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An empirical study of Factors contributing to the adoption of Free Desktop Open Source Software in Africa: A case of Kenya university students

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Abstract

Open source software has been in existence for some timebut its adoption among non-expert users has not been realized especially in developing countries. A number of critical factors such as performance expectancy, effort expectancy and facilitating conditions have been suggested as the determinants of Information and Communication Technologies (ICT) adoption in general. This study aimed to establishthe factors that determinethe adoption of free desktop open source software among university students in a developing country in Africa, in this case Kenya.Data was collected from 384 students from 17 different universities in Kenya. Based on technology adoption related studies in the literature six factors were used in designing the conceptual framework of this study which largely borrowed from the Extended Unified theory of acceptance and use of Technology (EUTAUT). The adjusted conceptual framework included indigenous factors in the Kenyan context that were found to influence the adoption of free desktop OSS. The six factors are user training, usability, compatibility, social influence, and social economic status.The empirical study revealed that user training, usability, OSS compatibility, social influence, prior experience and social economic status have significant combined effect on OSS adoption. The study further established that user training, OSS compatibility and social economic status have significant individual influence on OSS adoption at 10% level of significance.

Keywords: Freedesktop open source software, adoption, developing countries, voluntary technology adoption.

1. INTRODUCTION

Open source software (OSS) can be defined as a program whose source code is made freely available for anyone to change and distribute provided they abide by the accompanying license [1]. The fundamental intention of open source licensing is to deny anybody the right to *exclusively* exploit a software program, in order to allow many people to easily access the program [2].

Another closely related term to OSS is free software. The free software movement is championed by the free software foundation. Free software is defined as software which "the users have the freedom to run, copy, distribute, study, change and improve" [3]. Although the two movements differ in some areas, the Free Software Foundation (2014) acknowledges that the two have a common "enemy", proprietary software. The two terms OSS and free software nearly describe almost the same category of software but they stand for views based on fundamentally different values [4]. OSS is a development methodology while free software is a social movement. Stallman (2000) argues that free software is an ethical imperative because only free software respects the users' freedom. On the other hand OSS "considers issues in terms of how to make software 'better' in a practical sense only" Stallman (2000 pg 31).

There has been a lot of advocacy for OSS by different movements because of the perceived benefits of the software. The Open Source Initiative (1998)suggests that OSS could offer better products because open source software can be improved faster than conventional commercial software. This is because many programmers read, distribute and modify the source code and hence there is a rapid evolutionary process producing better software than the traditional closed model. This study focusses on OSS that is distributed at no fee and therefore is regarded as free Open Source Software.

Possession of personal computers in Kenya and in the African continent in general has been on the increase among individual users [5, 6]. The diminishing digital gap between the developed countries and the developing countries is a good ingredient in spurring economic growth in African countries. Despite the fact that ICT has a major role to play in economic development, the affordability of proprietary computer software has been a major issue for many computer users in developing countries [7]. Microsoft Windows operating system family and the Microsoft Office family are examples of common proprietary software.

In an EDC the cost of a software product on average, is in most cases, higher than an individual's yearly income (Ghosh, 2003). Bearing in mind the economic status of EDCs, one would expect that individuals in these countries would adopt free OSS as a natural choice leading to high adoption levels. Nevertheless, Reijswoud&Mulo (2007), observe that the assimilation of free OSS is limited even though international non-governmental organisations (NGOs) and organisations whose goal is to encourage and support economic development have been encouraging the adoption of free OSS software in these countries due to the economic benefits.

There was optimism in the early years of OSS development that the software would overtake proprietary software (PS) in adoption [8]. Nevertheless OSS products have not been widely adopted especially in Africa[9]. Current market share reports reveal that OSS products such as Linux and Firefox are lagging significantly in adoption [10].

Kenya is an emerging and developing economy as classified by the International Monetary Fund [11]. The population was estimated to stand at 43.0 million in the year 2014 [12]. The country also has a total geographical area of 591,971 Sq. Kilometres [12]. Although there are limited studies on actual computer literacy levels and access to computing devices by citizens and in the country, the ICT sector has been growing at impressive rates [13]. Over the last few years internet subscription has grown tremendously especially that of terrestrial mobile from 1,562,065 in 2009 to 8,436,578 in 2012 [12]. International Data Corporation (2014), estimates that ICT spending covering hardware, software, Information Technology (IT) and communication services has grown from 8.9% of Gross Domestic Product (GDP) in 2006 to an estimated 12.1% of GDP in 2013.

Technology acceptance models have been used in the past to explain the uptake of new technologies such as free desktop OSS. Technology Acceptance Model, Model of PC Utilization and Diffusion of Innovations are some of the models that have been developed over the years. These models seek to explain how and why individuals and organizations adopt new information technologies in general [14].

Open source software is a relatively new idea to many computer users in countries with developing economies such as Kenya. It is important to understand the factors that could affect adoption of free desktop OSS in Kenya. Possible factors that contribute to technology use behaviour which have been suggested in a recent model are; performance expectancy, effort expectancy, social influence and price value among others [15]. Major research gaps exist in the area of OSS adoption as it is clear that its adoption has received little attention [16].

Problem Statement

The adoption of free desktop open source software applications in developing countries is very low despite the apparent benefits of the software. The low adoption of free desktop OSS situation in developing countries in Africa introduces a need to understand the situation and the factors that contribute to the low adoption levels.

