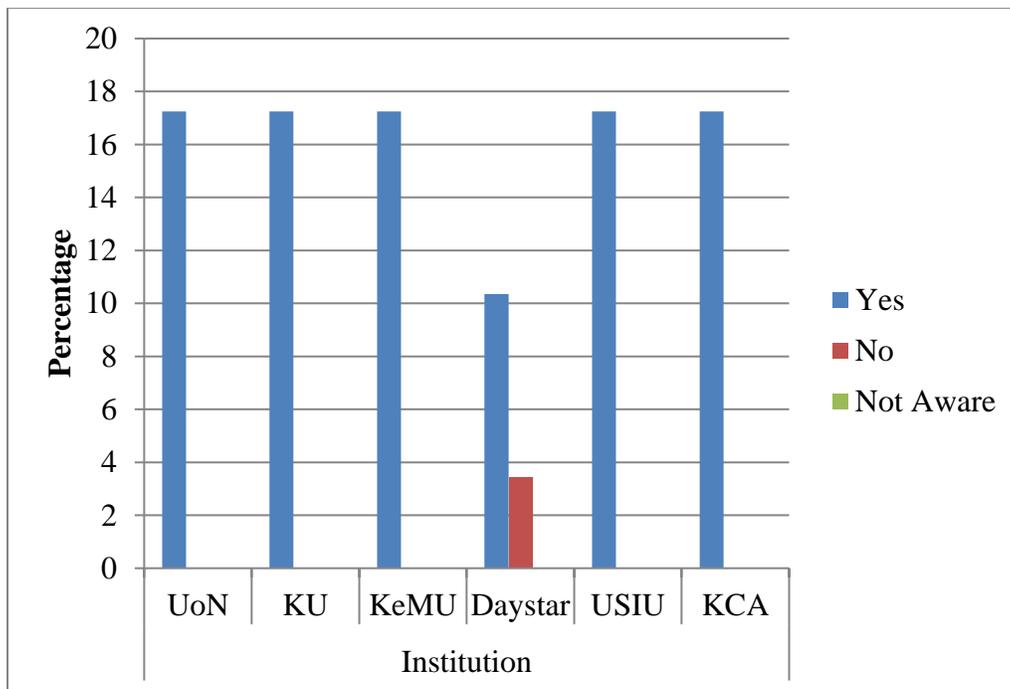


Figure 4.3: OSS Usage (Source: Research data, 2016)

An average of 17% of respondents from each of the sampled universities acknowledged that their libraries use open source software. Daystar university library stands out to have minimal usage

of open source software. In fact, about 3% of the respondents from the institution pointed out that they do not use any open source software while about 10% of the respondents acknowledged usage of OSS within the university’s library. Over 95% of all respondents acknowledged the use of OSS within their university libraries.

4.2.4 Period of Open Source Software Usage

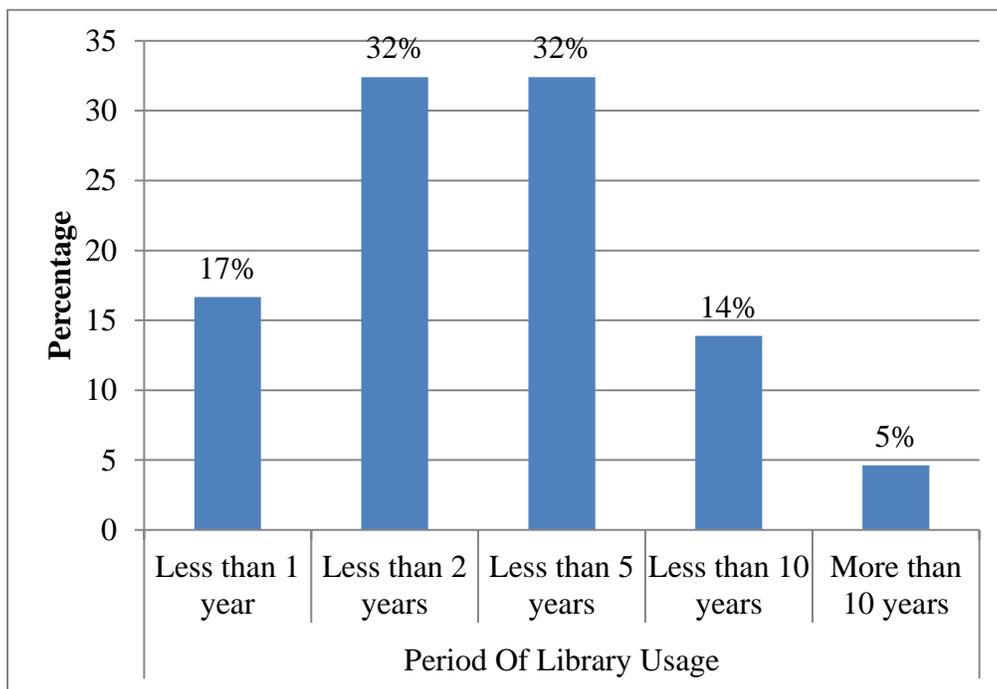


Figure 4.4 Period of Library services usage (Source: Research data, 2016)

Majority of the respondents had used different library services for a period of between 1 year and 5 years as shown in Figure 4.4 above.

4.2.5 Major Library Services Frequently Used by Library Users

Three out the several libraries services supported by different open source softwares, only are significantly used by patrons in Kenyan university libraries as shown in Figure 4.5 below. In the order of their major use, these services include Open Public Access Catalog (OPAC),

Institutional Repositories (IR), and Electronic Resources (E-resources). OPAC is used by about 27% of the respondents, while IR and E-resources are used by 13% and 23% of the patrons respectively.

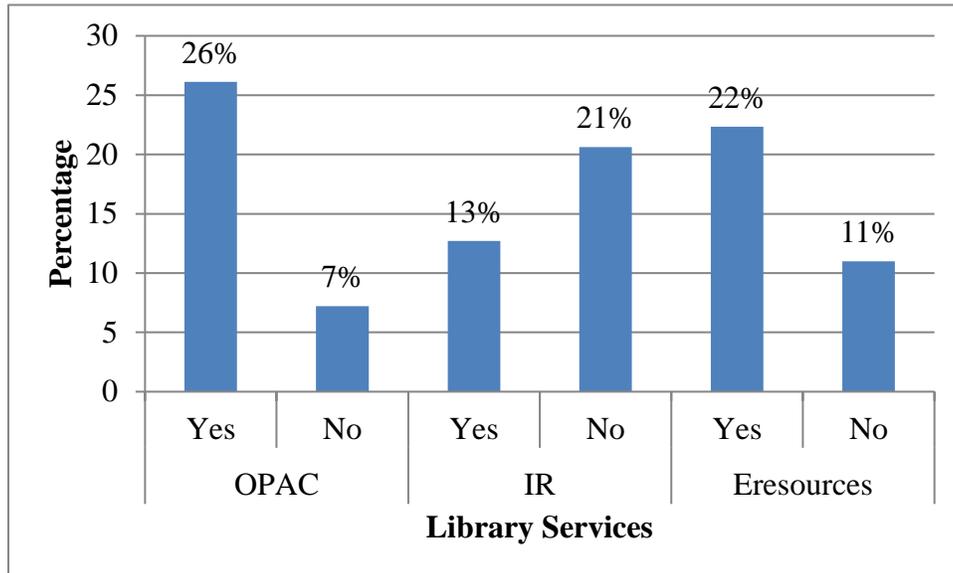


Figure 4.5: Major Library Services frequented by library users (Source: Research data, 2016)

The above findings are in agreement with Ndakalu's observation on the relative popularity of OPAC, Electronic resources, and institutional repositories among users of Kenyan University libraries (Ndakalu, 2014). It is worth noting that Institutional repository is sometimes referred to as digital libraries in some of the sampled university libraries such as in the University of Nairobi library.

