The potential role of Open Source Software in overcoming digital poverty

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Abstract

Developing countries, such as Tanzania, are characterized by digital poverty and a lack of information and communication technology (ICT) acceptance. The use of open source software (OSS) has been proposed as a potential strategy for addressing ICT acceptance challenges due to the fact that OSS characteristics seem to deal with some of the root causes of digital poverty and low ICT acceptance. However, despite the generally acknowledged potential of OSS for addressing digital poverty, OSS has not achieved the expected acceptance and usage in Tanzania. The aim of this study is to investigate the potential role of OS in overcoming digital poverty in Tanzania. The first objective aimed to identify specific ICT acceptance challenges. The second objective considered the perceived value of the OSS approach in Tanzania. Finally the ICT acceptance challenges were contrasted with the perceived value of OSS to gain an understanding of the potential of OSS to address digital poverty in Tanzania. A literature analysis, document analysis as well as observations of open source community activities were conducted to identify the ICT acceptance challenges and to formulate questions for a survey instrument and for interviews. Four open source communities in Tanzania were investigated and the findings were triangulated to contemplate the match between the ICT acceptance challenges in Tanzania and the perceived value of OSS. The contribution of the study is a list of ICT acceptance challenges specific to Tanzania. Furthermore pre-conditions for the acceptance of any ICT (including OSS) were

identified based on the relationships between access, ICT usage and poverty.

1. Introduction

Information and communication technology is regarded as a central enabler for economic growth within any society, but this has been mostly realized in industrial developed countries (Camara and Fonseca 2007). In developing countries, initiatives have been taken to raise awareness of the value of ICT but these countries see a rate of 50% ICT establishment failure (Ehikhamenor 2003). The causes for this failure are closely related to the factors that negatively affect ICT acceptance in developing countries. Focusing on Tanzania, as a developing country, the following ICT acceptance challenges have been identified by Mushi (2007):

- ⚔ Outside donor dependency
- ⚔ Lack of ICT experts
- ⚔ Culture
- ⚔ Low Income and Cost
- ⚔ Lack of ICT awareness

Amongst the feasible strategies used to address digital poverty is the increasing consensus for advocating OSS usage within the country. The aim of this study is therefore to investigate the potential role of OSS to overcome digital poverty in Tanzania. The properties and characteristics of OSS are regarded as mitigating factors of ICT acceptance challenges in Tanzania. For the purpose of the study, three sets of objectives were formulated. The first objective was to identify specific ICT acceptance challenges and the second objective was to consider the perceived value of the OSS approach in Tanzania. Finally the ICT acceptance challenges are contrasted with the perceived value of OSS to gain an understanding of the potential of OSS in addressing digital poverty in Tanzania

The paper is organised as follows; a brief introduction is provided in Section 1. Section 2 provides a literature framework with regards to digital poverty, OS in conjunction with its acceptance in developing countries and the state of ICT acceptance in Tanzania. Section 3 provides the research design and methodology for the study while the research results and findings are presented in Section 4. The discussion of the findings is presented in Section 5 and the conclusions in Section 6.

2. Literary framework

In this section we will discuss the fundamental concepts of the study starting with definitions in Section 2.1 and then moving on to OSS in Section 2.2 and ICT challenges in Section 2.3.

2.1 Definitions

In this section we define the concepts of digital poverty and ICT as these are fundamental to the question on the potential of OSS to overcome digital poverty. Digital poverty is defined as a lack of goods and services based on ICT. This might be a feature of any population segment, whether or not economically poor (Barrantes, 2007). Digital poverty cannot be separated from demand analysis since only those people with enough buying power can be part of the demand for goods and services. On the other hand, people need to know the benefits of such goods and services in order to demand those. Demand is therefore restricted by two main factors: the lack of income and the lack of information regarding the benefit associated with the consumption of the goods or service. The

economic understanding of demand, which requires resorting to traditional economic theories is beyond the scope of this paper and we will only focus on the product in question namely ICT.

ICT or Information and Communications Technology is described as the use of hardware, software, services and supporting infrastructure to capture, process, store, manage and disseminate information (Prasad 2009). In addition to this definition of ICT, Greenberg (2005) categorises ICT in three ways, depending on how long it has been in use: New ICTs based on digital communications (computers, satellites, mobile phones, the internet, e-mails and multimedia devices), old ICTs (radio, television, landline telephones and telegraph) and really old ICTs (newspapers, books and libraries). The ICTs that are categorised as *new ICTs* are facilitated by apparatus known as *software* and *hardware*. *Webster's dictionary (2011)* defines *software* as "written programs, procedures, rules and instructions that are executed by a computer to accomplish some task". These software instructions run on a physical device known as *hardware.*

2.2 Open Source Software (OSS)

Stahl (2005) defines OSS as software for which users have access to the source code that distinguishes it from most commercially published software that only allow users access to the object code. Free Open Source Software (FOSS) copyright licenses allow everyone to read, modify, and redistribute the source code, so programmers can improve and adapt the software, and fix bugs. The software can be shared with others, so users can give it to their colleagues and friends (Bridges 2005). OSS is typically developed through public collaboration, it is available to anyone (usually at little or no cost), it does not require proprietary license fees and it may be freely re-distributed (Pogue and Day 2004). OSS can be viewed as software itself or as an approach to software implementation. As software, the product created is accessible and can be modified, distributed, sold without putting any patent to it. On the other hand, OSS can be viewed as an approach to create free software in a collaborative, visible but controlled environment to ensure better end product. For the purpose of this study, OS is viewed in ways and the adopted definition of OSS is any ICT program or software created in a collaborative way such that the software is open to the public without any interference from the developer of the program, and the developed program is transferable and open to modification to suit different demands. OSS has specific licensing requirements (Open Source Initiative Movement 2011) that pertain to the distribution and source code. Since OSS circulation is not essentially controlled, modalities of circulation, including costs are solely determined by transacting individuals. The following characteristics of OSS have been listed in literature:

- ⚔ Quality: The practice of having many developers working on a project and making the source code available for inspection can improve the quality of the software (Ford 2007)
- ⚔ Cooperative development: Online communications have led to the formation of various communities of developers that work together to contribute code to OSS projects (Rota and Osterloh 2007).
- ⚔ Innovation and skills improvement: Knowledge is transferred and shared amongst developers to increase development skills. Problem solving in OSS brings innovation (Johnson 2006, Schroder, Schrettl and Bitzer 2006).
- ⚔ Cost savings: The software is free of charge and license fees in most cases (Ford 2007).

