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How does Open Source Software contribute to socio-economic development?

An investigation of Open Source Software as an alternative approach to technology diffusion, adoption and adaptation for health information systems development and socio-economic impact in Mozambique

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Key words

Open Source Software, socio-economic development, public goods, intellectual property rights, copyright, capacity building, health information system, health governance, public service delivery, Mozambique, South Africa

Abstract

Developing countries are net importers of intellectual property products and open source software (OSS) production is one way in which local socio-economic development can take place. The public goods characteristics of OSS are contested and this study investigates whether in a developing country context OSS is a pure public good that can be locally appropriated and not exclude any users or producers from doing so. This case study of an OSS public good finds that it does not have all the characteristics of a pure good, that there is a role for a sponsor, and in particular the importance of copyright protection of derivatives in order to ensure that the source code does not fall out of fashion and use. Having explored that, however, there is further evidence that OSS collaborative learning is both publically and personally beneficial for developing country computer programmers. Furthermore, the state benefits from the improved benefits of health information systems made possible through the appropriation of this model of learning.

Dedication

For my father Hertzog Henning and my children Benjamin and Gina

Declaration

This declaration is made in terms of the University Regulation G28.

I declare that this thesis is my own unaided work. It is submitted for the degree of Master of Arts, in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination in any other university

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Heloise Emdon

_____day of the _____2010

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I thank Dunbar Moodie who started me off in mid-career post graduate studies in the 90's at Andover Newton Theological Seminary and Kennedy School of Government, and Steve Song, my predecessor at IDRC whose normative and insightful stance on Open Source Software helped me explore more deeply this innovation of our age.

To my children Benjamin and Gina, my husband Clive and mother Moira for their patience and care through our first months in Canada while I remained so preoccupied with my studies. I wish to also remember my father, Hertzog Henning, who always encouraged me to add economics to my politics and philosophy majors. Thank you to my colleagues who also exercised patience but supported my perseverance, I thank you all.

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Preface

Over the past eight years, I have worked for the International Development Research Centre (IDRC), a Crown Corporation funded by Canada's International Assistance Envelope. I have been part of the Acacia Program Initiative and, since 2008; I have been the Program Manager of this Programming Initiative. Over 15 years of funding research in Africa on the use of information and communication technologies, related to access, use and usefulness, our interest was focused on seeking ways to lower the barriers of entry for Africans to participate in the global information society. In the process, we have supported research into policy, research in communities and in particular worked with universities and NGOs in supporting research capacity building in Africa. The internet introduced a range of innovative ways to access knowledge and appropriate knowledge. The internet has made access to several free resources possible, downloading and adapting can cut costs associated with expensive proprietary software licenses.

We have promoted and supported research into Open Access to educational materials, and Open Source Software as an approach to knowledge development and Openness as a principle in governance. This study is about finding out if the approach and the resources used in Open Source Software (OSS) can leverage assets from developed countries, while building capacity and economic improvements in Africa. This certainly was our assumption about one way of bridging the digital divide in funding several OSS projects in which this free resource of world class software prompted us to explore the economic benefits in a range of projects. Through my work, I was involved in supporting several research projects related to OSS in Africa. One study assessed how community telecentres and school users were making use of OSS; another project supported several Sub-Saharan Africa universities to network and to build OSS application for university teaching and student administration; and

several projects supported the use of OSS for health and microfinance applications development.

Repeatedly the infrastructure and skills divide rendered the use of OSS extremely difficult in resource-poor settings. Universities in South Africa were more able to promote OSS, but even these proponents often met with resistance. We continued to promote the use of OSS because, in our perspective, the reuse of software clearly provided us with cost-cutting development tools. Our imperative was not only to cut costs, but a commitment to create public goods for the Canadian taxpayer funds. It was therefore with conviction that we supported these projects in order to achieve development impacts.

I proposed this topic for more in-depth research concerning this apparent paradox, namely that an open software resource of world class quality could be exploited through free access to achieve social and economic benefits in Africa, but that these goods were not easily appropriated nor were they apparently universally accessible. I moved to Canada at the early stages of the research and conducted much of the field work either in person or using electronic communication. My position as a participant observer both as funder and researcher and my epistemological stance in this study is discussed in the Methodology chapter. Despite my proximity key respondents were not always available. Many of the interviews, conducted at a distance, were mediated, and one survey was conducted anonymously. In all research interactions I clearly stated the interest I had was for research for an academic qualification and not as an employee of the IDRC.

Furthermore, as an employee of the IDRC, I have had access to the electronic library resources -- any partner we fund enjoys the same privileges. I self-funded my studies, worked in my own time on the thesis and therefore have no obligations to my employer or the projects concerning the findings.

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Glossary

AMPATH	Academic Model for the Prevention and Treatment of HIV/AIDS program of Indiana University at Moi University Hospital, Eldoret, Kenya
AMRS	Ampath Medical Records System
API	Application Programming Interface
ARV	Antiretroviral treatment also referred to as anti-HIV or anti-AIDS drugs, or ARVs.
CDC	Centers for Disease Control, USA
EMR	Electronic Medical Record
FOSS	Free and Open Source Software
FOSSIL	Free and Open Source Software Informatics Laboratory
GPL	General Public License, the original free and open source software license
HISP	Health Information Systems Programme
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome
HL7	Health Level Seven International Standard
HMN	Health Metrics Network
ICD	International Classification of Disease
ICT	Information and Communication Technologies
ITU	International Telecommunications Union
IU	Indiana University
Java	An OSS object oriented programme for enabling visual interfaces
Jembi	NGO managing OASIS project, based in South Africa
MPL	Mozilla Public License
MRC	Medical Research Council South Africa
MySQL	OSS database software
NGO	Non-government organisation

OECD	Organisation of Economic Co-Operation and Development
Open MRS	Open Medical Records System
OSS	Open Source Software
Pepfar	The US President's Emergency Plan for AIDS Relief
PIH	Partners in Health
UEM	University Edouardo Mondlane, Maputo, Mozambique
UKZN	Univeristy of KwaZulu Natal, Durban, South Africa
USA or US	United States of America
UNCTAD	United Nations Conference on Trade and Development
WHO	World Health Organisation

Chapter 1: Introduction

This study began from my own involvement as a Programme Officer at the International Development Research Centre (IDRC), when we supported a pilot project that included the University of Eduardo Mondlane in Maputo. The project introduced a health information management system to enable better access to information regarding the pressures the HIV/AIDS epidemic was placing on the primary healthcare system. We supported a group of computer science graduates, who were commissioned to develop a death registry at Maputo central hospital, which is the country's main tertiary care centre.

The key international donor with regard to HIV/AIDS in Africa is the US President's Emergency Plan for AIDS Relief (Pepfar) program which provides support for African countries to dispense anti-retroviral treatment to their populations, and together with other donors supports the strengthening of African countries' primary health care programmes. Both types of programme require reporting and accountability concerning the funds, involving the use of health information management systems. Annually, in developing countries, global organizations spend US$ 0.5-1 billion dollars on different aspects of health information (AbouZahr & Boerma, 2005). Despite this significant amount of spending, little attention is paid to building the capacity of developing countries' computer programmers or statistical skills in the area of health information systems development.

For the pilot health information project at University of Eduardo Mondlane, our foci were on two separate, yet, interrelated issues - lowering the procurement costs of these proprietary health information software systems and building the capacity of local computer programmers' for developing, maintaining, and contributing to the modular building of a health information system

for the country. We hoped eventually to eliminate dependence on imported proprietary systems and find alternative paths to paying for a multiple user's license, annual license fees, expert adaptation, migrating data from old databases into the new system, localisation of modules to suit local business processes and even languages, training of local staff to use the new system, as well as providing customer service functions for troubleshooting and helpdesk functions.