Justification

Although a lot of research has been conducted in the area of OSS, the studies have concentrated mainly on the motivations of open source programmers and the project management of specific products [17, 18, 19]. According to these authors, although some research has been conducted on OSS adoption these studies have either concentrated on the adoption of specific open source products, have been conducted with companies outside of Europe (excluding Africa) or have concentrated largely on public administrations and companies operating in the primary software sector. Similar observations were made by Cenatic (2010) who noted that, major research gaps existed in the area of OSS adoption. Despite the fact that these studies were general and did not have an African focus, other studies by Johnston et al., (2013) and Bakar et al., (2014), have recommended the need for further research in Africa to establish the reasons for the low adoption of free OSS and the factors that could lead to its adoption. In addition the factors contributing to free OSS adoption by individuals is an area that has received very little attention compared to that of organisational adoption [20].

This study focuses on university students because the students fall in the category of the most literate in developing countries. They also generally use computers to a great extent in their studies and research as noted by empirical studies conducted in the past [21].

Research Objectives

The aim of this study is to achieve the following:

1. To investigate the factors affecting adoption of free desktop open source software by university students in Kenya
2. To investigate the relationships among factors such as usability, social influence

Significance of the study

The results of this study will inform free desktop open source software adoption stakeholders on the areas of improvement in order to increase its adoption guided by the independent variables identified by this study. This might play a critical role in increasing the level of free OSS adoption in the country and consequently lowering the software acquisition costs.

The findings of this study will also be useful to OSS developers, training institutions, software developers, the government of Kenya and others interested in promoting free desktop OSS adoption. The findings of this study will be useful in predicting free desktop OSS adoption in African countries which will inform design changes before users use Desktop OSS products. The findings contained in this paper could make a major contribution in achieving developing countries development goals and provide a basis for conducting further research in the area.

2. LITERATURE REVIEW

OSS is perceived to have a number of advantages, as discussed by several advocates of OSS and authors around the world. Some of the perceived benefits are cost saving, security, allowing customisation, reliability, offering better quality, customer support from a community, escaping vendor lock-in, encouraging innovations [22, 23].

A number of factors have been identified as affecting the adoption of technology such as Information Communication Technology. The common technology acceptance models are Technology Acceptance model (TAM), Motivational Model (MM), Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), combined TAM and TPB, Model of PC Utilisation (MPCU), Diffusion of Innovation (DoI), Social Cognitive Theory (SCT), Unified theory of acceptance and use of Technology (UTAUT) and Extended Unified theory of acceptance and use of Technology (EUTAUT) [14, 24, 25, 26]. Common factors identified by the technology adoption models are performance expectancy, effort expectancy, cost/price value, social influence, and facilitating conditions, hedonic motivation, behavioural intention and habit. The factors are discussed below;

Performance expectancy

Performance expectancy can be defined as the extent to which a person believes that using a system will help him or her achieve better results in job performance [14]. Performance expectancy is similar or closely related to perceived usefulness in TAM, Extrinsic motivation in MM, job fit in MPCU, relative advantage in DoI, and outcome expectations in SCT [27]. Venkatesh, et al., (2003) closely relates performance expectancy with perceived usefulness, extrinsic motivation and job fit. Performance expectancy is also a major construct in EUTAUT. Studies that have investigated technology adoption in organisations have established that performance expectancy is the main driver of technology adoption [15].

Effort expectancy

Effort expectancy can be defined as the level of ease associated with the use of a system [14]. Effort expectancy is similar to perceived ease of use, complexity and ease of use [27]. Perceived ease of use is one of the main constructs in TAM, complexity in MPCU and ease of use in IDT [15]. Effort expectancy is one of the main constructs in both UTAUT and EUTAUT [15]. Effort expectancy is closely related to usability which is defined as 'the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use'[28].

Although OSS has been in existence for some years now, issues of usability seem not to have received sufficient attention. One of the main advantages of PS over OSS is usability and if OSS has to compete with PS, the OSS developers need to ensure that its usability is at par with that of PS software [29, 8].

Cost/price value

The price of a software product is perceived to be an important factor for individual consumers because they normally have to bear the cost of the product [15]. Studies that have been conducted indicate that price is a significant factor that has an influence on consumer behaviour [30]. The UTAUT model had not captured this important construct and therefore in the EUTAUT, it was included in order to customise the model to the context of consumer technology use [15].

Social influence

Social influence is the level to which a consumer perceives that others who are important to the consumer believe he should use a product [14]. In the recent past technology adoption studies are focusing on social influence as a factor contributing to technology adoption [31].

There is a wide body of literature indicating that social influence is a significant factor that influences behaviour in a number of domains [32]. A study conducted in the area of OSS adoption indicated that social influence has a significant role in adoption of OSS technologies [33].
Social influence as a construct technology acceptance models is equivalent to social norms in TRA, social factors in MPCU and image in DoI[27]. Although the construct has different names in the models (TRA, MPCU, UTAUT) it bears the same meaning as the constructs contain the implicit or explicit belief that the behaviour of a consumer is influenced by the way they believe others will view them as a result of using a technology [14].

Facilitating conditions

Facilitating conditions means the extent to which a person believes that organisational and technical infrastructure exists to support the use of the system [14]. The term facilitating conditions is also used in MPCU although in DoI it is referred to as compatibility [27]. In DoI compatibility is defined as the extent to which an innovation is thought to be consistent with the current values previous experiences and requirements of potential adopters [34]. Studies have revealed that facilitating conditions play a significant role in the adoption of a technology especially for older workers in an organisational setup and that was the reason for including it in UTAUT [14]. In EUTAUT, the facilitating conditions construct is present and has a significant effect on behavioural intention [15].