2.3 Open Source Software in Developing Countries

The use of OSS (often also abbreviated just as OS for Open Source) in developing countries is inspired by OS success in developed countries. Various studies have been done on how OSS can be utilized in various areas (McKendrit, 2007). Weber (2004) states that nearly 40% of large American companies and 65% of Japanese corporations use Linux in some form. Furthermore, an EU survey

found out that 43.7% of German companies and 31.5% of British companies use OS. A special report by the Government Technology magazine (2006) learns that 50% of the top websites in the US run on OS servers, and that out of 50 states in the United States, 47 states are already running OS while also 50% of government agencies use OSS (McKendrik 2007). Based on the successes of OSS in developed countries, we consider the possibility that OSS can also be successful in developing countries particularly by focusing on the factors that favor OSS in developed countries. ICT has been viewed as a driving force behind development in developing countries in general and Africa in particular (Shi, Hutchinson, Yuc and Xua 2001) and ICT acceptance in developing country shows positive development (Walsham and Sahay 2006). Therefore the use of OSS could add to successes in ICT acceptance, if OS promotion efforts can be strategically planned and implemented effectively. In the literature on acceptance models the Technology Adoption Model (TAM) (Davis 1986), the Unified theory of acceptance and use of technology (UTAUT) (Vakentesh and Massingue 2003) and the Task Technology Fit (TTF) (Goodhue and Thompson 1995) model are three of the seminal models. Figure 1 is a depiction of OS characteristics in relation to the IT acceptance models and depicts the relationship between TAM, UTAUT and the characteristics of OS that potentially determine ICT acceptance, that is, social influence, facilitating conditions (*UTAUT*), perceived usefulness (*TAM*) and technology characteristics (TTF).
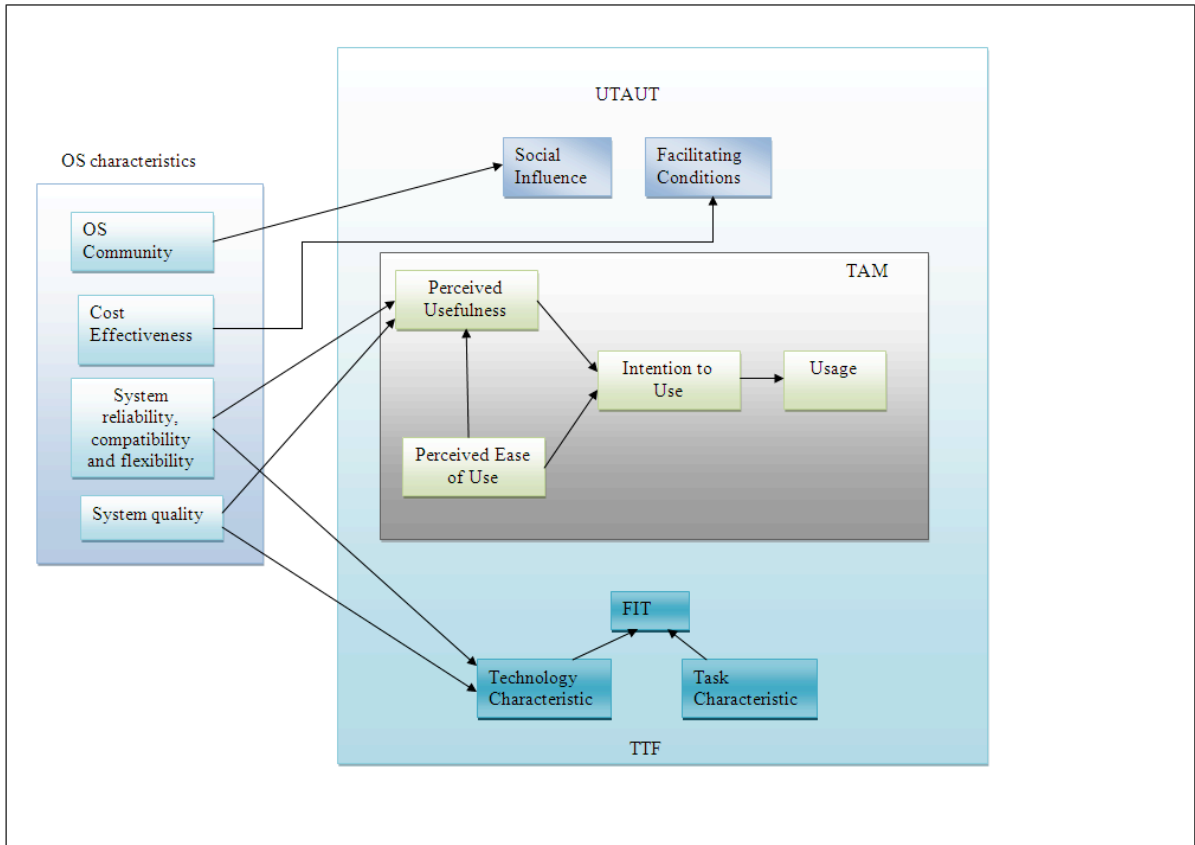

Figure 1 TAM for OS

2.4 ICT challenges

Following a literature analysis, a list of ICT acceptance challenges in developing countries were identified. These ICT acceptance challenges, within the context of Tanzania, are discussed below.