Health information systems provided as part of aid packages to developing country governments are usually bespoke systems (Titlestad, Staring, & Braa, 2009) meaning they are set up and customised for the funders' and their country partners' specific use and, therefore, do not allow for local adaptation nor control. Although health projects or facilities might initially receive training for implementing an information system provided to them, these systems are usually custom made for the donor's requirements, specifically monitoring and evaluation. Donor agencies often remain in control of these systems which are often also 'tied aid' , that is, produced by developed country enterprises.

Although imported information systems may be installed free of charge, after a period, they require the recipient developing country to pay to access their own patient data. In addition, companies that build closed source health information management solutions can also demand further royalty payments before giving original data back to the developing country (Levison & Fraser, 2008). Therefore, despite the apparent economic benefits that proprietary systems offer developing countries, such benefits need to be off-set by the associated cost, such as royalty payments abroad for licensed software and content.

Furthermore, the local adaptations required to commercial proprietary software often require technical experts to be flown in at great cost. in contrast to the closed model, the OSS design philosophy allows for flexibility, which enables each country to adapt software programmes,

translate software into local languages, and simplify local technical support. Therefore, adapting this type of system and in the process developing local expertise would be more beneficial for a recipient country, while also contributing to the development of public goods that other developing countries could appropriate. The public good aspect of OSS has intrigued researchers in the field of economics – the field in which I am also situated - for some time (Lerner & Tirole, 2000) and will be further discussed below.

1.1. Background to the project

The project at UEM was part of a larger process of co-operation amongst programmers from several countries, including South Africa, Zimbabwe, Mozambique, Kenya, Uganda, Malawi and Tanzania and the developers from the United States. The network has grown exponentially since this study has started beyond even these users in Africa, however, this study only focuses on the activities of the Mozambican software development node and its interactions with the South African and US-based computer programmers.

The Regenstrief Institute, a health informatics centre at Indiana University, USA, and Moi University Hospital in Eldoret, Western Kenya, are in a twinning partnership which led to Regenstrief developing a electronic medical record system for developing country use in 2002. The HIV/AIDS program at Moi University Hospital needed patient data to iron out the complications with antiretroviral treatment as well as to account to its funders how these expensive drugs were being used. The software of the initial project soon became unstable when the numbers of patients grew too large, exceeding 30 000 and growing exponentially (Tierney et al., 2002). By 2004 two medical doctors from the Regenstrief Institute developed a web-based

system to overcome the limitations of the earlier database [1]. With support from the initial funders of the project, the Rockefeller Foundation and CDC, it was decided that the software should be made free and open to the public, ie OSS. This resulted in the development of Open Medical Records Systems (OpenMRS), by the Riegenstrief Institute, together with Partners In Health, an international health NGO based at Harvard University, Massachusetts in the United States of America. This partnership also included at an early stage Chris Seebregts of the MRC in South Africa, who is also an associate professor at the University of KwaZulu Natal Computer Science Department. Seebregts and Hamish Fraser of Partners in Health collaborated on a US-funded grant from the National Institute of Health to establish health informatics training at the University of KwaZulu Natal.

The IDRC, my organisation, had already funded a project in South Africa where an electronic medical record system was pioneered by Seebregts in 2003, but this sytem was linked to a proprietary system purchased by a provincial government. In an effort to build a community of OSS programmers in Africa to appropriate OpenMRS, the IDRC got involved now with the OpenMRS team which Seebregts had joined. IDRC provided funding for a project called Open Architecture and Standards in Information Systems for Health in Africa (OASIS) which was managed by Seebregts at the Medical Research Council (MRC) in South Africa and later on an NGO in South Africa called Jembi. OASIS started with the establishment of three university-based "nodes". The first was the Free and Open Source Software Innovations Laboratory (FOSSIL) at the Department of Mathematics and Informatics, Science Faculty, University Eduoardo Mondlane (UEM), Maputo established in September 2008 (also known as MOASIS).

[1] The proponents developed a core application programming interface (API) around a data repository with a data model to centralise and standardise terms for collecting patient data model) based on 30 years of history from the Regenstrief Medical Record systems. The system is patient-centred and complies with internationally recognised standards for unique identifiers of patients (HL7) and is web-based running above the API.

The second was based at the Department of Tele-health and Computer Science, University of KwaZulu Natal, Durban, and the third was at the Centre for Public Health Informatics, University of Zimbabwe, Harare,at the University of Zimbabwe. Each of the three nodes that the IDRC supported in the project had a request from a government agency to develop health information systems. The South African node was asked to develop a health information system for the Tshwane District hospital, Gauteng. The Mozambique node had a request from the Ministry of Health (Ministerio de Saude (MISAU)) to develop a death registry for the Maputo Central Hospital. In Zimbabwe a clinic that was enjoying implementation had to stop the project because of a cholera epidemic in 2008 that resulted in the clinic being repositioned to cope with the emergencies.

Funding of the project also included annual meetings in South Africa that attracted software developers from across Africa and further afield, and have grown from 96 in 2006, the first year, to over 200 people n 2008. In 2009 the organisers restricted participation again to under 150 people. . Initial implementers came from institutions contributing and extending the core application and configuring it for their local use in Kenya, Rwanda, South Africa, Lesotho, Malawi, Tanzania, Uganda, Zambia and Zimbabwe (Seebregts et al, 2010). Subsequent phases of the OASIS project have expanded the sponsored community to other countries in Africa, including Rwanda, Uganda and Kenya (R. P. Seymour, Tang, DeRiggi, Munyaburanga, Cuckovitch, Nyirishema, & Fraser, 2010b). In a related development in Rwanda the IDRC funded the Partners In Health project to train a group of graduates for a year, who were subsequently employed in public health jobs to support Rwanda's uptake of OpenMRS. The meetings also include a hands-on development component, usually in the form of a challenge to get collaborators to work on problems with programmers that need help solving their particular

problems. I was a participant observer in one of these meetings and wrote an ethnographic sketch (Appendix 3).

We specifically funded the annual meetings to enable students to benefit from collaborative learning and allow them to interact with the original programmers of the OSS, potential users of the information, and other interested stakeholders. The focus of the meetings was on the OSS collaborative learning style, and they provoked my interest in the latter and its links to programme funding which has led to the current masters thesis. I became interested in whether collaborative learning approach was sufficient for programmers to appropriate and adapt the software for local use and to build their own capacity. Secondly, I asked if the funds required to support these workshops, which were quite significant, were in fact warranted. These preliminary questions led to more nuanced questions. What collateral, as it were, existed in this rather risky enterprise of workshopping, an approach designed to diffuse knowledge of the OSS. Funders supporting a range of essentially large workshops to expand the community beyond the three nodes of programmers in Southern Africa needed to see what the learning benefits were for the participants, to what extent were Canadian tax dollars leveraging skill and developing capacity – a kind of collateral to demonstrate that the investment into people has paid off. Could the organisers limit the amount of free-riding? What would the returns be, both to the project and the funder? Workshopping was an alternative to existing donor approaches to health information system development, which was characteristically the ‘parachute’ method, a developed country consultant dropping in to the developing country and disappearing after the training is done. Instead our approach aimed to build a peer learning network by funding regular workshops that allowed for collaborative learning.

