OPEN SOURCE SOFTWARE IN HEALTH INFORMATION SYSTEMS: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

The paper presents results of a study seeking to identify constraining and motivating factors associated with the adoption and use of Free Open Source Software to computerise health Information Systems in a developing country. The study approach is interpretive research to case study with a triangulation of several qualitative data collection methods such as interviews, group discussions and document analysis. The findings indicate that using open source software has advantages and disadvantages. The advantages are low entry cost to adopting software, possibilities of software localization, avoiding being hostage of proprietary software and foster knowledge acquisition among software developers. The disadvantages are the need for constant internet access, high switching costs, and lack of human resources especially IT professionals to maintain the software since users get more rights in using and maintaining the system. The study concludes that because of the dynamics in health information systems, open source is appropriate.

Keywords: *Open Source Software, Health Information Systems, software switching costs, proprietary software, software.*

Introduction

Information and Communication Technologies (ICTs) have great potential benefits towards social and economic developments in developing countries. Like in the developed countries, developing countries as well could benefit at large from improved efficiency gains in both production and services offering through the use of ICT. The world health organization (WHO) has long identified Health Information Systems (HIS) as critical for achieving health for all. A report of the WHO meeting (1987) clearly links improved health management to improved HIS as it argues that, of the major obstacles to effective management, information support is the one most frequently cited (WHO, 1987). The rationally for addressing health information systems (HIS) is that, HIS generate information in order to inform health planners and decision-makers on what is happening at health delivery facilities. In this way, HIS improve health management and health management is a pre-requisite for good health delivery services.

Despite the potential that health information systems have, in practice the collection, collation, compilation, analysis, and reporting of health data are riddled with major problems, especially in the context of developing countries. Most health care providers in developing countries equate information systems with filling endless registers, collating, and compiling health data, conducting minimum data analysis, and sending out reports without receiving adequate feedback (Pang, et al, 2003). Furthermore, the data received are often not helpful for health management decision-making because they are incomplete, inaccurate, untimely, obsolete, and unrelated to priority tasks and functions of local health personnel (Braa, et al, 2001; Lungo, 2003; Kimaro, 2006,. Wilson, 2000) suggests that, the creative use of microcomputer technology is one of the most promising means of improving the quality, timeliness, clarity, presentation, and use of relevant information for primary health care.

In our study, we focus on how technological choice to Information Systems (IS) implementations could have positive and negative effects on the sustainable implementation of health information systems. Specifically, the study is about the use of Free Open Source Software (FOSS) in computerising Health Information Systems. In proprietary software, programmers put restriction on the rights to their software and charge fees for each copy (limited number of computers). The prevention of use, copying, or modification can be achieved by legal or technical means. Technical means include releasing machine-readable binaries only, and withholding the human-readable source code. Legal means can involve software licensing, copyright and patent law. Other authors highlight that in proprietary software the owner is of prime importance. This contrasts with Free Open Source Software (FOSS) where the freedom of computer users is of prime importance (FSF, 2006).

In the literature, FOSS is presented as if its adoption and use is problem free. However, many

cases of FOSS adoption is on infrastructure based software such as Linux Operating Systems, Apache web server and email programs. Little is said on application systems such as Health Information Systems. This paper is aimed to shed light on essential issues that need to be taken seriously during the adoption and use of FOSS products in Health Information Systems. The research question addressed is:

what are the constraining and motivating factors associated with the implementation of Free Open Source Software in Health Information System of a developing country like Tanzania?

In this paper we underscore that, while the use of computers in health information systems could improve the performance of those systems, the computerization process is a challenging task because software being implemented are not coping with the nature of health information systems characteristics: (a) health systems are characterized by dynamic changes as diseases and drugs change; (b) require installation of the software to so many computers; (c) HIS express a high degree of heterogeneity ranging from old and new computer technologies and human resource force with various background.

