

# An Educational Framework for Free and Open Source Software

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**Abstract**—As the adoption of Free and Open Source Software (FOSS) is rapidly increasing, some countries have been mandating the use of FOSS in all government sectors, while other countries are in the process of adopting FOSS strategies. In addition, many education institutions have been adopting FOSS and have a competitive advantage over other institutions. The reasons of adopting FOSS are vary from one county to another and from one institution to another. However the main drives to this strategy are total cost ownership, free to make copies and distribute to others without being worried of software legality, reliability, availability, performance and security issues. This research intended to develop the framework for adoption of FOSS in education institutions in Zanzibar to reduce cost and increase computing power to students.

**Index Terms**—Free and open source software, cost saving, computing power, education institutions, Zanzibar.

## I. INTRODUCTION

The case for developing countries like Zanzibar to adopt FOSS driven Information Technology strategy is a compelling one, due to the poor financial condition of the country. Zanzibar forms part of the United Republic People of Tanzania. It is semi-autonomy with the Zanzibar government responsibility with several internal affairs including education services.

The enhancement of Information and Communication Technologies (ICT) activities and economy of scale and development delivery by government to its citizens are the main reasons for Zanzibar Government to switch from proprietary system to FOSS strategy in the education sector. Nevertheless, FOSS is community-driven and community-serving, with more networks friendly, more customized and more empowering features and bridging the digital divide between leased developing countries and developed countries.

FOSS is a concept and practice of making program source code openly available to everyone to use it. Developers can access the source code and can modifies and add new features to meet their local needs. Hence FOSS such as GNU/Linux operating system, OpenOffice.Org, Apache HTTP web server, java programming language and PHP web scripting language has no associated license fee [1].

The adaption of FOSS in Africa is rapidly increasing. Some countries like South Africa the government policies

mandated the use of FOSS and other countries like Namibia they have been used FOSS in primary schools. In November 2009, SchoolNet Namibia, an organization providing computing resources to the million-person nation, publicly rejected Microsoft's offer to put the Windows operating system in its schools and decided to keep its existing open source Linux systems [2]

## II. REVIEW AND ANALYSIS OF FOSS

Free (as in freedom) software and Open Source Software (OSS) are often treated as the same thing. The differences between them is regards to the license mode used, their belief and how and software should be after developed for sharing, modification, and redistribution. Free software generally appears licensed with the GNU General Public License (GPL), it is free, copy left license software, free to share and change the works [3]. While OSS may use either the GPL or some other license that allows for the integration of software that may not be free software. According to free software advocates Richard Stallman, free software is a social movement [3]. However, free software is always available as OSS, but OSS is not always free software. The uses of the abbreviation FOSS, F/OSS or FLOSS (L for libre) represent Free and Open Source Software, whereas for the purpose of this research paper focus directly with FOSS.

The general concept of FOSS is allowing the source code of software publicity available to everyone. The software or binaries are available via Internet and freely downloaded and used to who want to use it. The promise of FOSS is lower cost, better quality, higher reliability, more flexibility, and an end to predatory vendor lock-in [4].

### A. Challenges that Education Institution Faces to Adopt FOSS

The challenges that Zanzibar education institutions will face after adoption of FOSS were support and FOSS user friendly features. There are two types of support that institution needs; the support that institution's developer needs to obtain to ensure that the FOSS strategy are continuous improvements to meets the needs of the institutions and users, and another support is a technical support that institutions will get from higher level (Ministry or other institutions) or internal support to ensure FOSS strategy are well implemented and maintained.

In addition, major hardware vendors such as Compaq, Dell, Hewlett-Packard, and IBM offers primary and secondary Linux support for their desktop and server system, and also Linux distribution such as RedHat, Ubuntu, etc offers supports for their operating system [5]. Whereby, the institution's developers may benefit with this type of support to get directions when they have got stack.

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On the other hand, the educations need technical support such as setup, installations and configurations. In order to overcome with this type of support, the process of adoption of FOSS will start to the university level first. After students graduated they will be employed to schools and colleges and other will be volunteers to support FOSS to the community. Simultaneously, the support from the Ministry of education and other institutions such as computer for Zanzibar school will be needed.