1.2 Navigating the Literature

As these preliminary questions began to emerge, I explored the literature in three different, yet interrelated areas: the relationship between OSS and learning discussed in computer science and management science; the nature of OSS as a public good in the context of economic theory, which examined programmers' motivations for participating in developing OSS as well as the issue of sponsorship of OSS; and the development impact of OSS in a project such as the health information project at UEM where the literature on governance could provide assistance. The literature in these diverse, yet, interrelated fields led to the following research question, which became the overarching question of this study - how does OSS contribute to socio-economic development? The most common approach to this question – how does OSS contribute to development? – would be to look at how the **consumption** or **use** of software produced via OSS and placed in the public domain helped in the development process, ie the impact of OSS. What I discover is that the computer programmers in Mozambique and South Africa are initially involved in implementing and therefore consuming the OSS but as they start adapting and developing new applications their consumption turns to production, and in particular production of a public good. This is what led the study to also review the production of OSS. OSS is consumed by its producers. This narrowed my concern with OSS' contribution to development to the public good characteristics and how that shapes its production. In order to understand the impact of the use of OSS in the health sector and the relevance of health information systems and their diffusion and improvement to the health services in the country, the research thus turns also to governance issues.

In examining OSS, economists have been intrigued by computer programmers' willingness to volunteer their own time and knowledge to develop the source code and give it away. OSS appeared to be a pure public good which Economists understand to be a good that is non-

excludable, meaning that no one can be excluded from consuming the good, and non-rivalrous, meaning that the consumption of this good does not diminish it or use it up. Yet I wondered whether OSS in the African context could be understood as a public good. First, my hunch was that the cost of access to the Internet in Africa could exclude Africans from using OSS therefore rendering the good an 'impure public good' in the African context, in the sense that it was **not** 'non-excludable'. Another concern I had is that the OASIS project did not involve the computer programmers volunteering their time, as they were being paid to participate. I needed to investigate further the motivations that made Africans participate in an OSS project. Moreover, I was concerned that if the OSS programming depended on a funder, what would sustain the project if or when the funders pulled out given that pure public goods generally require public support for their production, In other words, would OSS only be supplied if there was public funding, and how would it be maintained in the public domain?

The economic theory of public goods states that when there is private provisioning of a public goods, like in the case of OSS programmers' volunteering their time, there will be a lot of free riders, other people who will use the good and not pay for it or contribute to it. This has lead to the conclusion that reliance on private suppliers of public goods will result in an undersupply of the public good. Yet, there was not an undersupply of OSS. I was also interested in this phenomenon from my position as a sponsor. I wanted to determine what role sponsors play and what trade-offs there were from interfering in the apparent voluntary participation of programmers in OSS. Though economists had investigated what motivates computer programmers to freely contribute their knowledge to the development of open source software, very few of these studies examined the participation of developing country programmers where consumption of OSS is affected by the economic and social context, i.e., the high costs of the

internet; limited exposure to OSS software production in universities and firms; as well as language barriers and cultural differences (Camara & Fonseca, 2007);(Staring & Titlestad, 2008), (Subramanyam & Xia, 2008) .Therefore, not only does this study attempt to address the issues discussed above, it also addresses a contextual gap by examining the phenomenon of OSS in the developing country context of Mozambique.

Opportunities for developing country computer programmers to participate, in the development of OSS software and information systems depends upon access to the internet. A vexing problem in using ICTs in development problems is the cost of internet access, the availability of infrastructure and the shortage of skills to make use of the technologies. Until the mobile phone revolution, these barriers to entry placed the development benefits of ICTs outside the reach of most developing country citizens. Yet, despite mobile phones' impact in the developing world context, the internet and its content remains too expensive, especially in Africa, to achieve the rapid expansion of users and producers. Therefore, another question I was concerned to explore was whether OSS could have similar impacts in developing countries as in developed countries.

The limited access to the internet in Africa, its cost and the assumed technical capabilities of users could mean that OSS development projects in Africa were too ambitious. United Nations Conference on Trade and Development (UNCTAD) claims that OSS can boost the Information Technology sector in developing countries by reducing barriers to market entry, cutting costs, and facilitating the rapid expansion of skills and (UNCTAD, Li, 2003) many African countries, amongst them South Africa and Mozambique, have followed other developing countries like Brazil, India and China by embracing the idea of OSS in their policies. Nevertheless, often these

policies do not consider the level of education and availability of broadband resources that would be necessary to enable OSS production.

Since the mid-1990s there hs been concern about a "digital divide" or exclusion from the internet and the information society more broadly of Africa and other developing regions. It soon became clear that telecommunications infrastructure was necessary for closing the divide, but several factors militated against investment in the sector. A decade ago, one in 100 Africans had access to a telephone. There have been dynamic changes since then roughly, a third of Africa's population (27%) now has access to a mobile phone – but internet access is still lagging behind (Chabossou, Stork, Stork, & Zahonogo, 2009), as is broadband connectivity, essential for transfer of OSS code. Table 1 illustrates how far Africa lags behind OECD countries in this investment-intensive infrastructure.

Table 1 Comparative access to ICTs, the World, Mozambique and South Africa

	Internet users per 100 inhabitants	**Main (fixed) telephone lines per 100 inhabitants**	**Mobile cellular telephones subscribers per 100 inhabitants**
Sub-Saharan Africa	6.47	3.17	26.77
Low Income	6.04	5.87	24.06
Lower Middle Income	15.69	15.23	50.99
Upper Middle Income	31.48	21.01	86.18
High Income Countries	54.78	43.85	112.42
Mozambique	0.93	0.33	15.42
South Africa	8.16	9.56	87.08

Source: selection from Chabossou, Stork & Zahonogo, 2008:18

Mozambique has the lowest penetration of internet use, less than 1%, amongst a selection of sub-Saharan countries that have been the subject of research under IDRC grants. According to the usage indicators in table 2 below most Internet In Mozambique is accessed at work (33%), at the university or school (29%) or cybercafé (28%) and a significant number of users (22%) were accessing the internet via mobile phones and 21% of users said they had access at home. This comes at a price. Broadband access on mobile phones is costly and as can be seen from the table below Mozambican's spend 32,6% of the disposable income on mobile phones, South African are not far behind at 29,3%. The figures extracted below are for internet and mobile use to demonstrate that both infrastructures are used for home or personal use and the level of expenditure on these communications is high compared with OECD countries. At OECD 2009 purchasing power parity (PPP) the price of mobile telephony is represented below. African households spend between 7.1% and 16.7% on communications, which is significantly higher than the 2.5% spent in OECD countries (Gillwald & Stork, 2008).

Table 2: Internet access, cost and use

	16+ yrs with email address	At home	At university or school	Using a Mobile phone	Average Internet expenditure per month	Price Mobile USD average 2009	Price Mobile USD PPP 2009	Monthly mobile expenditure /disposable income
Mozambique	0,8%	21%	29%	22%	$13.24	$27.15	$13.14	32,6%
South Africa	12,6%	20%	29%	7%	$15.12	$7.54	$4.81	29,3%

Source: Research ICT Africa, 2008/09 Household Survey of ICT usage

Several policy and market factors contribute to the high cost of communications services in Africa and could contribute to the large disparity between developed and developing countries in terms of the use of ICTs. The University Edouardo Mondlane, where the Free and Open Source

Laboratory (FOSSIL) is based, was the first to provide e-mail and internet services in the country as far back as 1993 and still plays an important role amongst Internet Service Providers in the country. Internet service provision in Mozambique is unregulated, unlike voice services which are subject to strict policy and regulation. The international gateway for internet access is however regulated (Muchanga, A & Mabila, F, 2007). I investigated in the research whether the lack of infrastructure and high cost of internet access were direct obstacles to participation of African programmers in OSS development, or indirect obstacles in that the African programmers lacked exposure to either the internet or programming experience. As we will see, these turned out not to be issues, though it did emerge that African programmers had different motivations for OSS participation than developed country programmers.