Literature Review

The overall aim of the article is to contribute to the debate of ICT and development in general and particularly to shed light on the challenges and opportunities of using Free Open Source Software (FOSS) to computerise Health Information Systems (HIS) in developing countries. Implementation of software (computerization process) in Information Systems (IS) has two extremes: (a) software development and (b) implementation or rolling up the software in organizations. While the first extreme is concerned with the technicalities of realizing the software, the second extreme is concerned with political negotiations, sponsorship and power struggle when rolling up software in organizations. In the next paragraphs we present theoretical concepts on Free Open Source Software and implementations of Information Systems (IS).

Implementation of IS in developing countries demands not only a transfer of technology but also the introduction of the culture that go with the system. As Heeks (2002) points out what is transferred is not only machines, hardware, software, skill and knowledge but also the attitudes, the value systems together with the social, political, and cultural structures. While it may be relatively easy to transfer the technical artefacts, it is far more complex to "transfer" the socio-cultural context to other settings. Like all other technologies, ICT is also context sensitive and ensuring technological learning is crucial to its successful transfer to developing countries. Thus, we need to understand that automating HIS in developing country is a kind of ICT transfer.

Authors cite bottlenecks in the development of effective IS that include the centralized and fragmented character of services, lack of coordination, poor quality and use of information, and the heterogeneity organizational context (Avgerou and Walsham, 2000). Kimaro (2006) argues that poor focus on the development of local expertise on the part of donor initiated projects and the tendencies of neglecting of social and organizational issues are cited as factors contributing to the problem of ineffective implementation of IS in developing countries.

Recent experience (Wilson, 2000; Braa and Hedberg, 2002; Lungo, 2005) attest to the potential for using computers in health information systems. Lippeveld and Sapirie (2000) advise a successful way of designing and implementing health information systems, by arguing that the success of a health information systems reform depends not only on technical improvements but also on in-depth understanding of political, socio-cultural, and administrative factors.

Developing countries and their donor partners are argued to review policies for procurement of computer software, to ensure that options for using low-cost open-source software products are properly considered and their costs and benefits carefully evaluated (Barton, et al, 2002). Not only FOSS reduce software licensing costs but also foster indigenous technological development by having access to the source code of software products (Weber, 2003; UN, 2004; Weerawarana and Weeratunga, 2004; Câmara and Fonseca, 2007). Other reasons for the adoption of FOSS in developing countries include avoiding being locked to proprietary software (UN, 2004), advancing knowledge more quickly, and helping to set up an information economy (Weerawarana et al., 2004).

Weber (2003) informs the difference between proprietary and open source software:

"…when a person purchases a proprietary software buys a right-to-use license. You can use proprietary software on a computer but only under very specific terms: you cannot reproduce it, modify it, improve it, or redistribute your own version of the software to others. Copyright, licenses, patents, and other legal structures provide a layer of legal protection to this regime,

but there is an even more fundamental mechanism that stops you from doing any of these things: proprietary software makers do not release their source code" (Weber, 2003, p.2).

While in proprietary software, the source code is the touchstone of the conventional intellectual property regime for computer software, the Free Open Source Software (FOSS) process simply inverts this logic. The essence of free open source software is that source code is free. That is, the source code for FOSS is released along with the software to anyone and everyone who chooses to use it (Weber, 2003; Weber, 2004).

In a legal perspective, Rosen (2005) focus on what matters most about open source licenses principles.

Table 1: The Principles of Free Open Source Software

Principle	Description
Licensees are free to use open source software for any purpose whatsoever	This indicate that an open source license may not interfere in any way with the use of the software by licensees
Licensees are free to make copies of open source software and to distribute them without payment of royalties to a licensor	However, this principle does not mean that a licensor cannot sell open source software. It merely says that a licensee need not pay the licensor for additional copies he makes himself, even if those copies are distributed to others
Licensees are free to create derivative works of open source software and to distribute them without payment of royalties to a licensor	This is based on the notion that quality software is built upon the foundation of earlier software and it promote the progress of science and useful arts
Licensees are free to access and use the source code of open source software	This requires the licensor to make source code available to licensees upon request at zero prices, not necessarily to distribute the code to everyone
Licensees are free to combine open source and other software	Open source licenses may not impose conditions or restrictions on other software with which the licensed software is merely combined or distributed

