



**GRADUATE STUDIES  
FACULTY OF INFORMATICS  
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# **The Practice of Opting for Open Source Solutions in Higher Education Institutions of Ethiopia**

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**The Practice of Opting for Open Source  
Solutions in Higher Education Institutions of  
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## DECLARATION

I hereby declare that this thesis is my original work and has not been submitted for any other degree before.

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Florida Alemayehu

June, 2010

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## **Acronyms**

ICT- Information Communication Technology

IT – Information Technology

OSS – Open Source Software

FOSS – Free and Open Source Software

tOSSad - towards Open Source Software adoption and dissemination

GPL - General Public License

MOE – Ministry of Education

GNOME- GNU Network Object Model Environment

KDE – K- Desktop Environment

NGO – Non Governmental Institution

UN – United Nations

UNDP – United Nations Development Program

MIT - Massachusetts Institute of Technology

VLE – Virtual Learning Environment

CMS – Content management System

LDAP – Light weight Directory Access Protocol

LAMP – Linux Apache MySQL & PHP

CIO – Chief Information Officer

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## **Abstract**

Open source software is gaining favor as an affordable ICT alternative in bridging the digital divide, enhancing universal access to information, facilitating technology diffusion and fostering local innovation in many developing countries. In Ethiopia, higher education institutions are one of the major consumers of ICT like in any other developing nation. However, given the fact that higher education institutions have limited resources and budgets and on the other hand with their increasing demand for technology, the need for these institutes to consider the open source alternative to balance the situation is very apparent. Yet, no researches had provided empirical analysis on the current status of open source software in higher education institutions of the country. The aim of this research was to reveal the current status of higher education institutes of Ethiopia towards open source adoption, to investigate the motivations behind the acceptance and rejection of OSS in these institutions and to forward contextual solutions and recommendations.

The survey for this research was conducted in March 2010 on six selected Universities in Ethiopia. The survey was complimented with qualitative interviews and observed data in addition to a self administered questionnaire to ensure the depth and quality of data. A total of 26 ICT officials (ICT directors, Policy makers, ICT budget administrators, software developers, technical staffs, trainers and those that have close relation with software procurement and deployment) in the six Universities were contacted for this purpose.

No ICT policy at work is found in any of the institutions, nevertheless, 50 % of them indicted they have draft policies to be approved which mentioned OSS. The attitude and awareness of OSS among ICT officials of higher education institutions of Ethiopia have been found positive in this research, however, awareness among the rest of the community is very low. On an individual scale a few selected ICT officials have an extensive awareness while the majorities have basic awareness in most of the institutions.

The server level practice of opting for open source solutions had been found very high in higher education institutions of Ethiopia. More than 90 % of server level applications are open source in 83 % of the institutions. However, desktop level open source software deployment is at a very

infant stage in one of the institutions and almost none in the rest. Results indicate the most prominent reasons for using open source software at the server are saving on total cost of ownership, better security from viruses and localizability and customizability. The main challenge in the use of OSS at the server according to this study is lack of expertise. Major barriers towards the adoption of open source software at the desktop found out by this research are the wide spread usage of pirated software, lack of awareness, resistance to change and training needs.

The results of this study highly indicated the necessity for a coordinated effort between government and higher education institutions for a better utilization of open source software through policy consideration, awareness creation, skills development and trainings, advocacy, open standards development, including OSS in student curriculum and creating appropriate environment for research and development in the area.

# 1. Introduction

## 1.1 Background to the study

As the advancement in the world of information technology and the internet escalates society has become more and more dependent on it for day to day activities, business transactions and communications. Computer technology led by the software industry has brought a huge change in the economies and life standards of countries that rely on it. Computers, mainly referring to the hardware in this sense, need software to manipulate data. Software is a set of instructions that tells a computerized hardware what to do for the achievement of a specific task. Due to the fast growth, high acceptance and adoption of computers by society during the last half of a century, the need for this core programs as well as the development in the area accelerated dramatically. The software industry is now one of the very huge economic powers in the world. Proprietary software package vendors like Microsoft and IBM collect billions of money out of revenue that comes from software sales per year. However, these business autonomy and monopoly is on the verge of change due to the rise of a new exceedingly competitive open source software development groups that give it away for free.

The origin of this software development paradigm dates back even before the emergence of proprietary software. The very beginning of open source software development is closely linked to UNIX operating system, developed by the AT&T researchers, which use to reveal its source code in the beginning and later became closed. The history of pure open source movement was begun by a guy named Richard Stallman who released the GNU and its utilities for free. The major event happened in 1991 when a young university student Linux Torvalds wrote his own operating system based on the idea he got from an older version operating system MINIX. He then released the source code for this operating system on the internet for anyone to use, change or upgrade it for free. This action of a young researcher opened the new era for software development by becoming a reason for the emergence of a whole new community of programmers, users and

implementers located all over the world that advocate, contribute and distribute this software all over the world called the open source community [2][3].

Open source software is software of which the code i.e. the computer instruction, steps, procedures and techniques applied to come up with it, is freely available along with the executable product. The term open refers to the disclosure of the how to of the product unlike the closeness of proprietary software vendors which only provide the end product and keep secret the code with them. The free tag that always comes with the name open source is not mainly about price it is meant to signify the freedom given, for those who want to and are capable of, to do any possible improvement with it. The very binding distinguishable characteristics of open source software from proprietary software lie on the deal anyone who has these software products has the automatic license to change, customize, upgrade, redistribute or even sell their own version as long as they acknowledge the source [3]. The most well known open source products that are widely being used include the Linux operating system, the Apache web server and the Mozilla Fire fox browser. Big name applications like Perl programming language and the GNOME desktop environment are also products of the open source community.

The adoptability of open source solutions has been growing continuously starting from its first appearance as a fully usable product. Many countries in the world including those who are developed and those who are on their way to development have considered the open source alternative very well. Countries like France, Spain and Germany in the developed world have already finished all the necessary preparation to implement open source solutions country wide and also countries like South Africa followed by Kenya, Namibia and Nigeria and to some extent Zambia are considering it from Africa. China, India, Japan and South Korea are taking the lead in initiating open source solutions in Asia while Brazil, Argentina and Colombia are among the front runners in Latin America [5][6]. Same trend follows in USA also; according to a recent research on North American higher education institutions usage of open source software it is found that 57% of the countries higher education institutions have replaced proprietary software by open source software [7]. At a research [8] held in 2006 on UK's higher education and

further education institution's attitudes and policies towards open source solutions by Oxford University, it was found 77% of them consider OSS when procuring software while 25% mentioned it as a policy.

Open source solution is attracting too many users from the developing world mainly because of the economic advantage it offers. The absence of costs associated with supplementary licenses in having open source products is the key reason for its reduced total cost of ownership. In addition to this the ability of open source software to run on older hardware platforms and less power full computers unlike proprietary software makes it less costly and advantageous for developing countries. Open source software offers an affordable financial alternative especially for poorer countries like Ethiopia if implemented correctly. It also gives an opportunity for innovation through customization and localization of the deferent products to meet inside demands even to the extent of having an indigenous software industry [9][11].

Higher education institutions with their increasing demand for information technology and as a nonprofit making sector, especially those which belong to the government, have to devise ways of cutting costs of having IT infrastructure while keeping this fascinating technology as a major way to excellence. There is a very promising possibility that these institutes can save a huge amount of money by using open source solutions [9][11][12]. By adopting open source software for academic computing, higher education institutions can also prepare their students for a rapidly changing technological world. In addition one of the major goals of a higher education institute in one country especially in a developing one is to harness the culture of innovation in its students mind set and ways of approaching life [12][13]. Teaching students to use open source solutions to tackle their computational issues will allow them to seek and foresee for further innovation, customization and independence due to the openness of the product inviting for improvement. Furthermore, higher education institutions have to foster the culture of free dissemination and reuse of knowledge by advocating the use of open source solutions for academic purpose.

It is the researcher's strong belief that higher education institutions always serve as a place where a country's future is reflected upon. Changes in these institutions will affect the society tremendously. This is because students who will graduate from these institutions will take the culture they have grasped from it and cultivate it within the society. Thus, targeting higher education institutions for this kind of change is targeting a country indirectly. The aim of this research is to identify the pros and cons of opting for this software product in higher education information systems, to assess the current state, policies and actions of the country's major higher education institutions regarding this issue, to investigate the factors, limitations and shortcomings that are influencing its usage and to recommend directions concerning future implementation.

## 1.2 Statement of the problem

From what we have learned in the study background, the need for open source solutions is not questionable. As a matter of fact it is not even an option for a poor country like Ethiopia. Fostering the culture of using open source solutions in a developing country like Ethiopia is very crucial to gain competitive advantage in a knowledge based economy of our age. However, even if many agree on the necessity of open source solutions for poor countries' fast development in the ICT arena, bringing the change everyone anticipated for is not an easy task. One has to wisely plan and target those sectors that will give it better results in a short period of time. The researcher believes higher education institutions are one of those sectors to start from. On the other hand, though the importance of these software packages for fast and economical ICT development and the susceptibility of higher education institutions for its achievement is very plain, surprisingly enough the attention given to it is very low. There hasn't been much actions and researches that focus on these sectors for the adoption of open source software in Ethiopia. Conducting this research will help identify the level of adoption, awareness and implementation of open source solutions in higher education information systems and the reasons behind its adoption rate. Major factors for its current position and the very sound reasons for implementing open source solutions will be discussed.

Generally, present state and future plans of using open source solutions in higher education institutions of Ethiopia, the obstacles they are facing along with the significance of going after it will be thoroughly conversed in this research. This will give a detailed picture of the problem at hand which in turn helps to come up with a solution easily. As to the researchers knowledge there hasn't been any research that was made on the experience, problems and current state of open source implementations in higher education institutions of Ethiopia. For that reason it is the researcher's strong conviction that this research will contribute a lot as a source of vital knowledge on the topic under study.

### 1.3 Significance of the Study

Knowing the current state of higher education institutions concerning this major phenomenon will help identify the distance that has been gone towards it yet and the limitations and factors that are lagging the pace of change. Finding out the answers for these two questions lays a foundation to determine what future actions and initiatives should be made by those who are responsible for its expansion and adoption. Furthermore the level of awareness and attitude towards using these software can be discovered and measures can be taken to improve the general know how. As it is generally believed knowing the cause of a problem is going half way to its solution. Discerning the attitudes, current status and the causes behind the present trend is worth investigation because it is the very critical and initial step to get to the point of total control over the issue.

The beneficiaries of this research can be categorized into two groups the first group is the universities themselves that will obtain information on what they need to know about their ICT alternatives, what open source software can provide them for free, their current stand in adopting open source solutions, where their problems lie concerning the issue, how they can overcome their problems and their future. The second beneficiary group consists of ICT Policy makers, ICT officials, researchers, IT professionals, the African Union for the achievement of its development goal in ICT, and those who are responsible

for paving ways in the realization of Ethiopia's fast ICT development goal. This group of the beneficiaries will find this research very useful and source of reliable and insightful information to come to terms with the issue easily and to make future decision concerning the migration from proprietary software to open source software.

## 1.4 Research questions

What is the current attitude, awareness and practice of using open source software in Ethiopian higher education institutions?

What are the reasons for using and excluding open source software in these institutions?

## 1.5 Objectives

### 1.5.1 General objective

The general objective of this research is to reveal the current status of higher education institutes of Ethiopia towards open source adoption, to investigate the motivations behind the acceptance and rejection of OSS and to forward contextual solutions and recommendations.

### 1.5.2 Specific objectives

The specific objectives of the study includes

- To assess awareness and attitude towards open source software among ICT staffs and community within each university

- To find out to what extent open source software is used on servers, desktops and academic information system of the Universities
- To identify the driving forces for using open source software if they do
- To identify the main reasons for excluding open source software in these institutes whenever they do
- To identify obstacles that are blocking or are believed to be for full utilization of open source solutions
- To recommend future directions based on results

## 1.6 Methodology

### 1.6.1 Research strategy

The main research strategy selected for this study is descriptive survey which is useful mostly when a research objective includes the opinions, attitude and practice of few selected respondents. Both quantitative survey and a qualitative interview are implemented as a main means to collect data for this research to ensure the depth and width of information. Observational analysis is also included whenever necessary.

### 1.6.2 Population

The source population for this study includes all government and private owned universities. The individuals who were contacted for data collection at each institute are those people responsible for software procurement/purchasing, developing institutional ICT policies, overseeing implementation of ICT policies, developing/administering institutional ICT budgets, designing/approving software licensing agreements, approving software development in house, and developing ICT training. Technical staffs that are involved in software development and administration like web design, ICT teaching,

training, network administration, system administration, database administration and those that give technical support are also included.

### 1.6.3 Sampling

A sample is a finite part of a statistical population whose properties are studied to gain information about the whole (Webster, 1985). Even though there are more than twenty universities and colleges that belong to the government and too many that are privately owned in Ethiopia, due to budget and time limitations the researcher is obliged to use purposive sampling to select those universities that will give it the most useful information for the purpose of the survey. The scope of the research is to cover only universities. University Colleges, Colleges and technical schools are not included in this research.

A total of six universities both from government and the private sector are selected for this research based on the information richness and easy accessibility. Addis Ababa University, Bahirdar University, Mekelle University, Adama University and Hawassa University are picked from those that are owned by the Ministry of Education (MoE). From the private sector only Unity University is chosen. The reason why only Unity University is selected from the private sector is because there are no other privately owned educational institutions in the country at a university level. Most of them are at University College and college level which are beyond the scope of this research. Respondents from each university were picked based on their responsibilities in their respective institution. Responsibilities must much one or more of the responsibilities listed in section 3.2.2.

### 1.6.4 Data collection instruments

In order to increase the reliability and validity of the data collected for this research, the questionnaire for this research is adopted from a similar research held in UK which is made available online by the FLOSS World project of the University of Maastricht.

The questionnaire is well designed, clear and applicable. The questions are carefully designed to indicate only institutional attitude. The questions are well put not to lead the respondent to any pre supposed answer. Respondents are also given free spaces in cases there are no exhaustive choices for a specific question. Though most of the questions are adopted from the original source, some modifications and contextualization are made in order to meet local context. It was the main instrument to collect data for this study.

As to content, it has thirty questions that are organized into four major parts. The first part of the questionnaire has questions related to the personal information of the respondent which will be used for categorical analysis. The second part of the questionnaire is composed of questions that are needed to find out the current status, future plan, awareness and policy consideration of each institute regarding open source software. The third part of the questionnaire has questions which asses the level of adoption of open source software at the server level of each institute. These questions find out the extent of usage of open source software on servers, the kind of server operating system they deployed, the kind of mail, web and database software they deployed, if there is any kind of virtual learning environment and educational software they have implemented and the their reasons for choosing or avoiding open source software. The fourth and the last part of the questionnaire consists of questions that collect data about the deployment of open source software on desktops, the extent of usage and the reasons to opt or not to opt for open source solutions.

Interviews are held only with the highest ICT officials of each institute except for one institution that does not have such a position in its organizational structure. In general in this research five ICT directors representing the five governmental institutions sampled for this research were interviewed. The overall theme of the interview questions is on their policies and software preferences for their organization. The main aim of the interview questions was to identify the attitude of high level ICT management towards open source software, their current stand and what they plan for the future of their organizational software need. Seven main questions were presented for interviewees. These questions cover whether or not they currently posses institutional ICT policy,

whether this policy or draft policy specifies any software acquisition procedure or preference if there is one, if open source software is mentioned in any way in the software acquisition procedures, to what extent and for what purpose are they being used, what the motivation is behind open source software acquisition and what challenges are there in doing so and finally what they plan for the future.

### 1.6.5 Quality of data

The questionnaire for this research is well designed and tested. Because it was already used for another research and gave a good result, there was no need for the researcher to make a pilot test before use. There are no vague, biasing or out of place questions in the questionnaire. However, it was necessary for the respondents to have a good English language skill to understand the questions well and respond appropriately. The researcher tried to make sure the respondents get the questions. This was not a problem though, since the source population for this study is comprised of well educated higher education staffs who understand English language very well.