Furthermore, FOSS movement has been considered usability features in their new versions (e.g. Fedora 12 and Ubuntu 9.04) to influence more users to use the products. Moreover, the study conducted by LeMay (2009) of CNET Network in United State found that Ubuntu now as slick and beautiful as Mac OS X or Windows 7 has new subtle interface which make a lot of people to use as a desktop operating system [6].

The parallel development of FOSS rather than linear, which involving large communities of globally distributed developers (highly talented and motivated), providing prompt feedback to users and developers contributions with truly dependant peer review, increase level of user involvement and extremely rapid release schedules (Sowe, 2007). In each year two versions of Fedora and Ubuntu were releasing. May 2010 Fedora 13 and April 2010 Ubuntu 10.04 were released. November 2010 Fedora 14 and October 2010 Ubuntu 10.10 will be released.

### III. THE PROPOSED FRAMEWORK

The proposed framework that will fit to Zanzibar's education institutions is cost saving framework to analyze the viability of FOSS to the institutions. Figure 1 illustrates the framework.

#### A. Environmental Scanning

The essential to examine the education institutions environment has given special importance to determine the current situation against FOSS and what need to be done to ensure FOSS will be well implemented in Zanzibar education institutions.

#### B. Internal Environment

##### 1) ICT awareness

The first attempt is to determine the ICT awareness in the education institutions. This involves determining how far the institutions apply IT in their daily activities. How many computers and computer equipments does the institution have, and how efficiently assist them in their academic activities. For the institutions which don't have FOSS awareness it will be better to be trained the opportunities and benefits of FOSS before adopting it.

##### 2) Technical skills and support

Another important internal factor is technical skills and support whereby the institutions need to have strong development team for continuous improvement of FOSS mechanism. Volunteers who are ready to support the institutions are required, thus institution should motivate their staffs to be FOSS volunteers. The development team should adopt FOSS to meet their needs and they should be able to customize and add new features for the benefit of their

institution and society as a whole. In addition this team should motivate FOSS creativity within their domain and should have a plan to support other institutions that are not yet mature in FOSS technologies.

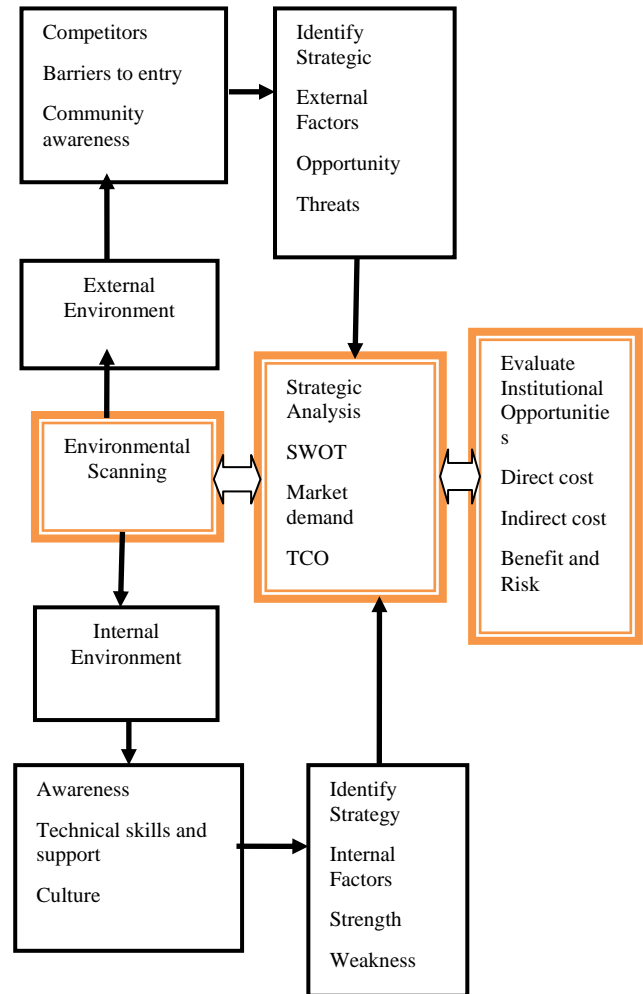


Fig. 1. FOSS cost saving framework the detailed analysis of the framework (adapted from Kenwood, 2001).