This paper reports empirical material collected during the implementation project. Because of the nature of the study which involved both technical implementation and political negotiations of the use of the software, we found that a theory that take account of social-technical aspect of IS implementation is relevant. Here we use concepts of Actor Network Theory (ANT) to follow the main actors, both human and non human, that were driving the process of implementing the software.

According to Walsham and Sahay (2006), ANT has been a popular theory in Information Systems (IS) literature in recent years due to its explicit way of conceptualising technology as one of the "actors" in any actor-network analysis. In particular, the moments of translation have been used by IS researchers to study the development and implementation of ICT based IS (Walsham and Sahay, 1999; Ramiller, 2005; Lee and Oh, 2006; Stanforth, 2006).

The main concept of Actor Network Theory (ANT) is the idea of 'actor-network', which was developed by Michel Callon and Bruno Latour in the 1980s to study science in action (Latour, 1987). With this concept ANT which regard the society as a socio-technical web where technical objects participate in building heterogeneous networks that bring together *actors* (elements) of all types, whether human or non-human (Latour, 2005). Actors and networks are mutually constitutive, meaning that the relationship with other actors and the network is built on the mutual influences and intermediaries that actors exchange between each other.

In the project we studied, actors range from people, documents, the establishing of facts, training workshops, and software. The actor-network is configured and built over time through the enrolment of allies (both human and non-human) by means of the process called *translation* (Callon, 1986). During the translation process, innovators attempt to create a *forum* - a central network in which all the actors agree that the network is worth building and defending. According to Latour:

translation occurs as actors enrol allies in the actor network and *align* their interests in a continuous process of renegotiation where claims become well-established facts and prototypes are turned into routinely used pieces of equipment. Since the claim

is believed by more than one person, the product bought by more than one customer, the argument incorporated in one more article or textbook, the black box encapsulated in one more engine, they spread in time and space (Latour, 1987).

Braa and Hedberg (2002) argue that following translation process is important to describe and analyse bottom-up processes where the outcome is far from given at the outset but is determined by the negotiations. This is especially true in the process of computerisation of paper based health information systems because the process start at the peripherals such as in the districts and hospitals where health data are being generated then comes to the national level. Walsham and Sundeep (1999) underscore that a major focus of the theory when applied in particular contexts is to try to trace and explain the processes whereby relatively stable networks of aligned interests are created and maintained, or alternatively to examine why such networks fail to establish themselves. Successful networks of aligned interests are created through the enrolment of a sufficient body of allies and the translation of their interests so that they are willing to participate in particular ways of thinking and acting that maintain the network. A representational point with respect to computer systems and software have been made in Bowker and Star (1994)

Modern information technologies embed and inscribe work in ways that are important for policy makers, but which are often difficult to see … arguments, decisions, and uncetainities … are hidden away inside a piece of technology of in a complex representation. Thus, values, opinions and rethoric are frozen into codes, electronic thresholds and computer applications. We can say that in many ways, software is frozen organizational discourse.

A frozen element (in this case software) is not opened to question by the actors in the network and is termed a black box. The way software designers scripts and worldviews are inscribed into the software is referred to as inscriptions. The idea of software as frozen discourse is an example of an inscription that resists change and displays properties of irreversibility (Walsham and Sahay, 1999). Various software standards provide illustration of irreversibility. The interest in this study is to find out how the standards embedded in open source software could be effect the implementation sustainability and use of health information systems.