## 2. Literature Review

### 2.1 Introduction

In this chapter literatures assessing the OSS origin, ideology, advantages and disadvantages over proprietary rivals, global acceptance, it's relation and impact on higher education information system and teaching learning process, proposed policy frameworks, determinants and barriers of adoption will be reviewed in relation to the research questions presented in this study.

### 2.2 History of Open source software

The history of Open source software can be divided into three different periods of time. The first period is during the 1960's in which IBM released the first free modifiable source coded software with the first large scale commercial computers before even the emergence of proprietary software [14]. Soon after, the trend of releasing both the hardware and the software by the same company has stopped and software sell became an independent industry while the hardware is manufactured by another company during the mid 1970's.

The unbundling of the software from the hardware is one of the major reasons for the emergence of proprietary software with a commercial intent [14]. This incident brought the open source software development to its second period of development. During this second period, the 1970's and 80's, even though it was a point in time where the commercial software industry has started to become a common source of software needs, there were major events that lay the grass root for the open source movement at present.

In the late 1970's and 1980's the American programmer Richard Stallman working in the Artificial intelligence Laboratory at MIT, motivated by his disappointment trying to get the source code of a laser printer from Xerox in order to fix the jamming problem it had,

founded the first free software initiative and the GNU project to produce operating systems with freely available source code and the general public license (GPL) that makes sure these software stays free. Richard Stallman has written most of the tools necessary for a full operating system like the compiler and editor by the end of the 1980's but the kernel which is the core of the operating system that handles the switching of processes and the management of resources was not written by this time. On the other hand the Californian Berkley university computer scientists were also developing the BSD Unix free software based on the UNIX basics.

However, the third and the remarkable period in the history of the open source software began in 1991 when a Finish student Linus Travolds came up with the first version of the Linux Kernel that later became a GNU/Linux operating system under the GPL license. A number of open source products have become available after this incident. The GNOME and KDE that gave the user friendly graphical interface to the open source operating system have contributed a lot to the acceptance of the open source software by the majority of users. The growth in quality has also increased immensely to the point of becoming a competitive alternative to the proprietary software products at the end of the 1990's.

### 2.3 Open standards and open content

Open standards, open source software and open content are issues of the same philosophy but of different interpretation and implementation. A standard in a technical context is a specification that is generally accepted and used by a specific industry [15][16]. It also has to be approved by a recognized organization. According to the openstandards.net open standards are those standards that allow full access to public use without constraints, in which components or extensions have no dependencies on formats or protocols that do not meet the open standards definition, which are managed and developed by a body independent from any kind of vendor and must be equally available to all competing vendors. From among the very well known open standards that are being used widely, the TCP/IP internet protocol, the Unicode coding standard and the HTML (Hyper Text

Markup Language) are to mention [17]. The most sensitive areas in the ICT arena that are demanding for an open standard right now are file formats and office applications. The need for open standards is mainly to increase interoperability among different products, to ensure quality and to avoid vendor lock in. Moreover, open standards will allow healthy competition among different vendors and offer the mass various alternatives avoiding monopoly. Open standards have contributed to the wide spread usage of open source software on the Internet.

Different causes are raised to further assert the significance of open standards. To employ open standards in ones company will protect it from loosing data created by an application that is to be obsolete [17]. Another benefit of using open standards is it lets the user to have multiple choices to use even to the extent of mixing products of different vendors to get the best out of all. In addition, open standards can make it easy to port one application to the other and to migrate data files very easily in case of a need for a distinct information system. Open standards have as well been considered at a national level especially on e-government initiatives of many countries like France, Brazil and United Kingdom.

On the other hand open content is an initiative to make freely available any kind of human creation like art works, pictures, audio, video etc for everyone interested. It follows the same philosophy and licensing as the open source software in that anyone who has this resources have the right to reuse, change or redistribute the content. The perceived usefulness of open content are improved access to information, quality of content resulted from collaborative work and peer review and improved management of content [34]. The most famous open content practices are the Wiki and blogs. Wikipedia is an online user generated encyclopedia that allows users to contribute, use and edit its content.

## 2.4 Proprietary software VS open source software

There have been various researches, debates and discussions on the pros and cons of both proprietary and open source software. One of the highly mentioned differences between open source software and proprietary software lays on the Openness of source code. Proprietary software products come to the user in binary forms without the source code. Some argue it cannot even be called software sell since it is more of letting the user use the software by selling the licenses [18]. The user does not own anything. Contrary to the commercial software business model, open source software lets the user not only to own the source code but also the right to change, update and redistribute as long as they acknowledged the source. As a result, Open source community based software development have been praised for its successful handling of healthy competition among different derivatives of the Linux kernel through the right provided to begin with what others have already done. This has been witnessed in the success of Fedora and Mandrake Linux which are derivatives of Red Hat Linux.

The other major concern that captures the attention in the battle between these two software providers is the matter of total cost of ownership. The total cost of ownership refers to the overall cost incurred in having one software product. It includes the cost of training personnel, of having associated inputs and the money needed to support and install the software in addition to the cost of having the software itself. Open source software has been the primary preference in this regard, as the proprietary software license charges are very high while there is almost zero cost of having open source software. But this is not to mean there is no cost at all in possessing open source software, most of the open source software vendors collect payments for distribution and support to keep the initiative sustained. Yet, open source software development is criticized for not allowing intellectual property rights to be kept for the creators of the software. Some even argue this will put a shadow to the sustainability of the software development paradigm [18].

Due to the hefty number of volunteer programmers from different background and expertise that are involved in bug fixing in open source software development, the time needed to find out bugs is very fast [19]. Contrary to this, programmers that are involved in writing programs for proprietary software vendors are limited in number because they are paid workers as full time employees. This confines their ability to find all of the bugs in a short period of time which resulted in some technical bugs of proprietary software found after the products are distributed to the market. A study on defect ratio of proprietary software versus a counter open source product shows six times as much defect in commercial software [20]. A Software quality study in terms of the number of crashes found out three to seven more crashes and hangs in commercial software than a similar open source product [21].

Security of software from hackers and virus writers is as well among the topics discussed in addressing the drawbacks and advantages of these two software development models. One way of tackling security intruders is to make sure there are no security flaws while writing a program prior to distribution. Open source software development again because of the number of people involved in writing and debugging the software, has a very high probability of avoiding these flaws without trouble than a proprietary software product. Furthermore, though hiding the source code of proprietary software was meant to secure it by the producers; in practice it seems to aggravate the curiosity of virus writers and hackers to set their full attention in attacking these products specifically [19][22].

Availability for a wider range of processor architecture and hardware refresh period are as well drawing much attention as crucial criteria in measuring the payback a given software product has in the long run. Open source products are available for much wider hardware architectures than proprietary software and the hardware refresh period time for Linux based systems is believed to be 6-8 years while it is 3-4 years for Windows based system [19].

Lack of ongoing reliable support and services have been raised as stumbling blocks to the adoption of open source software by a lot of companies as well as governmental

institutions [22]. Unlike proprietary software providers in using open source products there is no responsible personality or a company to sue in case of failure, rather there is whole other community that contributes and owns the product.

It is generally believed that community based software development helps to meet the needs of the customer much better than any other business model. This is because open source software development allows developers being sensitive to the demands of the customer. In addition community based software development speeds up technological advancement. The reason for this is given the cumulative IQ of the thousands of developers all over the world the time needed to research and development will be very small. This in turn speeds up the delivery of a quality product to the market [23].

## 2.5 Worldwide response to open source software

The open source software recognition as a basis and preferred infrastructure for the Internet is a topic that has been asserted by many on the state of the art. This is due to the highly powerful networking capabilities integrated in most of the products. The number one choice for web servers around the world is found to be Apache web server, which covers 67% of the internet web server needs in the world. It is also believed more than half of the server platforms in the world are Linux based. Mozilla FireFox a browser known for introducing tab browsing has been controlling the market for years. The most powerful tools to write web based applications like Perl, PHP and Python are the gifts of the open source community to the programming world [3].

The usage of open source software as a preferred option in internet technology slowly grew its territory to independent enterprise information systems mainly because of the search for a less costly product and the growth in the quality of the open source systems. Many small, medium and large sized companies are studying the economical feasibility of using open source software [24].

Numerous surveys and studies have been made on nation as well as continent wide adoption and policy consideration of open source software as a preferred option [25]. The European Union recently ratified an open standards policy for all its member European countries to follow, which laid a foundation for a wider acceptance of open source software in most of the European countries.

France is one of the countries in Europe that are taking giant steps towards FOSS dissemination and adoption. Through its policies and high profile projects the French government is advocating open source software deployment mainly in government and education [26][27]. Most of the technical universities in the country have embraced open source solutions as favored option. In addition the countries' national police, the French Gendarmerie nationale, the countries' parliament, and the countries grand telecommunication company, France telecom, fully migrated to open source products at a desktop level. The French government also encourages open source software development in the country by alleviating tax burdens [26].

Germany is among the leading countries in the world in adopting open source products by giving official government support [28]. The German federal government motivation for moving to open source software is the need for an increase in security in data processing and data communication. Several governmental and private institutions in Germany make use of open source software. The migration to Linux desktop in Munich was a success story in 2004. The same action was repeated by the city of Mannheim [29]. Germany also takes the lead by having the top number of users of open office [30]. Next to Germany and France the United Kingdom, Italy, Belgium, Sweden and Spain are to mention in taking nationwide response to the open source adoption in Europe [6][25].

Countries like China, India, South Korea, Japan and Israel have been reported making policy preferences for OSS adoption in their policies. Latin countries like Peru, Mexico, Argentina and Brazil, are also assessing the open source alternative very closely [6][31]. A collaborative open source initiative among the most prominent countries in Asia (China, South Korea and Japan) was announced in 2003 [31].

China enforced open source software usage whenever feasible in the governmental ministry offices of the country. The government of china also backs up internal open source projects within the country. Red Flag Linux is the most famous Chinese version Linux developed internally. According to Guohua and Curtis [32], 30% of Chinese desktops are running Linux specifically the Red Flag Linux distributed by the Chinese themselves. The Chinese government advocates open source software usage mainly because of the need for a better security, independence, avoiding illegal software usage, cost savings and growing local software industry and skills [35].

Higher education institutions are one of the major focus centers in the Chinese open source initiative [32]. This is mainly for two reasons. Since china is still among the developing nations, saving the cost of having a proprietary software product for its higher education consumption is a cause for choosing the open source alternative. Besides financial issues, china has in mind to use the opportunity of the open source initiative to develop its internal computer skill in order to avoid its dependency on proprietary software providers. In order to meet this goal effectively, targeting higher education institutions is the best policy at hand to equip its educated man power with the knowledge of open source tools, features and functionalities for future independence.

The Chinese open source movement however has been reported facing obstacles due to low awareness and software piracy practiced in the country that over shadowed the benefits of open source software [33]. In china, as it is in many developing nations, anyone can get commercial software for free due to the rampant software piracy. Consequently, it was found difficult to persuade users to switch to open source products for the benefit of reduced cost. Because of this reason in china open source software is still popular among the governmental agencies and the education sector only.

South Africa escorts the initiative in Africa. South Africa started considering the merits of open source software in 2001 in order to save the countries high expense on proprietary software for other internal needs. South Africa made the use of open source

software legitimate in government in 2007 [34][35]. Most of the government departments, universities, schools, research institutes and small and medium sized enterprises in the country make use of open source software. The open office suite is also localized into the 11 official languages of South Africa and is now being used by the public sector. The country has a stated open source software policy that legitimizes open source software over proprietary software. The policy also mandates open standards as a prerequisite for every software development.

According to the Vital Wave consulting [36] , the South African open source task team composed of officials from all sectors in the country, has confirmed the use of open source software can further national development goals by lowering costs, increasing productivity, and improving citizen convenience, while enhancing security, interoperability, scalability and efficiency. The support of global NGO's like the UN, World Bank, African Union and IDRC, celebrated South African OSS proponent Mark Shuttleworth and his foundation and international ICT companies like HP, Novell, IBM and Oracle and many more have played a great role in awareness creation of OSS in south Africa in addition to the enormous effort done by the government. The nation of South Africa is among the top leading countries in open source initiatives and is a role model for the rest of Africa in this regard.

As to the UNDP there are four categories of OSS policy, on a scale from prescriptive to voluntary. These are mandated use of OSS, preference for OSS, mandated Open standards, and best value a vendor neutral approach. According to an open source government policy considerations survey made in 2007 by Center for Strategic and International Studies it is found, among 268 open source policy initiatives worldwide 192 were finalized. Among the finalized 192, 177 were accepted and 16 rejected. The survey categorized the policies in terms of those on a research and development level, advisory level, preference level, and mandatory level. Among the 177 approved policy initiatives 59 of them have considered open source software on a research and development level, 56 on advisory level, another 56 as a preferred option and the rest 6 mandated open source software usage. Among the total open source policy initiatives of 268, 131 were

from Europe, 70 from Asia, 36 from Latin America, 19 from North America and the rest is from Africa and the Middle East.

## 2.6 OSS in developing countries

Technology is a basic necessity for development in this age. The access to these technological innovations demands an already existing strong economy and power because of the high price tagged on these products. But those developing countries with tight economies which desperately need these technologies cannot afford to have those innovations with such an elevated price. It looks like the technology is just making the rich richer leaving the poor as they are and enlarging the gap between the haves and the have-nots as a result. The access gap between those people who make well use of information communication technologies and those who do not is usually referred to as the digital divide. Many propositions have been given to put an end to the digital divide. OSS is one of the solutions proposed by many [34][38][39] as both technological equipping and affordable way for developing countries to reach out their societal information needs.

The economic advantage of open source software for developing nations is addressed by many economists and scholars. Jamil, Mohab and Hamid [38] have strongly emphasized the need for OSS for fast and affordable transfer of technology in terms of software, hardware and content for developing countries. According to their findings, the OSS advantage for developing countries is not only low cost but also the collaborative and networked support and reduced cost of negotiations, transactions and licensing.

They further added the opportunity provided for customization and localization through the OSS licensing agreements will facilitate the technology transfer and diffusion within the society. The current trend for acquiring these technologies in the developing nations is either through direct purchase, high rated projects or by foreign investment. Furthermore they strongly argued even if technologies can be attained either through foreign investment or direct purchase, it still has a greater negative impact on these

countries future. The major reason for this accordingly is since proprietary software providers does not transfer the how to of the product they provide; these countries will still have no chance for independence in the long run.

According to Sanjiva and Jivaka [37], open source cannot be seen as a mere product choice for developing countries, it is rather a strategic alternative for fast economic development through the reduction of cost invested for IT. According to their analysis, a developing nation can create value to its economy through IT by creating new business opportunities for private sector in the IT sector, by reducing IT cost both for government and the private sector and by improvement in the effectiveness and efficiency of governance. The creation of value through business opportunities would occur with capacity building in the private sector using OSS. That is through the development of IT skills of developers and others and the adoption of open source based business models by private firms. In the execution of E-Government strategies, open standards primarily and then open source software would be critical to an effective implementation strategy. The study further illustrates developing countries must formulate open source driven IT strategy as depicted in fig 2.1 that must be shown by the countries' IT policy, advocacy, capacity building, e-government and brand equity.

The paper also puts pre conditions that must be met for an effective handling of open source software in developing nations. The first condition is the intellectual property law enforcement which avoids the common problem in most developing nations which is the usage of pirated proprietary software. This problem gave a false reality of one can have a proprietary product at no cost which in turn devalued the economic advantages of OSS.

The second major requirement is the availability of low cost and fast internet access for open source activities to continue in one country. Most of the open source communications and development is done online. So developing nations must make sure they have provided these infrastructures in universities, companies and other major sectors in advance for OSS to be disseminated and used effectively.