1.3. Structure of the study

In order to explore ability of the OASIS project's ability to use OSS, and adapt it for local use that will have development impact in the country I will start by navigating the literature, in Chapter 2, concerning the public good characteristics of OSS. Secondly, I will explore the literature about how OSS is organised and how learning takes place in this organisation. The third level of exploration relates to how the OSS is used for improving health services in developing countries. In Chapter 3, I will describe how I went about doing the research for the case study, the methodology chapter will include my epistemological stance as a participant observer and discuss the extended case study method in more detail. Chapter 4 structures the findings according to the three levels of enquiry outlined in the literature review and uses the following analysis: 1) OSS as a public good; 2) OSS as a learning system and 3) the contribution of OSS to development impact. In Chapter 5 I will reflect on the main and subquestions of this report and discuss limitations of the study and areas for future research.

Chapter 2 Literature Review

> "Open source software is a public good: Its use is non-rival, and it involved a copyright-based license to keep private intellectual property claims out of the way of both software innovators and software adopters – while at the same time preserving a commons of software that everyone can access" (O'Mahony, 2003b)

The above argument should satisfy any public funders to strengthen and support the production and use of Open Source Software because they are public goods. As a funder supporting technological change within a research framework, I am confronted by a complex milieu of several streams of literature. One that attempts to provide an integrated framework of the a) readiness to make use of ICTs, b) the availability of ICTs, c) the uptake of ICTs and d) the resulting development impact of ICTs is called the ICTs-for-development value chain (Heeks, 2010). Although the linearity of the ICT4D value chain makes it slightly limited, it nevertheless demonstrates the connectedness of the stages of ICT4D change and will be used as a heuristic in this thesis as I will draw on it as a framework to discuss the various aspects of ICTs.

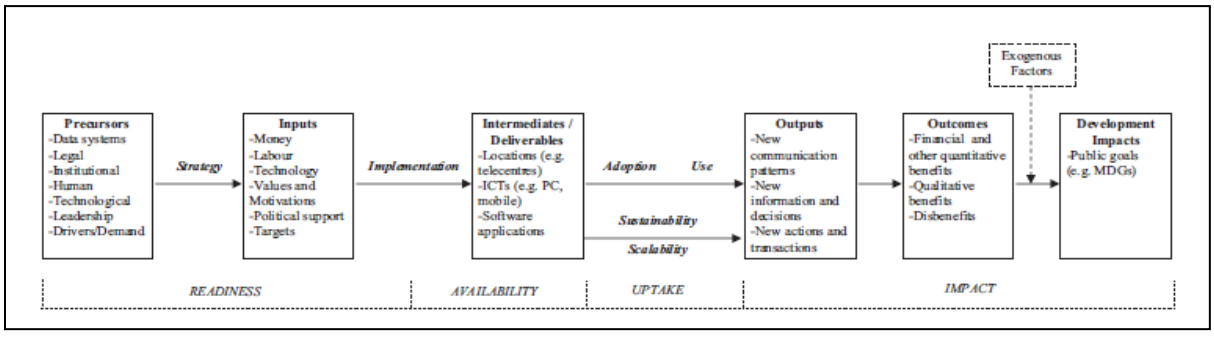


Figure 1 The ICT-for-development value chain. Source: Heeks, 2010

Heeks (2010) argues that much of the activity in ICTs-for-development and in the literature has explored the readiness and diffusion of information and communication technologies -- and many failed projects -- on the left hand side of figure 1. Development informatics has emerged as

a field from the disciplines of computer and information sciences, communications studies, and information systems borrowing frameworks from outside the discipline in management studies, actor-network theory. Few studies use frameworks to assess socio-economic development impacts, explicated in the indicator on the right hand side of the figure. Impact in this value-chain model are defined as a) Outputs --new communication patterns, new information and decisions, new actions and transactions; b) Outcomes -- costs and benefits of the uptake and use of the ICTs and c) Development impacts -- exogenous and externally verifiable, such as the attainment of societal development goals eg. Millennium Development Goals of improved health and education.

The ICT-for-development value chain, proposed by Heeks (Figure 1) offers a visualisation of the value-added processes in the use of ICTs for development purposes. . My study will investigate OSS from the points of view of readiness (motivation to produce the software); availability of the infrastructure (whether the internet's availability makes access and use possible); the uptake (the sustained use for implementation information systems using OSS in the developing country context) and the impact (the effect in health governance in Mozambique).

An important aspect of OSS is that the consumption of it is as a public good. I will draw on the literature of OSS as a public good in order to understand the public good characteristics of OSS, because these are clearly important for public funders. Then on the outcomes level of Heeks' (2010) ICT-for-development value chain I will investigate the learning that takes place in the organisation of OSS. Finally on the development impacts level I will investigate the contribution that OSS makes to broader development goals. Thus, I have adapted this ICT-for-development framework by Heeks (2010) to address the three main questions of my thesis.

The way in which I have structured this chapter is to offer definitions of key concepts related to this study, mostly stemming from public goods theory and then discuss the literature in relation to each of my research questions. Thus, the first section of this chapter will address the economic literature related OSS as a public good and breaks the "readiness" and "availability" of the input level of aspects of Heeks' value-chain model of ICTs-for-development down to discuss whether the public good aspect of OSS enables it to be non-rivalrous and non-excludable in a developing country context. Public goods are characterised by their consumption and I will thus also look at the consumption aspects of OSS in a developing country context, thereby discussing its non-rivalrousness and the challenges of free riders and non-excludability. The users of OSS often also produce OSS and hence the productions aspects of OSS will also be discussed.

The second section discusses literature from the fields of computer science and organizational management to address my second question of the collaborative forms of learning in the social production (Benkler, 2006) process. For this question, my level of analysis is the organisation of OSS. This focus could be likened to the "uptake" in Heeks' (2010) value-chain model .

And, finally, the third section of this chapter addresses literature from the field of the political economy in order to address my final question, which is whether the applications produced by OSS have "development impacts" the last category of value in Heeks' (2010) ICTs-for-development value chain, particularly surrounding the relationships between health, information, and governance.

2.1. In what way does the theory of public goods explain OSS in a developing country context?

The public goods characteristics of OSS make it attractive to potential donors in the development aid arena. The dominant view of OSS is that it is a pure public good consumed at zero cost with public benefits. An emergent view in the literature suggests certain complexities in the case of OSS that may render the public good impure in the sense of being excludable in the sense that in a developing context access to the OSS is not at zero cost and is therefore a club good. Another view emerging from the literature is that OSS is indeed rivalrous as it might not be the consumption of it that leads to its depletion but the challenge of keeping the technology current and up to date, and therefore requiring some form of proprietary rights to ensure sustainability. I will first explore these aspects in the literature and then apply these concepts in the analysis of the case study.

"Good" is a generic term for exchangeable items and consumption of the goods defines it. The characteristics of public goods, for instance, are consumed at zero cost and no-one can be excluded from consuming it, nor does the good get used up when it is consumed or when it is used in the production process (Oakland, 1987). Another way of saying this is that it is non-excludable and non-rivalrous (see Figure 2, block 1). By contrast there are pure private goods, consumed at marginal cost and when consumed or used for production these goods are completely used up and no longer of use to others, therefore private goods are rivalrous and excludable (Figure 2, block 4). A fireworks display in a public park is a public good. The display could have been paid for by the local government, or it could have been put on by an individual seeking no compensation. No one is excluded from viewing the fireworks, this is a pure public good. The display, however, could have been presented in the middle of an empty desert. This display would be a private good because it must be of interest to consumers otherwise the fact that it is undiminished is irrelevant (Oakland, 1987).