Hedonic motivation

Hedonic motivation is the perceived fun or pleasure that results from using a technology [15]. Subjective norm bears the same meaning with hedonic motivation which is a major construct in TPB [35]. Subjective norm is the perceived social pleasure to perform the behaviour in question [36]. Hedonic motivation is perceived to be significant in a household PC usage setup and not in a workplace setting because the aspect of fun is not relevant in a workplace setting [37]. Hedonic motivation is a construct in the Model of Adoption Technology in Households (MATH), which was initially proposed by Ajzen (1991) and modified by Brown & Venkatesh (2005) who retained the construct in the modified model.
In MATH the hedonic motivation construct is present with the name hedonic outcomes and in EUTAUT the name hedonic motivation is used to refer to the same construct.

Behavioural intention

Behavioural intention is a construct that represents an individual's deliberate plan to apply effort to carry out a behaviour [38]. In UTAUT, behavioural intention predicts usage behaviour and is (behavioural intention) determined by performance expectancy, effort expectancy and social influence [14]. Behavioural intention is also present in TRA as a determinant of behaviour [36]. EUTAUT also has the behavioural intention construct as a determinant of use behaviour [15]. Empirical studies for some time now have established that individuals often fail to act according to their stated intentions [39]. Some recent studies have also challenged the role of behavioural intention as a key predictor of technology use [40].

Habit

Habit is defined as a repeated behavioural pattern that an individual performs automatically without being conscious [41]. Once a behaviour has been repeated routinely, a mental linkage is established that activates a routinized behaviour [40]. Habit is a related term to experience although different because experience is necessary but not sufficient when an individual is forming a habit [15]. Venkatesh et al., (2012) note that in the context of technology use, habit is a perceptual construct that reflects the results of previous experiences. Habit is a one of the new constructs that were introduced in EUTAUT [15]. The habit construct has also been incorporated into the expectation confirmation theory (ECT) because it provides extra explanatory power in explaining IS adoption [42]. Limayem et al., (2007) suggest that, prior use predicts habit because once an individual has used a technology previously, the individual is likely to continue using the technology and it eventually becomes a behaviour.

Table 1. A comparison of the constructs in the common technology adoption models

Construct	**Constructs with a similar meaning**	**Models/theories using**
Performance expectancy	perceived usefulness, Extrinsic motivation, job fit, relative advantage	TAM, MPCU, DoI, SCT, EUTAUT, UTAUT
Effort expectancy	Perceived ease of use, complexity, ease of use	TAM, MPCU, DoI, UTAUT, EUTAUT
Cost	price value	E-UTAUT

Social influence	social norms, social factors, Image	TRA, MPCU, DoI, UTAUT, EUTAUT
Facilitating conditions	Compatibility	DoI, UTAUT, EUTAUT
Hedonic motivation	Subjective norm	TPB, EUTAUT
Behavioural intention		TRA, UTAUT, EUTAUT
Habit		EUTAUT

Source: Researcher
The table above reveals that EUTAUT has all the eight constructs identified from the different common technology adoption models. The eight constructs of EUTAUT are performance expectancy, effort expectancy, cost/price value, social influence, and facilitating conditions, hedonic motivation, behavioural intention and habit. EUTAUT was developed with the aim of predicting voluntary technology adoption and was tested in the mobile internet consumer context [15]. EUTAUT synthesised all its major predecessors and accommodated all the constructs although some have different names as demonstrated by the above table [43].

Other factors considered to contribute to Free Desktop OSS adoption

The literature reviewed indicates that there are some other factorsthat are likely to contribute to the adoption of free desktop OSS in the Kenyan setup but have not been explicitly captured by the existing technology adoption models. The factors are discussed below;

User training

Several researchers have established that training is an important component in the adoption of computer applications and technology [44, 45, 46, 47, 48, 49]. A study conducted by Nelson et al., (1987) concluded that user training facilitates individuals to use Information Systems and also established a relationship between end user ability to use an information system and the adoption of the same.

A study conducted by Hung et al., (2012) that sought to identify influential factors that contribute to the National Healthcare Services Systems success in Taiwan, established that user training is a major factor that contributes to system use and in turn user satisfaction. This finding supports the earlier finding by Nelson & Cheney (1987), which advanced the same theory. User training is the most important stage in the implementation of new software [50].

OSS Compatibility with other software
According to Dedrick& West (2004), the decision to implement OSS platforms is greatly influenced by the compatibility of the new technology with current technologies, skills and tasks. In their view, compatibility with current applications is a major concern in the adoption decision. In their study they established that the lack of Linux support for applications such as PeopleSoft and See Beyond was a barrier to adoption in organisations. Another study conducted by Johnston et, al. (2013), revealed that product compatibility is the most problematic technological factor because in many organisations Microsoft is the common standard. The study further revealed that compatibility can be an issue, with regard to the file formats of the different products.

Skills compatibility

Compatibility with current skills is another factor that contributes to the adoption of OSS because in some cases the users and IT support staff have to be given time to adapt to incompatibilities between OSS and other proprietary products[16]. According to them, implementation of OSS products has implications regarding staffing needs where in some cases it is difficult to find system or network administrators with the necessary skill to handle the new OSS environment. Another study conducted by Johnston et al., (2013), contradicted the above findings because the respondents did not see skills as an important or an influencing factor at all because they believe that they can learn from their colleagues or from the experts. Users who have skills that are incompatible with a new software product might need some training to enable them use the new product.