Educational infrastructure is also among the crucial criteria to fast adoption of OSS according to Sanjiva and et al [37]. Training and teaching basic skills of using OSS must be given by higher education institutions and other educational institutions with in a developing country. A country must also first advocate the culture of free dissemination of knowledge and information for a better and fast adoption of OSS.

Generally any developing country must soon or later consider the open source alternative for reducing cost of IT investment, for future independence, for security and autonomy and as a means to address intellectual property rights enforcement. And the decisive roll of higher education institutions in developing nations, for the achievement of these goals through awareness creation, training and skills development on open source software, is crystal clear.

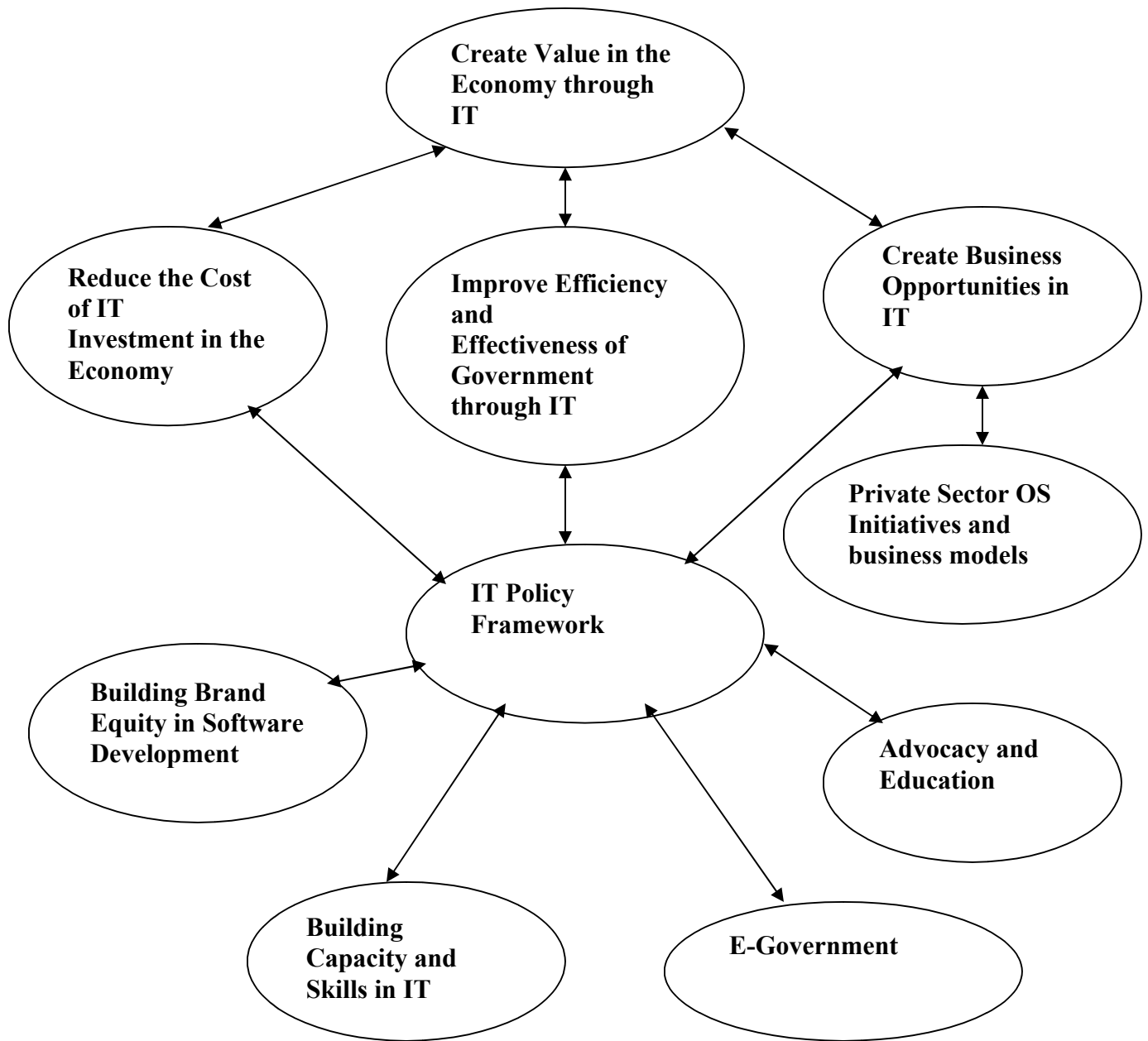


Figure 2.1: Strategy map for developing countries (Sanjiva and Jivaka, 2004)

## 2.7 Open source software in higher education

Universities demand high information technology infrastructure and applications that is comparable to large commercial enterprise consumption. Universities and other high level educational institutes require software for their fundamental teachings like operating systems, word processing and the internet as well as for back end servers( web, proxy,

file, mail, database and firewalls), computer laboratories, staff desktops, and PC's that are used for different purpose within the campus. Higher education institutions also need special purpose software such as content management system, course management system, finance system, registrar system and library system. But unlike commercial companies universities have low income and lesser resources. Community based software development is the only option for higher education to get software that is highly robust, sustainable and mission critical and at the same time less costly. Due to this reason open source software has been proposed by many [40][41][42] again for higher education information system need as an alternative and affordable solution to proprietary and home built software.

Some argue that cost is not the only issue that obligates higher education institutions to use open source solutions [43][44]. They further relate the philosophy of scientific research to the OSS philosophy in that scientific finding has been verifiable throughout history and as a scientific product the source code of a software must also be accessible and be approved based on open verifications. The usage of closed source software will put in danger the integrity of the science culture. Higher education institutions are supposed to save the scientific trend of open access by using and promoting the usage of open source software. In addition, fostering the culture of openness in academic environment is believed to be necessary because it is a way to cultivate collaborative work, transparency and continued innovation. Open source and open access resources are changing the academic world dramatically in this regard. Due to the ideology of peer review and free exchange of idea ,that is becoming highly advocated among scholars, projects like Wikipedia, MIT's open course ware project and Open dictionary have become very successful and of vital use among many [44].

Many universities train their students for the jobs they will have after graduation and the outside world is yet using many proprietary software products. Because of this reason some argue teaching students using open source products will give them hard time when they get out. But, there are also others which argue that higher education institutions must be free of giving vendor specific knowledge when they train their students on how

to use computers [44]. The teaching learning must focus on core knowledge of computer software in general and must make the students equipped across multiple vendors.

On top of applying open source software for higher education ICT consumption, some further recommend the usage of open sourced software in teaching computer science students will cultivate creativity. According to Katie [13] most computer science teachers believe using open source software in the teaching learning process aggravates the curiosity, creativity and innovation among students. Most students in schools that use open source products like Linux to teach students have witnessed the excitement and eagerness to modify and work on what others have done in the students' attitude. The availability of the source code also made it easier for teachers to explain the root functions of the computer to the students.

From the managerial and strategic advantage point of view since academic institution information system need is for mission critical purposes in the strategic value hierarchy that need to be only reliable, open source software can meet these needs effectively without investing too much on proprietary product that are highly featured and sophisticated [46].

The other aspect that ties higher education to the open source ideology is the emergence of the Web 2.0 with its very powerful tools like wikis, blogs ,podcasting and other interactive web applications allowing student centered learning system in education through peer evaluation and content generation . Open source blogging platforms like Word press are among the common tools used for blogging. Open source podcasting tools like Audacity that are used to share and upload content in an audio form are also being used by many educational institutes [3].

Though the merits of open source software for higher education information system are viable there are still areas of use in higher education information system that the open source community has not yet provided a matured solution or even no solution at all.

Here in table 2.1 are some of the well known open source products with their category and purpose that are being used in higher education information systems world wide

OSS	Category	Use
Moodle Or Sakai	VLE; virtual learning environment or course management system	To develop, create, upload and administer assignments, quizzes and other learning resources
Joomla	CMS ( content management system )	System that makes it easy to collect, organize and present multimedia information over the web
Koha	School/college administration	Library admissions, etc
Thunderbird	Mail client	e-mail
Kuali	Student information system	Provides students and administrators with tools to manage curriculum change and to develop individual Learning Plans.
Gimp	Image and Graphics tool	Image retouching and editing tool
Bind	LDAP server	Light weight Directory Access Protocol , centrally manages user accounts and provides a shared user directory across a network
Zimbra	Web mail	full-featured collaboration suite that supports email and group calendars

Table 2.1: Some open source software used in higher education information system

## 2.8 Open source adoption frameworks

There are a few of software adoption frame works that are suggested by different scholars. Leaving the pros and cons of open source and proprietary software behind for the decision of managers and stake holders, many agree on the proper handling of OSS adoption like any other software. According to tOSSad [45], it is highly recommended to

clearly outline the reasons and motivations for migration, to make sure there is an active support and awareness among IT staffs and users, to build up expertise, to start with non critical systems and to ensure that every step of the migration are manageable before any migration planning to OSS is made.

Stephen and Joel [46], on their conceptual model for OSS adoption, studied the varying strategic importance of IT for different organization to place a foundation for the question when to adopt new technology? Their frame work considers the tradeoff between features, risk and cost for open source adoption. They saw the degrees of IT importance for a given industry based on the type of the industry and a firm's position within the industry. ITs' importance for the firms' performance can be strategic, factory, support and turn around. By strategic it is how IT is related to the business strategy. Organizations use a range of information systems in which some are for competitive advantage and some are supportive. They insist on considering product attributes like features (what's new or valuable about a new product), risks (reliability, available support and vendor dependability) and cost (initial purchase price, ongoing support cost, upgrade fees and total cost of ownership including personnel, related equipment costs such as, power, air conditioning, security etc.) depending on the strategic importance of an IT system for the organization when adopting a new technology. Table 2.2 shows the relationship between the category of the information system with its main goal and the key driver that must be considered.

<b>Stage</b>	<b>Goal</b>	<b>Driver</b>
Strategic	Competitive Advantage	Differentiation
Mission critical	Reliability	Risk
Support	Efficiency	Cost
Laboratory	Evaluation	Future Advantage

Table 2.2: Goals and drivers at each stages of an information system (Stephen and Joel)

In their frame work differences of strategic importance of IT systems within a firm are categorized into strategic that give competitive advantage over rivals for which high feature to create differentiation is expected, mission critical which are firm specific systems that keep the organizations ongoing for which reliability should be the main concern to mitigate risk e.g. transaction processing, support that boost the efficiency of the organization for which efficiency and low cost are the main driver e.g. desktop applications, and laboratory systems, which are new technologies being experimented that can grow into any of the stages or can also be avoided without being used, future advantage should be the driver to keep this kind of software. So according to Stephen et al [46] whenever adopting a new technology in order to mitigate risk one has to begin with the lowest strategic value systems. Table 2.3 shows the tradeoffs between the specific stage of the application and the required feature, the level of risk to take and the cost incurred.

<b>Stage</b>	<b>Features</b>	<b>Risk</b>	<b>Cost</b>
Support	Minimal	Moderate	Low
Mission Critical	Standard	Little or none	Moderate
Strategic	High	Low	High
Laboratory	Varies	High	Medium

Table 2.3 Tradeoffs between stages of information systems and feature, risk and cost (Stephen and Joel)

Their final goal was to develop a model where open source can be adopted. The model indicates a firm's open source policy must be formulated depending on the industry context, the firm context within the industry, the open standards attitude and open source attitudes. Then the model presents two stages of selection process. The first stage considers the open source policy at hand, the application context that is the strategic value of the application to be recruited and the available products at hand to establish the choice set. Finally the organization can select the most favorable product based on its own selection metrics.

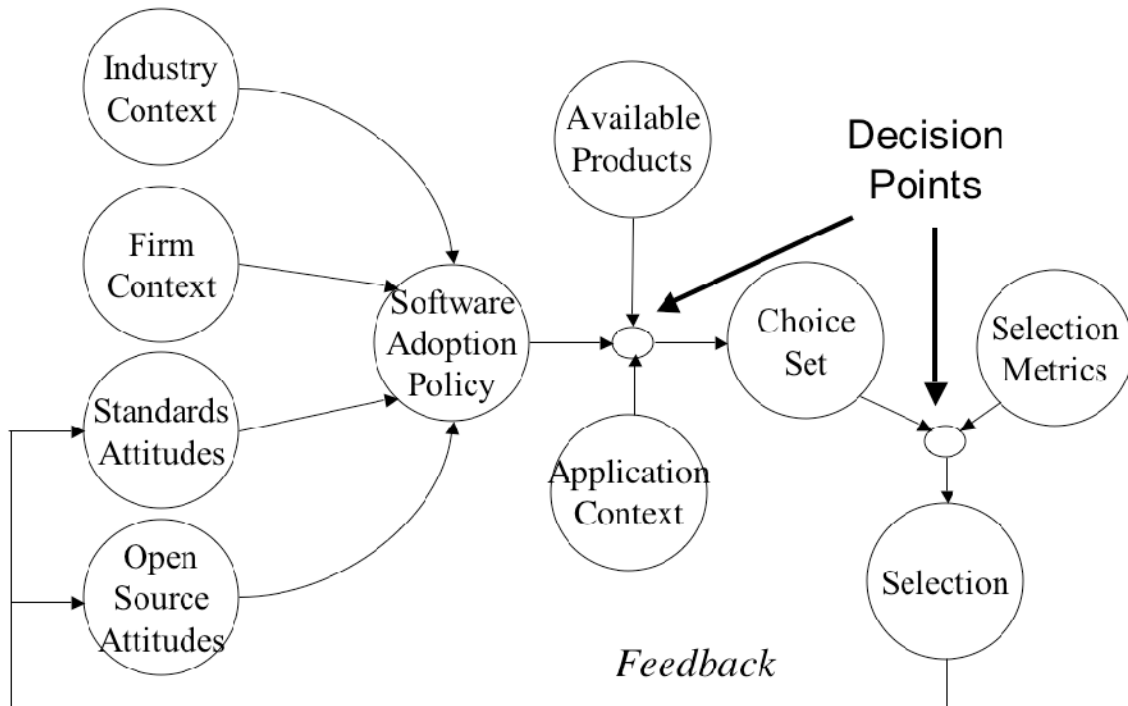


Figure 2.2: Model for open source software adoption (Stephen and Joel)

Since Higher education institutions are non profit making organizations differentiation is not an issue for their information system need. They can benefit from this study's findings in that since much of their investment on IT is concentrated on support and mission critical stages they can minimize cost by adopting open source software products that are reliable, full featured and less costly than a counter proprietary product.

On a frame work depicted in figure 2.3 proposed for a Swiss small and medium sized enterprise free and open source acceptance the main constructs considered in the proposed framework are; performance expectancy, the degree to which an individual believes that using the system will help him or her to attain gains in job performance, effort expectancy, the degree of ease associated with the use of the system, social influence, the degree to which an individual perceives that important others believe he or she should use the new system, facilitating conditions that refer to user training and user awareness related characteristics and community participation that refers to the

propensity to participate (collaborate, cooperate, communicate) in similar interest groups. This are used to assess the user’s inclination to open source software [47].