4.3 Descriptive Findings

4.3.1 Types of Open Source Software Currently Being Used in Kenya University Libraries

According to Figure 4.6 below, only three kinds of Open Source Software are currently being used in the management and deliver major library services. The three include DSpace, Koha, and

Evergreen, in the order of their use. 18.62% of the respondents acknowledged that their university libraries use DSpace to manage contents of their digital libraries while 14.48% and 1.38% acknowledged that their libraries use Koha and Evergreen respectively.

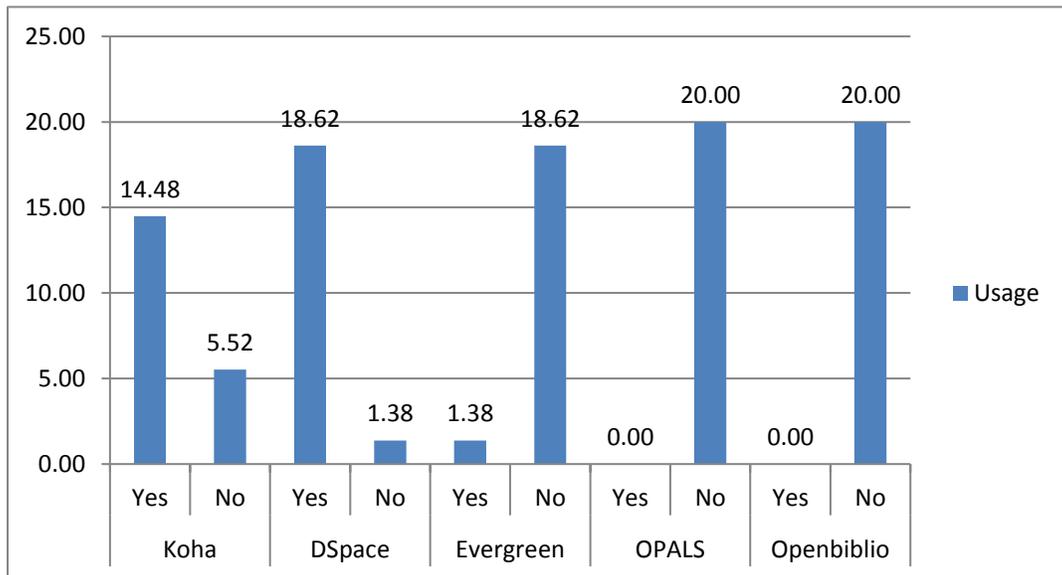


Figure 4.6: OSS Usage in Kenyan University Libraries (Source: Research data, 2016)

These findings are consistent with high popularity of Koha and DSpace over other open source software products in Kenyan university libraries (Amollo, 2013). However, it is worth noting that other open source software such as Ubuntu Linux operating system and Servers are being used to host these major Library Management Systems. For instance, an interview with System Librarians from University of Nairobi, Kenyatta University and USIU revealed that Linux Operating Systems and Servers are being to host their digital libraries or institutional repositories.

4.3.2 Cost-effectiveness of Open Source Software

The cost effect of Open Source Software in the university libraries was entirely investigated through face-to-face interviews with system librarians from the sampled university libraries.

System librarians in University of Nairobi, USIU, and Daystar reported that their libraries use a mixture of commercial and open source systems in the management of their mainstream library functions and digital libraries. Whereas all the three aforementioned university libraries reported substantial annual subscription costs of their main library management systems, the other three university libraries (Kenyatta University, KeMU, and KCA) reported a near-zero financial spending in the installation and maintenance of their library management systems. Kenyatta University, KeMU, and KCA libraries all use Open Source Software (Koha) to manage their mainstream functions such as Cataloging, circulation, acquisition and management of print resources.

According to system librarians interviewed, there is no other form of costs associated with Open Source Software besides occasional but minimal costs incurred during in-house training sessions conducted for the library staff and users. This view is line with Randhawa's observation that open source software products have negligible cost issues since no initial costs are involved in their acquisition (Randhawa, 2008). It is important to note that all the six university libraries use DSpace (an Open Source Software) in the management of their digital libraries.

4.3.3 Usability of Open Source Software

The usability of Open Source Software in the sampled university libraries was gauged on the easy with which library users would search and retrieve both print and electronic information resources from their respective university libraries. These resources are usually accessed and retrieved by through the OPAC, Institutional Repositories, or digital libraries which are either supported by proprietary or open source softwares. It is important to note that all the sampled

university libraries use open source software (DSpace) to facilitate their digital libraries. Additionally, half of the libraries use Koha to facilitate their OPAC with an exception of UoN, USIU, and Daystar university libraries that use proprietary software for their OPAC. It is therefore scientifically acceptable to gauge usability of OSS in Kenyan University libraries based on their expressed ease of access and retrieval of information materials from these libraries. Figure 4.7 shows that 56% of the respondents acknowledged that OSSs in their respective libraries are easier to use.