⚲ Donor dependency: Donor dependency has been mentioned as one of the ICT acceptance challenges in Tanzania. There are generally few local ICT manufacturers, with the private

sector being largely dependent on the importation of ICT from outside the country (Mushi 2007). The established research institutions also depend on funds from donors to be able to operate. Magni and Pennarola (2008) call these moderators *facilitating conditions* in the decision to use ICT. These moderators are also regarded as *external variables* by the Technology Acceptance Model (TAM) (Davis 1986), *external variables* includes the environment and conditions to which ICT products will be developed. If these external variables (small number of local ICT manufactures and the private sector dependence on outside manufacturers) are not conducive to the innovation of ICT products, this will have a negative effect on the *perceived usefulness* of the ICT products (Magni and Pennarola 2008).

⚔ Lack of ICT experts: Hamner and Qazi (2009) mention the level of education and training of individuals as a factor influencing intentions to use ICT products. These skills are regarded as the know-how to build ICT applications and assisting end-users to use the applications (Prasad 2009).

⚔ Culture: Anandarajan et al. (2002) emphasises the modification and management of ICT for different cultural contexts. These authors mention that, depending on the culture, s*ocial influence,* as a determinant of ICT usage, affects the attitude and behaviour of individuals differently in various societies.

⚔ Low income and cost: Magni and Pennarola (2008) and Hamner and Qazi (2009) mention cost in terms of purchasing power for ICT products as a moderator in the determinant of ICT acceptance. In other words, low compensation of employees will have a negative effect on the affordability of technology. This means that even if employees need the technology, they will lack the ability to pay the costs involved. Eventually, this will affect the attitude towards usage of the technology, as it will be regarded as unaffordable and thus out of reach (Magni and Pennarola 2008; Hamner and Qazi 2009).

⚔ Lack of knowledge: Lack of ICT awareness, poor information and illiteracy have been identified as challenges facing ICT acceptance (Scacchi 2007).

3. Research design

The research strategies involved case studies on four OS communities in Tanzania. Data capturing involved three methods namely participant observation, interviews document analysis and a survey. Questionnaires were distributed via email groups to each of the OS member teams. The interviews and questionnaire were expected to provide answers to the two main questions and the sub questions on OS promotion as listed in section 3. The OS community profiles are presented in Section 3.1 and the data capturing methods, namely questionnaires and interviews in Section 3.2.

3.1. OS Community Profiles

Four OS communities were used as case studies. These communities are described in Table 1 below.

Table 1: OS community profiles		
Name	Emblem	Description

TAFOSSA		TAFOSSA, short for 'Tanzania Free and Open Source Software Association' is an organization that aims to create awareness about OS movement in the country, build local capacity and coordinate development of free and OS software while ensuring integrity and conformity to the wider national ICT agenda.
TLUG		TLUG stands for 'Tanzania Linux User Group'. The main objective of TLUG is to provide a forum through which Tanzanians can meet and share their experiences in the development and usage of OS tools and technologies
KILINU		Kilinux is an open Kiswahili localization Project. Kiswahili is a Tanzanian official local language while English is the second. The main activity of Kilinux is, therefore, to make sure that any technical knowledge available in foreign languages is made available in Kiswahili. Distribute OS software freely and advocate for use of OS.
UBUNTU		UBUNTU is one of various Linux operating system free distributors across the world. The Tanzania UBUNTU association team focuses on creating UBUNTU awareness in the country.

The four OS communities have one common goal, namely to promote the use of OS in various areas of ICT application but the following differences in focus have been identified:

- ⚔ TAFOSSA focuses mainly on creating OS awareness by coordinating various OS local initiatives
- ⚔ Kilinux mainly strives to localize foreign knowledge through OS. For example, by having the knowledge translated into a local language.
- ⚔ UBUNTU aims mainly at forming a community of UBUNTU users and so their scope is relatively limited in that very little consideration is given to the local situation.
- ⚔ TLUG strives to create a large community of Linux users across the country

Given this background on what the four selected OS communities comprise, the next section presents the data analysis of the questionnaires completed by members of these communities.

3.2 Questionnaires and Interviews

To allow observation, the researcher joined in as an active member in each of the OS communities (TAFOSSA, TLUG, KILINUX and the TANZANIA UBUNTU ASSOCIATION). As a member it was possible to join the discussion forums, as well as attend the seminars and the general meetings about OS matters arranged by the communities. Observation was used to note the member daily contributions via the communication tools. The communication tools provided room for developers to meet and share code and ideas on how to go about the projects. After gaining their trust, the

researcher used a questionnaire and sent it to 30 of the four OS community members for answers and all of them gave feedback. To determine the practical applicability of OSS in the industry, another 10 respondents were interviewed using a researcher-administered questionnaire. The interview process involved the selection of 10 people that deal with ICT matters in the workforce, these included IT managers and end users. The findings from the interviews are triangulated with the findings from the survey and used to extend and explain the findings of the survey as the interviews allowed more in-depth data capturing. Table 2 shows the contribution of each of the OS communities to the survey and the interviews respectively.

| Table 2: The distribution of respondents from survey and interview				
Facility	**Members**	**Members surveyed**	**Members interviewed**	**Total Respondents**
TAFOSSA	28	8	3	11
TLUG	23	7	2	9
KILINUX	30	8	3	11
UBUNTU	21	7	2	9
Total	**102**	**30**	**10**	**40**

Both the survey and interview responses were based on the issues that users mentioned. This means that users may have omitted certain issues simply because they did not think about them at the time. The alternative would have been to provide responses and ask them to state the importance but in this study was deemed more important not to limit users to specific responses.