In our case, ANT is useful in describing constraining and motivating issues that affected the construction, configuration and stabilising the actor-networks. Also it shed light on how the technological choice in this case, FOSS, becomes an important actor during the moments of translation (problematization, interressement, enrolment and mobilization). The philosophy and Intellectual Property Rights (IPRs) within open source software development make a difference when FOSS based software is used to computerise HIS. Steinmueller (2001) argues that access to equipment and know-how is needed to make productive use of later stages in technological development. However, "existence of Intellectual Property Rights (IPRs) and their global enforcement often raise real issues about constraints on access to state-of-the art equipment and know-how that new entrants may face" (Steinmueller, 2001).

In summary, the literature review informs that FOSS is a way to avoid confrontations with Intellectual Property Rights (IPRs) institutions. In the other side Actor Network Theory (ANT) enlightens strategies for implementing technological innovations. However, the way FOSS are presented in the literature is like its implementation in Information Systems such as Health Information System in developing countries is a silver bullet (unproblematic). Thus, we have grounded issue to look, is FOSS implementation problem free? Hence our research question, what are the challenging and motivating issues in FOSS based IS implementation.

Research Methodology

Over a period of three years (2005-2007), the Department of Computer Science, University of Dar es Salaam in collaboration with the Institute of Informatics, University of Oslo have been collaborating in working on a project known as "Building European-Africa collaborative Network for applying IST in Health care sector" (see BEANISH, 2005). Through this project, implantation of FOSS based software in the HIS in Zanzibar was achieved. It is within this wide project our study took place from January 2005 to August 2007. The paper uses an interpretive approach to case study for the research as presented in (Walsham, 1995); Klein and Myers, 1999). Walsham (1993) argues that interpretive approach is suitable methodology to study IS as social systems, where the aim is to investigate the intricacies of social and technical aspects of IS development. Arguing on the relevance of case study, Yin (2003) contend that case study is an adequate empirical enquiry which helps in investigating a contemporary phenomenon within its real-life

context, and in which multiple sources of evidence are used.

The first author assumed the position of overall BEANISH project coordinator. Thus, he spear headed all the political negotiations to successful implementation of the project. The negotiations included, selecting software technology (between proprietary and Free Open Source Software), acquiring human resources especially software developers and negotiating integration of various conflicting interests of HIS stakeholders. The second author was one of the programmers and principal researcher. With respect to this study, he designed the data collection tools and led the process of data collection, management and analysis. In our study, we used several qualitative data collection methods: *in-depth interviews*, *group discussion*, *participant observations*, *passive observations*, *document analysis*, and *software usage analysis* (the proprietary software of HIS in mainland and the FOSS software of HIS in Zanzibar).

We conducted prolonged interviews with health officers at the national, regional and district administrative levels regarding the use of software in their respective Health Information Systems. An interview session ended between one to two hours and because of the long period of time in the research, some respondents were interviewed in two or more different time in different places. During the progress of the research, we conducted sensitization workshops, project planning meetings, and user training workshops. We used these meetings to table group discussion around the research interests, the use of open source software, to solicit views of various useful people. In the mainland, we staged interviews with the HIS IT person of the Ministry of Health regarding the use of software as a tool for analysing, storing and reporting health data. The Ministry of Health has proprietary software being used at the national level as well as at the Regional Medical Offices and District Medical Offices. In this study, we had an opportunity to interview two regional HIS coordinators and five districts HIS coordinators who are using the system constantly. In Zanzibar, during our study, a Free Open Source Software was in use in all districts and at the national level (ministry level). Again we had on opportunity to interview national HIS coordinator, and six district HIS coordinators (two from Pemba and four from Unguja).