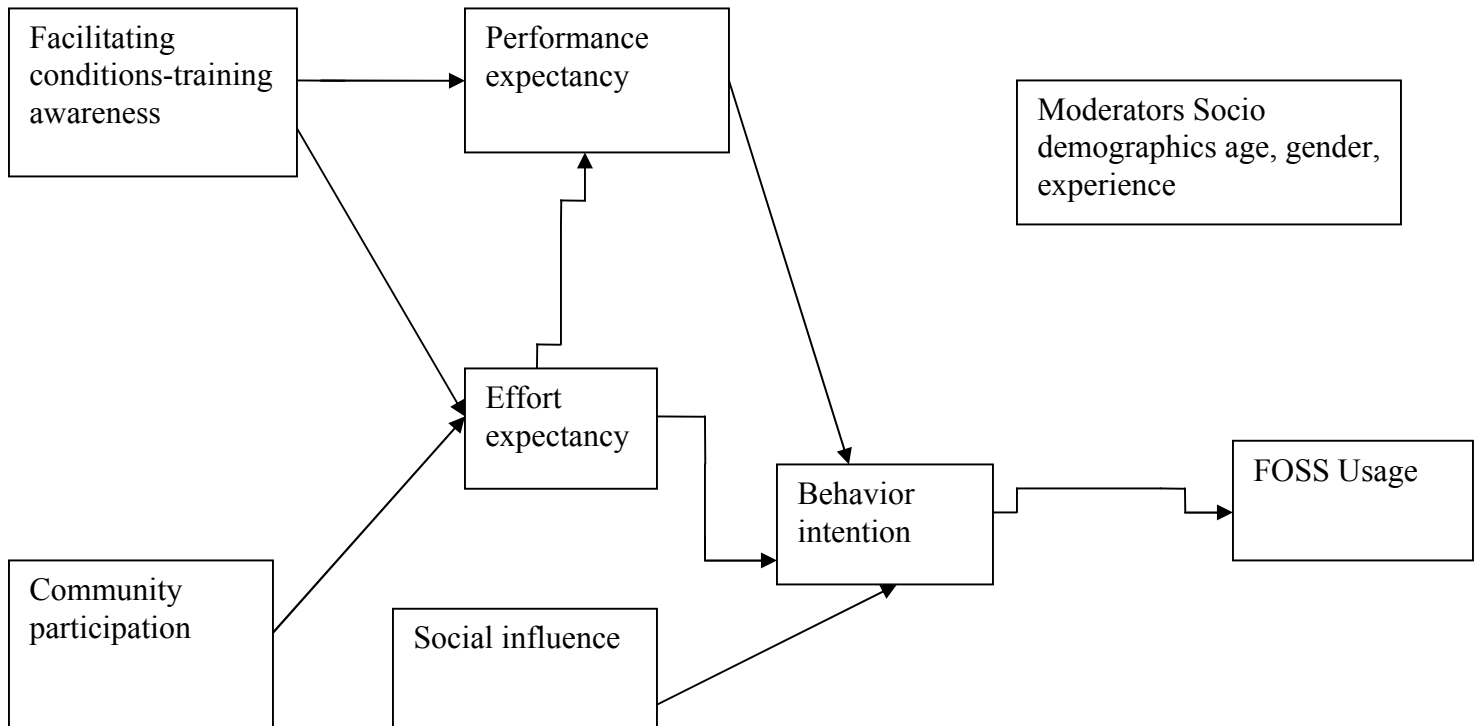


Figure 2.3: Open source software acceptance model (Sanjay and France)

### 2.8.1 Options of adoption

The European Union guideline for those who wish to partner with open source software providers puts three major issues to be addressed when partnering with FOSS developers which in turn have three options each, the type of software, the type of service and the type of partner [48].

**The type of software:** It categorizes the type of software into generic purpose, specialized purpose and specific purpose software. Generic purpose software are general purpose software that are essential for every kind of user like operating systems, office applications and browsers. Specialized purpose software like

content management system, work flow systems etc are in the second category and the third type specific purpose software that are designed to solve a specific job.

**The type of service:** The type of service refers to the kind of service the user expects. This also is divided into three. The first one is if the service is needed to develop new software from scratch. The second one is if services are given to improve (reuse, adapt or integrate) an already existing solution that has been developed externally. The third type of service is if it is needed to improve internally developed software.

**The type of partner:** The third major option to be considered in adopting open source software is the type of partner. There are three options here also. One can partner with the free and open source community with no specific legal personality or with nonprofit organizations of developers as a second option or the third option is to partner with commercialized open source software providers.

**Implementation:** Many FOSS adoption guide lines assume different implementation levels and gradual migration. A complete migration to FOSS adoption at once is not advisable as the development in open source software is not yet matured in many areas in which proprietary software is more advanced and useful. A mixture of both open source software and proprietary software is the most appropriate solution right now. There are software that the open source community does not even considered yet which are only available in proprietary form.

The simplest way to consider FOSS implementation according to tOSSad, is to divide the implementation into server level, desktop level, office automation and free and open file formats. Due to the highly featured server level open source products like Linux, Apache web server, My SQL and PHP making the LAMP stack for the internet, server level migration has been the easiest one so far. Desktop level migration has been tested and

found to be successful in many countries but still gradual migration is recommended in this area. Office automation software is one of the areas the open source software is challenging the most famous proprietary office automation software Microsoft Office. The Open Office software can run on both open and proprietary platforms. However many agree on the consideration of open file formats and open standards before any kind of migration is proposed. If open standards are there users will be able to choose whatever kind of software they like to use and still be able to communicate with each other. Interoperability can only be insured through the adoption of open standards.

## 2.9 Determinants of OSS adoption

Factors that influence the adoption of open source software are studied by some scholars. In his research Thomas [50] has seen the determinants of open source software adoption in for profit organizations from the perspectives of perceived task compatibility, perceived triability, perceived compatibility, perceived skill compatibility, perceived continuity, perceived software cost savings, perceived third party support and perceived top management support. Perceived compatibility, task compatibility and triability, that are dependent on the enterprise IS/IT architecture and strategy, are the main findings of the study that are found to be main determinants of the open source software adoption.

Tomasz and Krystyna, [49] on their investigation on Poland open source software implementation to find out the determinants of open source software adoption, have surveyed 178 enterprises and public institutions in the country. They have considered four major factors that are benefits, costs, environment and organization based on the technology–organization–environment (TOE) theoretical framework. Of the four factors considered determining adoption decisions they found that only perceived benefits and environment are the most significant ones in adopting open source software.

Kamseu and Habra [51] in their research to find out the determinants of open source software adoption regarding quality; they categorized factors that influence the quality of open source software from three different angles that are the product that is the product

performance to the user's satisfaction, the process which must be well organized and understood and the community that contributes to the development. They concluded the combined effect of these three factors as depicted in fig 2.4 is very influential to the adoption of open source software.

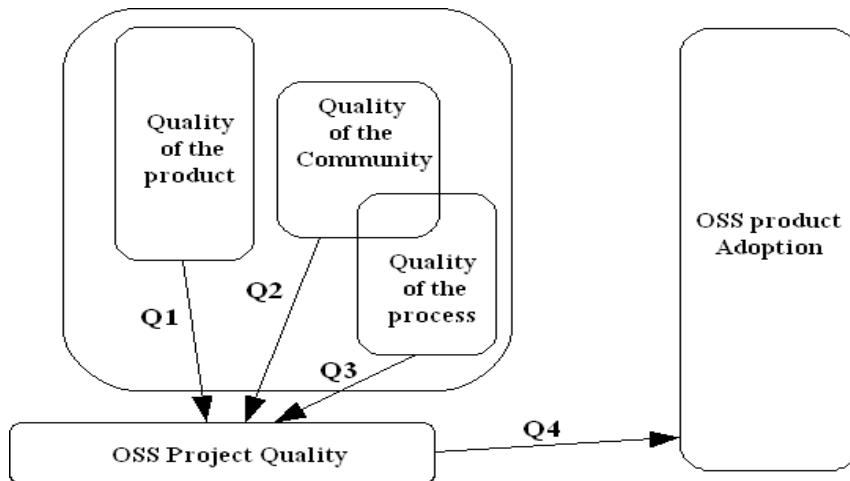


Figure 2.4: Quality determinants of open source software adoption (Kamseu and Habra)

## 2.10 Barriers of OSS adoption

A research [52] on Australian firms that explored the barriers to open source adoption rate sites the main barriers for open source adoption in Australian firms as lack of ongoing support mainly related to the lack of specific organization to contact or sue in case of failure using an open source product, lack of relevance which is observed in firms that have already a well established and working proprietary products, commitment to commercial software vendor, low perception on the requirement of open source software for their business and lack of resources.

CIO.com, as sited by Neresen [53], interviewed 328 IT managers and executives and found out 53 % of them are using open source software but on the search why the rest 47 % are not doing so, it has found out the major barriers to open source software adoption are product support concerns 45%, awareness/knowledge of available solutions 29%,

security concerns 26%, lack of support by management 22%, licensing or legal concerns 21%, investment in architecture from other vendor(s) 20%, software quality issues 20%, customization concerns 15%, irrelevancy 7%, pressure on open-source providers by commercial vendors 5% , and finally software cost allocation policies 2%.

Farber [54] has outlined six barriers to the open source adoption despite its highly rated benefits. These are lack of formal support, velocity of change that is constant upgrades and numerous projects that is not comfortable for decision makers, lack of road map because of informality in the open source development community that irritates CIO's who wants to be planed and secured, functional gaps, the existence of too many licensing schemes confusing executives and endorsements from independent software vendors.

A tOSSad [55] study on the main barriers of open source software adoption in public sectors puts the barriers in three categories as administrative barriers, financial barriers and legal issues. Some of the administrative barriers mentioned in the study include user problems like resistance to change, lack of confidence, the belief of "free" is not good does not offer quality, the use of "pirated" versions of proprietary software, exaggerated perception that specific training is needed for OSS more than what it takes for proprietary software, perception that OSS is still very much related to anarchy instead of professionalism and lack of business models that create confidence in OSS. Technological problems cited as main barriers are security problems and system failure, universality of Microsoft operating system and lack of standardization in formats and compatibility and transfer of files. Some of the financial barriers outlined by the study are difficulty in establishing or estimating a final total cost of ownership, difficulty in establishing Interoperability costs and costs related to establishing Open format standards, huge costs related to marketing and increasing public awareness of OSS, high initial training costs required and high switching and customization costs

## 3. Results

### 3.1 Quantitative Study

#### 3.1.1 Survey administration and Response rate

The questionnaire was self administered. This is done to increase the quality of data collected and the response rate. Meeting respondents in person helped to better clarify and explain the objectives and importance of the research so that they would give genuine information. Consequently, respondents were well informed about the aim of the research before filling out the questionnaire. The respondents were also confirmed about the confidentiality of the information they will be giving before distributing the questionnaire.

Every respondent was given a time gap of three days to finish the questionnaire and return but most returned within a day. Five individuals from each one of the five governmental institutions and three individuals from the private institution due to lack of appropriate personnel that meets the responsibilities needed to fill this questionnaire were contacted. Therefore, a total of 28 questionnaires were administered and all 28 were returned. However, due to important missing values and unfinished answers 7 questionnaires were removed. Finally, from the total number of questionnaires administered, 75 % (21) which are appropriate for analysis were selected, which is a reasonable amount for sound analysis and conclusion.

#### 3.1.2 Respondent distribution

Generally the respondent distribution based on responsibilities for this research is fairly reasonable. Respondents were contacted directly at their working places; however, due to training leave and workloads some respondents at some institutions who were supposed

to fill the questionnaire couldn't make it. The questionnaire was sent to them via their email but they didn't respond back.

Some of the respondents have more than one of the responsibilities required to fill this questionnaire. The highest percentage of respondents based on administrative responsibilities is from those that are involved in software procurement and purchasing. The respondent distribution based on responsibilities that filled the questionnaire indicates 11 (52 %) of the respondents are directly involved in software procurement and purchasing at their institution. 10 (47 %) are responsible for developing institutional ICT policies for their institution. 9 (43 %) of the respondents who filled the questionnaire are overseeing implementation of ICT policies in their institution while 4 (19 %) of the total respondents are involved in developing and administering institutional ICT budgets in their institution. 6 (29 %) of the respondents represent those who are involved in designing and approving software licensing agreements for their respective institution. 7 (33 %) of the total respondents are responsible for approving in house software development and finally 9 (43 %) are responsible for developing ICT training in their institution.

Highest number of respondents in terms of technical skills and responsibilities is from the network administrators. Of the total respondents 16 (76 %) of them are responsible for the administration of the network in their institution. Generally respondent distribution based on skills shows 11 (52 %) are skilled in software development, 11 (52 %) in web design, 13 (62 %) are giving ICT training and teaching, 15 (71 %) are system administrators, 10 (47 %) are database administrators and 15 (71 %) are giving technical support in their institution.

<i>Category of responsibility</i>	<i>Specific responsibility</i>	<i>Percentage</i>
Administrative responsibilities	Software procurement/purchasing	52 %
	Developing institutional ICT policies	47%
	Overseeing implementation of ICT policies	43%
	Developing/administrating institutional ICT	19%

	budgets	
	Designing/approving software licensing agreements	29 %
	Approving software development in-house	33%
	Developing ICT training	43%
Technical skills	Software development	52 %
	Web design	52%
	ICT/Software training/teaching	62 %
	Network administration	76 %
	System administration	71%
	Database administration	47%
	Technical support	71 %

Table 3.1 Distribution of respondents based on responsibilities and skills

Of the total respondents 86 % are involved on both administrative and technical endeavors in their institution and the rest 14 % are only involved in technical responsibilities.

### 3.1.3 Institutional ICT Policy

It was evident from the answers given concerning institutional policy presence and if software is mentioned in it, that none of the institutes have currently a working ICT policy. The results show none of the institutes sampled for this research have a stated ICT policy or strategy. However through the interview it was possible to find out they have a draft policy under construction that is not yet approved and they said this new policy mentions software. Therefore, the answers for these questions will be well elaborated on the discussion part of the interviews.

### 3.1.4 Practice

#### The practice of examining OSS software in software procurement

Though there are no compiled and ratified policies advocating the use of open source software in these institutions, in practice it is found OSS is considered as an option when procuring software by all (100 %) of the institutions sampled for this research.

<i>Practice</i>	<i>In number</i>	<i>Percent</i>
In practice OSS is examined as an option when procuring software	6	100 %
In practice OSS is not examined as an option when procuring software	0	0 %

Table 3.2 Practice of examining OSS in procurement

#### In the long run what ICT officials believe is better for their institution

Most of the ICT officials responded for this study believe it's better if their institution uses both open source software and proprietary software in the long run. A few (18 %) of the respondents chose to have an extreme position in this regard. Accordingly, the answers for this question show many of the respondents (82 %) in this institutions believe it's better for their institution to use both proprietary and open source components mixed and 14 % of the respondents believe it's better to use OSS only for their institution while a rather small (4%) percent of the respondents believe it's good to use proprietary software only.

<i>Belief</i>	<i>Percentage</i>
To use proprietary software only	4 %
To use some OSS components and some proprietary components	82 %

To use OSS software only	14 %
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Table 3.3 Respondent’s belief of what’s better in the future

*Note.* This table represents the personal belief of respondents for their institution

### Awareness of OSS by ICT services staff

The awareness of the majority of ICT service staff on OSS is generally on the basics level. However, there are a group of staffs that specifically work on open source software in most of the institutions, due to this the highest result (48 %) for the awareness of OSS by staff of the sampled institutions ICT services indicate a few staffs have extensive awareness (an OSS support team in three of the institutions) and the rest have basic awareness. The researcher had the chance to observe what this support teams do in some of the institutions and have witnessed that they are engaged in deploying, customizing and supporting many flavors and products of OSS. The researcher also noticed they have taken many OSS trainings and they have a strong management back up. The next large number (33 %) goes to the option a few staffs have basic awareness and the majorities have no awareness about OSS. 14 % of the respondents some representing their departments only and some representing their institutions said all staffs have basic awareness. The rest (5 %) believe no awareness by all staffs describes best their institutions OSS awareness by ICT staffs.

<i>Awareness of OSS by ICT staffs</i>	<i>Percent</i>
There are no staffs of the institution’s ICT services with any awareness of OSS	5 %
A few staffs have basic awareness and the majorities have no awareness about OS	33 %
All staffs have basic awareness	14 %
A few staffs have extensive awareness and the majorities have basic or no awareness	48 %

Table 3.4 Awareness of ICT services staff on OSS

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

## ICT service staff experience of deploying Open source software

The majorities (44 %) have said experience of ICT service staff of deploying open source software is concentrated on few ICT staffs that are working specifically on open source deployment in the institution. 30 % of the respondents also said a few staffs have extensive and the majorities have basic or no experience which indicates the same situation but these group of respondents believe those few staffs have more than basic awareness. However, 17 % of the respondents said all of the staffs have basic experience and 9 % said a significant number of them have extensive experience.