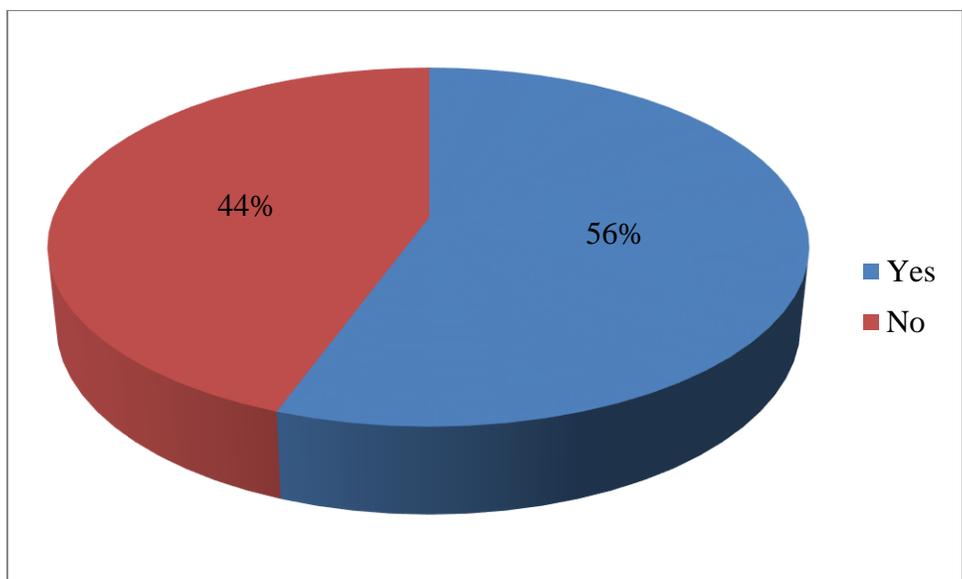


Figure 4.7: OSS is Easy to Use (Source: Research data, 2016)

From Figure 4.8, USIU library had the highest number of users who could use their library system with ease at 18% while only 6% of users at Daystar university library found their library system easy to use. It is important to note that number of users who expressed difficulty in the use of Daystar university library system were higher than those who could easily use the system. Majority of users from the other five university libraries could easily their library system. Users’

confessed ease with major library open source systems confirms the usability of open source software as reported in Giri (2012).

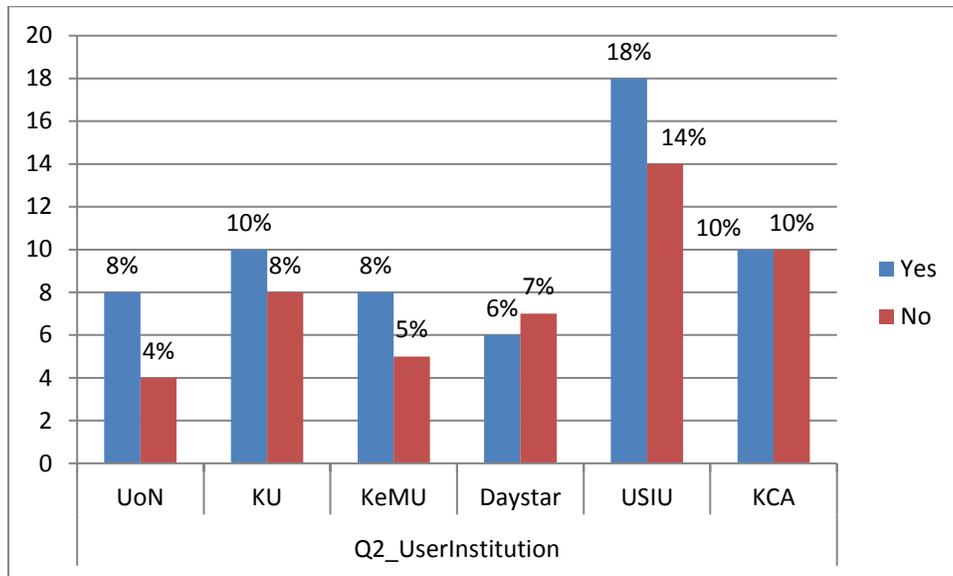


Figure 4.8: Ease of Using Library Systems (Source: Research data, 2016)

In terms of user-friendliness of the library systems currently used in the sampled university libraries, about 36% of the respondents described their library systems as very user-friendly while 45% of the respondents rated the same as averagely user-friendly. None of the respondents found their library system unfriendly. See Figures 4.12 and 4.13 below.

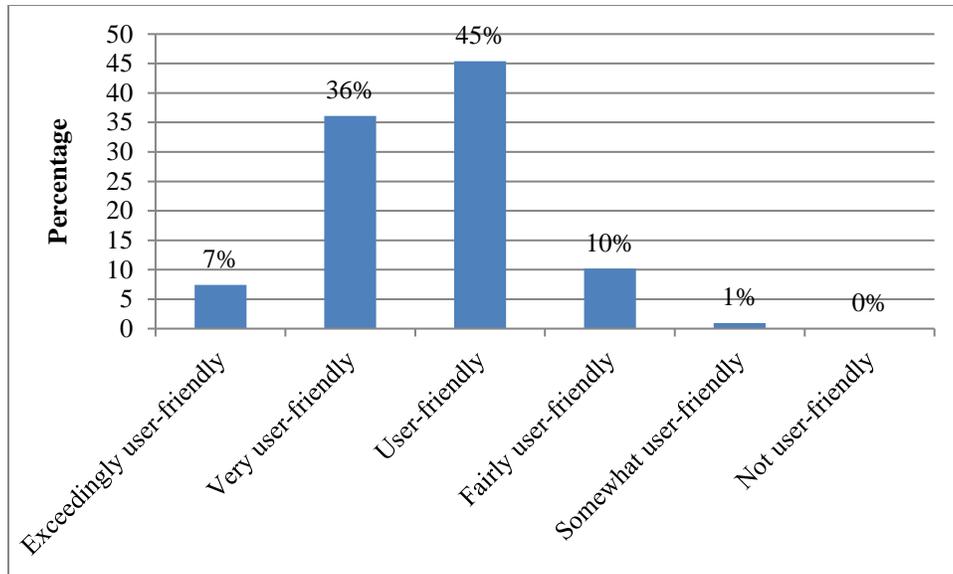


Figure 4.9: User-friendliness of the current library systems(Source: Research data, 2016)

4.3.4 Reliability of Open Source Software

Reliability of OSS was measured on the basis of the perceived prompt resolution of library systems breakdown. 69% of the library staff questioned acknowledged that breakdowns of their library systems were resolved promptly while 31% of the users indicated slackness in the resolution of their library systems' breakdown.

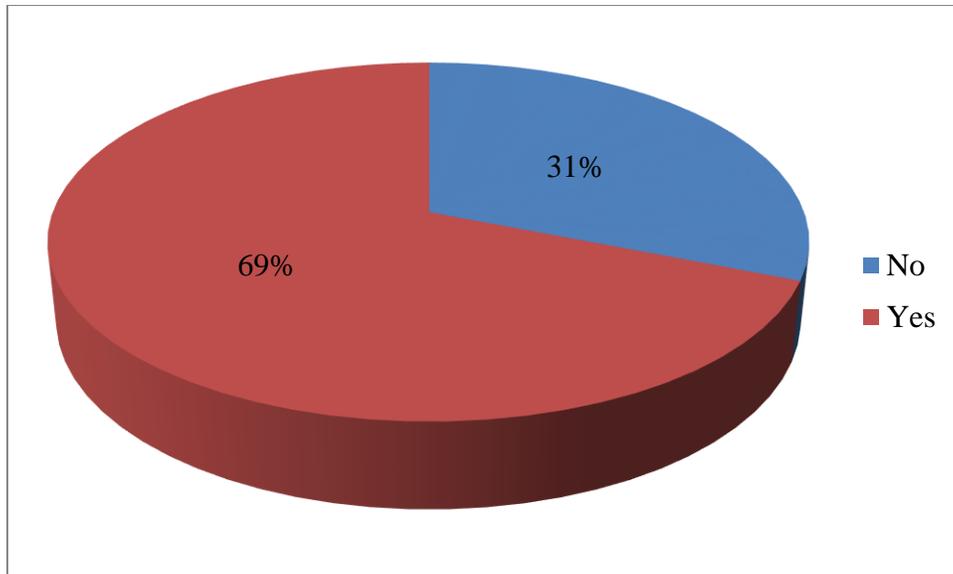


Figure 4.10: Reliability of current library management systems
(Source: Research data, 2016)