Table 2: Health Data flow in the Health Information System in Tanzania Mainland

Name of Report/Form	Frequency	From	To
HF Staff listing form	Annual	All health facilities	District Medical Office
Equipment inventory form	Annual	All health facilities	District Medical Office
Physical structure inventory form	Annual	Government health facilities	District Medical Office
Health facility annual report form	Annual	All health facilities	District Medical Office
Health facility quarterly report form	Quarterly	All health facilities	District Medical Office
Renovation/Maintenance report form	Annual	Government health facilities	District Medical Office
Equipment breakdown report form	Annual	Government health facilities	District Medical Office
Notifiable disease report form	Weekly	All health facilities	Regional Medical Office
District quarterly report	Quarterly	District medical Office	Regional Medical Office
DMO Staff listing form	Annual	District Medical Office	Region
Regional quarterly report	Quarterly	District medical Office	Ministry of Health
RMO Staff listing form	Annual	District Medical Office	Ministry of Health

In addition, the authors were part of the technical implementation team of the FOSS based HIS in Zanzibar. This gave us opportunities to discuss even with sponsors of the project, various stakeholders (especially several vertical programmes such as Expanded Immunization Programme, HIV/AIDS and TB). Since we interviewed the subjects in their working areas, we also had access to fieldwork documents such as reports, training manuals and ministerial directives on the use of the respective software. Most important, we had have access to software bug reports and other usage problems. For

example, software bugs report and new features lists sent to the software developers which needed to be fixed urgently. In this way, we had a picture on how users struggle to sustain their respective software while ensuring that the software accommodate new changing requirements. In general we played the role of participant observers especially in Zanzibar and passive observers in the main land.

Content analysis approach was the approach used to analyses the empirical data. Babbie (2007) defines content analysis as the study of recorded human communications and Holsti (1969) offers a broad definition of content analysis as any technique for making inferences by objectively and systematically identifying specified characteristics of messages. As there are various use of content analysis approach, our use of this data analysis approach is to describe and make inferences about the characteristics of communications we held with various people regarding the adoption and use of open source phenomena in health information systems. The process of research data collection was constantly informed by the theoretical concepts. Specifically we followed the translation process, where we gave much attention to data that gives hints on how actors were enrolled and data that could help to argue for or against Free Open Source Software. Analysis of the data was conducted from the beginning of data collection process. We used diaries to record fieldwork notes and later sometime on the same day we typed the notes on a computer word processor. Then, we proceeded with coding the notes. Coding is a method of findings synthesis whereby fieldwork notes are marked, categorised and grouped together to form a specific theme (an informed trend of the data collected). We executed data analysis (coding and categorising) repetitively throughout the study. The findings are presented in the next section.

Research Findings and Analysis

Through the content analysis process, we coded data and categorised them under thematic headings; then counted and tabulated. However, in this paper the findings are presented in qualitative form (verbal presentation) rather than in quantitative (descriptive statistics and figures). This is because the focus is to express the issues in our own language under thematic. In line with the focus of our paper, the findings are presented with respect to the opportunities and challenges of using Free Open Source Software in Health Information Systems. In summary our study found that HIS adopting FOSS benefit with: (1) Low Total Cost of Ownership of software; (2) software localisation; (3) avoid locked by IPRs regimes; and (4) foster political integration of conflicting interests of health delivery vertical programmes. We also have several challenging issues: (1) availability of IT professionals in HIS; (2) intensive dependence on IT infrastructure especially the internet and (3) switching costs if the ministry would decide to abandon its proprietary software and go for FOSS.

Low Total Cost of Ownership of software at start up: FOSS based software are cheap and sometime distributed at no charge (like in the case of Zanzibar). Thus, its entry point is not expensive. Any one can take the software and start to prototype. Respondents were primarily asked about their motivation to use open source software products. The results indicate that lower cost, high reliability and availability of external support are prime motivations for organizations to adopt and use open source product. Respondents concluded that open source software products lower ICT expenditure in three different ways: first, the software was free (no charge) or it is cheap in terms of money; the products run on cheap hardware which eventually lowers hardware expenditure; and that support contracts are often cheaper when compared to supports for proprietary software products. This concludes that under the open source phenomenon, the total cost of ownership of software products become low.