#### 3) Culture

FOSS culture should be implemented and practiced within educational institutions. Linux desktop operating system such as Ubuntu should be installed in all computers within the institutions. Open Office 3 should be used as an office automation package, together with different FOSS to be used to perform all activities within the institutions. If the FOSS culture will be well implemented within education institutions it will be easy for students to use FOSS after finishing their studies.

#### C. External Environment

##### 1) Community awareness

The society perception against FOSS needs to be examined to ensure acceptance of the new strategy to the community. The society should be well informed on what is going on in the education system and the needs of such changes in education sectors. By using local media such as radio, TV and news-papers the ministry of education will inform the society the importance of FOSS in the education system and what opportunities that the institutions would get after adoption of FOSS.

## 2) *Competitors*

The achievement of the schools that adopt FOSS and those proprietary bases should be analyzed. One among expected benefit of FOSS is to gain competitive advantage against other institutions which did not adopt FOSS. When FOSS strategy is well implemented within education institutions, the institutions will have no worry of purchasing software thus the money will be used to upgrade library and similar issues, the students will use modern way of learning, so that they will be more productive than students from other schools.

## 3) *Barrier to entry*

Entry barriers can diminish or prevent FOSS mechanism acceptance to the education institutions. These barriers would be examined and feasible solution will be planned to ensure FOSS strategy well implementation. The support is the main barrier that may hinder the adoption of FOSS in the institutions. In fact, the current situation is that schools and some colleges are not yet for FOSS mechanism; however some universities have capacity to start with. After universities (e.g. SUZA) have successfully implemented FOSS, the benefit and opportunities have clearly shown. The graduates will be employed to schools and colleges and some will become volunteers and supporter to FOSS initiatives to schools and society as a whole.

Moreover, the perception of some people that Linux is only used for server will become barrier to education institutions that they will feel FOSS is not for them rather only for administrators. This will be eliminated by educating academic staff and students by given vivid case studies such as UMU??? in Uganda which has gained high achievement after using Linux desktop operating system and other FOSS application within the university environment.

Furthermore, new improved usability feature of new Linux distribution such as Fedora 12 and Ubuntu 9.04 are no longer barrier to use Linux desktop operating system. By simulating the new improved features and given them to practice, the students will note the effectiveness and usability of this software and probable they will start to use the system.

## IV. SWOT ANALYSIS

Strength's Weakness Opportunities Threat's (SWOT) Analysis assists the institutions to expose the advantages and opportunities that will obtained when adopting FOSS.

### A. *Strength*

#### 1) *Culture of sharing*

The FOSS strategy emphasized the culture of sharing; one institution can share software with another institution without violating license of the software. In addition, the institutions will share expertise and experience as well as will create new skills to enable high success of FOSS mechanism to the institutions.

#### 2) *Long-term accessibility*

Provided that sufficient interesting and skills are available in the educational institutions, the life of open source products will continue. In addition, since the code is publicly available the academic staff and students are not entirely dependent on particular software to maintain and use it. Nevertheless they can use source code to develop software

based on their needs and requirements. In-house maintenance and support within FOSS community are always encouraged to continue the product's life indefinitely.

### B. *Weakness*

#### 1) *Hard to originate*

As noted by Kenwood [5] in order for FOSS projects to be viable, it must be able to amass a large enough community of highly skilled and interested developers to concentrate on a problem. The FOSS project must be relevant and interesting to a large group of developers, the larger the project the more development and debugging the code, so that the high level of cooperation within developers of different institutions is required.

#### 2) *Trained staff*

Due to the fact that the current curriculum is based on proprietary approach, therefore only few staffs have FOSS skills in the education institutions. However after adopting FOSS strategy to the universities the number of FOSS trained personnel will increase rapidly.

### C. *Opportunities*

#### 1) *Internet connectivity*

The technology of internet enables Linux development and support to continue 24/7 (24 hours, 7days a week) around the world. With the help of the internet, the institutions can create open source web portal, course management system (such as Moodle, Sakai project, etc) to provide students easy access learning materials. In addition with the use of email lists, newsgroups, and websites will enhance communication within education institutions and outside the institutions.