4. Results and findings

In this section we present the results and findings by considering the responses to ICT challenges in Section 4.1 and the perceived success of OSS in addressing ICT acceptance challenges in section 4.2

4.1   ICT challenges

The first objective, as stated in Section 1, aimed to identify the various challenges that face ICT acceptance in Tanzania. Participants were asked to list the ICT acceptance challenges facing Tanzanian society. The results of the surveys were categorised and the number of times each category was mentioned was tallied. Figure 2 depicts the major challenges ranked by the percentage of respondents that mentioned the challenge.

Figure 2: Major ICT acceptance challenges in Tanzania
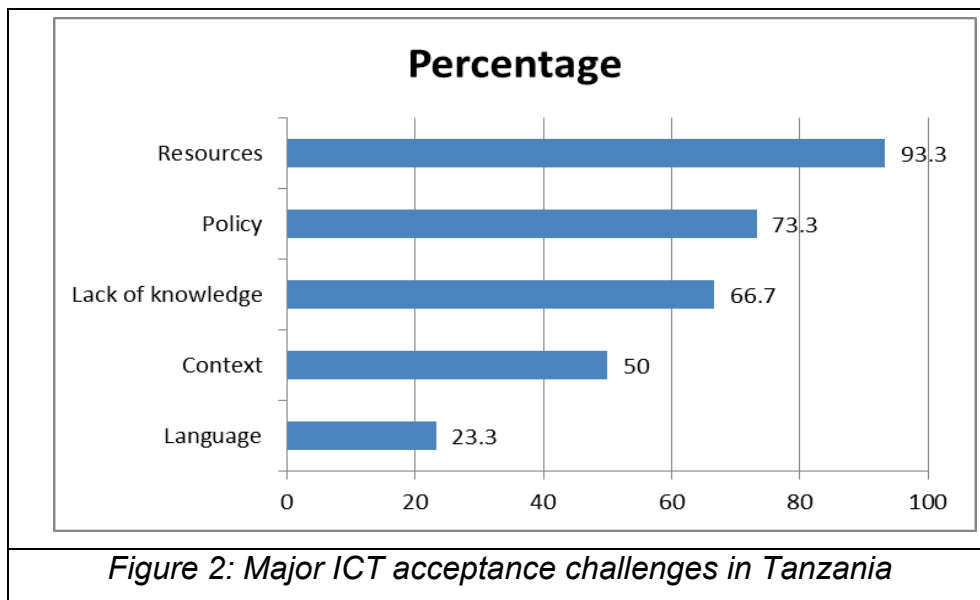
It is evident from Figure 2 that resource constraints (mainly with regard to cost) is the most important ICT acceptance challenge, followed by the lack of policy implementation and the lack of knowledge and skills. The responses obtained from the interviews administered to 10 respondents in relation to the five ICT acceptance challenges that appear in Figure 2, are as listed in Figure 3.

Figure 3: Interview responses to selected ICT acceptance challenges
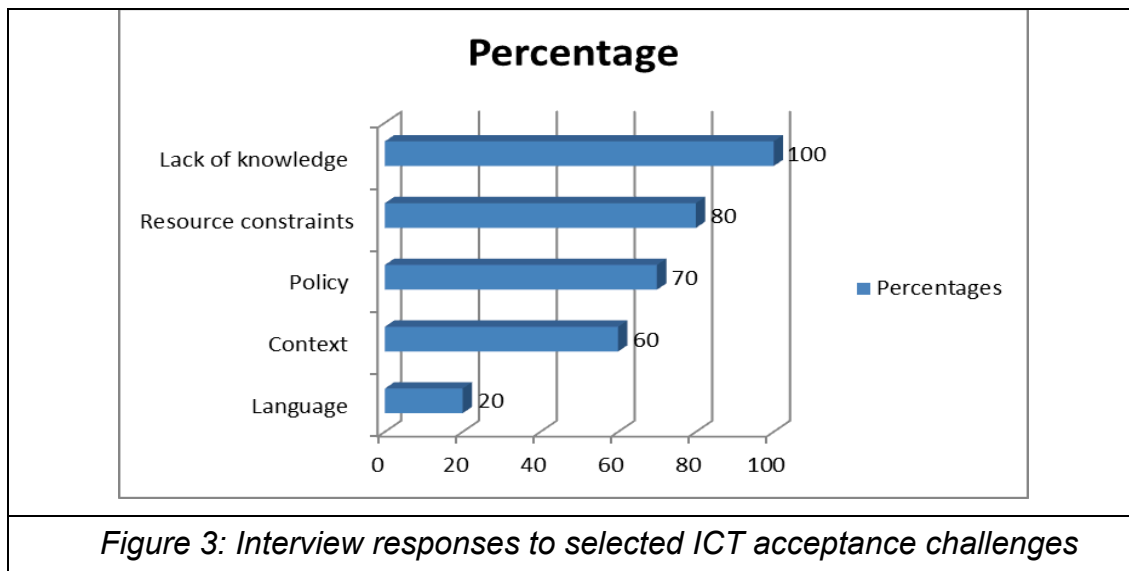
The results obtained from the interviews do not concur with the results obtained from the surveys, in that not all of the ICT acceptance challenges retain their order in terms of frequency of occurrence across the respondents. Comparing the results obtained from the interviews with the results of the survey, it is observed that the same themes arise but the order of importance seems to differ. For example, *resource constraints,* which are the most important determinants of ICT acceptance challenges according to the survey results, appear to be the second most important challenge in the interview results. The interviewees considered lack of knowledge as the most important ICT acceptance challenge in Tanzania. This difference in opinion may have been motivated by the fact that most of those involved in the interviews were professionals in different fields, including ICT, and therefore they saw lack of knowledge on the use of ICT as a more important constraint than lack of resources. The issue of language retains its position as being least important in both the survey and

the interviews but it is still among the top four challenges. Each of the challenges identified will now be discussed in more detail:

⅄ Resource constraints

Resource constraints were identified as one of the major challenges facing ICT acceptance in Tanzania by 93.3% of the survey respondents and 80% of the interview participants. It was claimed that ICT infrastructure is capital intensive as it requires money to establish and maintain. Owing to this capital intensity, only individuals with sufficient income can afford such facilities. The issue of resource limitation is implicit in the responses from actual and potential ICT users whereby 95% of those who had already accepted ICT said that cost was one of the factors that resulted in some people not using ICT. Furthermore, all of those who had not accepted ICT were of the view that they would accept ICT software, if the cost was lower. The majority of the Tanzanian population, especially in the rural areas, is poor and can barely afford basic necessities, such as food, clothing and modest housing (URT 2003). One of the respondents commented that "if someone cannot meet his basic needs, it becomes difficult for him/her to even think of ICT, but if cost was avoided, people would wish to accept ICT". The findings suggest that, in general, the limited resources available for ICT activities are reflected in the restricted extent to which technology is put to use, the small number of ICT training centres and the limited number of ICT experts. It was also shown that the limited investment in ICT is a result of the lack of demand in the consumer market.

⅄ Context

The respondents (50% of the survey sample and 60% of the interviewees) indicated that the prevailing local conditions in Tanzania are among the factors that constitute problems in terms of ICT acceptance and development. As far as context is concerned, it was indicated that the local environment economically, socially and culturally does not favour the intensive application of ICT. The issue of context is also implicit in the literature analysis, as indicated by such variables as culture, illiteracy and poor infrastructure. The major point raised was that the population is still too involved in work that is physical labour intensive so that the demand for sophisticated tools, including ICT, is minimal. Seven interviewees, that is, 17.5% of the total sample, were of the view that few Tanzanians engage in activities that demand the adoption of ICT and that the local initiative to be creative in product development has been suppressed by the ready availability of products from overseas and neighbouring countries. However, ignorance and lack of knowledge also limit the acceptance of ICT. In general, it is evident that most Tanzanians are set in low technology usage and this has had a negative influence on ICT acceptance. For example, eight interviewees (equivalent to 80% of interviewees) contended that there are people whose jobs could be greatly simplified by ICT but because they are comfortable with the old ways they have not changed. Such people need a very strategic promotion to prove to the potential value of ICT. The majority of the rural population of Tanzania is either illiterate or limited to Kiswahili literacy. With regard to illiteracy, one respondent stated that ICT demands some reading ability in order for the user to follow some instructions, even if there is an instructor. This is because at some point one would need to communicate and respond to commands using the language peculiar to the ICT profession. Two of the respondents mentioned that there is still very little software available in Kiswahili, and this may discourage people from trying to acquire ICT skills because of the possible embarrassment they could face when trying to communicate.

⅄ Lack of knowledge

The surveys showed that a lack of knowledge was regarded as third in importance after resource constraints and policy. However, in the interviews *lack of knowledge* was the most significant ICT acceptance challenge as it was identified by all interviewees (100%). It was noted that ICT could still face acceptance challenges even if other factors are addressed,

because if people do not know about the different uses of ICT, they probably would not adopt ICT even if resources were not scarce and ICT was affordable, or the context negative. This is evidenced by the findings, as 11 (27.5%) survey respondents indicated that some ICT software is not user-friendly. Indeed, it would seem that the question of user-friendliness is a matter of preference, based on attitudes and prior knowledge of ICT software. The lesson that can be learnt from the observations in this section is that education is needed so that both the actual and potential ICT users can rid themselves of erroneous attitudes with regard to ICT applications in some domains of use. In the context of the current investigation, this calls for effective education. Some 15 survey respondents (37.5%) were of the view that certain aspects of ICT were not popular, as many people were not aware of their existence.

⚲ Policy

Most of the respondents demonstrated an awareness that the growth and acceptance of ICT in Tanzania depends to a great extent on the degree to which policy makers will recognise the importance of ICT in promoting a knowledge-based society. This is reflected in the fact that the element of policy came second in the survey (73.3%) and third in the interviews. Moreover, 80% of the respondents in the interview indicated that Tanzania has not realised the importance of giving a boost to ICT for the general betterment of society, despite having in place an ICT policy. Affirming this claim, one ICT company manager pointed out that Tanzania had not given tax incentives to ICT-based firms. The respondent added that since the country has not paid due attention to the area of ICT, it is lagging behind in the field of spreading education using the latest technology. Respondents suggested that it was not enough to have policies in place; the implementation of policies deserves increased attention. Demonstrating an understanding of the influence of policy on ICT acceptance, 50% of the interviewees maintained that people in general and Tanzanians in particular tend to have more trust in issues that are overtly and practically supported by the government. They further argue that issues which are undertaken solely by individuals and private operators tend to be questionable since there have been instances where businesses have been abused by private practitioners and consequently banned by government. Thus, government could help to spread the word since its voice is more trusted and it also has more resources. Another way in which policy influences ICT acceptance, according to one of the interviewees, is that the government is responsible for the daily operation of all activities such that legal and institutional support could be easily realised. Citing an example, the respondent suggested that the government could demand that every government employee be ICT literate.

⚲ Language

Of the survey respondents 23.3% claimed that policy could also influence the issue of language, as it may foster the use of the language with which people are familiar. They added that there have been instances where such a move has worked, including the bilingual use of Kiswahili (the national language) and English in various areas which had been dominated by English only. Examples include filling forms used in the banking industry, as well as transactions at automated teller machines (ATMs). They added that the same could be done in other areas of ICT, including computer programs. In the literature analysis it was established that language is one of the major factors that hinder the easy assimilation of ICTs by many developing countries (Keats, Beebe and Kullenberg 2003; Keats and Beebe 2004; Vakentesh and Massingue 2003)**.** Furthermore, radio and TV programmes, computer software and printed texts are produced in countries with different cultural backgrounds. Consequently, such tools may fail to engage users, hence affecting ICT acceptance negatively.