Software localisation: software localisation includes translating the software to local languages and customising it to local requirements. It is thus imperative that for a software localisation to happen, programmers need to have full access to the software source code. The opportunity provided in FOSS is that it is legally allowed to modify a system. Thus, you do not need to start from scratch, you can take mature software and localise it. In the case of Zanzibar, the software was originally developed in South Africa. However, the software could not be used as it was in Zanzibar. Funds were solicited and a team for customising the software was made. In the team which customise the software for the HIS in Zanzibar, the original developers were not included. Yet, at the time of writing the software was customised and implemented in all districts and national level in Zanzibar. This tells a lesson that it is possible to rely on different developers to customised and fix bugs in a software developed by a different vendor.

Means of acquiring knowledge: this theme emerged when discussing with programmers who participated in the customization of the software in Zanzibar. These were fresh from the university and

it was their first serious mission in delivering a product. All acknowledged that they have learned a lot of programming skills by studying the source codes of the open source software. This is obviously true that you cannot change software without first understanding the source codes. Moreover, the concept of software modularisation makes the learning curve to be short. That means, a new programmer does not need to understand the whole system, instead what matters is to learn the module in question.

Avoid locking situation: with its unlimited number of users and number of installation philosophy, FOSS is a viable alternative for large information systems such as HIS. This is because a country would like to install the system in so many computers all over the country. In Zanzibar for example, the system was installed in all districts, major hospitals and at the national office.

The nature of health information systems is featured by frequent updates of data elements. The health items being recorded such as diseases and drugs. New drugs are invented and old drugs are banned from use. A good example was when Tanzania adopted Vitamin A supplement. In the mainland the proprietary software had no column for recording Vitamin A data elements and hence a range of one year data was not able to be recorded. Another incident is when the Ministry of Health banned the use of 'Chloroquine' for malaria treatment instead it introduced 'Fancidar'. The software had a column for recording Chloroquine but not for Fancidar. Thus, it required to be updated. These changes took so long time to be effected because the Ministry had to prepare a budget for the vendor to effect the changes in the software.

Foster political integration: in the health sector, there are many vertical programmes which collect same health data but using different tools. While problematising the need for the software so that all health data stakeholders (vertical programmes) are being pointed to one source of data, the immediate question is if the software is flexible enough to have unlimited number of users. We found that, FOSS is convincing and make the decision to agree on having one repository data (which we call political integration) faster. In proprietary software, adding more users means paying more and hence increasing costs.

Unavailability of IT professionals: IT professional in the Ministry of Health is a rare professional. Thus, ICT initiatives have to be supported by outsiders. During our study, in Zanzibar, there was no single IT professional working with HIS. In the mainland, there was one staff with background in IT but working as a statistician. The challenge now is, even if FOSS are distributed with their source codes, there is simply no one to make necessary change in the system. However, FOSS provides the opportunity to buy support services from any vendor, and hence there is much flexibility when using FOSS products in that, you don't rely on the original vendor of the software.

Intensive dependence on IT infrastructure: during the project in Zanzibar, one of strong actors in facilitating the project was Internet. We found that working with FOSS technologies require constant connections to the Internet. The low connectivity in developing countries may hinder harnessing all FOSS related opportunities. Table 3 presents the way infrastructure hampers FOSS freedom.

Table 3: Consequences of ICT Infrastructure on FOSS Claims

Critical Issue	FOSS Claims	Resulting Consequences
ICT Infrastructure	Source Code freely available	Difficulty to acquire and give back to the community those source code without Internet
	FOSS community collaboration tools like bug reporting tools, support, etc.	No internet infrastructure, instead alternative ways have been in use (e.g. sms, and phone calls). This hinders to reach all participating community members.
	Derived works allowed	Derived works realised but cannot feedback to the community members.
	Avoid locking	Since the customized derivative product cannot be shared back to the community, the organisations will be locked to those developers. The adopters become owner and thus carry the burden of future software upgrades.