#### 2) *Many distributors*

According to Kenwood [5], there are some 204 unique distributions of Linux on the market, which are offering Linux software packages with integrated tools. Marvelous of these distributions are competing one another as the result evolution of the operating system adding more features as well as user-friendly features, improving its packaging and advertise for its use to the community. On this regard, the FOSS team will have responsibility to choose which Linux distribution is feasible to Zanzibar education institutions based on their environment and requirements.

#### 3) *Competitive support structure*

The free availability of source code of Linux and another FOSS enable many vendors to learn the platform and to provide support. Because vendors compete against one another to provide support, the quality of the support increases while the end user cost of receiving the support decreases, this make support don't rely on one vendor as proprietary does, the support continue to be available even if one support vendor goes out of business [5]. The involvement of major hardware suppliers such as Compaq, Dell, Hewlett-Packard, IBM which offers Linux support for desktop and server increases competitive and enhance quality of support.

### D. *Threats*

#### 1) *Lack of compatible application*

Applications are very important to any company; the company may select the operating system based on the nature and type of their applications to meet their goals. Proprietary application has dominated the specific application market,

such as hospital, military, etc. However, FOSS community initiatives increase to come with compatible applications in all sectors. Additionally, there is lot of applications which can be used for education institutions in their studies activities.

### *2) Needs for version control*

Since there are a lot of versions of FOSS applications with frequent releases, the education institutions should ensure that the chosen versions are integrated and compatible. However the institutions shouldn't jump to every new version, they should use experienced technology to ensure it supports their activities.

### *3) Market demand*

The analysis also involved the market demand to determine whether the FOSS movement fulfills the requirements of the society. Society needs knowledgeable people, with the effective adoption of FOSS, the community may change by utilizing modern techniques and practices. In addition, the employment opportunities will increase for students after graduating; they will be employed in government and private sectors.

## V. BENEFIT AND RISKS OF FOSS

FOSS has got many benefits compared to proprietary software. The following are benefits of Linux system versus Window NT.

### *A. Ability to Customize*

Since the source code of Linux is open, the institutions can customize the software to meet their needs. As far as programming skills are available within the education institution, programmer may expand an existing functionality to provide totally new features or system. Because of its customization, the modularity of Linux enables it to be used in a wide range of system, from supercomputer to a refrigerator and is more preferred over Windows NT for isolated, single task servers, such as DNS, File, Mail and Web [5]

### *B. Availability/Reliability*

This is the amount of time a system is up and running. The survey conducted by Blood Research company found that, after running both Linux and Window system for a one year test, Linux crashed once due to hardware fault (disk problems), which took 4 hours to fix. Window NT crashed 68 times, caused by hardware problems, memory (26 times), file management (8 times), and various odd problems (33 times). All this took 65 hours to fix. These showed that Linux is more reliable than Window system [8]

### *C. Design Flexibility*

The Linux kernel can be customized to accommodate new features to meet the institution needs. Several educational applications can be designed to support education development.

### *D. Security*

By comparing security issues, Linux is more secure than Windows system. Windows machines are attacked more by virus, Trojan, worms and other malware. Because windows are more vulnerable by viruses is not probable that windows desktop software dominate the desktop computers. In fact,

many viruses, Trojan, worms and other malware that infect windows machines do so through vulnerability in Microsoft Outlook and internet explorer [8]. The design of Window is a source of this vulnerability, Petreley [8] identified the main reasons are:

Windows origin is single-user system, which was designed to allow both user and applications free access the entire system. This means even viruses, Trojan and other malware could temper with any critical system program or file. Although Windows XP, Window 7 and Windows Server 2003 represented progress to isolate users and applications from sensitive areas of the operating system towards true multi-user capabilities, however haven't escaped all of the leftover single-user security holes.