<b><i>Experience of deploying OSS</i></b>	<b><i>Percent</i></b>
A few staffs have basic experience of deploying OSS and the majorities have no experience	44 %
All staffs have basic experience of deploying OSS	17 %
A few staffs have extensive experience and the majorities have basic or no experiences	30 %
A significant number of staff have extensive experience and the minority have basic or no experience	9 %

Table3.5 The experience of ICT services staffs in deploying OSS

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

### 3.1.5 Deployment of software on servers

#### Software deployed on servers

There is an extensive use of open source software on servers in most of the institutions surveyed. In a number of the institutions except for some servers, the researcher witnessed, all servers are running on an open source software platform. Of the six institutions surveyed for this research only one institution (representing 17 % of the institutions) have been found using proprietary software only. The rest (83 %) comprising five of the governmental institutions have shown dramatic shifts to OSS on servers. All

respondents indicated in their answers that “some” cannot describe their deployment of OSS on server. Most of their software (more than 90 %) on server level is of open source products.

<i>Software deployed on servers</i>	<i>In number</i>	<i>Percent</i>
On its server, the institution has deployed only proprietary software in the past and will continue to do so in the future	1	17 %
The institution deploys some OSS on its server	5	83 %

Table 3.6 Software deployed on servers

### The extent of open source software use on servers

Those institutes who have claimed to deploy open source software on their servers, excluding the institute which deployed proprietary software only, have answered this question. The results for the extent of open source software usage indicate, of all the institutions who said have deployed open source software, the majority of the institutions (60 %) preferred to describe it as the institutes server’s use some proprietary and some OSS components. However, 40 % of the institutions, two in number, preferred to describe the extent of OSS usage in their institution as the institution’s servers use only OSS components. These two institutes have migrated to open source software fully on the server level.

<i>Extent of OSS use on servers</i>	<i>In number</i>	<i>Percent</i>
The institution’s servers use only OSS components	2	40 %
The institution’s servers use some proprietary and some OSS components	3	60 %

Table3.7 The extent of OSS use on servers

## Operating systems used on servers

Though there are a number of server operating systems on the market, it looks like only Linux brands, Windows and Solaris are the most favorite ones in the higher education information system. The results of this question illustrate the three brands Linux, Windows and Solaris have dominated the server operating system deployment in the higher education institutions of Ethiopia. It was evident from the results that 33 % of the institutions use only Linux flavors (Red Hat, SuSE, Debian, Ubuntu, Fedora), while 50 % of them use all Linux, Windows server and Solaris. As to the findings of this research Linux is used by 83 % of the higher education institutions in Ethiopia as a preferred server level platform while Windows server is being used in 67 % of the total institutions. However, the researcher has observed the special Linux brand that is famous and widely used differs from institution to institution. One of the institutions uses only Open Suse series, in the other institute Debian is the major operating system used and Fedora dominates the server platform in another institute. The remaining 17 % (one institution) use only Windows server 2003 and earlier operating systems.

<b><i>Operating System used on servers</i></b>	<b><i>Percent</i></b>
Linux (Red Hat, SuSE, Debian, Ubuntu, Fedora) only	33 %
Windows Server 2003 and earlier only	17 %
Linux (Red Hat, SuSE, Debian, Ubuntu, Fedora), Windows Server 2003 and Solaris	50 %

Table3.8 Operating systems used on servers

## Mail software

Postfix and Send mail, both open source products that route and deliver electronic mail, are used by half of the institutions surveyed. The open source product Exim and Microsoft's Exchange server are not used by any of the organizations. Postfix and

Sendmail have equal number (25 % both) of users in these institutions. But the majorities (50 %) of users use mail software other than the widely known mail software.

<i>Mail software used</i>	<i>In number</i>	<i>Percent</i>
Postfix	1	17 %
Sendmail	1	17%
Both Postfix and Sendmail	1	17%
Other	3	50 %

Table3.9 Mail software being used

### Web server software

Apache web server is the most widely used web server in the global internet market. It looks like the same situation happens in the institutes surveyed for this study as well. In response for the type of web server software used in the institutions, a dramatic result was found showing all (100 %) of the institutions sampled for this research use open source web server products for their servers including the institution which indicated it only wants to deploy proprietary software. 67 % of this institutions use only Apache web server and the rest 33 % use Apache web server and Apache Tomcat server. From this result Apache web server is found being used by all the higher education institutions.

<i>Web Server software used</i>	<i>Percent</i>
Apache web server only	67 %
Apache web server and Apache Tomcat server	33 %

Table3.10 Web server software being used

### Database server software

The software used on database servers is also dominated by open source software just like the operating system and web server software. The finding for the type of database server used in these institutions signifies 50 % of the institutions use MySQL only as

back end data base server software. 33 % of them use both OSS database servers MySQL and PostgreSQL. The rest 17 % use Microsoft SQL server only. The summary of the outcomes show 83 % of the institutions use OSS database servers while 17 % use proprietary database server software.

<b><i>Database software used</i></b>	<b><i>Percent</i></b>
MySQL only	50 %
MySQL and PostgreSQL	33 %
Microsoft SQL Server only	17 %

Table3.11 Database server software being used

### Virtual Learning Environment being used

Moodle, an open source software product, is found to be the most familiar and only used virtual learning environment in the institutions surveyed for this research. All of the institutions (100 %), (The five governmental institutions) that indicated they use a Virtual Learning Environment (making 83 % of the total population), said they use Moodle as a VLE which is an open source software.

<b><i>VLE used</i></b>	<b><i>Percent</i></b>
Moodle	83 %
None	17 %

Table5.12 Virtual learning environment being used

### Reasons for using proprietary software on servers

As indicated in Table5.6 17% of the institutions indicated they only use proprietary software and from among the rest 83 % as shown in Table5.7 60% of them said they use both on servers. The possible motivations for using proprietary software were given in the questionnaire to find out the most deriving force for doing so and all ten of the

reasons specified in the questionnaire were picked as a cause for using proprietary software by all of the institutions even though the degree of importance and the number of people who backed it up as a reason varies. Expert support is taken as a serious and most important reason taking 77 % of the respondents vote as a reason for using proprietary software. It seems there is extremism in regarding the need for specialized software as a reason for selecting proprietary software. 53 % of the respondents say it is not a reason at all while 43 % of them regard it as the most important reason for using proprietary software. Again majorities of the respondents (59 %) do not believe low additional upgrade cost is a reason for using proprietary software product but 41% of the respondents believes it is. Low staff support cost is not also regarded as a reason by the majorities (53 %) of the respondents while 47 % believe it is. However, 59 % consider personnel preference is a reason while 41 % said it is not. Again performance of the software is backed up by 53 % of the respondents as a reason for having proprietary software. Low in house expertise on OSS is also taken as a reason by the majorities (59 %). For the rest of the reasons specified in the questionnaire like, consultancy support was already in place, the software was donated and there is no switching cost, greater part of the respondents does not think they are reasons at all.

Generally, the most important reasons taken serious by more than 50 % of the respondents for using proprietary software on servers in these institutes are the availability of Expert support, performance of the software, personnel preference and the fact that there is no enough in house expertise on OSS, in decreasing order of importance.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Needed specialized software	53 %	0 %	47 %
Low additional upgrade costs	59 %	18%	23 %
Low staff support costs	53 %	29 %	18 %
Personnel preferences	41 %	24%	35%
Performance of the software	47 %	6%	47 %
Expert support	23.5 %	23.5 %	53 %
No in house expertise on OSS	41%	29 %	30 %

Consultancy support was already in place	59 %	35 %	6 %
The software was donated	70 %	12 %	18%
Software was already in use, there was no switching cost	65 %	29 %	6 %

Table3.13 Reasons for using proprietary software on servers

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

### Reasons for using OSS on servers

83 % of the higher education institutions surveyed in this study indicated they use OSS at server. Unlike the result of the reasons for using proprietary software in which only four reasons have the majority vote, here all of the reasons given are taken serious for using open source software on servers. The reasons specified for using OSS were nine and all of the reasons are considered as vital for choosing open source software by more than 50 % of the respondents. Better response to bug fixes and better interoperability with other products are selected as a reason by 100 % of the respondents. Next to that saving on total cost of ownership is believed to be a reason for using open source software by 93 % of the respondents of which 72 % regarded it as the most important reason. Only 7 % believe it is not a reason. Lower likelihood of getting locked in by a software provider, the possibility of migrating data across systems and the ability to modify source code for a specific reason are all picked up as a reason by 86 % of the respondents. 79 % believe the ability to customize OSS is also a reason. Ideological reason is believed to be a reason by 57 % of the respondents while 43% consider it not a reason.

Better response with bug fixes, better interoperability with other products, saving on total cost of ownership, lower likelihood of getting ‘locked in’ by a vendor, the modifiability of the source code as needed, the possibility of migrating data across systems and the

need for custom made software are the decisive reasons for using open source software on servers in the institutes surveyed for this study in the order of decreasing importance.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Saving on total cost of ownership	7 %	21 %	72 %
The possibility of migrating data across systems	14 %	57 %	29 %
The possibility of migrating data from existing systems	36 %	43 %	21 %
For ideological reasons	43 %	14 %	43 %
Needed custom made software	21 %	43%	36 %
Able to modify source for specific reason	14 %	29 %	57 %
Better response with bug fixes and/or support	0%	43%	57%
Lower likelihood of getting 'locked in' by a software provider	14 %	14 %	72 %
Better interoperability with other products	0 %	64%	36%

Table3.14 Reasons for using OSS on servers

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

### Reasons to exclude OSS on servers

Most of the reasons presented as a potential cause for avoiding open source software none of them are regarded as a main barrier. Out of ten reasons put for excluding open source software, all of the reasons are regarded as not reasons at all by more than 50 % of the respondents. 37 % believe legal issues and interoperability and migration problems are reasons for not using open source software. 21 % regarded migration costs and the lack of specialized software to satisfy some needs as a reason. 32 % consider time costs of identifying relevant software and the need for third party support software as decisive for the exclusion of OSS. 42 % believe training needs are reasons for avoiding open source

software. 27 % put lack of information about the experiences of other institutions as a reason to avoid open source software. 16 % said nobody wanted OSS in their institution.

In general, training needs, legal issues, interoperability and migration problems and migration cost are potential reasons for avoiding open source software.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Legal issues including license	63 %	21%	16 %
Interoperability and migration problems	63 %	26 %	11 %
Migration costs	79 %	16 %	5 %
Time costs of identifying relevant software	68 %	21 %	11%
Lack of information about experiences in other institutions	63 %	21 %	16 %
Needed 3 <sup>rd</sup> party support	68 %	21 %	11 %
No open source specialized software to satisfy our needs	79 %	10 %	11 %
Training needs	58 %	16 %	26 %
Meeting user expectations	68 %	16 %	16 %
Nobody wanted it	84 %	16 %	0%

Table3.15 Reasons for avoiding open source software on servers

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

### Who supports OSS on servers?

It is found evident at half of the institutions (50 %) to support open source software is part of the job specification of some individuals among the ICT service staffs. The researcher has witnessed a team working on this area only at some of the institutions

visited. 33 % said some individuals have built the capacity to support open source software by themselves but it is not part of their job specification. However, 17 % said its part of the job specification all ICT staffs to support open source software. None of the institutions outsource the support of open source software outside their organization.

<i>Who Supports OSS on servers</i>	<i>Percent</i>
Some individuals have the skills to support OSS but it is not part of their job specification	33 %
It is part of the job specification of some individuals to support OSS	50 %
It is part of the job specification of all ICT staff to support OSS	17 %
The support of OSS is outsourced	0 %

Table3.16 Support for OSS on servers

### 3.1.6 Deployment of software on desktop

The results for the deployment of open source software indicate there is no adoption at all in most of the institutions. Because of this reason some of the answers are given based on the personal experiences of respondents.

#### Operating systems being used on desktops

The operating system used on desktops unlike the server is dominated by proprietary software product Windows. All (100 %) of the institutions surveyed for this research are using Windows as a main desktop platform and 17 % of them use only Windows. 83 % of the respondents, however, said they use Linux for desktop along with Windows. The researcher observed Linux is used as desktop operating system most of the time by ICT service staffs and individuals who have a keen interest in open source software among the academic community.

<b><i>Operating system used on desktop</i></b>	<b><i>Percent</i></b>
Windows XP , Windows 98 and earlier	17 %
Both Windows XP and Linux (e.g., Red Hat, SuSE, Debian, Fedora, Ubuntu)	83 %

Table3.17 Operating systems being used on desktops

### Reasons for Using or avoiding software on desktops

The answers given on desktop adoption of open source software do not represent the institutions reasons and motivations since no move has been taken to desktop level migration in any of the institutions observed. However, the respondents have answered this questions based on their personal observation of users in their institution and what they have experienced themselves. In addition, most of the respondents sampled for this research in each organization are users of open source software on their personal computers.

### Reasons for using proprietary software on desktops

Proprietary software is almost the de facto software on desktop in most of the institutions. Many reasons have been taken as decisive for this reality. Personnel preferences have taken the majority (91 %) of the response as a reason for using proprietary software on desktop. Next to that the need for a specialized software, performance of the software and the fact that the software is already in use so that there are no switching costs, take the next high number (72 %) of back up as a main driver for using proprietary software on desktop. Low staff support costs and the availability of expert support have been selected as a reason by 61 % of the respondents. However, 50 % of the respondents do not believe there is no enough in house expertise on open source software leading to the use of proprietary software on desktops. 83 % do not believe also the fact that the software is donated is a reason for using it.

Personnel preference, the fact that the software is already in use and so no switching costs , the need for a specialized software, performance of the software, low staff support costs and the availability

of expert support are the most influential reasons for using proprietary software on desktop in decreasing order of influence.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Needed specialized software	28 %	44 %	28 %
Low additional upgrade costs	61 %	33 %	6 %
Low staff support costs	39 %	44 %	17 %
Personnel preferences	11 %	39 %	50 %
Performance of the software	28 %	50 %	22 %
Expert support	39 %	39 %	22 %
No in house expertise on OSS	50 %	33 %	17 %
Consultancy support was already in place	61 %	33 %	6 %
The software was donated	83 %	11 %	6 %
Software was already in use, there was no switching cost	28 %	39 %	33 %

Table3.18 Reasons for using proprietary software on desktops

*Note.* The answer for this question is taken from more than one individual in each institution and some answered for their department

### Reasons for using open source software on desktop

The reasons for using open source software presented here represent the respondent's side of view only because there is no much use of open source software on desktops on the whole community. The fact that most of the respondents utilize open source software for their personal use has helped them to answer this question. Therefore, the results of this question may not represent the institutions stand. According to the data collected from these individuals, ideological reasons dominate the reasons for using open source software on desktops getting 86 % vote. Saving on total cost of ownership and lower likelihood of getting 'locked in 'by a software provider gained through using OSS, are

major reasons for using open source software for 78 % of the respondents. 71 % regarded the ability to modify source for specific reason, better response with bug fixes and support and its better interoperability with other products as a reasons for using it. The need for custom made software is also picked as a reason by 57 % of the respondents for using open source software. The possibility of migrating data across systems is a reason for half (50 %) of the respondents while the possibility of migrating data from existing systems is not a reason for 64 % of the respondents.