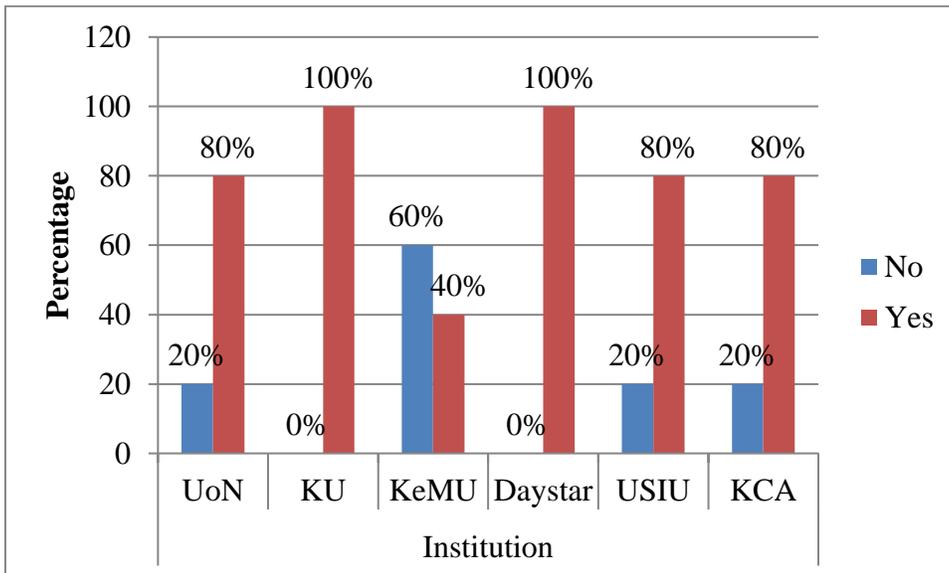


Figure 4.11: Reliability of current library management systems
(Source: Research data, 2016)

4.3.5 Scalability of Open Source Software

Two metrics were used to gauge the scalability of OSS. The first step was to investigate whether both library users and staff have experienced any change in the service delivery of their respective university libraries. Figure 4.15 below shows that 81% of the respondents have experienced change in the service delivery of their university libraries. The next step in the measure of OSSs' scalability involved examining whether there has been an increase in the volume of both print and electronic information materials provided or supported by the respective university library management systems. Figure 4.13 indicates that 52% of the respondents reported that there has been increase in the volume of library information materials that are supported by their respective library management systems

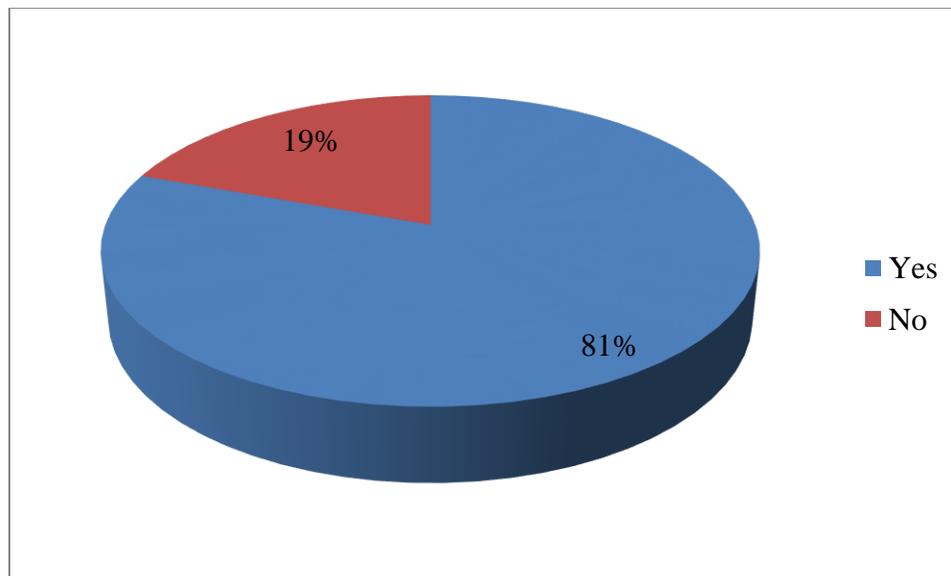


Figure 4.12: Change in Libraries' Services Delivery (Source: Research data, 2016)

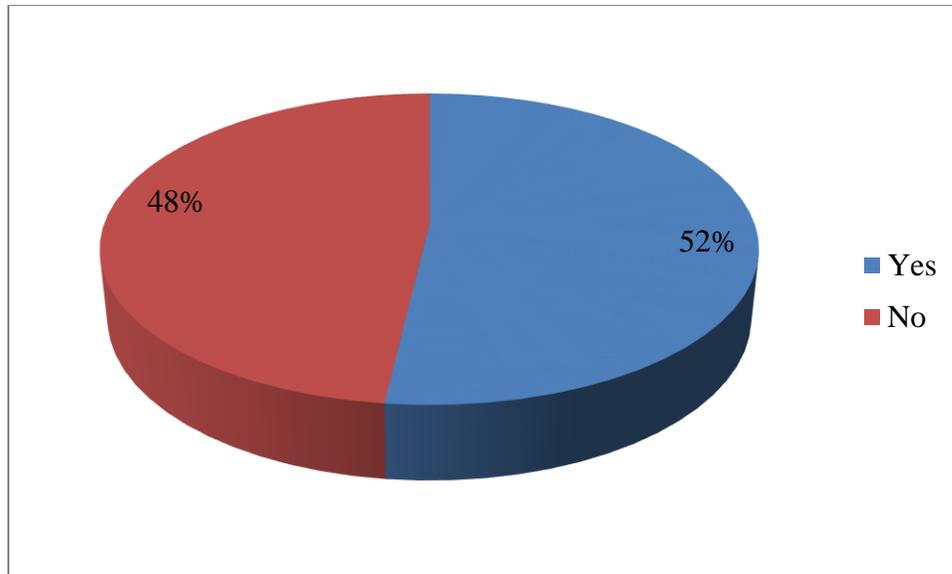


Figure 4.13: Increase in Information Materials (Source: Research data, 2016)

4.4 Level of Library user Satisfaction With their Library Services

To borrow from Larson and Acheaw's conclusion on library users' satisfaction, expressed satisfaction of library users is a good indicator of the extent to which university libraries are able to recognize and meet the informational needs of their users (Larson & Acheaw, 2012). The authors stressed that library staff have the sole responsibility of establishing the needs and expectations of the varying informational needs of their users. Just like in any service-providing institution, patron satisfaction is of great importance.