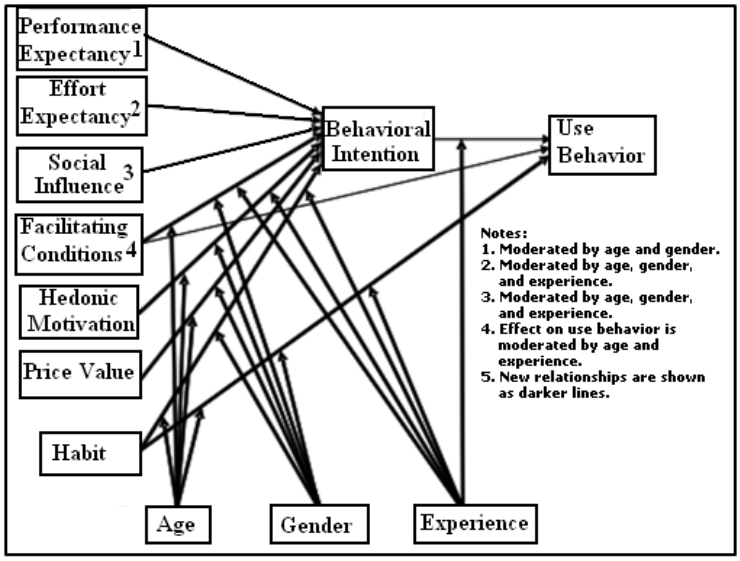
Prior experience

Users with prior experience of a technology are more likely to use it because experience makes knowledge more accessible in memory [51]. Knowledge gained from past behaviour helps to shape intention to use a technology implying that IT usage may be more effectively modelled for experienced users [36].

Extended Unified Theory of Acceptance and Use of Technology (EUTAUT)

This study adopted a modified EUTAUT as a theoretical framework. The Extended Unified Theory of Acceptance and Use of Technology is a recent adjustment of the UTAUT. UTAUT model suggests three direct determinants of intention to use which are; performance expectancy, effort expectancy and social influence. It also suggests two determinants of usage behaviour which are intention and facilitating conditions. The moderating factors are experience, voluntariness, gender and age. EUTAUT made some improvements on UTAUT by incorporating three additional factors, hedonic motivation such as enjoyment, price value of the technology and habit [15].

Figure 1:Extended Unified Theory of Acceptance and Use of Technology

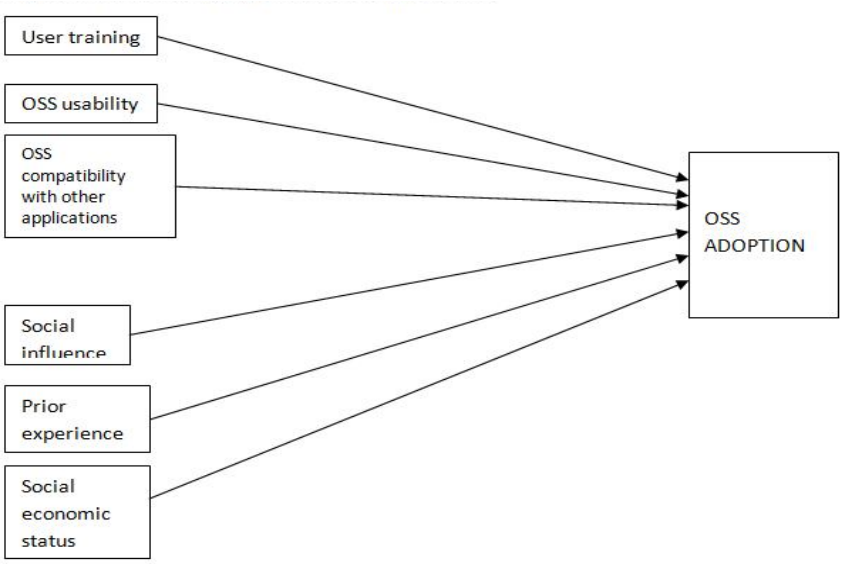


Source: [15]

Conceptual model

The diagram below shows the conceptual model on which this research is based.

Figure 2: OSS in developing countries conceptual model



Source: researcher's

And thus the hypotheses:
Hypothesis 1 (H1): user training has a positive and direct effect on OSS Adoption
Hypothesis 2 (H2): OSS usability has a positive and direct effect on OSS Adoption
Hypothesis 3 (H3): OSS compatibility with other applications has a positive and direct effect on OSS Adoption
Hypothesis 4 (H4): social influence has a positive and direct effect on OSS Adoption
Hypothesis 5 (H5): prior experience has a positive and direct effect on OSS Adoption
Hypothesis 6 (H6): social economic status has a positive and direct effect on OSS Adoption

Justification for the hypothesis

Hypothesis 1 (H1): user training has a positive and direct effect on OSS Adoption
The author hypothesises that if users are trained on OSS use, they will be motivated to use OSS because they are less likely to have challenges while using OSS. In this case training will encourage adoption of Desktop OSS by users.
As discussed in earlier user training plays a very important role in the adoption of computer applications and technology [45, 32, 52]. Studies have proved that user training programs on computer skills have a strong influence on the acceptance and sustained usage of new systems [46]. This hypothesis is also supported by TPB which has a construct called perceived behavioural control [36].