Generally the most accepted reasons for using open source software on desktops in decreasing order of influence are ideological reasons, saving on total cost of ownership, lower likelihood of getting locked in by a vendor, the ability to modify source code, better response with bug fixes and support, better interoperability with other products and the need for custom made software.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Saving on total cost of ownership	22 %	21 %	57 %
The possibility of migrating data across systems	50 %	36 %	14 %
The possibility of migrating data from existing systems	64 %	22 %	14 %
For ideological reasons	14 %	50 %	36 %
Needed custom made software	43 %	50 %	7 %
Able to modify source for specific reason	29 %	14 %	57 %
Better response with bug fixes and/or support	29 %	21 %	50 %
Lower likelihood of getting 'locked in' by a software provider	22 %	14 %	64 %
Better interoperability with other products	29 %	57 %	14 %

Table3.19 Reasons for using OSS on desktops

*Note.* The answer for this question is taken from the perspective of the individuals who filled the questionnaire only

### Reasons for avoiding open source software on desktops

Much of the reasons given as potential cause for avoiding open source software have not been found sound enough for most of the respondents except for training needs. More than 50 % of the respondents regarded all of the reasons to exclude open source software as not reasons at all except for training needs. 80 % say legal issues are not barriers at all for using OSS. 67 % do not believe migration costs; lack of information about experiences in other institutions, the need for third party support and the lack of OSS to satisfy special needs are reasons at all for avoiding open source software in their own case. 60 % also think migration problem is not a reason for excluding open source software. Time costs of identifying relevant software and meeting user expectations are as well not regarded as reasons for excluding open source software by 54 % and 53 % of the respondents respectively. However, 53 % of the respondents believe training needs can be taken as a reason for not using open source software in their organization. Training need is the only reason gaining more than 50 % support as a cause for avoiding open source software.

	<i>Not a reason</i>	<i>A reason</i>	<i>Most important reason</i>
Legal issues including license	80 %	7 %	13 %
Interoperability and migration problems	60 %	33 %	7 %
Migration costs	67 %	27 %	6 %
Time costs of identifying relevant software	54 %	33 %	13 %
Lack of information about experiences in other institutions	67 %	20 %	13 %
Needed 3 <sup>rd</sup> party support	67 %	20 %	13 %

No open source specialized software to satisfy our needs	67 %	20 %	13 %
Training needs	47 %	13 %	40 %
Meeting user expectations	53 %	27 %	20 %
Nobody wanted it	60 %	33 %	7 %

Table3.20 Reasons for avoiding OSS on desktops

Note. The results for this question must be taken only from the perspective of the individuals who filled the questionnaire

### Summary of reasons

	On Servers	On Desktops
<b>Main reasons for using proprietary software</b>	<ul style="list-style-type: none"> <li>• The availability of expert support</li> <li>• Performance of the software</li> <li>• Personnel preferences</li> <li>• Lack of in house expertise on OSS</li> </ul>	<ul style="list-style-type: none"> <li>• Personnel preference</li> <li>• The software is already in use ( no switching costs)</li> <li>• The need for a specialized software</li> <li>• Performance of the software</li> <li>• Low staff support costs</li> <li>• The availability of expert support</li> </ul>
<b>Main reasons for using open source software</b>	<ul style="list-style-type: none"> <li>• Better response with bug fixes and/or support</li> <li>• Better interoperability with other products</li> <li>• Saving on total cost of ownership</li> <li>• Lower likelihood of getting ‘locked in’ by a vendor</li> <li>• The modifiability of the source</li> </ul>	<ul style="list-style-type: none"> <li>• Ideological reasons</li> <li>• Saving on total cost of ownership</li> <li>• Lower likelihood of getting locked in by a vendor</li> <li>• The ability to modify source code</li> <li>• Better response with bug fixes and support</li> <li>• Better interoperability with other</li> </ul>

	<p>code as needed</p> <ul style="list-style-type: none"> <li>• The possibility of migrating data across systems</li> <li>• The need for custom made software</li> </ul>	<p>products</p> <ul style="list-style-type: none"> <li>• The need for custom made software</li> </ul>
<p><b>Main reasons for avoiding open source software</b></p>	<ul style="list-style-type: none"> <li>• Training needs</li> <li>• Legal issues</li> <li>• Interoperability and migration problems</li> <li>• Migration cost</li> </ul>	<ul style="list-style-type: none"> <li>• Training needs</li> </ul>

Table 3.21 summary of reasons for using proprietary software and open source software

## 3.2 Qualitative study

### 3.2.1 Response rate

ICT directors of all governmental institutions selected for this research, which were needed for interview, were available and interviewed per schedule. No interview was held at Unity University, the only private institution sampled for this study, because of its organizational structure there was no ICT director or any ICT official except for technical staffs.

Generally, the interview response rate was successful. One high level ICT official from every institute was supposed to be interviewed. From the total persons, six ICT officials representing the six institutes, that should be contacted for interview only one was not available. So the interview was 83 % successful.

### 3.2.2 Institutional ICT policy

According to the ICT directors of the governmental institutions interviewed for this purpose there is no stated ICT policy in use by now in any of the institutions. However, there is a draft policy about to be approved and ratified in three of the institutions. Two of these institutions have finished the draft policy and are on their way to approve and publish it. The ICT director for the other institution which has also a draft ICT policy said there is one discussion yet to be made before the policy is approved. The ICT directors for the two institutions which do not have a draft ICT policy have said they only have a network use policy in use by now. One of these institutions directors, however said there was an ICT policy being used before but it is about to change due to the business plan re engineering being implemented in their institution.

	<i><b>ICT Policy</b></i>
Institution 1	Draft ICT policy about to be approved
Institution 2	Draft ICT policy about to be approved
Institution 3	Draft ICT policy in process
Institution 4	Network use policy only
Institution 5	Network use policy only

Table3.22 ICT policy of institutions

### 3.2.3 Software considerations within the policy

The presence of an ICT policy or a draft ICT policy does not guarantee the policy explicitly considers software acquisition procedures and selection. This question was raised for those ICT directors that said they have a draft ICT policy. They all said their new institutional ICT policy includes software acquirement, selection and deployment procedures.

### 3.2.4 Open source software in policy

If policy includes issues of software selection, the next natural question for the researcher was if open source software in any way was included in this policy. The answer for this question was “Yes “by all of the respondents. The ICT director for one of the institution said their institutions’ new ICT policy advocates the use of open source software both on server and desktop level. He said the institution has been investing 30 % of its budget to purchase licensed software. He added this investment is not appropriate. Moreover, he said by using open source software they are preparing themselves for the future where software piracy will no longer be possible in the country. He also added, though their ICT policy is not yet put to use, they already started practicing it.

The second institution ICT director as well said their institution new ICT policy highly promotes the usage and deployment of open source software. He indicated they are already implementing what is written on the draft policy even if it’s not approved yet. He added that their policy recommends open source deployment on personal computers in addition to server and academic information system software. The interviewer also observed a special open source team working intensively on the ICT policy and awareness creation within the campus in this institution. They have a plan to change all the labs within the campus first to run on open source platform and then to move to personal computers. The director mentioned there is high demand and awareness about the OSS among the academic community in his institution though there is a resistance and reluctance among the administrative community.

The third institutions’ ICT director as well gave the same answer that his institution’s new ICT policy have put open source software as a preferred option due to its fast maturity and affordability but he said it is not strictly advocated. He said the reason why his institution does not advocate strict migration to open source products is because there are software the institution use that are not yet available in the open source market. He further added his institution is negotiating with Microsoft to purchase software in a

minimized cost through their special offer to third world countries. He as well mentioned feature as an issue for avoiding open source software adoption sometimes.

### 3.2.5 The extent and purpose of Open source software usage

The extent and purpose of open source software usage differs from institution to institution according to the interviews held at each institution. The director for the first institution said they currently implemented open source software fully on the server level and they are working on the desktop level migration. He said they are about to install open office in every other desktop in the campus. They also have a pool of computers running on open source platform for students to use. He also said their library system, registrar system and online registering system used in the campus are all open source products. On the server side he said their web server (Apache web server), database server (MySQL), proxy server, DNS server (Bind) and firewall are all open source software and are running on Open Suse. The open source library integrated system Koha is too running on Debian. Besides Moodle is implemented as a virtual learning environment and is now being used in this institution.

The second institution ICT director as well said they have fully migrated to open source software on the server level though they've not taken any step on the desktop deployment yet. However, he said most of the ICT services staff uses open source software (Debian) for their personal use. Furthermore, their web server (Apache web server), their proxy server and database server are all open source products and are running on Debian. The e-learning system in the campus is running on Solaris. Moodle is also being used as a virtual learning environment in the institution. Ubuntu is as well used as a main platform in this institution next to Debian.

The third institution implemented open source software on more than 90 % of its server side applications according to its ICT director. He, however, said there is no intention yet rose on desktop level migration. But, the Kennedy library labs are running on open

source platform. The electrical engineering department labs are as well dual booted and they have installed open office on windows platform for students to get use to it. The library system is also open source software (Koha). On the server level the institution uses Apache web server for the web server, proxy server ( Squid), DNS server ( Bind), the network management system all open source software but MySQL and Microsoft SQL server are both used as database server software all running on Fedora and Solaris platforms. In addition to this open source product Moodle is used as a virtual learning environment, Bind is used as LDAP server, Zimbra is used for web mail and Joomla is implemented as a content management system in the institution.

At the fourth institution the ICT director said, though they have an intention to migrate fully to open source software on servers, currently some of their server software like their web server runs on a window platform. Their database server software is also Microsoft SQL server. However, their mail server software ( Zimbra), web server software ( Apache), virtual learning environment ( Moodle) and content management system (Joomla) are all open source software running on Ubuntu, Open Suse and Fedora. At the desktop level no work is done yet at this institution. But they have two central labs running open source software for anyone interested to use.

According to the information collected from the fifth institution's ICT director, this institution has deployed open source software for its server side operating system and student information systems. The ICT director said the library and e-learning systems used in the campus are both running on Ubuntu. The database server ( MySQL ), proxy server and web server ( Apache) are all open source software. Desktop level deployment has not been yet considered in this institution as well.

### 3.2.6 Motivations and challenges of using OSS

The main motivations for using open source software seem to revolve around the issues of cost, security and customization among managers of the higher education institutions surveyed for this research.

As to the ICT director of the first institution, the main reason for the adoption of open source software in his institution is to avoid the high licensing cost of having proprietary software. He further said, despite the rampant practice of using pirated software in the country, the institution does not want to involve in such illegal endeavors and wanted to prepare itself for an affordable and yet full featured solution. The second main reason addressed by the director was security from virus attack. He said even if one cannot say open source products are not totally a target of virus writers, he said in practice they are the safest solutions at hand. He also said one of their driving forces for the wide acceptance and deployment of open source software is the influence of the Germans running the ICT office of the institution. The institution did not face any challenges yet in migrating its server side application to open source software however he indicated there is expected high resistance to change from users on the effort to migrate desktops.

According to the second institution's ICT director, cost reduction and the need for customizable software is the main motivation for adopting open source software in his institution. In addition the interviewer learned that the Belgian VLAR project also assists and funds the open source movement in the campus. The challenges mainly faced by this institution in the process of migration to OSS is the wide spread use of pirated software, lack of support and the resistance to change among the community.

The director for the third institution mentioned cost reduction as a main motivation for adopting open source software in his institution as all did. He said the cost of having licensed software is highly expensive and unaffordable for his organization so the adoption of open source software is an inevitable solution at hand. The second reason he raised was the issue of virus protection. He said it is very costly to buy licensed antivirus software these days so the only solution is to run less vulnerable software from virus attack. When he talks about the challenges they have faced in adopting open source software he raised two issues as main obstacles. These were less awareness about OSS and less expertise on open source products (most ICT staffs are Microsoft certified and are more comfortable with Windows).

The fourth institution's ICT directors' view is no different from the others; he said their main driving force into adopting open source software is the issue of cost reduction. The need for localizable software and the issue of virus attack are also reasons for this institution to migrate to open source software. The challenges this institution faced and is currently facing in using open source software include resistance to change and low expertise and personnel support. He said most of their ICT service staffs are experienced in supporting windows.

The initiative to move to an open source product in the fifth institution arose mainly from the motive to reduce cost of having a software product. In addition the director said sometimes specially on network side the features of open source software are much better than their proprietary rivals. This also is one of the reasons they adopt open source software.

<i>Main Motivations</i>	<i>Main Challenges</i>
<ul style="list-style-type: none"><li>▪ Cost reduction</li><li>▪ Security from Virus</li><li>▪ The need for customizable software</li><li>▪ Better feature ( specially on server software)</li></ul>	<ul style="list-style-type: none"><li>▪ Wide spread use of pirated software</li><li>▪ User resistance to change</li><li>▪ Lack of support</li><li>▪ Lack of awareness about OSS</li><li>▪ Lack of in house expertise and support on OSS</li></ul>

Table3.23 Summary of motivations of ICT directors for choosing to use OSS and their challenges

### 3.2.7 What the future holds

All of the governmental institutions have plans to use open source software more in the future. The future plan of the first institution is to migrate all the desktops in the campus to open source software just like what they did to the server applications. They have in mind to avoid the use of any pirated software within the compound of the institution. The director for the second institution said their future plan is to deploy open source software on labs first and then after training the ICT staff at each college/ department to train the community under their jurisdiction, they have a plan to deploy open source software on every other personal computer in the campus. They also have a short term plan to deploy open source software fully on the whole campus network services.

Within the third institution there are pre specified future plans regarding open source software except for putting it as a preferred option wherever the need for a new software acquisition arises. The fourth institution however, has a plan to work on first on the server side because some of their servers are still running on Windows platform. They have plans to teach the community and move to desktop deployment after they are done with the servers. The fifth institute also has a plan to migrate to open source software on desktop level but not in a recent time.

## 4. Discussion

### 4.1 Introduction

A number of researches and conceptual analysis worldwide has been published on open source software ideology, motivations, economic advantages, higher education adoption, policy considerations, adoption frameworks, software development paradigm, global impact, role for fast growth of developing nations in the ICT arena and its philosophical and economical influence on the education sector as it is tried to cover some of them in the literature review section of this paper. However, as to the researchers' knowledge, no research or any kind of publication have been conducted concerning the current situation of open source software adoption in the Ethiopian higher education institutes and the education sector of the country in general. The aim of this research was to find out what is going on in terms of the attitude, awareness, practice and motivations of using open source software in higher education institutions of Ethiopia and to lay foundational knowledge on the topic under study for future researches in Ethiopia.

This research provides the knowledge about the current awareness, attitude and practice of using open source software in higher education institutions of Ethiopia. It discusses the adoption of open source software on server and desktop level in the institutes. It indicates the main motivations in using open source software in these institutes whenever they do, the significance of these motivations and the challenges they are facing in doing so. It also shows the reasons open source is used on the desktop and the chief causes why open source software has not been widely deployed at the desktop level yet.

A few researches have been held on the status of open source software with in the higher education in some countries like the UK, US and China. The researcher have found it significant to compare the results found in this study with that of UK higher education open source survey results and the US best higher education open source practice survey results of 2006 because of their high resemblance in objective and study design to this

research. Therefore, comparisons will be made among these results whenever needed in the discussion that follows.

## 4.2 Discussion of Findings in relation to the research objectives

### Attitude and awareness

The main means used to find out the attitude and awareness of open source software in the institutions was to assess their explicit policy considerations towards open source software. The findings of this study indicated even though there are no specific institutional ICT policies at work in any of the higher education institutions in Ethiopia surveyed for this research, there is a draft policy on its way to be published in half of the institutions. These draft policies have considered open source software according to the highest ICT officials of these institutes. This is one of the most important findings of this research. 50 % of the institutes surveyed in this study have considered OSS in their ICT policy to be published. The considerations range from advocacy to simply putting it as an option. In UK unlike the institutions surveyed in this study 93 % of the higher and further education institutions have a stated ICT policy of which 25 % of them mentioned open source software in their policies.