	Non-rivalrous	
Non-Excludable	Yes (1) Public good (Pure)	No (3) Commons Good (Impure)
	No (2) Club Good (Impure)	No (4) Private Good (Pure)

Figure 2 Characteristics of goods consumed

There are furthermore two more categories of semi-public goods, namely club goods or commons good (Figure 2, block 2 and 3). Returning to the fireworks display illustration, the municipality could charge an entry fee to the display or the display could be put on at a private club. In both cases this public good is impure because it excludes those who cannot pay (block 2). Impure public goods are the result of market failure (Stiglitz, 2006) and cause the consumption of the goods to be exludable or rivalrous. Goods are rivalrous, but not excludable, when they are in the public domain, in other words no one can be exluded from consumption, but one person or group of people consuming the good affects the consumption of others (block 3), this renders the good rivalrous (also referred to as depletable). These are commons good and can result in overcrowding of the commons and overconsumption can deplete the stock for others that have access. Consumption of these semi-public or impure public goods is either excludable (block 2 above) or rivalrous (block 3 above), but not both (ibid).

Public goods are not necessarily provided by governments, which helps to explain that the definition of goods is related to the characteristics of the good itself and not the provider (ibid). Pricing of private and public goods are also different. Private goods are exchanged at marginal cost in a perfectly competitive market, according to neo-classical theory giving the producer the incentive to reproduce it, but pure public goods are available to all at zero marginal cost. The

marginal cost of public goods is zero because the good is always available to everyone once it is produced (non-excludable) and consumption of it never depletes the good (non-rivalrous). Public goods have become a concern in developing economies. The World Bank devoted its World Development Report of 2004 to improving public service delivery to the poor, investigating alternative ways of public and private provision. State delivery of public services, especially to the poor, often fails in many developing and developed countries. State services are paid for by the collection of taxes designed to aggregate and transfer benefits to all. Poor people have less choice for services than the wealthy; however, several examples are emerging that point to the wealthy being served by public services while the poor choose to pay for services. Recording these examples has, in some of the literature, lead to rethinking of the standard dichotomy of public versus private consumption and provision of goods (Besley & Ghatak, 2004).

Externalities are the unintended "spillovers" of any good and may be benefits or costs. To go back to the example of the fireworks, a private entrepreneur could put on the display and charge for an entry, however, people living around the park could view the display without paying for it. This is an externality. If the externality is positive, it creates benefits but it can be negative, resulting in costs. There are cases where the positive economic spillovers could be more beneficial than the intended benefit of the good itself but, as it is unplanned the creator can not quantify it (Hallgren, 1994). Private and public goods may have public externalities. Public good externalities are non-excludable and non-depletable – a nation that fails to limit carbon emissions contributes to global effects on the ozone layer. Private industries pollute public rivers. These are examples of both public and private goods that have externalities that are non-excludable. Another negative externality of public goods is that there are many "free riders" - people who enjoy the good but do not pay to consume it, such as the people who do not pay to attend the

fireworks display but can watch it from their back windows. When there are too many free riders the producer of the good will not have any incentive to continue to produce the good.

Network goods are goods that are pertinent to this study because they display a certain type of externality called complementarity. The Internet is a network good, one that is described as not having a single economic characteristic but, instead, multiple characteristics (Hallgren, 1994), some of which are clearly private goods such as the cost of accessing it at ones home, or a secure internet site that requires payment for access, and others that are clearly public goods such as wireless access spots that are freely available or publicly provided access at a library or open access content .The Internet has been funded by public monies, and many software products produced for it have been developed for use in the public domain, but there are also aspects of the internet which are user-paid. Certain externalities are derived from the consumption of network goods because the benefits are enhanced by the number of other people using similar or compatible products (Shy, 2001). The value of the benefit or utility of the externality improves with the increased number of users. An email address is only useful if other people can be contacted that way and are using the same standard (ibid) and becomes more useful as more people join the network This is the reason for using standards for interoperability between users within networks or even between networks because the number of users increases the network's positive externalities.

Knowledge is an important category of public goods. Knowledge is a public good because it is never used up when it is consumed, the same knowledge is available as a resource for others and it is non-excludable because it is "difficult if not impossible to exclude an individual from enjoying the good" (Stiglitz, 2006). For example, once a mathematical theorem is published, it is

impossible to exclude others from having access to and learning this theorem (ibid). However patents aim to turn knowledge from a public to a private good.

Software has been defined as "knowledge embodied in capital goods" (Baetjer, 1998) and is likened to the tools of an artisan which contribute to increased productivity. Software can be licensed under copyright laws, and some even as patents, and can only be consumed if paid for. However, software can also be licensed for the public domain. The licenses used to control the use of such public domain software ensures that the code of the software is open and the use of it is free, and the strongest licenses require that if improvements or additions to the software should be placed back in the public domain. In this section I will investigate the of OSS as a public good I will investigate it under several subheadings, namely 1) OSS as a pure public good and are the consumers always the producers, doing away with the concern over free riding, or 2) Is OSS a club good, that requires the consumer to be part of a fee-paying club to be able to consume the good or 3) Is OSS a commons good that, while not being able to exclude any consumers from free use, can become obsolete (or depletable) because the motivation to keep it updated for constant technological change is lacking. The literature in this domain also considers 4) the role of the sponsor.

The dominant view in the economics of OSS is that it is a pure public good, that no-one is excluded from consuming OSS and that the resource will never become depleted when used, in other words it is non-rivalrous. However, as I will present some contributions to the discourse that will argue that there are instances of exclusion and therefore that OSS is either a club good and others who argue that there are aspects of the consumption that suggest that the source code can become depleted, and that it therefore could be a commons good. As the definition goes a good can be either a club good or a commons good, but not both. I will investigate these three

claims and will then apply the concepts in the case study in order to assess which of these perspectives is validated.

2.1.1. OSS is a pure public good

The public goods characteristics of OSI make it attractive to potential donors in the development aid arena. The dominant view of OSS is that it is a pure public good consumed at zero cost and produced for public benefits. Consumers derive direct benefits from their ability to customise software programming to their own needs, and by doing so giving of their knowledge and time to produce a public good (Lerner & Tirole, 2000). This private contribution to the public good has presented a puzzle that has lead to a large contribution of the economic literature on OSS.

a) Consumption and production of the public good

The motives that influence these computer program consumers of OSS and go on to privately produce a public good -- is one of the most frequently examined issues in the field of OSS economics and raises an issue for public good theory in general since the standard view is that public goods are undersupplied due to free riding leading to private suppliers unwillingness to supply goods for which they cannot internalise the full benefit. Some of the earliest and ongoing studies done on this issue distinguished differences between OSS programmers' intrinsic and extrinsic motives. The motivations that the users of OSS have to not only use the software but produce it and contribute the adaptations back to the public domain have been attributed to user needs and user innovation (Von Hippel & Von Krogh, 2003b) recreational value (E. S. Raymond, 2001) reputation also referred to as "signalling"(Lerner & Tirole, 2000)(Lerner & Tirole, 2002), trial-and-error learning (Garzarelli, 2004), and reciprocity (Bitzer et al., 2007).

These motivations can be broken into two major types: intrinsic and extrinsic. For example, learning and problem solving were seen as intrinsic motivations for the programmers to participate. Signalling their value to future employers was seen as a delayed extrinsic motivation as it suggested the programmers could get better paying jobs because of their reputation. There is also a recognition that the computer programmers, who develop open source software, are amongst the most educated and sophisticated users (Dahlander & Mckelvey, 2005)

The dominant view presented by economists about what motivates computer programmers to consume OSS and to produce OSS is that there is a delayed reward system -- their contribution is acknowledged because it is clearly linked to a module or a programming project but they are not compensated immediately. The open acknowledgement of the programmer's work signals their worth and their level of expertise. Clearly this depends on the task they worked on; the problem they solved; how clever the solution was; and whether the software was useful to other tasks in the future. Therefore, reputation and peer esteem were considered the prime motivations for these software programme developers' participation in developing OSS (Lerner & Tirole, 2002). Such motivations can be conceptualized as private benefits that accrue from establishing career paths, while the products they produce are public goods, as defined above. The OSS programmers are user-innovation focused (Morrison, Roberts, & Von Hippel, 2000; von Hippel & Jin, 2009).