Hypothesis 2 (H2): OSS usability has a positive and direct effect on OSS Adoption
The author hypothesises that if OSS is usable, many users will enjoy using the software as they can easily perform the tasks. When users enjoy performing tasks in particular software, they are likely to adopt that software. The construct is supported by many models although in different terms. In TAM it is equivalent to perceived ease of use, in MPCU and DoI, it can be equated to complexity, in UTAUT and E-UTAUT it is effort expectancy. Effort expectancy in UTAUT and EUTAUT means the level of ease associated with the use of an application [14]. Studies on discretionary use of information systems have proved that effort expectancy is a major determinant of the intention to use a system [15].
Hypothesis 3 (H3): OSS compatibility with other applications has a positive and direct effect on OSS Adoption
This hypothesis is based on the fact that many OSS products are not compatible with proprietary products. The human computer interaction features such as icons for example used by PS are different from the ones used by OSS software. In this case a user who is used to PS may not find it easy to use OSS because the PS knowledge is not transferable to the equivalent OSS product. Another aspect of compatibility is in document portability from OSS application software to an equivalent PS product.
The concept of compatibility is deemed important in the adoption of an innovation and it is one important aspect that Rogers (1983) considered to be a determinant of technology adoption. In DoI, an innovation is adopted faster if it is consistent with past ideas and past experiences [53].
Hypothesis 4 (H4): social influence has a positive and direct effect on OSS Adoption
Empirical studies have demonstrated that social influence is a determinant of technology adoption (Venkatesh et al., 2012). This study hypothesises that peers can influence the adoption of OSS products among university students. University students are subject to influence from peers, lecturers etc.
Hypothesis 5 (H5): prior experience has a positive and direct effect on OSS Adoption
In this the author hypothesises that if a computer user has used an OSS product before either at a school that he/she attended earlier, in a cybercafé or another place, that user is more likely to adopt that OSS product.
Studies have proved that users with prior experience of a technology are more likely to use it because experience makes knowledge more accessible in memory [51]. Knowledge gained from past behaviour helps to shape intention to use a technology implying that IT usage may be more effectively modelled for experienced users [36]. This hypothesis is also supported by TPB which has a construct called perceived behavioural control which is discussed in section **Error! Reference source not found.**[36]. Prior experience develops behavioural control because it increases an individual's confidence in their ability to use a computer application.

Hypothesis 6 (H6): social economic status has a positive and direct effect on OSS Adoption

The author hypothesises that users that have limited financial resources are more likely to adopt OSS. This is because OSS is obtained for free or at a very minimal downloading cost. Computer users with unlimited financial resources are less likely to adopt OSS because they can easily afford PS. This study expects that majority of the students in developing countries come from poor backgrounds and therefore not able to afford PS because of its exorbitant cost.
Software price value has been proved to be a major determinant of adoption of technologies in voluntary setup because the consumer usually bears the monetary cost of use [15]. Although the construct is not present in other technology adoption models, Venkatesh, et al., (2012) proved that the construct played a significant role in a consumer technology use setup.

3. RESEARCH DESIGN AND METHODOLOGY

This study employed a quantitative approach in collecting and analysing data. The explanatory or analytical research design was used to measure therelationship between the independent and dependent variables.

Data collection tools

The collection of data was conducted through the use of closed ended questionnaires with a general structure of Likert scale questions with a pre-existing set of answers. A sample population of students in Kenyan universities was used as respondents. Before the actual survey was undertaken, the researcher tested the questionnaire as a data collection instrument by conducting a pilot survey. The questionnaire was improved based on the findings of the pilot study. After the pilot study, random sampling was used to determine the respondents of the actual study which was determined by the number of universities in Kenya and the total number of students.

Sample size

In this study a formula proposed by Kothari (2004), was used to determine the sample size. The population of students in Kenyan universities is finite and the formula below was used to determine the sample size (Kothari, 2004).

$$n = \frac{Z^2 \cdot p \cdot q \cdot N}{e^2 (N - 1) + Z^2 \cdot p \cdot q}$$

Where:
p = sample proportion, $q = 1 - p$;
z = the value of the standard variate at a given confidence level and to be worked out from the table showing the area under a Normal curve;
N = size of population
e = acceptable error (the precision)
n = sample size

Based on the above formula the sample size based on the total number of students of 182,253 students in the year 2010/2011 worked out to 384. A representative sample from each university was calculated based on the student population in each of the university. The above sample per university participated in filling in the questionnaires.

Sampling method

Purposive sampling technique was used in this study. A purposive sample was selected in 17 universities (16 from the National Bureau of statistics list and 1 new fast growing university) to identify a sample of students to be involved in the study. Purposive sampling was used because not all the university students have used desktop OSS and for that reason any student selected from the population would not have given useful feedback. Therefore purposive sampling was used to select respondents who have used OSS and actually own a personal computer. The students to be used in the study needed to satisfy the following criteria;

i. Must have used desktop OSS
ii. Own or have access to a personal computer in which they can install software without authorisation restrictions

Validity and Reliability of the instrument

In order to ensure credible results the researcher conducted pilot and statistical tests in order to ensure that the instruments were valid and reliableas explained in the subsection below. In this study reliability of the research instrument was done using Cronbach's alpha reliability coefficient. The results of the Cronbach's alpha reliability coefficient are shown in Table 1.

Table 1: Cronbach's alpha reliability coefficient

Measurement Items (Interval Scale)	Items	Cronbach' Alpha	Reliability Results	Inter-ItemCorrelation	Item-to-total correlation

OSS usability	*5*	*0.758*	Acceptable	*0.742-0.825*	*0.821-0.864*
User training	*5*	*0.757*	Acceptable	*0.520-0.769*	*0.650-0.821*
OSS compatibility with other applications	*5*	*0.837*	Good	*0.767-0.841*	*0.734-0.869*
Social influence	*5*	*0.829*	Good	*0.502-0.651*	*0.556-0.757*
Prior experience	*5*	*0.843*	Good	*0.506-0.915*	*0.506-0.834*
Social economic status	*5*	*0.764*	Acceptable	*0.760-0.785*	*0.645-0.867*
OSS adoption	*5*	*0.781*	Acceptable	*0.807-0.890*	*0.594-0.673*

Source: Author

The above tested consistency reliabilities for measurement of items which were based on Cronbach's alpha reliability. The measurement items were found to be suitable because Cronbach' Alpha values were greater than 0.70. According to Sekaran (2003), the closer the Cronbach's alpha is to 1, the greater the internal consistency reliability. This was an indication that the questionnaire items in each set of questions testing an area of interest such as OSS usability were positively correlated to each other.