The three other institutes have no institutional ICT policy at all so the only way to get their awareness and attitude towards open source software was through their practice. In practice all six (100 %) of the institutions are found to be considering open source software when they purchase and deploy software. However, one of the institutes is not using open source software except for its web server application and has indicated it has no intention at all of using open source software in the future as well. Therefore, only 83 % of the institutions are practicing the use of open source software. According to the higher education survey held in 2006 in America two thirds (75 %) of the higher education institutions were considering the option of open source software and 57 % of this institutes have implemented open source infrastructure software (such as Linux,

Apache and Open Office). In UK 77 % of the higher education institutions consider open source software in practice according to an open source watch survey in 2006 in the country. The results of this study indicate 83 % of the higher education institutions in Ethiopia are considering open source software which is very comparable with the situation in US and UK.

The awareness of ICT service staff on open source software is also another indicator of the level of awareness. As the results show though there are few ICT staffs that have an extensive knowledge on open source software, most of the staffs have basic awareness. At one of the institutions it's part of the job specifications of all staffs to support open source software while there is a specific open source special team working only on open source software in two of the institutes. Compared to the results in UK higher education ICT staff awareness in open source software in 2006, the results are almost similar.

In general the attitude and awareness among ICT officials and ICT service staffs towards open source software in 83 % of the institutes in Ethiopia is found to be high. 17 % of the institutes constituting 1 in number have not shown much interest towards open source software. Even if the awareness of open source software among 83 % of the institutes have been found high, there is a high skills and deployment practice concentrated on few interested groups. Personal belief of ICT officials in these institutes shows 82 % of them think it is better for their institute to use both proprietary software and open source software in the future while 14 % have an extreme stand in that they want their institute to use open source software only. However, the awareness of open source software among the rest of community in the institutes is very low as indicated by the ICT officials, which made it very difficult to migrate to open source software at the desktop level.

## Practice of using open source software

The practice of using open source software was assessed on server and desktop level independently. The use of open source software on servers in the higher education

institutions of Ethiopia is very high. The main areas of software use on servers were assessed in this study to find out the overall picture of the practice on servers. The main server applications that are included in the questionnaire were operating system used, mail software used, web server software being used, database server software being used and virtual learning environment being used. In addition, it was possible to find out what kind of software is used for DNS server, proxy server and firewall and for other campus information system needs like library system, finance system, registrar system, web mail and content management system through the interviews.

The results for the practice of using open source software on the server level show 83 % of this institutes use open source software almost for more than 90 % of their software needs on servers. 40 % of this institutes use only open source software on the server while 60 % of them use proprietary software some times. Linux derivatives Open suse, Debian, Fedora and Ubuntu are the most widely used open source platforms on servers in these institutes. 50 % of the institutes use open source mail software Postfix and Sendmail. The rest use other mail software but all of which different from the proprietary product Microsoft Exchange server. Open source web server software Apache is used by all (100 %) six of the institutions on web servers. Apache Tomcat server is also used by 33 % of the institutes as additional web server software. 83 % of the institutions use open source database server software MySQL and PostgreSQL. Generally open source software products are the main software used on all major server applications in the five governmental institutions of Ethiopia surveyed for this study.

Even though the consideration of open source software in general between US, UK and Ethiopian higher education institutions is comparable, the findings of this research indicate there is a much higher adoption of open source software in Ethiopian higher education institutions than the US and the UK when it comes to the percentage of deployment of each specific product. For example open source web server (Apache) is used by 53 % of the institutions in US and 57 % of the institutions in UK while it is used by all (100 %) six of the institutions in this study. Open source operating system (Linux) is used by 51 % of the institutes in US and 60 % of them in UK when it is used by 83 %

of the institutes here. Open source database server (My SQL) usage in US higher education is 38 % and it is 54 % in UK while it is being used by 83 % of the higher education institutions in Ethiopia.

The results of the interviews with the ICT officials on the purpose and extent of open source software use show open source software is used for most of the information systems in the institutions in addition to servers. It was also possible to find out the kind of software used for DNS server, proxy server and firewall in some of the institutions. Koha, an open source library system is being used in two of the institutions. Zimbra, open source web mail software is used by all five of the governmental institutions. Joomla, open source content management system, is also being used in most of the institutes. Other open source server products like Squid (proxy server), Bind (DNS server) are being used by most of the institutes.

The most significant difference between the findings of UK and US higher education open source surveys and this study is evident when it comes to the higher education specific open source software products like Moodle. Only 25 % of the US higher education institutions are actively engaged in implementing higher education specific open source software in practice in some way of which only 5 % use Moodle. The number of users of Moodle is very small in UK as well. Only 11 % of the higher education institutions in UK are using open source Virtual learning environment Moodle according to the OSS watch survey in 2006. The findings of this research have shown, however, contrary results to the situation in UK and US in that 83 % of the higher education institutions in Ethiopia use open source virtual learning environment Moodle. So in general the status of infrastructural open source software is much better in Ethiopian higher education institutes than it was in US and UK by the year 2006.

The outcomes of this study signify the practice of using open source software on desktop is almost none in all of the institutions surveyed. All (100 %) use Windows operating system on desktop. Some open source operating systems are deployed on desktops in 83% of the institutions. These desktops are mostly used by the ICT service staffs and

some interested groups only. There are one or two labs in all five of the governmental institutions with open source operating systems installed on them. Except these the rest of the desktops in all of the institutions are still running proprietary software. However, there is an intention of deploying open source software on desktops in most of the institutions future plans.

The findings of this study indicate there is a huge difference in the adoption of open source software on servers and desktops in the higher education institutions of Ethiopia selected for this research. Open source software is almost the de facto software for servers in most of the institutions while proprietary software Windows and the rest of Microsoft products are the only software used on desktops in most of these institutions. As it is evident from the results of this study open source software covers more than 90 % of the software need on servers for 83 % of the institutions while there is no one who uses open source software at the desktop level except for the ICT service staffs and some interested groups in this institutions.

The main cause for the low adoption of open source software at the desktop as described by most of the ICT officials first and for most is the wide spread use of pirated proprietary software. Due to long lived and wild use of pirated software, there are even those that do not know there is such a thing called proprietary software and that they are using an illegal copy of software. Consequently, the availability of proprietary software at no price has over shadowed the inherent advantages of using open source software for free in higher education institutions of Ethiopia as it is in many developing nations. This situation has created reluctance towards the adoption of open source software on both managers and users. Nevertheless, the director for one of the institutions said one of the motives deriving their institution in planning to migrate to open source software on desktop level is to avoid illegal use of software with in the campus.

The second reason cited by most of the directors is the resistance to change. Users are not willing to change the status quo. They are already familiar with Windows operating system and they became dependent on it since it has been there starting from their first

encounter with computers. A lot of effort is needed to change this situation which is in the future plans of many of the institutions. Lack of awareness is also mentioned by these officials as a main challenge in this regard. 53 % of ICT service staffs believe training need is the major cause of avoiding open source software on desktop.

## Main reasons for using open source software

The reasons for using open source software on servers differ from the reasons cited for using open source software on desktop. Most of the potential reasons presented for users to decide are considered essential for using open source software on servers by more than half of the respondents. They all (100 %) agree that better bug fixes/ support and better interoperability with other products than proprietary software are among the main reasons for using open source software. These reasons are also cited as important on desktop but not at first priority like on servers. This is due to the fact that bug fixes and support are mostly needed on server applications than the desktop.

The second most important reason agreed upon by most (93 %) of the respondents for using open source software is the reduction in the total cost of ownership. This reason has also been indicated vital by the results of the interviews. All of the directors cited saving on total cost of ownership as a main motivating factor for them to decide to adopt open source software for their servers. They also indicated this is one of the potential reasons they plan to migrate to open source software on the desktop in the future. This is also a potential reason for using open source software on desktop for 78 % of the respondents even though there has not been any experience in this regard yet in these institutions.

86 % of the respondents regarded lower likelihood of getting locked in by a software provider, the possibility of migrating data across systems and the ability to change source code as needed as decisive in using open source software for servers. Lower likelihood of getting locked in by a software provider are also considered as important for using open source software on desktops by 78 % of the respondents. The ability to customize software for local needs is also a decisive factor on servers for 79 % of the respondents.

ICT directors of these institutes as well mentioned the need for customizable software as a main driving force for using open source software on their servers and what motivates them to use it on desktops in the future. 57 % believe it is also a reason for using it on desktop. Ideological reasons are considered important for using open source software on servers only by 57 % of the respondents while it is the main reason for desktop level adoption taking 86 % of the respondents support. The reason why Ideological reasons have a stronger role on desktop level open source users can be due to the fact that this users that gave the responses have equal opportunity to use both proprietary and open source software for free due to software piracy highly practiced around them but they still chose to use open source software which can only happen by the individuals free choice and conviction regard less of cost advantages.

The major reasons for using open source software in US and UK are more or less similar to the findings of this research. The saving on total cost of ownership, integration with other products already in use, better feature and functionality and security were found as compelling reasons for using open source software in US higher education institutions. The same trend also holds in UK as well. Saving on total cost of ownership, avoiding vendor lock in and better interoperability with other products are the top ranked reasons for using open source software in UK higher education institutions. The reasons that are driving the adoption of open source software in Ethiopian higher education institutions that are found from this research are also not far from the reasons in US and UK. Better bug fix and support, saving on total cost of ownership, better interoperability with other products, avoiding vendor lock in and the need for custom made software are to mention as a key driver in Ethiopian higher education open source software usage according to this study.

## Main reasons for avoiding open source software

The main reasons for avoiding the use of open source software can originate from the side of the institutions situation, the perceived problems of using open source software and from the main reasons for using proprietary software. The reasons for avoiding open

source software also differ on servers and desktops. Though the percentage of respondents which regarded them as important are less than 50 % , according to the results of this study, the main factors for avoiding open source software on servers include training needs, legal issues, interoperability and migration problems and migration costs. 42 % agreed on the influence of training needs for avoiding open source software on servers. Training need is also the only vital reason supported by more than half of the respondents (53 %) for avoiding open source software on desktop.

The other perspective to see the reasons for avoiding open source software is to find out the reasons proprietary software are used both on servers and desktops. Unlike the reasons for using open source software most of the reasons picked as factors for using proprietary software does not signify the nature of the software rather they indicate the dependency of the institutions on proprietary software because of a long term use of these products.

The availability of expert support on proprietary software is raised by 77 % of the respondents as the most important reason why proprietary software is used on servers. Personnel preference is also one of the reasons supported by 59 % of respondents why proprietary software is being used on servers most of the time. Personnel preference has taken the highest support (91 %) as the most important reason from among the reasons for using proprietary software on desktop. Another 59 % of respondents as well regarded the lack of enough in house expertise on open source software as a factor for the usage of proprietary software on servers. But this was not a convincing reason for more than half of the respondents for using proprietary software on desktops. Nevertheless, 53 % agreed on the performance of the software as a reason for using proprietary software some times. The fact that the software is already in use so that there is no switching cost is also most important reason for using proprietary software on desktop along with the performance of the software and the need for a specialized software some times.

In general, these results indicate the lack of expert support on open source software, the lack of awareness, the fact that proprietary software is already in use causing migration

costs, the need for a specialized software and sometimes poor performance of open source software can be taken as potential reasons for avoiding open source software in most of the institutions in addition to training needs, legal issues and interoperability and migration problems.

## Main obstacles for full utilization of open source software

The results of this study indicate the major obstacles for full utilization of open source software in higher education institutions of Ethiopia are mainly four, which are the use of pirated proprietary software, lack of expertise in open source software, lack of awareness and resistance to change among users.

The use of pirated software had become a culture even to the extent of users not knowing that the software they are using is illegal. In addition to its illegality, this practice has overshadowed the need for a sustainable and secure solution like the use of open source software. This situation in turn caused a deeply rooted reluctance and ignorance among managers and users.

Lack of expertise in open source software is among the chief challenges for the adoption of open source software in higher education institutions of Ethiopia. ICT staffs are usually trained for proprietary software products when they are recruited. Except for one institution the rest of the institutions do not demand their staffs to have a good knowledge of supporting open source software before they are recruited. There are a group of individuals who work on open source software in most of the institutions; but they are few in number. This has caused the institutions to have less confidence on deploying open source software as much as they like.

Lack of awareness especially among desktop level users is also one of the obstacles for higher education adoption of open source software. Many of the users have not even heard of open source software let alone know what it means and what it can offer them according to ICT officials contacted for this study. Except for some computer elite

individuals and ICT staffs the rest of the community has been trained computer courses using proprietary software products and that is the only software they know. Due to this reason users only want to use what they are familiar with before.

The fourth challenge and most probably the direct result of the above three difficulties is the resistance to change. As it is indicated on the reasons for using open source software in this study 91% of them said the main driver is personnel preference. Users are not usually willing to change the status quo.

## The future of open source software in higher education institutions of Ethiopia

The measures taken towards the adoption of open source software at the server level in higher education institutions of Ethiopia is enormous, as it is found evident in the findings of this research. But the desktop level migration is almost none in these institutions. Given the danger and none sustainability of using pirated software this situation must change one way or the other. The adoption of open source software seems to have a bright future in higher education institutions of Ethiopia due to this and other reasons.

Most of the institutions surveyed in this study have indicated they have a long term plan to stop the use of pirated software and adopt open source software at the desktop. One of the institutions is already about to start the migration at the desktop. The other institution also has a plan of installing open source software in all its labs in a recent time. All the other three institutions, except for the private institute which has not considered open source software yet and has no plan to do so in the future as well, have also indicated they do plan to migrate at the desktop in the long run even though they don't know the exact time they will start to do so by now.

## 5. Strengths and Limitations of the Study

### Strengths

- One of the main strengths of this study is that it is the first research to find out the status, practice, awareness, the reasons and the challenges of using open source software in higher education institutions of Ethiopia. The fact that the research strategy is a descriptive survey and the first in the country has made the study a corner stone laying foundational knowledge about the status of Open source software adoption in the country's academic sector.
- The other core strength of this research is, since the study focuses not only on status and practice but also asses the believed decisive factors for using and avoiding open source software in these higher education institutions, it can be a source of insight for decision makers and researchers working or planning to work on this area of study.
- Administering the Survey using a pre tested and implemented questionnaire has given a great strength to the research with regard to the quality of data collected.
- The implementation of both interview and questionnaire and sometimes observation helped to gain in depth information about the issue.

### Limitations

- Time and finance has greatly limited the scope of this research. The country has so many Technical Schools, Colleges, University Colleges and Universities that make use of information system at different level and application areas. However, due to shortage of time and resources the researcher was forced to consider the Universities solely of which only six were selected. This restricted the

generalization that can be made about the higher education institution application of open source software in the country.

- The second limitation of the study was, results assessing on how many computers open source software is deployed were not included due to lack of precise data from the institutions.
  
- Lack of similar local researches and publications, to have a view of what has been done in the area locally before, was a challenge that was not overcome. The researcher has looked in every other place for locally made researches and publications in the area, but could not find any.

## 6. Conclusion and recommendations

### Conclusion

- The attitude and awareness of open source software is at a good state among ICT officials and ICT staffs but the rest of the community is almost clueless about the open source software phenomena. This can be one of the causes for the significant difference in the adoption of open source software at the server and the desktop in most of the institutions. Awareness and attitude assessment through policy considerations indicate open source is considered in the draft policies of half of the institutions in Ethiopia. On an individual scale a few selected ICT officials have an extensive awareness while the majorities have basic awareness in most of the institutions.
- The server level practice of opting for open source solutions had been found very high in higher education institutions of Ethiopia. More than 90 % of server level applications are open source in 83 % of the institutions. Open source software Apache Web server, Moodle, Linux & Linux derivative operating systems, MySQL and PostgreSQL, Postfix and Sendmail, Koha and many other open source software are extensively being used by these higher education institutions in Ethiopia. In addition, open source DNS server software, proxy server software, content management systems, library systems, and registrar systems have been found used in some of the institutions.
- Major motivations among managers for using open source software at the server are commonly found to be saving on total cost of ownership, better security from viruses and localizability and customizability. Reasons agreed upon by more than 90% of the ICT officials and ICT service staffs for using open source software on servers include better bug fixes, better interoperability with other products and saving on total cost of ownership. Next to these three, lower likelihood of getting

locked in by a vendor, the possibility of migrating data across systems, the ability to modify source code for a specific reason and the customizability of the software are the motivations in adopting open source software for servers in the institutions. However, training needs, legal issues, interoperability and migration problems and migration costs are potential reasons for excluding open source software on servers. The scarcity of expert support and the fact that some proprietary software were already being used causing migration costs have been a challenge in using open source software in most of the higher education institutions.