One of the criticisms of studies that supports the dominant view of OSS as a pure public good also comes from the neo-classical view but argues that little is researched concerning the many unknown OSS projects (Bitzer et al., 2007). Mostly large well known OSS programmes like Linux and Apache (Lerner & Tirole, 2000); (Raymond, 1999) are researched and little is known about the whether there will be an undersupply of the software in the smaller less well

know applications (Bitzer et al., 2007) adapt the private-provision-of-public-goods model to demonstrate that it is the inherent playfulness and the reciprocal gift culture of the producers that motivates the producers.

In contrast to this view, several empirical studies demonstrate that the contributions back to the global code are highly skewed to a small percentage of programmers. A study amongst MSc graduates, and the first of its kind amongst a general population instead of a population of OSS users, found that only between 7% -24% contributed their improvement of the kernel to the wider community (Dahlander & Mckelvey, 2005). Others felt they had developed application that was not useful to others. The authors conclude that users only diffuse when they believe that it can benefit others, and that these producers were a special kind of free rider compared with those users who use the OSS applications but do not contribute back.

Another perspective emerged when it was discovered that many contributors to open source software were already employees of information technology firms, meaning they were being paid to participate in the OSS community (Lakhani & Von Hippel, 2003). In addition to this realization, researchers have identified the incentives for firms to participate in OSS production (Dahlander & Wallin, 2006). The few studies focusing on the developing world context offer different reasons than in developed countries to explain programmers' motivations for participating in the development of OSS. One exploratory study of large samples of OSS developers argues that North American programmers, who were mostly experienced programmers, were motivated to participate in OSS development in order to share their knowledge with inexperienced counterparts, an intrinsic motivation; whereas programmers in India and China were more motivated by extrinsic rewards for income (Subramanyam & Xia, 2008) The Indian and Chinese programmers were strongly driven by career concerns and

financial benefits, which lead these researchers to conclude that programmers, in a developing country context, are more motivated to participate in OSS development for monetary reasons than their developed country counterparts. This evidence runs contrary to the dominant view of what motivates computer programmers to produce public goods since, in developing countries the extrinsic motivation (income) and the "internalised extrinsic" motivation, which is in response to the Indian and Chinese governments public policy to support open source programming in their country, have been shown to be stronger motives for developing country programmers to participate in the development of OSS, as opposed to the intrinsic motive to share and learn, or the delayed extrinsic motivation of signalling, which are developed country programmers' reasons for participating (ibid). These counter arguments do not detract from the notion that OSS is a pure public good, but demonstrate that there is some level of compensation to the producers.

b) Free Riders create positive and negative network externalities

While this compensation for producing the software could be seen as a way of overcoming the negative externality of free riding, some have argued that there is no free rider problem with OSS. Lerner & Tirole (2000) argued in their "Simple Economic of OSS" that free rider consumers in the context of OSS provide the opposite effect to the standard view of free riders , because the more people that download it for free, the more value is added. The statement "given enough eyeballs, all bugs are shallow" (Raymond, 2001) has become an OSS mantra, and it means the free riders, or non-paying user of OSS peers report the code defects, leading to improvements of the source code. The most costly part of software production is the proofing process of software development, 82% of the cost of producing software is contained, not in the software itself, but the complexity that arises from testing and debugging and the adaptation

required for users in unique situations (Bessen, 2006). This explains why the dominant view of OSS as a pure public good relies on and experiences free riders as positive network externalities because the network thrives on more users, who set the requirement of standards and interoperability, and thus expand the network. The expansion of users through the number of free-riders, leads to positive network externalities from the large number of consumers. According to this view the consumer are in fact not free riders but are contributing to production and in the case of OSS consumers can become producers. By doing so, the producers of such software promote standards, improve the pace of technological development and, through first mover advantage even create technological lock-ins (Bonaccorsi & Rossi, 2003a).

However, some neo-classical economists have argued that the weaker property rights will only be used if the software is a complex public good, arguing that simple public good software producers have a greater incentive to generate profits. Using a predictive model to demonstrate that complex local adaptation is a niche market that will attract OSS approaches, but that software that does not require a high level of user-support can be built into the product through help-screens, and the producer or investor, according to the predictive model, can aggregate the market and secure a returns on that investment from large scale software production (Bessen, 2006). Simple public goods will thus be produced as proprietary software to earn the investor returns and overcome the problem of non-paying customers. The predictive model demonstrates that it is the more complex software public goods that requires contracting third parties to do the debugging, and therefore rely on the "free-riders" to do the debugging during the start up phase of complex public goods – those situations that require high levels of local adaptation. This argument furthers the standard neo-classical view of intellectual property rights, but suggests that in complex public goods that intellectual property is not desirable. However, OSS programmers

require “viral” licensing that make programmers contribute to adaptations to the software under the General Public License (GPL -- also known as “copyleft”) under the same license that the software was produced, namely free and open (Bessen, 2006)

c) Discussion

The standard views presented thus far suggest that OSS is a pure public good that does not suffer from the negative externalities of free riders or from under-provisioning because the producers are not compensated. Firstly, the consumers of the free software are themselves found to be producers that are either compensated by delayed improved income through signalling or, as was found, in particular in developing countries, OSS consumer-producers do it for the pay. This should address the concern that there would be an undersupply of the public good. There is yet another nuanced neo-classical view that the incentives for producing these free public goods relates only to complex public goods software and not simple public goods software would produce higher returns to the investor if produced under proprietary licensing. At least one case study, however, found that several of the free consumers of the public good were in fact not producing or sharing their improvements, which could lead to a concern that the OSS resource could become obsolete. This is the main concern that I will investigate under the following heading to find out if OSS is indeed a pure public good, or whether it too can become obsolete.

2.1.2. Is OSS a commons good?

If an open resource is not maintained or in the case of OSS not continually contributed to then its usefulness will decline or another way of looking at it is that it will become depleted or obsolete (Gambardella & Hall, 2006). These views suggest OSS may be a commons good – an impure public good that is rivalrous if it falls out of use when not fashionable amongst software

developers or when not maintained. O'Mahony (2003) proposes from evidence collected in the field that the conditions of OSS licenses and other forms of collective governance are used to maintain and exercise rights over their work restricting distribution of the work under certain circumstances. This evidence does not call into question the public benefits of the OSS but reconciled the assumptions about the non-rivalrous assumptions about OSS (ibid). She argues that observers have failed to recognise OSS code is free but the community that initiated it continue to hold maintain and control their rights over the code to prevent any privatisation of code that prevent future streams from being available to the community (ibid). However, O'Mahony finds that "free software" and "open software" are not always in joint supply, in other words producing the same benefits to all, but the supply is vulnerable to usage and would threaten its availability to all over time, thus making it rivalrous in the manner defined by commons pool resources, where the tragedy of the commons can occur because of poorly governed collective resources (Ostrom, 1993 in O'Mahony, 2003a). Use of OSS will not diminish in the present, but the future stream of benefits is at risk (O'Mahony, 2003a). Locally designed mechanisms can be used to overcome the tyranny of the commons becoming depleted.

Several examples of how future streams of OSS may be diminished are presented in the literature demonstrating the rivalrous outcomes of some forms of OSS governance. Some of the OSS licenses allow the software to be used to generate an income from derivatives of the initial code, but the strong viral license or copyleft license does not allow this. Stanford Universities responsibility to maintain the server protocols of the internet while public funds to maintain their work was dwindling, suggested the need for assymetrical pricing for the public sector provisioning of products, (Hallgren, 1994). Other examples demonstrate how undersupply of OSS or free riders do not commit code back to the public domain and can diminish the supply of

OSS. The literature points to the copyright license becoming a disincentive for continued production particularly when diminishing returns lead to the OSS falling out of use. An example of software under the GPL software license is a project that was supported by the US Federal Government to develop a data base for the United Veterans Association, originally developed for government resulted in a spin-out open source project VistA (West & O'Mahony, 2008). The evidence that only a small community continued to work on the project after the Federal Government stopped investing in it suggests there is no longer a cohesive development community committed to it (ibid) nor a commitment to keep it technologically updated.