ANALYSIS AND RESULTS

DEMOGRAPHICS

Fifty five point seven per cent (55.7%) of the respondents were male while the rest forty four point three per cent (44.3 %) were female. The ages represented by the respondents raged from eighteen to twenty six (18-26) who were in different years of study at the various universities.

Questionnaire results

The questionnaire results were initially analysed using a descriptive approach in order to depict certain trends from the data and to determine the factors affecting adoption of OSS. Regression analysis was used to establish the nature of the relationship between the different variables.

The descriptive analysis for the questionnaires are discussed below in the different categories

Usability

Ninety nine point five percent (95.5%) of the respondents perceived that OSS is not user friendly compared to PS such as Ms Office and Windows. Ninety nine point two percent perceived that the icons used by desktop OSS are not easily recognisable. Ninety seven point four per cent of the respondents perceived that PS has better help facilities.

Social influence

Ninety six point four per cent of the respondents disagreed that people who influence their behaviour think that they should use Open source software. This is an indication that the students' peers, lecturers and others that influence their behaviour have also not been influencing the respondents to use OSS.

User training

Ninety nine point two of the respondents disagreed that they had been trained on using Free Desktop OSS and therefore perceived that they did not have the knowledge necessary to use Open source software. Ninety four point eight of the respondents perceived that training on Open source software could increase their productivity while using the software. Ninety nine percent of the respondents perceived that training on the use of Free Desktop OSS is not easy to find.

Compatibility

Ninety nine point five of the respondents disagreed that the knowledge they have in using proprietary software can be transferred to Open Source software without requiring further training.Ninety six point nine of the respondents perceived it is not easy to open a Microsoft word document in Open office Writer without losing any format properties. The results indicate that respondents believe that OSS is not compatible with PS in several areas.

Social economic status

Ninety nine point five of the respondents agreed that Open source software is more affordable than proprietary software. Ninety six point nine of the respondents perceived that they had inadequate resources and would therefore not afford to buy PS.

Prior experience

Ninety seven point four percent of the respondents indicated that they were not using Open source software before they joined the university. Ninety nine point two percent of the respondents indicated that computer training in the school they attended was not conducted using open source software. The results indicate that majority of the respondents have limited opportunities to use OSS.

Open source adoption

Eighty four point nine percent of the respondents had PS such as windows and Microsoft Office installed and did not have Free Desktop OSS installed in their computers. Eighty eight point six percent of the respondents indicated that they did not prefer using OSS. The respondents who had windows installed in their computers indicated the software was already pre-installed in the computer when they bought the computer

Regression and correlation analysis

Regression and correlation results are discussed in the subsections below.

R-Square

This statistic measures how successful the fit is in explaining the variation of the data [54]. R-square is the square of the correlation between the response values and the predicted response values. This measure is also called the square of the multiple correlation coefficient and the coefficient of multiple determination [54].

Table 2: R-Square test model summary

Model	R	R Square[b]	Adjusted R Square	Std. Error of the Estimate
1	.971[a]	.943	**.942**	2.02860

The overall model explains 94.3% of the variations in adoption using the **R square** goodness of fit. This percentage is acceptable since the minimum is about 70% [54].

Analysis of Variance (ANOVA) test

Below are results of the ANOVA test. The ANOVA test is the primary step in discovering factors that are influencing a given data set [54]. In this study, ANOVA was used to test the stated hypothesis.

Table 3: ANOVA test results

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	25622.264	6	4270.377	1.038E3	.000
	Residual	1555.549	378	4.115		
	Total	27177.813[b]	384			

Since the p-value is less than 0.05, user training, usability, OSS compatibility, social influence, prior experience and social economic status have significant combined effect on OSS adoption.

The regression test below is testing for the level of significance of the individual independent variables in this relationship.

Table 4: Coefficients[a,b]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	USER TRAINING	.138	.073	.084	1.905	.058
	USABILITY	.099	.070	.035	1.424	.155
	OSS COMPATIBILITY	.157	.073	.100	2.165	.031
	SOCIAL INFLUENCE	.032	.070	.015	.450	.653
	PRIOR EXPERIENCE	.026	.066	.020	.394	.694
	SOCIAL ECONOMIC STATUS	.540	.046	.730	11.796	.000

a. Dependent Variable: OSS ADOPTION

b. Linear Regression through the Origin

From the regression results above the study can conclude that, user training, OSS compatibility and social economic status have significant individual influence on OSS adoption at 10% level of significance.

4. DISCUSSION OF FINDINGS

This study investigated the contribution of some perceived factors thought to be significant in the adoption of OSS in Developing countries. The factors as hypothesised in the study are; usability, user training, OSS compatibility, social influence, prior experience, social economic status, job market demands, proprietary software piracy culture and patent and copyright laws.