4.2 The success of OS in promoting IS acceptance challenges

The positive features of OS as perceived by the participants in the survey and the interviews are

depicted in Figure 4. Based on the information in Figure 4, more than 90% of the survey respondents identified affordability as one of the major features that differentiate OS from its proprietary counterpart. Similarly, affordability was mentioned by 70% of the interviewees. These findings suggest that the respondents were aware of the cost benefits that OS has over proprietary software. As was noted in the literature analysis and Section 4.1 resource constraints are among the most significant challenges facing ICT acceptance in developing countries in general and Tanzania in particular. It can thus be concluded that the affordability of OS can address resource constraints as an ICT acceptance challenge. Therefore OS could provide solutions to some of the issues pertaining to ICT acceptance challenges in Tanzania. As pointed out previously, income differentials among the population are reflected in the patterns of ICT acceptance in Tanzania, as well as in the developing world in general. However, the affordability of OS could make more sense if more efforts were made to see that the public is made aware of the value of ICT and OS as a feasible approach to accessing ICT. Furthermore, people need a reason for using the software; in other words, a demand should be created.
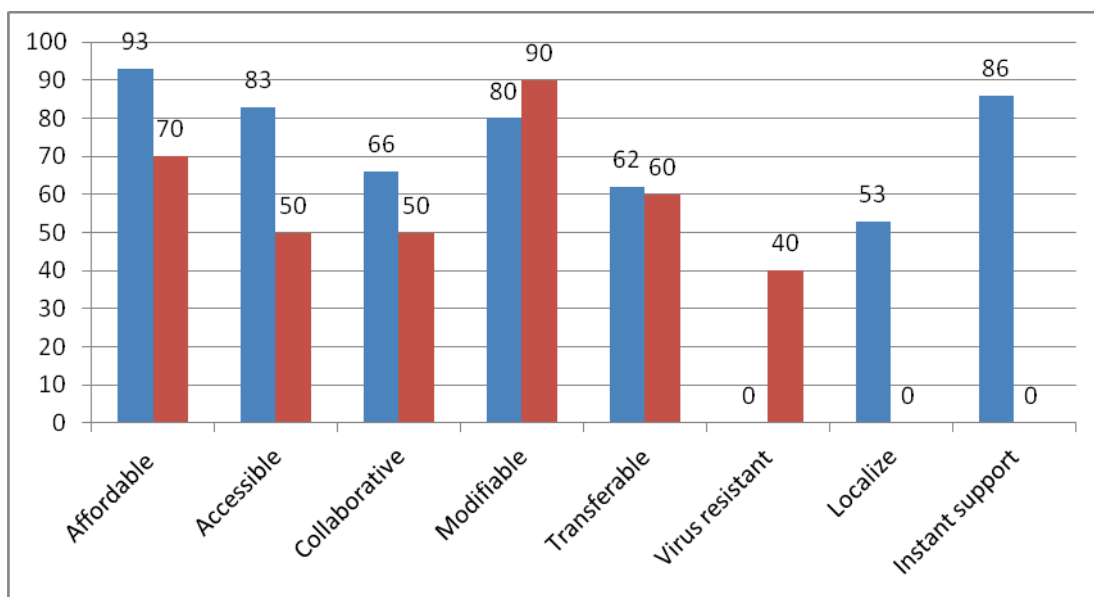

Figure 4. Perceived positive feature of OS based on the survey and the interviews

(Blue bar represents survey results, red bar represents interview results)

Another feature that gives OSS an opportunity to address ICT-related challenges is the accessibility since it is free of proprietary rights and procedures that might discourage users from using the facility. This fact was underlined by 83% of the survey respondents and 50% of the interviewees. By making OSS more accessible, more people will be encouraged to accept it, thus providing an alternative to the bureaucracy associated with proprietary software.

Sixty- six of the survey respondents and 50% of the interviewees mentioned that OSS is collaborative such that different people can share their knowledge and experiences and thus facilitate rapid adoption of ICT. One of the interviewees stated that when people learn that they can find answers to their problems from other people without paying them or even seeing them, they become motivated to use OSS. Similarly, it was pointed out that the discussion topics posted on forums and blogs may make people aware of things that they did not know or they had not bothered to find out because they thought they would not benefit. In this way, therefore, people change their attitudes to certain applications. Another point raised in relation to collaboration is that people tend to imitate other people. If people know that certain programs and applications can be found in OSS, they might tell

their friends who might adopt the software.

The respondents indicated that the ability of OSS to be modified gives it an advantage over other sources since users can modify the facility to suit their needs. The interviewees indicated that different people have different ICT demands because of the varied nature of their activities. This would mean then that any system that may not allow modifications to suit different situations and applications may have disadvantages over a user-friendlier tool. The flexibility of OSS in addressing individual differences among groups thus makes it preferable to proprietary software. Another observation closely related to modification is the fact that OS can be transferred from one individual to another without linking the transaction to the manufacturer. This tends to reduce the bureaucracy involved in acquiring the facility as is the case with conventional proprietary software. Transferability was mentioned by 62% of the respondents in the survey and 60% of the interviewees respectively (see Figure 4). The interviewees also linked transferability with affordability in that even those with low incomes could have access to the facility from friends and relatives without compromising the licence requirements.