User Satisfaction			
User Institution	Mean	N	Std. Deviation
UoN	2.4167	13	.90034
KU	3.0000	18	1.02899
KeMU	2.6154	13	.76795
Daystar	2.6923	15	.75107

USIU	2.3750	18	1.00803
KCA	2.8000	18	.83351
Total	2.6296	95	.92315

Table 4.2: Level of user satisfaction (Source: Research data, 2016)

Users of USIU library indicated highest level of satisfaction with the services being offered by their university library while users of Kenyatta university library were the list satisfied with their library services according to their mean satisfaction level of 3. From the Ritchert scale that was provided level 3 indicated that users were just satisfied. However, it is important to note that all the university libraries investigated performed almost equally since the range between the one with the highest level of satisfaction and the lowest was 0.625. An average user satisfaction of 2.6296, shown in table 4.2 above, conforms with earlier findings as confirmed by Kumar (2008), Cullen (2001), Martensen&Gronholdt (2003) as reported by Larson and Acheaw' (2012). Figure 4.14 below is a graphical representation of library users' levels satisfaction as per their respective university libraries.

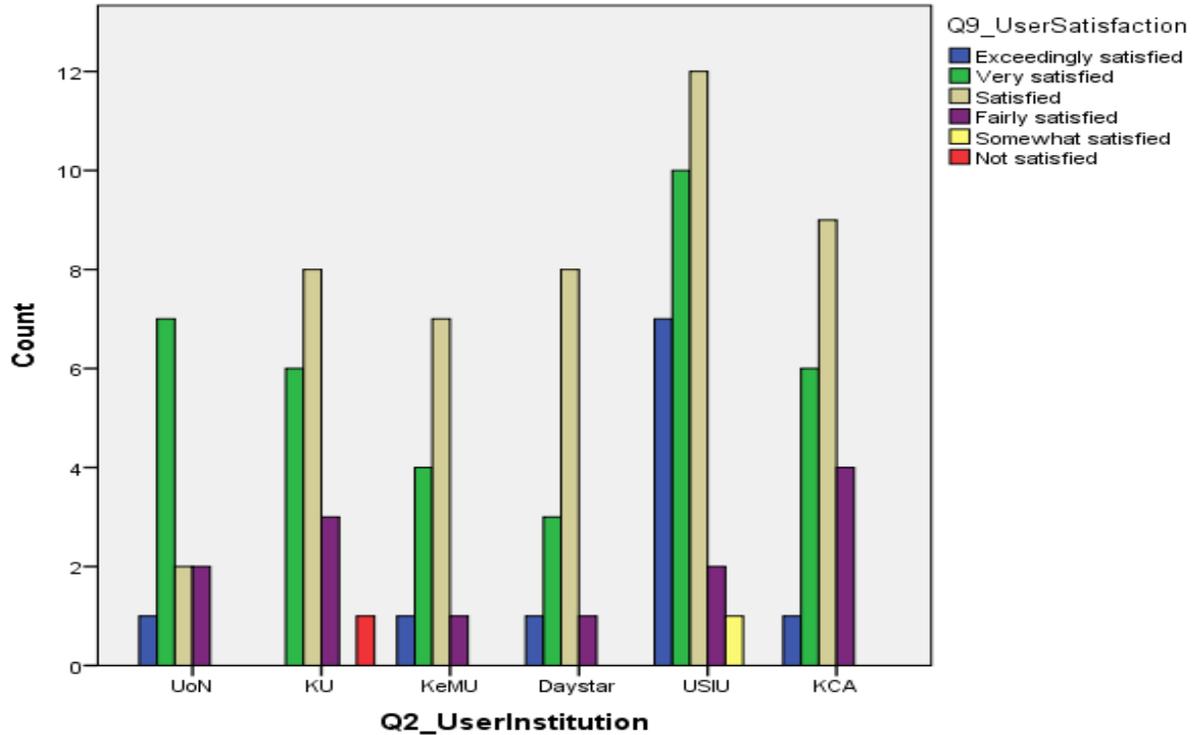


Figure 4.14: Users' level of satisfaction with current library services (Source: Research data, 2016)

4.5 Regression Analysis

Both library users and staff perceptions of OSS features were used to determine the contributions of OSS features on the performance of their respective university libraries. This section presents results of regression analyses that was done to establish relationship between composite indices of the four features of Open Source Software and Library Performance Index.

4.5.1 Regression Model

A strong relationship was established between the Library Performance index and the four features of Open Source Software. The strength of this relationship is indicated by 0.345 value of the adjusted R Square shown in Table 4.3 below. As indicated in the same table, exploratory or the predictor variables included Software Cost Index, Usability Index, Scalability Index, and the Reliability Index. Additional information on how these indices were computed are contained in the Inferential Data Analysis section (3.7.2) of this report.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.660 ^a	.435	.345	.81465	.435	4.812	4	25	.005
a. Predictors: (Constant), Cost Index, Usability Index, Scalability Index, Reliability Index									

Table 4.3: Model Summary (Source: Research data, 2016)

4.5.2 ANOVA

In order to establish whether the independent variables (features of Open Source Software) have real influence on the variation on the dependent variable (Performance of Kenyan University Libraries), an analysis of variation (ANOVA) was computed and the result presented in Table 4.4 below.

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	12.775	4	3.194	4.812	.005 ^b

	Residual	16.591	25	.664		
	Total	29.367	29			
a. Dependent Variable: Library Performance Index						
b. Predictors: (Constant), Cost Index, Usability Index, Scalability Index, Reliability Index						

Table 4.4: ANOVA (Source: Research data, 2016)

It is evident from the Table 4.4 that predictor variables (Cost, Usability, Scalability, and Reliability of OSS) have real effect on the dependent variable (Library Performance). The F-statistics with significance level of 0.005 falls within the recommended margin to reject the null hypothesis. According to Kimberlin and Winterstein (2008) a null hypothesis (H0: None of the explanatory variables explains variation in Y, dependent variable) should be rejected if the computed significance value is less than 0.05. As such, it is permissible to authoritative report that cost, usability, reliability, and scalability of OSS significantly predict performance of Kenyan university libraries.

4.5.3 Coefficients of Independent Variables

Regression analysis was done to establish the magnitude and the direction of the relationship between the dependent and independent variables. Table 4.5 below presents the findings of the regression analysis. Values in the Beta coefficient columns represents the magnitude and

directions of change that can be realized on the dependent variable due to a unit change in any of the independent variables.