These observers argue that the bounded nature of the community-initiated production requires rights to protect against any changes in the public good and that through copyright and norms, even brands the goods are protected, and that therefore the characteristic of OSS is rivalrous when consumed, leading to the conclusion that OSS is a commons pool, and therefore an impure good (O'Mahony, 2003; West & O'Mahony 2003). The motivation for preserving the commons by open licenses could allow commercial and noncommercial constituents to retain the incentives for commercial uptake of the software after funding dries up after the incubation of several projects that have been placed in the public domain. In particular, publicly funded collective production such as science and university contributions to the public domain, should have some copyright protection that provide incentives for copyrighted production later on in the product cycle, one which initially builds incentives in for open collaboration, but then allows for copyrighted production for higher value production when the open coordination facilitated by the institution of the license becomes sub-optimal (ibid). Incentives such as these could be retained in order to produce private gain and to maintain the public good (Gambardella & Hall, 2006).

Examples of software products that benefited from the copyright derivative is TeX, a highly specialised software derivative originally developed in the public domain for font management of mathematical theories in word processing. Another example of overcoming these challenges is the Mozilla Public License. Mozilla did not achieve the desired diffusion until a foundation was established to support ongoing sponsorship of a core development group (West, Gallagher, & Square, 2006; West & Lakhani, 2008a). This other class of license for OSS has come into use making provision for the open production and collaborative processes to be used in the initial phase of a software products life but allows for some derivatives to be produced under copyright or while property protection. These are the two main branches of copyright licensing that govern open source software, and other branches of knowledge intensive immaterial products such an open science and open data (Gambardella & Hall, 2006).

Another way of establishing whether use is not diminished is by establishing whether using OSS to diffuse the software is used by implementers who can adapt the software for locally relevant applications. However, these local adaptations or derivatives need to ensure that the local adaptation remains compatible with the core code, to ensure that the adaptations could be redistributed and reused (Bonaccorsi & Rossi, 2003b). When these open resources are viewed from a developing country perspective there seems to be evidence that these compatibilities are not necessarily in place. In a survey of Brazilian firms and IT professionals who were using OSS, the authors found that, although the software was used for the work they were doing in the public sector and firms the adaptations made for local use were not contributed back to the global code source. Respondents complained that there was insufficient shared taxonomy and documentation of the OSS programs to assist them as users to overcome the adaptation challenges they faced or interoperability with other software that was in use (Camara & Fonseca, 2007). Another case

study referred to earlier found that in Sweden and the United States, OSS users were not placing their adaptations back in the public domain (Dahlander & McKelvey, 2006).

From these observations in the literature the concerns raised around OSS as a resource that can become diminished if adaptations are not kept up to date may be missing, raising a concern that OSS may indeed demonstrate market failure and require levels of public investment and institutions to regulate its use. This raises the concern over the role of the sponsor in OSS, an area of the literature that I will next investigate.

2.1.3. The role of the sponsor

Empirical findings from OSS case studies, particularly around the issue of sponsorship, suggest that it is not always individuals voluntarily contributing their time to OSS (as was discussed in terms of the dominant and often repeated perspective of OSS in much of the literature) but that there is initial investment, referred to as sponsorship, that takes place. This support often takes place prior to or at the launch of a program with the intent of advancing the OSS community. In some instances, the sponsorships have been found to provide a solid technical foundation for large-scale innovation (West & O'Mahony, 2008). These seed funds, grants, or sponsorships, from international or national public funds or from private firms, have been found to reduce the risk of computer programmes becoming defunct. The business model for innovation in the public sphere that West & O'Mahony (2005) put forward, arises from an analysis of projects such as OpenOffice desktop productivity software and IBM's sponsorship of Eclipse development tools. It appears these products require on-going sponsorship to improve the projects' chances for success (West & O'Mahony, 2005b).

Thus, the business model, both for commercial and public investment, requires ongoing sponsorship in order to expand the community of participating developers and for marketing and recruiting potential contributors. This investment occurs, particularly, through well paid core computer program code writing leadership or by way of competitions to attract coders. Furthermore, it has been found that the ongoing role of a formal sponsor can reduce "ambiguity" and provide structure, which keeps the project moving forward (ibid). This point suggests that some form of hierarchy and management by a small core of developers is required to ensure the project's for sustainability. This model would be in the form of someone, who earns an income, being in charge of the project and enabling potential contributors to find a role within the coding community.

At the time that Lerner and Tirole (2000) were writing "Some Simple Economics of Open Source" programming was fairly new, Raymond (1998) had started writing about the organisational differences and the assumption was that the user-innovations were mostly developed by software hobbyists, the notion of sponsored of funded software projects was not yet considered. However, several case studies of private firms that use OSS has revealed a more nuanced perspective on the incentives. As already discussed, being paid to program is an incentives for OSS program developers, even while enjoying the acknowledgement of peers who might be in proprietary firms. The intra-firm networks are seen as means of leveraging technological spillovers and ways in which firms can leverage complimentary assets (Dahlander & Wallin, 2006). Market leaders such as Sun Microsystems and IBM find value in diffusing their hardware with OSS licensed software, the stigma of OSS being unbranded and sup-optimal is therefore no longer the case. Even though the OSS programmers and firms appear to lead in the networking, the benefits to firms that pay employees to collaborate or use the software to

increase their network externalities is not diminished. The licenses do not allow them to appropriate for themselves without contributing back and they use the exposure to improve their knowledge. This successful merging of a firm and community of software programmers contributes to the concept of the public good innovation through knowledge creation.. OSS use and diffusion is not restricted to programmer-lead communities but as the literature grows, is more likely to be the result of a firm or organisation sponsoring or funding the start-up and diffusion stage of an OSS program. (West & O'Mahony, 2005a) The organisational model of these projects might be more hierarchical because it is not initiated by volunteers and these sponsorships are likely to come from firms seeking to create the solution (ibid). Sponsored OSS also creates an incentive for the production.

Funding an OSS program development, in the literature referred to as "sponsorship", appears to be a norm to signal branding for OSS development. An important assumption in the development arena, that OSS is largely done by unpaid volunteers is therefore questionable and strongly suggests that there is a role for public or private sponsorship to maintain a commons pool of Open Source goods. This is not to say there are no OSS projects that are contributed to or managed by volunteers, but many of them program as part of their paid work as academics, or are working with firms committed to OSS or even incumbents with various motivations for participating in the wider community for gaining expertise.

There remains one concern that crops up in the literature of OSS economics that needs to be investigated namely that some consumers need to join a club in order to consume the good. As discussed in the introduction chapter, the low levels of internet penetration in developing Africa could effectively exclude potential consumers. I will now investigate these claims bearing in mind that a good cannot be both a club good and a commons good.

2.1.4. Is OSS a club good?

In the following section, I will again interrogate the dominant paradigm economic literature on OSS, particularly to determine if OSS is always a non-excludable resource, which is how it is conceptualized in this paradigm. This question is important to explore when examining a developing country context because of the high cost of internet access in Africa. This high cost of access may make OSS an excludable resource as opposed to a non-excludable one. The internet is important to OSS for two reasons. Firstly, it acts as a physical layer through which open source software is distributed or diffused. And secondly, the software, though immaterial, is the outcome of specialised knowledge and has intellectual property value. Furthermore, as was discussed in the introductory chapter, in Africa, the internet appears to be most likely used by individuals with higher education or at their place of employment. Therefore, given what could be a limited amount of the population accessing the internet, I will investigate if, for this reason, whether OSS is excludable in this context.