Another feature of OSS is the ability of OSS to be adapted to address local conditions. Indeed, if OSS can be modified it means it can be used in a variety of local conditions. The major concern in relation to this localisation was the issue of language. The interviewees pointed out that language was an obstacle that could discourage people from adopting ICT since most of the programs, instructions and applications are available only in English. This is an important consideration since the majority of Tanzanians are fluent in Kiswahili and other local languages. At the same time these are the very people who are involved in the majority of production activities in the country. Kilinux was given as a good example of a source that has considered the question of localisation in an attempt to get more users to adopt ICT by offering alternatives to some operations and terms which people might find difficult. Although the respondents could not quantify the extent to which Kilinux had succeeded in developing local terminology that could cater for the dominantly Swahili-speaking population of Tanzania, the initiative indicates the good intentions of OSS in terms of accommodating differences in local conditions across the world.

5. Discussion

Despite the apparent potential of OSS to be used in overcoming digital poverty, OSS is not widely used. In Tanzania, the society's perception on the complexity of OSS stands as a barrier for its wide usage. Advanced ICT experience is seen as a requirement in working with OS software. This in turn negatively affects the user's attitude towards the acceptance of OSS, resulting in a more stronger reliance on popular and well established proprietary software. It is also noted that advocating OS usage in Tanzania receives limited support from both Private and Government sectors while financial backing is crucial in creating awareness of new ICT's within the society. Another challenge is the organisation structure amongst the existing OSS communities. The lack of leadership and organization hierarchy hampers activity evaluations that are necessary from time to time. OS project management and monitoring has proven to be a difficult task due to this matter

In addressing these challenges, various recommendations have been made. One of the solutions that Scacchi (2007) proposes is the creation of social networks that promote ICT so as to bring about awareness through online discussions on websites, portals and forums where developers and interested parties would meet and share ideas on how to improve their development skills. Carmichael and Honour (2002) support the idea of online discussions and believe that the discussions tend to facilitate the creation of various alliances and promote community developments. These OS practices have, therefore, been identified as the best way in which to promote global ICT awareness, in contrast to proprietary software (Bourque, Dupuis, Abran and Moore 2004). In a country like South Africa, Van Belle and Ellis (2009) view proprietary software licences, which deny access to the source code, as a

barrier to technological innovation. OS software, on the other hand, is viewed as a perfect tool for innovation and for the transfer of programming skills and could provide South Africa with a better way to establish ICT infrastructure in the country. The government, as one of the major stakeholders in ICT acceptance and OSS in particular, has an important role to play. It is the organ concerned with the formulation and reinforcement of policies and regulations guiding ICT in Tanzania and therefore, stands a better chance of formulating, reinforcing and reviewing the policies and regulations for ICT and, for that matter, OS. Furthermore the government has financial and human resources that could be spent on developing OS software and sponsoring promotional activities.

In addressing the lack of organisation structure by the OS communities and the difficulty in implementing their plans for carrying OS activities, these communities need to evaluate their activities against the existing regulations and guidelines. The communities should also try to carry out some type of needs analysis to establish the actual needs of the kind of audience they want to target, so that they can tailor their practices to that group. This may help to address the issue that OS programs are more advanced than is actually needed by or expected of an ordinary ICT user.

6. Conclusion

In this paper we identified ICT challenges if Tanzania and people's perception of OSS through interviews and a survey. The main ICT challenges were identified as resource constraints, lack of knowledge, context, policy and language. It also was found that OSS is perceived to have many characteristics that should be useful in helping to overcome digital poverty. Those characteristics include affordability, accessibility, collaboration, modifiability and virus resistance.

Three main pre-conditions for realising the potential of OSS in overcoming digital poverty have been identified. The first is creating an awareness of the value of ICT and that of OSS in overcoming the resource constraints. The second is government involvement and support and the third is the strategic alignment of OS communities to ensure that their objectives and the implementation of the objectives reach the target outcomes. The study was done on OSS users as they were identified as people who could provide insights on the challenges of using OSS. This is limiting and further research is needed to verify the findings by repeating the study with a larger sample including people who have not used OSS. Furthermore, the methodology could be changed to empirically capture the relative importance of the issues identified in this study.

7. References

Anandarajan, M., Igbaria, M., and Anakwe, U. P. 2002. "IT acceptance in a less developed-country. A motivational factor perspective". *International Journal of Information Management.* Elsevier, Netherlands, 22(1):47-65.

Barrantes, *R.* 2007. Analysis of ICT Demand: What Is Digital Poverty and How to Measure It?, INSTITUTO DE ESTUDIOS PERUANOS, available at http://web.idrc.ca/openebooks/342-3/#page_29, [Accessed 8 April 2012].

Bridges.org, 2005. "Comparison Study of Free/Open Source and Proprietary Software in an African Context. Implementation and Policy-Making to Optimize Public- Access to ICT". available at http://www.bridges.org/files/active/0/SoftComp_Final_24May05r.pdf, [Accessed 4 Jan 2011].

Bourque, P., Dupuis, R., Abran, A. and Moore, J.W. (eds.).2004. "Guide to the software engineering body of knowledge". *Proceedings 10th International Workshop on Software Technology and Engineering Practice, IEEE* Press, 6-8 October 2002, New York: USA, pages 8:23.

Camara, G. and Fonseca, F. 2007. "Information Policies and Open Source Software in Developing

Countries". *Journal of the American Society for Information Science and Technology,* John Wiley&Sons, New Yok, USA 58(1):121–132.

Carmichael, P. and Honour, L. 2002. "Open Source as Appropriate Technology for Global Education", *International Journal of Educational Development,* Elsevier, Amsterdam, The Netherlands, 22(1): 47-53.

Davis, F. D. 1986. "A Technology Acceptance Model for Empirically Testing New End-user Information Systems: Theory and Results". *Dissertation*, Massachusetts Institute of Technology, Massachusetts, USA, 1:219.

Ehikhamenor, F. A. 2003."Information technology in Nigerian banks: The limits of expectations." *Information Technology for Development,* Wiley Online Library, Hoboken, New Jersey, USA,10(1):13-24.