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.534	.958		.557	.005
	Usability Index	.463	.117	.657	3.953	.001
	Reliability Index	.200	.233	.220	.859	.004
	Scalability Index	.029	.299	.022	.097	.009
	Cost Index	-.223	.248	-.178	-.219	.007

a. Dependent Variable: LibraryPerformanceIndex

Table 4.5: Coefficients of Independent Variables (Source: Research data, 2016)

By integrating the regression model (discussed in section 3.7.2) with the findings in Table 4.5 above, the relationship between the dependent and independent variables is summarized in the following equation;

$$Y = 0.534 + 0.657x_1 + 0.220x_2 + 0.022x_3 - 0.178x_4$$

Where; x_1 , x_2 , x_3 , and x_4 represent OSS's usability, reliability, scalability, and cost-effective indices.

The equation above summarizes library users' perceived contribution factors of OSS features on the performance of Kenyan university libraries. Four key inferences can be made from the above model. For instance, unit change in open source software's usability index is likely to cause a positive increase of 0.657 on the overall performance of a university library. Nichols, Thomson,

and Yeates' advocacy for improving satisfaction of open source software users by developing user-friendly interfaces concurs with this positive correlations between user-friendliness of library systems and their performance (Nichols, Thomson, &Yeates, 2003).Usability of open source software contributes to the overall performance of Kenyan university libraries in terms of their friendliness to the library users and ability to facilitate easier search and retrieval of library information materials (Rani &Chinnasamy, 2014).

A positive change on OSS's reliability indices is likely to increase performance of the libraries by a factor of 0.22. Similarly, an attempt to increase the scalability of library open source systems has a 0.022 incremental effects on the performance level of the library. Additional insights on OSS reliability reveals that faster delivery of library services and the speed at which breakdowns of library systems are resolved has positive relationships with the perceived performance of Kenyan university libraries (Tramboo, 2012). Cost index of OSS was measured in terms of the software's acquisition and maintenance costs. According to the study, cost of an Open Source Software relates negatively to the perceived performance of a university library. Hence, a unit increase in any cost components of an OSS is likely to cause a 0.219 decline on the library performance.

CHAPTER FIVE:SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study's findings, conclusions and recommendations in accordance with the previously mentioned research objectives in chapter three.

5.2 Summary of the Study

5.2.1 Background Information

The study established that all the sampled university libraries have used and are still using open source software to manage various library functions. Specifically, DSpace is used by all the six university libraries to manage their respective institutional repositories or digital libraries. Koha is another open source system that is used by half of the university libraries studied to manage major library functions such as circulation, cataloging, OPAC, and acquisition among others. Additionally, the study found out that these libraries use Linux operating systems and Linux servers to host both DSpace and Koha. In terms of open source software usage period, the study found that over 60% of the sampled libraries have been using OSS for a period of between 2 to 5 years.

5.2.2 Cost of OSS and performance of Kenyan university libraries

The study revealed a strong negative relationship between cost of software and performance of the Kenyan University Libraries. The slope coefficient of -0.219 of the software cost index indicates that a unit increase in the software cost component can cause a 0.219 decrease in the perceived performance of the library. However, the study also found out that open source software that are currently being used in the sampled libraries are cost effective. There are very minimal costs involved in the acquisition, installation, and maintenance of the open source

software. All of the sampled libraries have internal experts responsible for the management and maintenance of the library systems. The presence of internal ICT specialists reduces the training costs associated with open source software in the libraries.

5.2.3 OSS Usability and performance of Kenyan university libraries

Usability of Open Source Software was measured on the basis of the software's user-friendliness and the ease of navigation through the library system. A strong positive relationship was established between the usability index of OSS and library performance. A unit improvement on the usability of a software has a 0.657 incremental effects on library performance. It is worth noting that usability index had the greatest statistical significance compared to other three OSS features which were included in the study. The P-value of 0.001 is statistically significant.

5.2.4 Reliability of OSS and performance of Kenyan university libraries

Reliability index was used to measure the promptness in the resolution of system breakdown issues and sustained availability of the library services which are offered by the help of open source software. The study established a positive relationship of 0.22 between OSS reliability and performance of university libraries. It then follows that 1% improvement in the reliability of OSS will improve performance of a university library by 22 per cent.

5.2.5 OSS Scalability and performance of Kenyan university libraries

According to the findings of this study, scalability is not statistically significant as far as library users' perception of library performance is concerned. The study reports a positive relationship of 0.022 (2.2%) between scalability index of Open Source Software and performance of Kenyan University libraries. This implies that an attempt to increase software scalability by 1 unit should

yield 2.2% increase on the performance of the library. However, this incremental effect is not statistically guaranteed due to the variable's P-value of 0.09. The P-value is far beyond the recommended boundary of <0.05 .

5.3 Conclusion

Going by the findings of this study, it is important to conclude by pointing out that features embedded in any Open Source software play significant role in fostering performance of University libraries in Kenya. The cost-effective feature of Open Source Software as pointed out by Shaikh and Cornford (2011) has been confirmed in the study. All the system librarians interviewed disclosed costs associated with installation, maintenance and training on OSS are quite negligible.

In addition to their cost-effectiveness, Open Source Software which are currently being are fairly reliable. The sampled libraries hardly encountered system breakdown or security breach. The few hitches were promptly handled by system librarians in their respective universities. Scalability also an important feature of any software usable in a university library, whether the software is Open Source Software or propriety. University libraries are expected to grow in terms of quantity of their information resources as well as quality of their services. A suitable software is therefore expected to support their holistic growth.

Usability of the library system stands out as the most influential determinant of the library performance among the library users. As such, more concentrations should be focused on improving usability components of Open Source Software in order to realize optimum

performance from the library systems. Factors such as user-friendliness of the software interface and ease of navigating through the system should be prioritize as part of technological strategies to improve performance of University Libraries in Kenya.

5.4 Recommendations

In order to realize the maximum benefits of Open Source Software products that are currently available in the market, a number of adjustments should be considered by managers of Kenyan university libraries. First and foremost, university libraries in Kenya should consider strategic adoption of Open Source Software in key areas of their operations. The libraries should capitalize on OSS's cost-effectiveness as a strategic step in improving their financial health. Amollo (2013) observed that university libraries in Kenya are operating under tight budgets. A cut on the libraries' budget on technology by careful and planned adoption Open Source software will help alleviate the financial issues among university libraries in Kenya.

Secondly, managers of university libraries in Kenya should consider partnering with either internal or external software developers to continuously improve usability of their systems. Library users judge performance of their university libraries on the basis on the systems' usability. Navigation through the system should be made easy enough such that even the novice computer users should get their way around a library system.