- The practice of deploying open source software on desktop is almost none in all of the institutions except for the personal use of some ICT staffs and interested groups. The main challenges for the adoption of open source software at the desktop are found to be the wide spread usage of pirated software, lack of awareness, resistance to change and training needs. The reasons and perceived usefulness of open source software for those few users for using open source software at the desktop include ideological reasons, saving on total cost of ownership, the ability to modify source code and customizability.

## Recommendations

Based on the findings of this research, the researcher is strongly convicted of the need for the following measures in order to improve the current situation in higher education software acquisition process and alleviate the problems they are facing right now.

### Short term recommendations

- Open standards and formats should be formulated and stimulated by a governmental body or a multi sector task group and be published for all companies and sectors to follow on their ICT development and acquisition endeavors for a better interoperability, innovation, long term access to data and avoiding dependency.
- Every aspect of software development within higher education institutions as well as within the government, especially e- government initiatives, must seriously consider the open standards, open format and open source issues in advance before any kind of investment.
- ICT policies must be prepared and put to use in all of the higher education institutions of Ethiopia for a better and organized management of ICT resources and proper handling of capacity building activates like awareness creation to be undertaken.
- Policy makers in general and higher education ICT policy makers specifically must take into consideration the benefits of Open source software in reducing cost in their decision making process and must focus on software that are most relevant in the local context. In most of the higher education ICT consumption reliability and stability of software is more preferable than functionality and high rated features.

- The use of pirated software, which blocked the effective utilization and acceptability of open source software at the desktop according to this study, must be strictly banned within the campuses and the country in general and long term solutions and strategies must be planned instead. Solutions that are less costly, long lasting and dependable like the open source initiative must be implemented at every level and in all sectors especially in the academic sector as soon as possible. Effective handling of Intellectual property right can also be possible through the promotion of open source software to bear the consequences of such laws.
  
- Training staffs with the necessary knowledge to support open source software must be the next very critical task for higher education ICT officials in Ethiopia. As the findings of this research indicate lack of expert support is found to be the main barrier for not adopting open source software in most of the institutions. One way to alleviate this problem can be by demanding the ability to support open source software at the time of new staff recruitment and by creating appropriate atmosphere for already existing staffs to have a good acquaintance and interest to open source software.
  
- Even though the awareness of high ICT officials and ICT staffs on open source software is found to be good in most of the Universities according to the results of this research, there is a lot to be done when it comes to convincing higher managerial officers and the community in general to use open source software at their personal computers. Frequent trainings and awareness creation campaigns must be mobilized by the higher education institutions both within their own community and the society in general in order to alleviate the problem of resistance to change and dependency on one kind of vendor specific product.

## Long term recommendations

- The opportunity provided for future software independence and local innovation through open source software should be seriously considered by higher education research and development officials and the government. Higher education institutions in combination with the government can create a favorable environment for open source software research and development initiatives.
- Open source software must be included in the curriculum of every student to prepare future human power that will serve the government and other sectors in this regard. The roll of higher education institutions in awareness creation, training and skills development in OSS is crucial.
- Pre requisites for proper utilization of open source software like low cost and fast internet access and intellectual property law enforcement should be given enough attention.
- Long term desktop level migration to open source software in higher education institutions and the public sector for cost effective utilization of ICT resources must be planned and preparations for it must begin.
- A mobilized effort involving all public sectors, private sectors and the nonprofit making sectors should be launched to raise public awareness and usage of open source software in the education sector and the country in general.

## Suggestions for future research

Further research can be held to extend and enhance this research especially in terms of scope for better generalization. This research has revealed the current status of open source software adoption in higher education institutions of Ethiopia and the factors and barriers inhibiting its adoption. The same research topic with the same methodology can also be repeated to assess the situation in other public and private sectors.

In addition, the researcher has noticed the necessity to consider the following research topics in the future from the outcomes of the research itself and personal experiences during the course of undertaking this research.

- Causes of user resistance to change : the case of migrating to OSS
- The impact of building OSS human expertise on the adoption rate of OSS
- What factors affect the process of software selection in the public sector of Ethiopia
- The degree of dependency on proprietary software in Ethiopia and its future Impact
- Open standards and open formats knowledge and attitude in Ethiopia
- The feasibility of Open source software policy for Ethiopia

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## Annexes

### Annex1: Questionnaire

ADDIS ABABA UNIVERSITY  
GRADUATE STUDIES  
FACULTY OF INFORMATICS  
DEPARTMENT OF INFORMATION SCIENCE

My name is Florida Alemayehu, a post-graduate student in Information Science at Addis Ababa University Faculty of informatics. Currently I am doing a Masters thesis entitled as *“The Practice of Opting for Open Source Software in Higher education Institutions of Ethiopia”*.

The objective of this self administered questionnaire is to collect data from ICT officials, managers, trainers and those that have close relation with software procurement and deployment on their practice, attitude and experience of deploying open source software in their respective institution. It will take a maximum of 15 minutes to fill the Questionnaire . You are selected to participate in this study because you have one or more of the roles mentioned above in your institution. The information you provide me is extremely important and valuable. I would like to assure you; the information that you give will be used only for the research purpose. You have full right to refuse to take part or to stop filling the Questionnaire at any time. But the information that you will provide is quite useful to achieve the objective of the study.

Considering the information you get from the general information above, I would be thankful if you spend some time to answer questions related to the issue.

Thank you for your willingness to participate in this study.

## **PART I    *Personal information***

**1. What is the name of your institution?\*** \_\_\_\_\_

**2. Do you have any of the following responsibilities in your institution?**

**Please check as many responsibilities as apply.**

- Software procurement/purchasing
- Developing institutional ICT policies
- Overseeing implementation of ICT policies
- Developing/administrating institutional ICT budgets
- Designing/approving software licensing agreements
- Approving software development in-house
- Developing ICT training

**3. Are you skilled in any of the following technical activities?**

**Please check as many activities as apply.**

- Software development
- Web design
- ICT/Software training/teaching
- Network administration
- System administration
- Database administration
- Technical support

## **PART II**

*What follows are questions about the management of and policy regarding ICT in your institution. Some of the questions refer to open source software (OSS) which is software released under a license certified by the Open Source Initiative. Typical examples of OSS are Linux (e.g., Red Hat, SuSE, Debian), Apache web server, Mozilla Firefox and OpenOffice*

**4. Does your institution have a stated ICT policy/strategy?\***

Yes       No       I don't know

**5. Does this policy or any other policy/strategy at your institution specify anything regarding software?\***

Yes       No       I don't know

**6. If your answer to Q5 is Yes, is open source software (OSS) mentioned as an option when procuring software in this policy/strategy?**

- The institution has a policy/strategy in which OSS is not mentioned
- The institution has a policy/strategy of not using OSS software
- The institution has a policy/strategy that explicitly considers OSS as an option
- The institution has a policy/strategy in which OSS is the preferred option
- I don't know

**7. In practice, is open source software (OSS) examined as an option when procuring software for your institution?\***

Yes       No

**8. In the long run, what do you think is better for your institution's computer systems: to use proprietary software or to use OSS components?\***

- To use proprietary software only
- To use some OSS components and some proprietary components
- To use OSS software only
- I don't know

**9. What best describes the awareness of OSS by staff of your institution's ICT services?\***

- There are no staffs of the institution's ICT services with any awareness of OSS
- A few staffs have basic awareness and the majorities have no awareness about OSS
- All staffs have basic awareness
- A few staffs have extensive awareness and the majorities have basic or no awareness
- All staffs have extensive OSS awareness

If none please explain \_\_\_\_\_

**10. What experience of deploying OSS does the staff of your institution's ICT services have?\***

- There are no staffs of the institution's ICT services that have deployed OSS
- A few staffs have basic experience of deploying OSS and the majorities have no experience
- All staffs have basic experience of deploying OSS
- A few staffs have extensive experience and the majorities have basic or no experiences
- A significant number of staff have extensive experience and the minority have basic or no experience

If none please explain \_\_\_\_\_

### **PART III**

***In what follows you are asked a few questions about the deployment of software on your institution's servers***

**11. What is the approximate number of servers used at your institution?\*** \_\_\_\_\_

**12. Which of the following statements applies best to your institution's deployment of software on its servers?\***

- On its server, the institution has deployed only proprietary software in the past and will continue to do so in the future
- On its server, the institution has deployed OSS in the past and will deploy only proprietary software in the future
- On its server, the institution does not deploy OSS now but it will deploy some OSS in the future
- The institution deploys some OSS on its server

**13. If you are deploying OSS on your institution's servers, to what extent is OSS used?**

- The institution's servers use only OSS components
- The institution's servers use some proprietary and some OSS components

**14. Which of the following operating systems are used on your institution's servers?**

**Please select as many operating systems as apply**

- Windows Server 2003                       Windows NT or earlier                       AIX  
 Free BSD                                       NetBSD                                       OpenBSD  
 Linux (e.g., Red Hat, SuSE, Debian)       HP-UX                                       MacOS  
 Mac OS X                       Open VMS                       OS/2                       Solaris

Other operating system (Please describe) \_\_\_\_\_

**15. Which of the following mail software are used on your institution's servers?**

**Please check as many as apply.**

- Exim                       Postfix                       Sendmail                       Exchange

Other mail software (Please describe) \_\_\_\_\_

**16. Which of the following web server software are used on your institution's servers? Please check as many as apply.**

- Apache web server                       Apache Tomcat server  
 Microsoft Internet Information Server (IIS)

**17. Which of the following database servers are used on your institution's servers? Please check as many as apply.**

- MySQL                       PostgreSQL                       Microsoft SQL Server                       Oracle

Other database server (Please describe) \_\_\_\_\_

**18. Which of the following Virtual Learning Environments are used on your institution's servers? Please check as many as apply.**

- Moodle                       Bodington                       Blackboard                       WebCT

**19. What software if any does your institution use in the following areas?**

- LDAP server                       Webmail                       Calendar/diary server  
 Content Management System       Wiki                       Blog

**20. If you are using proprietary software on your institution's servers, how important were the following**

	<b>0 = Not a reason</b>	<b>1 = A reason</b>	<b>2 = Most important reason</b>
Needed specialized software	0	1	2
Low additional upgrade costs	0	1	2
Low staff support costs	0	1	2
Personnel preferences	0	1	2
Performance of the software	0	1	2

Expert support	0	1	2
No in house expertise on OSS	0	1	2
Consultancy support was already in place	0	1	2
The software was donated	0	1	2
Software was already in use, there was no switching cost	0	1	2

**21. If you are using OSS on your institution’s servers, how important were the following reasons for using OSS?**

**0 = Not a reason      1 = A reason      2 = Most important reason**

Saving on total cost of ownership	0	1	2
The possibility of migrating data across systems	0	1	2
The possibility of migrating data from existing systems	0	1	2
For ideological reasons	0	1	2
Needed custom made software	0	1	2
Able to modify source for specific reason	0	1	2
Better response with bug fixes and/or support	0	1	2
Lower likelihood of getting ‘locked in’ by a software provider	0	1	2
Better interoperability with other products	0	1	2
Other reason (Please describe) _____			

**22. If any decisions were made to exclude OSS on your institution’s servers, how important were the following issues in these decisions?**

**0 = Not a reason      1 = A reason      2 = Most important reason**

Legal issues including license	0	1	2
Interoperability and migration problems	0	1	2
Migration costs	0	1	2
Time costs of identifying relevant software	0	1	2
Lack of information about experiences in other institutions	0	1	2
Needed 3 <sup>rd</sup> party support	0	1	2
No open source specialized software to satisfy our needs	0	1	2
Training needs	0	1	2
Meeting user expectations	0	1	2
Nobody wanted it	0	1	2

Other issues (Please describe) \_\_\_\_\_

**23. If you are using OSS on your institution's servers, who supports OSS?**

- Some individuals have the skills to support OSS but it is not part of their job specification
- It is part of the job specification of some individuals to support OSS
- It is part of the job specification of all ICT staff to support OSS
- The support of OSS is outsourced

Other (Please describe) \_\_\_\_\_

**PART IV**

***The following questions are about the use of software on desktops within your institution***

**24. Which of the following statements applies best to your institution's deployment of software on its desktops?\***

- On its desktops, the institution has deployed only proprietary software in the past and will continue to do so in the future
- On its desktops, the institution deployed OSS in the past and will deploy only proprietary software in the future
- On its desktops, the institution does not deploy OSS now but it will do some OSS in the future
- The institution deploys some OSS on its desktop

**25. If you are deploying OSS on your institution's desktops, to what extent is OSS used?**

- The institution's desktops use only OSS components
- The institution's desktops use some proprietary and some OSS components

**26. Which of the following operating systems are used on your institution's desktops? Please select as many operating systems as apply.**

- Windows XP       Windows 98 or earlier       Free BSD
- NetBSD       OpenBSD       Linux (e.g., Red Hat, SuSE, Debian)
- MacOS       MacOS X       OS/2       Solaris

Other operating system (Please describe) \_\_\_\_\_

**27. If you are using proprietary software on your institution’s desktops, how important were the following**

<b>0 = Not a reason</b>	<b>1 = A reason</b>	<b>2 = Most important reason</b>
Needed specialized software	0	1 2
Low additional upgrade costs	0	1 2
Low staff support costs	0	1 2
Personnel preferences	0	1 2
Performance of the software	0	1 2
Expert support	0	1 2
No inhouse expertise on OSS	0	1 2
Consultancy support was already in place	0	1 2
The software was donated	0	1 2
Software was already in use, there are no switching costs	0	1 2
Other reason (Please describe) _____		

**28. If you are using OSS on your institution’s desktops, how important were the following reasons for using OSS?**

<b>0 = Not a reason</b>	<b>1 = A reason</b>	<b>2 = Most important reason</b>
Saving on total cost of ownership	0	1 2
The possibility of migrating data across systems	0	1 2
The possibility of migrating data from existing systems	0	1 2
For ideological reasons	0	1 2
Needed custom made software	0	1 2
Able to modify source for specific reason	0	1 2
Better response with bug fixes and/or support	0	1 2
Lower likelihood of getting ‘locked in’ by a software provider	0	1 2
Better interoperability with other products	0	1 2
Other reason (Please describe) _____		

**29. If any decisions were made to exclude OSS on your institution’s desktops, how important were the following issues in these decisions?**

<b>0 = Not a reason</b>	<b>1 = A reason</b>	<b>2 = Most important reason</b>
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Legal issues including license	0	1	2
Interoperability and migration problems	0	1	2
Migration costs	0	1	2
Time costs of identifying relevant software	0	1	2
Lack of information about experiences in other institutions	0	1	2
Needed 3 <sup>rd</sup> party support	0	1	2
No open source specialized software to satisfy our needs	0	1	2
Training needs	0	1	2
Meeting user expectations	0	1	2
Nobody wanted it	0	1	2
Other issues (Please describe) _____			

**30. Is there anything you would like to add to the information that you gave in this questionnaire and that you have not been able to express?**

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***Thank you!***

## Annex2: Interview

1. Is there a stated ICT policy in your institution?
2. Does this policy or your draft policy specify anything regarding software?
3. Is open source software mentioned in any way in your draft policy?
4. To what extent and for what purpose is open source software being used in your institution?
5. What is your motivation behind open source software usage and what challenges have you faced in doing so?
6. What's your plan for the future regarding open source software?