Ford, R. 2007. "Open Vs closed: Which source is more secure?" *ACM QUEUE,* New York, USA 5(1):34-38.

Government Technology, 2006. "Open source special report: Separating fact from fiction"California, USA, Available at: <http://www.govtech.com/library/case-studies/Open-Source-Special-Report-Separating-Fact.html> [Accessed 5th April 2011].

Goodhue, D. and Thompson, R. 1995. "Task-Technology Fit and individual performance", *MIS Quarterly*, Management Information System Research Center, University of Minnesota, Minnesota, USA 19(2):213-236.

Greenberg, A., 2005. "ICTs for poverty alleviation: Basic Tool and Enabling Sector*" ICT for Development Secretariat*, Department for infrastructure and Economic Cooperation, SIDA, Canada November 2005. Available at www.sida.se/publications [Accessed 3rd June 2012]

Hamner, M. and Qazi, R. 2009. "Expanding the Technology Acceptance Model to examine personal computing technology utilization in government agencies in developing countries". *Government information quarterly*, Elsevier, The Netherlands 26(1):128-136.

Johnson, J. 2006. "Collaboration, peer review and open source software", *Information Economics and Policy*, Elsevier, Amsterdam, The Netherlands, 18(4):477-497.

Keats, D.W., Beebe, M. A. and Kullenberg, G. 2003. "Using the Internet to enable developing country universities to meet the challenges of globalization through collaborative virtual programmes," *Journal of the Internet, First Monday* Editorial Group, University of Illinois, Chicago, USA, l8 (10):1-13.

Keats, D.W. and Beebe, M.A. 2004. "Addressing digital divide issues in a partially online masters programme in Africa: The NetTel@Africa experience," *Fourth IEEE International Conference on Advanced Learning Technologies, 30 August- 1 September 2004, Joensuu, Finland,* available from < http://ieeexplore.ieee.org> [Accessed 17 March 2011].

Mushi, A. 2007. "ICT Research Opportunities and Challenges: The case of Tanzania", University of Dar-es-Salaam, Tanzania, available from http://euroafrica-ict.org/, [Accessed 17 February 2011].

McKendrik, J. 2007. "Open Source in the enterprise. New software disrupts the technology stack". *Independent Oracle Users group (IOUG),* USA, Available at < http://www.immagic.com/eLibrary/ARCHIVES/GENERAL/GENPRESS/U070904M.pdf > [Accessed 25 June 2011].

Magni, M. and Pennarola, F. 2008, "Intra-organizational relationships and technology acceptance". *International Journal of Information Management,* Elsevier, Amsterdam, The Netherlands,

28(6):517-523.

Open Source Initiative Movement 2011. 'The Open Source Definition', Available at www.opensource.org/docs/osd [Accessed 15 February 2011].

Pogue, T. and Day, B. 2004. "Free/Libre& Open Source Software and Open Standards in South Africa. A Critical Issue for Addressing the Digital Divide", *National Advisory Council on Innovation*, South Africa, Available at http://www.naci.org.za/pdfs/floss_v2_6_9.pdf , [Accessed 9 July 2011]

Prasad, N. 2009. "ICT enabled services in fertilizer marketing management", Chamber Fertiliser and Chemicals Limited, Available at <http://www.faidelhi.org/training%20programme/ICT-09/Workshop%20at%20Manali/PDF%20files/N%20Prasad.pdf> [Accessed November 2011].

Rota, S. and Osterloh, M. 2007, "Open source software development-Just another case of collective invention?" *Research Policy,* Elsevier, Amsterdam, The Netherlands, 36(2):157-171.

Stahl, B. 2005. "The impact of open source development on the social construction intellectual property", *IGI Global* 2005, Hershey, Pennsylvania USA, available from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.101.671 [Accessed 9 April 2011].

Shi, S., Hutchinson, S. M., Yuc, L. and Xua, S. 2001. "Towards a sustainable coast: An integrated coastal zone management framework for Shanghai, People's Republic of China."*Ocean & coastal management,* Elsevier, Amsterdam, The Netherlands, 44(5-6):411-427.

Scacchi, W. 2007. "Open source software development: recent research results and emerging opportunities". *The 6th Joint meeting on European software engineering conference and the ACM SIGSOFT symposium on the foundations of software engineering,* ACM, 3-7 September 2007, Cavat near Dubrovnik, Croatia, (1):459-468.

Schroder, P, Schrettl, W. and Bitzer, J. 2006. "Intrinsic motivation in open source software development". *Journal of comparative economics,* Elsevier, Amsterdam, The Netherlands, 35(1):160-169.

URT, 2003. "National information and communications technology policy", Ministry of Communications and Transport, Dar-es-Salaam, Tanzania, available at < http://www.tanzania.go.tz/pdf/ictpolicy.pdf > [Accessed 5 May 2011].

Vakentesh, S. and Massingue, C. 2003. "Building awareness and supporting African universities in ICT management," *Doctoral Dissertation*, Delft University of Technology, Netherlands.

Van Belle, J.P. and Ellis, J., 2009. "Open source software acceptance by South Africans MSEs: Barriers and Enablers". *Proceedings of the 2009 Annual Conference of the Southern African Computer Lecturers Association*, ACM, 29-1 July 2009, Eastern Cape, South Africa, pages 41-50.

Webster Dictionary, 2011. "Software", available at http://www.webster-dictionary.org/definition/software, [Accessed 25 October 2011].

Weber, S. 2004. "Open Source Software in developing economies", University of California, Berkeley, USA, available at <http://mediaresearchhub.ssrc.org/open-source-software-in-developing-economies/attachment > [Accessed 12 April 2011].

Walsham, G. and Sahay, S. 2006. "Research on information systems in developing countries Current Landscape and future prospects", *Journal for Information Technology for Development,* IOS Press, Amsterdam, The Netherlands, 12 (1):7-24.