Members of the library staff should be given regular technical training so as to keep them updated on new system developments. Such training sessions will facilitate prompt resolution of system failure issues thus improving the system's reliability. As observed by Chiware (2010), the

general inadequacy of technically skilled personnel to maintain library management systems should be addressed to avoid overdependence on few individuals.

Equally important is the need for regular information literacy training of all library user. The study's report on users' perception of library performance as it relates software scalability may be a pointer to the users' ignorance of library's information resources beyond the print materials. Additionally, the researcher discovered that majority of library users are yet to realize the full benefits of Open Source Software products within their libraries as they are untrained on the usage of the same. For instance, majority of undergraduate and postgraduate students still rely on the popular search engines like google and yahoo for most of their research activities. Majority of library users are incapable of navigating through their digital libraries without external help from professional librarians. This inadequate library user education deprives users of their autonomous search for knowledge and also leaves most of library materials underutilized.

5.5 Suggestions for further research

Since the sample used in this study was limited to university libraries within Nairobi metropolitan, there is need for a wider study on the impacts of open source software features on the performance of university libraries from various geographic regions. A geographically diverse study may unearth dynamic insights foreign to Nairobi metropolitan in which this study was based.

REFERENCES

- Alves, P., Reais, A., & Alves, E. (2012). Adopting an opensource Integrated Library Systems in academic Libraries : Experiences so far with Koha and RFID at Polytechnic Institute of Bragança, *1*, 3–4.
- Amollo, B. A. (2013). Feasibility of adaptation of open source ILS for libraries in Kenya : a practical evaluation. <http://doi.org/10.1108/EL-12-2011-0171>
- Bash, E. (2015). *Open source systems bring Web 2.0 to special libraries. PhD Proposal.* <http://doi.org/10.1017/CBO9781107415324.004>
- Chiwere, E. R. T. (2010). Positioning the technological university library in higher education and human resources development in Africa. *Library Management*, *31*(6), 391 – 403. <http://doi.org/10.1108/01435121011066153>
- Commission for Higher Education. (2012). *Standards and Guidelines for University Libraries in Kenya* (Revised ed). Nairobi.
- Das, S. (2008). Ranganathan 's Five Laws in the Light of ICT, 399–401.
- Delone, W. and Mclean, E. (2003). The DeLone and McLean Model of Information Systems Success : A Ten-Year Update. *Journal of Management Information Systems*, *19*(4), 9–30.
- Giri, R. NewGenLib 3: An Integrated Open Source Library Management System that Makes your Library Visible in Web (2012).
- Hoq, K. M. G. (2015). Rural library and information services, their success, failure and sustainability: a literature review. *Information Development*, *31*(3), 294–310. <http://doi.org/10.1177/0266666913515693>
- Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and reliability of measurement instruments used in research. *American Journal of Health-System Pharmacy*, *65*(23), 2276–2284. <http://doi.org/10.2146/ajhp070364>
- Kothari, C. (2008). *Research Methodology; Methods and Techniques*. New Delhi: New Age International Publishers.
- Kumar, T. K. G. (2014). Attitude of NEWGENLIB software users towards the adoption of open source. *International Journal of Digital Library Services*, *4*(4), 112–125.
- Lochhaas, S., & Moore, M. (2010). *Open Source Software Libraries*. University of Iowa.
- Macharia, P. M. (1994). *A comparative study of CDS/ISIS and INMAGIC in relation to manipulation of textual databases*. Kenyatta University.

- Ndakalu, O. A. (2014). *Access and utilization of digital information services in academic libraries: the case of University of Nairobi*. University of Nairobi.
- Nichols, D. M., Thomson, K., & Yeates, S. A. (2003). *Usability and open-source software development*. University of Waikato.
- Nicholson, S. (2004). Preprint of : Nicholson , S . (2004). A conceptual framework for the holistic measurement and cumulative evaluation of library services . A Conceptual Framework for the Holistic Measurement and Cumulative Evaluation of Library Services, *60*, 1–29.
- Odongo, M. (2012). Adoption of Open Source and Open Standards In Academic Libraries in Kenya. In *SCECSAL XXth Conference*. Nairobi.
- Palmer, A., & Choi, N. (2014). The current state of library open source software research. <http://doi.org/10.1108/LHT-05-2013-0056>
- Randhawa, S. (2008). Open Source Software and Libraries. In *Trends and Strategic Issues for Libraries in Global Information Society* (pp. 369–377). Chandigarh, India. Retrieved from http://eprints.rclis.org/bitstream/10760/13172/1/Open_Source_Software_and_Libraries.pdf
- Rani, S., & Chinnasamy, K. (2014). A Study on User s ’ Satisfaction of Electronic Resources and Services in the Self Financing Colleges Affiliated to Madurai Kamaraj University, *1*(6), 223–230.
- Raza, A., Capretz, L. F., & Ahmed, F. (2011). An Empirical Study of Open Source Software Usability. *International Journal of Open Source Software and Processes*, *3*(1), 1-16. doi:10.4018/jossp.2011010101
- Robinson, L. (2012). *Changeology: How to Enable Groups, Communities and Societies to Do Things They’ve Never Done Before*. Chicago: UIT Cambridge.
- Rogers, E. M., & Everett, M. (2003). *Diffusion of Innovation* (5th ed.). New York: The Free Press.
- Rossi, B., Russo, B., Succi, G., Rossi, B., Russo, B., & Succi, G. (2012). Adoption of free / libre open source software in public organizations : factors of impact. <http://doi.org/10.1108/09593841211232677>
- Samuels, R. G., & Griffy, H. (2012). Evaluating Open Source Software for Use in Library Initiatives: A Case Study Involving Electronic Publishing. *Portal: Libraries and the Academy*, *12*(1), 41–62.
- Sanaman, M. S. G. (2012). Open source integrated library management systems Comparative analysis of Koha and NewGenLib. *Electronic Library*, *30*(6), 809 – 832. <http://doi.org/10.1108/02640471211282127>

- Shaikh, M., & Cornford, T. (2011). Framing the Conundrum of Total Cost of Ownership of Open Source Software. *IFIP Advances in Information and Communication Technology Open Source Systems: Grounding Research*, 208-219. doi:10.1007/978-3-642-24418-6_14
- Thusoo, A., Shao, Z., Anthony, S., Borthakur, D., Jain, N., Sarma, J. S., . . . Liu, H. (2010). Data warehousing and analytics infrastructure at facebook. *Proceedings of the 2010 International Conference on Management of Data - SIGMOD '10*. doi:10.1145/1807167.1807278
- Tramboo, S. (2012). A Study on the Open Source Digital Library Software' s : Special Reference to DSpace ,EPrints and Greenstone, 59(16), 1-9.
- Ullah, N., & Morisio, M. (2013). An empirical analysis of open source software defects data through software reliability growth models. *Eurocon 2013*. doi:10.1109/eurocon.2013.662502
- Uzomba, E. C. (2015). The Use and Application of Open Source Integrated Library System in Academic Libraries in Nigeria : Koha Example.
- Wasike, J. M. (2015). Opening libraries to cloud computing : a Kenyan perspective. <http://doi.org/10.1108/LHTN-09-2014-0072>

APPENDICES

Appendix I: Letter to Respondents

Jared O. Otieno
Kenyatta University,
P.O BOX 410-90200
Kitui.