Usability

This study established that the majority of the users perceive that OSS is not user friendly compared to PS. The findings are consistent with those of a study by Sen (2007) who concluded that one of the main competitive advantages of PS over OSS is usability. He further opines that if OSS has to compete with PS, the OSS developers need to benchmark with PS. Raza &Capretz (2012), argues that although user centred designs are gaining popularity within OSS, usability is not being considered as one of their primary goals.

This study has established that OSS is perceived as being less user friendly compared to PS. In order to improve on its usability, the human computer interface needs to be improved in order to be at par with PS. The icons need to be improved and made easier to recognise by designing them to look closer to the ones that are used in PS as the users are used to them. Likewise the navigation needs to be redesigned to be similar to that of PS.

The study noted that all the computer users are introduced to PS when starting to use computers. By the time the users encounter OSS they are used to PS and it therefore becomes challenging to convert to OSS because of the difference in human computer interface (HCI) features in the two. The author suggests that if they had been introduced to OSS before PS the same conversion challenge would have been experienced due to the difference in the two types of software.

User training

The results of user training in this study reveal that majority of the respondents have not been trained in the use of OSS. The study further noted that the general computer training offered as a common course in the university generally covers PS products. Most of the respondents also said that they did not have adequate knowledge in the use of OSS and further said that it is not easy to find OSS training. This situation is alarming as user training is key in the adoption of technologies such as software. As noted by Bedard et al., (2003), training is an important component in the adoption of computer applications and technology. Another study conducted by Nelson & Cheney (1987), concluded that user training enables users to use Information Systems. They further noted that end-user training results in end-user ability to use information systems which consequently contributes to Acceptance of Information Systems (IS) technologies.

This study notes that due to the limited OSS training opportunities in universities, adoption of OSS products is likely to continue being low unless there is a change of policy by the training institutions.

OSS Compatibility

The majority of the respondents in this study perceive that OSS is not compatible with PS in a number of ways. The different areas of incompatibility as noted by the respondents are; transfer of knowledge from PS to OSS, compatibility

of documents across the two types of software, ability to install application software across the OSS and PS platforms. Generally above 70% of the respondents in this study felt that OSS is not compatible with PS in all the above aspects.
Compatibility is a desirable characteristic in software as it gives users flexibility and freedom to use any preferred software. With such flexibility users do not have to worry about compatibility in cases where users wish to open a document created in a software by a competitor company. In some cases users create documents in a particular software and they send it to another individual who does not have the software they used to create the document.
The findings of this study are consistent with those of a study by Dedrick and West (2004), who noted that the decision to implement an OSS platform is greatly influenced by the compatibility of the new technology with current technologies, skills and tasks. This finding is further supported by Morgan & Finnegan (2007), who noted that compatibility is one of the drawbacks of OSS. According to them incompatibility with current technology, skills and tasks is a weakness of OSS.
In order to have higher adoption levels among the university students, it is important for OSS software developers to have compatibility in mind. This does not only apply to Kenyan university students' population but also applies to other populations including users in developing countries at large. One of the major inhibitors of compatibility is the PS companies who do their best to ensure PS is not compatible with OSS in all aspects [55]. Appelbe (2003), also note that companies such as Microsoft deliberately make sharing of documents difficult and inconveniencing.

Social influence

This study established that software adoption decisions of the users in the studied population are influenced by their peers. The questionnaire findings revealed the studied population is highly influenced by peers, lecturers and other people they respect with more than 90% of the sample acknowledging this influence. One of the reasons given for this influence is that they can easily get help if they get stuck. They also prefer using software that their peers are using because it becomes easy to share files, while others do not want to be different from their peers and people they respect.
The above findings are consistent with other related studies such as that of Vannoy&Palvia (2010), which concluded that social influence is a factor that contributes to technology adoption in general. Another study conducted by Gwebu and Wang (2011), also indicated that social influence has a significant role in adoption of OSS technologies.

Social economic status

The findings of this study indicated that the majority of respondents are not in a position to acquire licenced software because they are expensive. However over 97% of the respondents felt that if they were earning a good salary, they would buy PS. This means that the respondents prefer PS to OSS and they would only adopt OSS in situations where they are unable to acquire PS.
The finding above is a clear indication that PS is generally not affordable to ordinary users in developing countries. OSS products could take advantage of this situation to push OSS among this population.

Prior experience

The majority of respondents of this study perceived that they had limited opportunities to use OSS. The respondents had not come across OSS before joining university although the study noted that some cybercafés have OSS. The reason why cybercafés install OSS as noted in the interviews is to comply with the law and not by choice or demand from their customers.
This study noted that the limited opportunities to use OSS deny the respondents an opportunity to gain experience which is essential in adopting OSS products. These findings are consistent with those of Fazio &Zanna (1978), and similarly to those of Ajzen (1991), who established that prior experience of a technology is more likely to result in use of it because experience makes knowledge more accessible in memory. In order to achieve higher adoption levels, it is important to give users opportunities to use OSS.

Open source software adoption

OSS adoption among the Kenyan student population is very low as noted in this study. The questionnaire responses indicate that more than 80% of the sampled population do not have any form of OSS software in their computers. On the same theme it is important to note that more than 75% of the respondents bought their computers with Windows already installed as can be seen in table 6-15. The findings are consistent with other similar studies conducted in the area such as the finding of Bridges.org (2005), who noted that there is very limited use of OSS in most African countries.

5. CONCLUSION

The empirical study established that the factors affecting adoption of desktop OSS are usability, user training, OSS compatibility, social influence, prior experience, social economic status.
Training institutions in Kenya do not offer OSS training as basic computing skills but they offer PS training. This makes it difficult to convert from PS to OSS because they have not received any formal training. The conversion is also

made more difficult due to the significant difference between the two types of software in terms of the graphical user interface.