Switching costs: the proprietary software are protected with Intellectual Property Rights (IPRs) make it very difficult for Health Information Systems locked on these systems to switch to other systems otherwise risk loosing their old vast amount of data. For example, if some data elements records such as name of diseases were mixed up with the software source codes (hard coding programming style) and that it is illegal to access somebody's software source codes, it's simply means the data cannot be migrated to software. Switching costs are those one-time inconveniences or expenses a customer incurs in order to switch over from one product to another, and they can make for a very powerful moat. Companies aim to create high switching costs in order to "lock in" customers. The more customers are locked in, the more likely a company can pass along added costs to them without risking customer loss to a competitor.

Discussion and Implications

To synthesise the findings, Free Open Source Software (FOSS) plays a central role to strengthening networks with regard to implementing health information systems in developing country. Translation processes especially enrolling actors is fostered by the FOSS phenomena. There are several stakeholders in Health Information Systems which overburden health workers at the health facilities with request of collecting health data. Implementation of software is a way of creating a central repository of all health data. However, if the software itself is a proprietary one, then access to that central repository could be limited. Thus, the success of convincing stakeholders to form alliance for creating the central repository is very much affected by the inscription of the software. For example, the question of unlimited number of users and unlimited number of installation is a FOSS strong point of interest to speed up the enrolment and stabilisation of the networks around creating central repository.

In the case we studied in Zanzibar, the software was acquired at no charge. This is strength of FOSS products in that it overcomes entry barriers in that, an organization could acquire and prototype the software with no cost before it decides to invest on it. Moreover, in the project we studied, the programmers were paid for the act of localising the software to the needs of the HIS in Zanzibar. The strategy for paying local developers to customise a software is by it self a motivation for enrolling some actors such as local ministries of health and donors. In proprietary, huge amount of money goes to the software. Sometimes decision makers and donors are reluctant to pay big some of money for software especially if the software is from a foreign company. In the Zanzibar project one officer from the ministry of health commented this.

"There is a different when you pay somebody to do a work and to pay for purchasing software. This ensures that we will fully own the software on our own" (Health Officer, 12th June 2005, Headquarter Office, Ministry of Health Zanzibar).

We interpreter the excerpt that the fact that the payments are re-directed to local developers instead of the original developers, this make different to the organisations. In addition, since local developers (in this case Tanzanian instead of South African) have got an opportunity to learn and customise the DHIS, there is innovation here, though this is not important to the client system.

Software developers were important actors in the project studied, where actually the one who inscribe practices in the codes of the software. Stabilising the network requires that software developers are fully engaged with project. Beside from money, working of FOSS give the developers an opportunity to learn new skills of programming by looking on the software source code of established software developers. In the project studied software developers were fresh from the university and thus studying source code is of great motivation to them.

In proprietary software, customers do not own the software, but have given a licence to use the software. This is depicted in the license which in most of the case protects users from accessing the software source codes or even imitating to create similar software a process known as reverse engineering. In contract, in FOSS, users actually own the software. Users have the freedom to buy support from any vendor different from the original author of the software. This peculiar feature of FOSS is actually an attractive factor for enrolling actors such as developers, donors and health officers to support the initiative.

The despite the likely hood of forging a stable network for implementation FOSS in health information systems, the challenges presented are a constant threat. Challenges are likely to hinder important actors from achieving their goals and hence turn away, de-stabilising the network. An example is internet infrastructure. If the developers are heavily depending on the internet to post questions and seeking clarification to the original author of the software through emails, un-availability of the internet (which is now an actor of the network) would simply make life difficult to the developers. As a result they will not learn the

system and would simple un-able to localise the software.

Conclusion

The article articulated the potential of Free Open Source Software in Health Information Systems. Grounded on the distinction between proprietary software and open source software, we see proprietary software as a bottleneck toward computerised HIS. This is because HIS are too dynamic systems which require flexible software and user empowerment. We see opportunities for using open source software due to the fact that these programs ship with their source codes and have no copyrights restrictions. Thus, they facilitate the use of in-house IT staff to study and update the software. Supporting service can be bought from any vendor. No lock-in of users to a sole original developer of the software.

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