21st April, 2016.

Dear respondent.

**REF: CONTRIBUTIONS OF OPEN SOURCE SOFTWARE FEATURES ON
PERFORMANCE OF KENYAN UNIVERSITY LIBRARIES IN NAIROBI
METROPOLITAN, KENYA**

I'm an MBA student at Kenyatta University. Currently, I'm researching on the effects of Open Source Software usage on performance of Kenyan university libraries in Nairobi metropolitan. Therefore, I'm requesting for your kind assistance and cooperation in attaining the objectives of the study by filling-in the attached questionnaires.

You are hereby assured that the information you give will be treated with utmost confidentiality and that it will be used for this study only.

Yours faith fully

Jared Otieno.

Appendix II: Questionnaire to Library Users

The aim of this questionnaire is to establish the extent to which Open Source Software have been used in Kenyan University libraries and also to ascertain the overall impact of Open Source Software usage in the sampled libraries. The data that shall be gathered through this questionnaire will be helpful in evaluating the impact of OSS as well as suggesting the most appropriate way to maximize benefits of OSS usage in Kenyan University Libraries. Kindly respond as honestly as possible.

Section A: Personal Data

- 1. Please indicate your position; (Tick as appropriate): a) Student
b) Teaching staff c) Others (Specify);
- 2. Name of your Institution: a) UoN b) KU c) Kemu d) Daystar
e) USIU f) KCA g) Strathmore
- 3. Your highest academic qualifications (Tick where applicable)
 - 1 Post Graduate
 - 2 Undergraduate
 - 3 Diploma
 - 4.Others
(specify).....

Section B: Experience in OSS Usage

4. Indicate whether you have used any of the library services listed below;

- 1. Online library catalogue searching (OPAC)
- 2. Institutional repositories /Digital libraries
- 3. Electronic resources
- 4. Cataloguing
- 5. Others

.....

5. How long have you been using the University library's resources?

- 1) Less than 1 year'
- 2) Less than 2 years
- 3) Less than 5 years
- 4) Less than 10 years
- 5) More than 10 years

6. Have you experienced any change in service delivery or in operation of your university library?

- 1. Yes
- 2. No

7. If yes, what are the changes you have experienced in service delivery or in operation of your university library?

- 1) Increased availability of information materials
- 2) Faster service delivery by the library staff
- 3) Rich and more information materials relevant to your needs
- 4) Easier search and retrieval of online information resources
- 5) Others (Specify)

.....
.....

8. On a scale of 1- 6 rate the user-friendliness (attractive and easier to navigate) of your university's digital library. (Tick as appropriate)

- 1. Exceedingly user-friendly
- 2. Very user-friendly
- 3. User-friendly
- 4. Fairly user-friendly
- 5. Somewhat user-friendly
- 6. Not user-friendly

9. On a scale of 1- 6 rate your level of satisfaction with the current library services offered in your university's library. (Tick as appropriate)

- 1. Exceedingly satisfied
- 2. Very satisfied
- 3. Satisfied
- 4. Fairly satisfied
- 5. Somewhat satisfied
- 6. Not satisfied

SECTION C: Personal Opinion on Library services

10. You are satisfied with the current library services because; (You can have more than one reason)

- 1. Online library system is easy to use
- 2. Information materials are easy to access.
- 3. You always get quality information from the library.
- 4. System problems have been resolved promptly.
- 5. The system is flexible and fits your informational needs.
- 6. Others:

.....

11. You are not satisfied with the current library services because; (You can have more than one reason.)

- 1. Online library system is not friendly to you.
- 2. Information materials are difficult to access through the system.
- 3. You hardly get relevant information to your need.
- 4. Others:

(Specify).....

12. Do you wish the library would change any of the software currently in use?

- 1. Yes (Please answer question 13)
- 2. No (Please answer question no. 14)

13. Please give reason(s) why you wish for the change.

.....

14. Please give reason(s) why you do not wish for the change.

.....

Thank you very much for your time!!!!

6. Indicate whether you have used any of the library services listed below;

- 1. Online library catalogue searching (OPAC)
- 2. Institutional repositories /Digital libraries
- 3. Electronic resources
- 4. Cataloguing
- 5. Serials management
- 6. Acquisitions
- 7. Circulation
- 8. Others

(Specify);.....

7. How long have you been using OSS products?

- 1. Less than 1 year'
- 2. Less than 2 years
- 3. Less than 5 years
- 4. Less than 10 years
- 5. More than 10 years

8. Have you experienced any change in service delivery or in operation of your university library?

- 1. Yes
- 2. No

9. If yes, what are the changes you have experienced in service delivery or in operation of your university library?

- 1. Increased availability of information materials
- 2. Faster service delivery by the library staff
- 3. Rich and more information materials relevant to your needs
- 4. Easier search and retrieval of online information resources

5. Others (Specify)

.....
.....

Section C: Opinion on OSS

10. On a scale of 1- 6 rate the user-friendliness (attractive and easier to navigate) of your university's digital library. (Tick as appropriate)

- 1. Exceedingly user-friendly
- 2. Very user-friendly
- 3. User-friendly
- 4. Fairly user-friendly
- 5. Somewhat user-friendly
- 6. Not user-friendly

11. On a scale of 1- 6 rate your level of satisfaction the current library services offered in your university's library. (Tick as appropriate)

- 1. Exceedingly satisfied
- 2. Very satisfied
- 3. Satisfied
- 4. Fairly satisfied
- 5. Somewhat satisfied
- 6. Not satisfied

12. You are satisfied with the current integrated library system for the following reason(s). (You can have more than one reason)

- 1. Easy to use
- 2. Annual maintenance is not costly and affordable.
- 3. No additional charge when the library needs to upgrade to newer version of the software.
- 4. System problems are resolved promptly.

5. The system is flexible and additional functions can be added as required by the library.

6. Others

(Specify);.....

13. You are not satisfied with the integrated library system currently used for the following reason(s). (You can have more than one reason.)

1. Annual maintenance is costly.

2. Additional charges are incurred when upgrading to a new version of the system.

3. System problems have not been dealt with promptly by the software company.

4. The integrated library system is not flexible (e.g. Additional functions cannot be added as required by the library).

5. Others:

(Specify).....

14. Do you wish the library would change any of the Open source software currently in use?

3. Yes (Please answer question 15)

4. No (Please answer question 16)

15. Please give reason(s) why you wish for the change.

.....

16. Please give reason(s) why you do not wish for the change.

.....

Thank you very much for your time!!!!

Appendix IV: Research Approval Letter



Appendix V: Research authorization permit