This study further established that PS and OSS are not compatible. This makes it difficult for users to move documents from PS to OSS. This discourages the population under study to use OSS as they can share the files with their friends and colleagues.

The study also established that students are influenced by their peers on areas of software adoption. It was noted that the university students like using the software their peers use because they don't want to be different from them. It also makes it easy to share files and information amongst them.

Recommendations

In order to make OSS products popular in developing countries it is important for the OSS movement to develop marketing strategies and programmes. The developers also need to pay close attention to the usability of the software in order to make it at par with their PS counterparts. Currently OSS uses icons and GUI that varies a lot from PS which makes OSS products complicated to use. The OSS developers need to use icons and GUI features that are close to those of PS without infringing copyright laws. OSS should also be made compatible with PS in order to make sharing of documents easier across the software.

Training institutions have a big role to play as they are able to promote the use of OSS by offering basic training in these products and make it the natural choice of software for the learners. The institutions will able benefit by doing this as they will also cut licence costs. The learners will be able to make their own choice on whether to adopt OSS since they will be having the knowledge to use it.

The governments of developing countries such as Kenya need to make deliberate efforts to promote adoption of OSS products. This will save a lot of money in terms of licence fees which can be channelled to other areas of the economy. This can be done by passing legislation that supports the use of OSS products. The government also needs to take more measures to stop software piracy as it also hinders the adoption of OSS products.

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APPENDIX A1

The questionnaire below is meant to collect Open Source adoption data

Bio data
Respondent Number _____

1. Name of University _____
2. Year of study
   □ Year 1 □ year 2 □ Year 3 □Year 4 □Year 5
3. Age
   □ 18-20yrs □ 21-23yrs □ 24-26yrs □ 27-30 yrs □ 31 and above
4. Gender
   □ Male □ Female
5. Area of study (i.e Business) _____

		Strongly agree	agree	neutral	disagree	Strongly disagree
1	Open source software such as Linux and Open Office is more user friendly than proprietary software such as Microsoft office and Windows.					
2	Open source software such as Linux and Open Office has familiar icons that are more easily recognizable than proprietary software such as Microsoft office and Windows.					
3	Open source software such as Linux and Open Office has better help facilities, tutorials and wizards than proprietary software such as Microsoft office and Windows.					
4	Navigation while performing tasks in Open source software such as Linux and Open Office is easier than in proprietary software such as Microsoft office and Windows.					
5	I find it easier to format a document using Open office writer than Ms Office Word					
6	People who influence my behavior think that I should use Open source software.					
7	People who are important to me think that I should use Open source software.					
8	Most of my university lecturers use Open source software					
9	Most of my friends use Open source software					

10	Most of my class and college mates use Open source software					
11	I have been trained to use Open source software such as Linux and Open Office					
12	Training on Open source software could increase my productivity while using the software					
13	The general computer training offered as a common course in the university covers open source software as an area of training					
14	I have the knowledge necessary to use Open source software					
15	I can easily find training on the use of Open source software					
16	The knowledge I have in using proprietary software can be transferred to Open Source software without requiring further training					
17	I can easily open an Microsoft word document in Open office Writer without losing any format properties					
18	I can easily open an Open office writer document in Microsoft Word without losing any format properties					
19	I can easily install any software on Ubuntu or Linux platform					
20	An Ms Excel document can easily open in Open Office calc without reporting any conversion errors					
21	I would find Open office easier to use if it used the same icons as Microsoft Office for in its interface					
22	I would find Open office easier to use if it used similar menus as Microsoft Office in its interface					
23	I would find Ubuntu easier to use if it used a similar desktop and start menu as the Microsoft Windows 7					
24	I would find Ubuntu easier to use if tasks were performed in a similar way as they are performed in Microsoft Windows 7					
25	I would prefer the Windows 8 start button to be used in Ubuntu					
26	Open source software is more affordable than proprietary software					
27	If I earned a good salary then I would buy Proprietary Software rather than Open Source Software					
28	Students like me generally have limited resources					
29	Proprietary software is exorbitantly expensive to students					
30	I would easily raise Kshs. 15,000 to buy an Ms Office 2010 license					
31	I was using Open source software before I joined the university					
32	Computer training in the school I attended was conducted using open source software					
33	I have limited opportunities to use Open source software					
34	Learning institutions I attended before joining the university supported the use of Open source software					
35	I have used OSS in cybercafés and other places before I joined the university					

36	Majority of the potential employers require employees who can use Open source software					
37	The job adverts I have seen require candidates who can use Open source software as a mandatory requirement					
38	The jobs my friends do require candidates who can use Open source software as a mandatory requirement					
39	I could miss employment opportunities if I did not have Opens source software skills					
40	The career guidance I have received indicates that I need OSS skills in order to easily secure a job					
41	All the proprietary software I have in my computer has a license that is not shared with other users					
42	There is no need to purchase proprietary software such as Microsoft office and Windows from software stores such as PC world because I can easily get it from my friends.					
43	I can spend large amounts of money to buy licensed proprietary software such as Microsoft Office 2010 which costs about 15,000 Kshs in my current financial status.					
44	I get the same value from the unlicensed software as a computer owner who has licensed software					
45	Most of My friends buy genuine software for their computers					
46	Using Open source software makes my work more interesting					
47	I like using open source software					
48	The Windows I use was already pre-installed in the computer when I bought the computer					
49	My computer only has Proprietary software such as windows and Microsoft Office installed and has no Open source software such as Open office and Ubuntu					
50	Many students at campus prefer open source software					