On the other hand Linux has been designed from the ground-up to isolate users from applications, files and directories that affect the entire operating system. Each user is given a user directory where all of the user data files and configuration files are stored. So that it is nearly impossible to send an email to a Linux user that will infect the entire machine with a virus, but even if they did, the most damage or delete is the user's own files. 92 percent of those surveyed conducted have never experienced a virus, Trojan, or other malware infection on Linux [8]

Windows is monolithic system that is unstable by nature, because the system has many interdependencies whereas most features are integrated into single unit. This architecture mode puts far too many features in the core central sphere where most damage can be done tends to make security vulnerabilities more critical than they need to be. On the other hand, Linux is for the most part a modularly designed operating system, from the kernel to the applications. This means whenever a task can be done outside the kernel, it must be done outside the kernel, thus no users and even virus are able to access to the vulnerable parts of a Linux system.

## VI. RISK OF FOSS

Although there are many benefits of FOSS for education institutions as mentioned earlier, however the FOSS technologies are not without risk. The risk of FOSS will depend on institution environment, knowledge and skill of internal personnel and the licensing model chosen. The institution should develop a risk assessment team to examine each of the risk associated with FOSS, rate those risks in the context of their institutions, and recommend strategies to mitigate those risks before proceeding with the development of FOSS strategy.

The risk of FOSS in education institution are lack of support; review software licensing models (to choose model that aligns with their intension), the ability of programmer to see the code causing problem and change it to fix problem; and form an open source advisory group, for advising and monitoring FOSS strategy [8].

After the institution identified, and analyzed the risk of FOSS, they should mitigate cost and risks associated with FOSS. Giera [9] described the set of activities the institutions can do to minimize the costs and risks of FOSS.

- Plan appropriately: FOSS can provide great benefits but the institutions have to cover the bases before deploying these platforms.
- Establish risk assessment teams: Getting the Ministry officers, academic staffs, audit, finance, and security to assess and plan for the ministry's unique risk is a crucial component of a successful FOSS strategy.
- Get an advisory group: Formalized the risk team to advice on FOSS risks.
- Get help: Institutions should employ the services of third-party providers, if only in small, emergency support contracts to minimize the risks of downtime and other production problems. Organization such as Computer for Zanzibar School (CZS), and experienced universities (such as SUZA) will be used to support the institutions before being gained FOSS experiences.
- Track costs: Institutions should establish ongoing measurements for support, maintenance, and cost of management tools and costs of training.

## VII. CONCLUSION AND RECOMMENDATIONS

The adoption of FOSS varies from one country or institution to another, the strategy that taken by certain country (such as Brazil and South Africa) or institutions (such as Tamar school and UMU), cannot be best fit to Zanzibar. Environment changes, poverty level, computer illiterate, internet penetration and FOSS awareness are the main factors that make a difference between Zanzibar with other countries or institutions that has been adopt FOSS. However detailed analysis must be made to determine the impact of FOSS in Zanzibar education institutions before adopt it. The following recommendations are important for implementation of FOSS strategy.

First, amending school syllabus to open standard, which will involves FOSS courses that students will study from primary schools to universities. For primary schools they will use FOSS for word processor and gaming, more efforts should be applied to higher education institutions and secondary schools whereas FOSS to be among core courses of the students.

Second, the formation of FOSS team which comprises lecturers from Universities (such as SUZA) who are familiar with FOSS and other members from Ministry of education. The aim of FOSS team is to provide consultations and prepare curriculum which would be used in education institutions. Hundreds of FOSS systems are now in widespread used by thousands, or in some cases, millions of end-users [10]. Thus, FOSS team should pursue detailed analysis to determine which FOSS systems are suitable for Zanzibar education institutions to bring relative knowledge to students.

Third, Computer for Zanzibar School (CZS) is NGO registered to provide free computers to schools. The CZS will be used as a FOSS center. Because most of its members are IT professional and the secretary is one among Linux guru in Zanzibar, thus it will be ease to integrate with open standard. To this extent, the CZS would be responsible for technical supports and advises to education institutions.

A Final recommendation, the government through Ministry of education with involvement of CZS and universities would establish FOSS Research Center. The aim of this center is to conduct FOSS researches and to carry out different FOSS projects to support ICT strategy in education. Some of the projects that center would conduct are:

- Wireless connection projects for all education institutions in Zanzibar, which able them to share contents and increase relationships within schools.
- School web portals and databases, to enhance sharing of materials and software between schools.

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