According to literature in the dominant paradigm, OSS is freely and rapidly diffused across the internet and the transaction costs and access costs are zero. This makes the assumption thatt the global networked society is egalitarian. Interestingly, scholars particularly in the developing country context, are beginning to challenge this assumption, specifically because of global inequities surrounding access to telecommunications and internet infrastructure (Garzarelli, 2004) as well as related to skills required to make use of the internet (Schmidt & Stork, 2008b). In order to explore this debate further, in particular in the context of Africa where the cost of connectivity to the internet places it beyond the reach of most people, the following section will consider, under what circumstances the consumption of OSS may actually be excludable.

Economic theory explains a market failure of pure public goods occurs when producers of the good decide to keep free riders out and start to charge an access fee or subscription charge. This action means that these goods are no longer pure public goods and instead become impure public good that are otherwise referred to as club goods (Figure 2, block 2). Examples of club goods are golf courses or private sports clubs where a member has to pay the price to participate in the public good. But public good theory also insists that a club is a voluntary group that derives mutual benefit by sharing the costs of the excludable benefits (Sandler & Tschirhart, 1980). Therefore, members "pay the price" of, or a subscription to keep the good exclusive but also maintained so that all club members can use it without the resource diminishing for the other members. These are impure public goods. The utility gained from belonging must exceed the cost of enrolment (ibid). The following section will discuss how these concepts apply to the context of OSS, particularly in a developing world context and given the global asymmetries in telecommunications and internet access which were referred to in the introduction chapter.

Slow progress in Africa's investment into broadband infrastructure is well documented (Chabossou et al., 2009; Chabossou et al., 2009; Esselaar & Stork, ; Gillwald & Stork, 2007; Gillwald, 2009; Gillwald, 2009) Reasons for slow progress mainly stem from policy barriers and hindrances in effective telecommunications sector regulation, which result in market failures, such as inefficient operators and regulators' inabilities to manage the competing interests of consumers and investors (Stork, 2010). Tables 1 and 2 in Chapter 1 were used to illustrate Mozambique's dramatic backlogs in terms of access to the internet and to computers. These figures were derived from nationally representative household survey, and nine of the seventeen African countries surveyed, reported three main reasons why individuals do not access the internet -- lack of skills (the most common reason); not owning a personal computer; and the

high cost of internet (Gillwald, 2009). In order of most common to least common, the surveyed households access the internet either at cybercafés, educational institutions or at work, with the least number of people accessing the internet at home. In many countries, educational institutions are the first point of affordable access for many users. There is furthermore argument that access statistics do not explain the "potential inequalities stemming from differentiated internet use" (Hargittai, 2005:372, in (Schmidt & Stork, 2008a)) but rather that higher education level implies more exposure to technology (Kiiski & Pahjola, 2002 in ibid), which increases the ability to rapidly adapt technologies.

In conclusion, based on the above literature, it is evident that the consumers of OSS are highly educated, and the correlations of skills and internet access indicate that the low penetration of the internet in Africa is enjoyed primarily at education institutions and work situations. The correlation of the access and skills to make use of the internet and its resources are not a trivial coincidence. The literature of developed country computer programmers that use and produce OSS makes the assumption that these are highly skilled computer programmers, it stands to reason then that characteristics should also be assumed in the context the African context.

2.1.6. Policy as extrinsic motivation to produce OSS

Policy incentive s also provides a form of extrinsic motivations if governments encourage and support the OSS production domain. As will seen below these incentives could give mixed signals, and might have to provide many resources particularly for developing the skills of developer in the education. The South African government has seen the opportunity of stretching its administration budget allocations by following a cost-saving strategy and fostering local entrepreneurial opportunities and skills development. Government policies to embrace OSS

contribute to an enabling environment, but the South African government policy has a strong opt-out clauses. The intention and motivation for OSS is clear but the statements "unless proprietary software is demonstrated to be significantly superior" and binding government developers to seek OSS licenses "where possible" do not create a strong mandate. If anything, motivations for "significantly superior" are hard to override when users are locked in. The SA government can further be excused because the known challenges that Brazil experienced. Both countries have developed code for public service use, but have done so by creating software for own use.

Often these programs are not licensed at all and at best could be called "Government Source" built for government use, often distributed on the internet and certainly not as a global good in mind. Appropriation of OSS norms will require further development effort in order to achieve the firm-based and community-initiated models that intertwine "the best of both worlds" from private investment and collective action.(Von Hippel & Von Krogh, 2003a) An example of achieving this kind of diffusion by following the OSS norms and licenses, Ubuntu Linux, developed by the private sector in South Africa, has become the most popular desktop alternative to Windows. Implementation research, such as this study, can provide the evidence to assist governments to strengthen their resolve and understanding of the OSS norms and their economic benefits.

There was insufficient empirical evidence to validate any cost-savings of OSS for the public sector, it has been inferred. However, it is evidence that some state policies are required to test the assumption of these savings. Moreover, developing country experience suggests that capacities to make use of open source software are still lacking. Appropriating the spillovers is

largely not yet covered in empirical research. Implicit in this thesis is a comparison between OSS and proprietary software.

2.1.5. Discussion

The discourse around whether OSS is a pure or impure public good raises several issues and is of concern in this study because of the use of public funds in supporting access and the production of the software. From the paradoxes and contradictions raised in the discussion of the characteristics of OSS as a pure public good lead me to raising particular research questions in relation to the case study that I will investigate, in term of public goods theory.

If OSS has the characteristics a pure public good then the consumption of it will be non-rivalrous and non-excludable. The exploration of this view in the literature lead to an understanding of the characteristics of both the consumption and production of OSS since users were also the innovators or producers of the goods, creating of OSS a special kind of public good. I will investigate whether the users in the case study also become producers of this public good. I then will investigate in the case study whether there is a strong contribution back of source code or whether there is a free rider problem. This will lead to a discussion of the license conditions chosen and whether the founders of OpenMRS could rely on a copyleft contribution to continually populate and keep up to date the software or whether there were other considerations for sustaining the software in use. I will also investigate whether the infrastructure and skills shortages in the case study rendered the OSS in the case study a club good. Finally, in terms of the public goods theory of OSS, I will investigate if there is a role for the sponsor in launching the software in a developing country context. In a developing context it might be more complicated in that cost of access to the internet might exclude users and producers. It appears that the benefits, even though tentative, do demand sponsorship and some form of

extrinsic motivation. Public policy provides some form of extrinsic motivation but is not enough, and should extend to beyond the incentive to producers but also to ensure the education system develops the skills of computer programmers. It is to this issue of learning that I will turn next, to investigate whether the collaboration amongst individual producers. The literature that I will investigate is in the field of informatics and draws also from the field of organisational management.

2.2. How does OSS learning take place?

The organisational and management sciences have also investigated the production of OSS made possible by the norms and rights, motivations and benefits as described above. IN this section I will be considering the second stage of Heeks' (2010) ICTs-for-development value chain which is concerned with uptake of the technology that has been diffused in the previous input stage. This has lead to an investigation into the way in which OSS results in different forms of organisation. I will investigate the characteristics of OSS production that encourages collaborative learning processes as these lead to important considerations for a funder concerned with capacity building in a developing country context. I was furthermore interested in whether the non-hierarchical nature of the OSS organisation (Raymond, 2000) always managed to reproduce itself. Based on prior experience of funding a collaboration amongst 14 African Universities to develop OSS software relevant to enhance delivery of university courses and improve student administration, which had its core node at the University of the Western Cape, it was found that diffusion of the skills to adapt the software in decentralised contexts across the universities was difficult to achieve. This lead the African Virtual Online Information Resources (AVOIR) project managers to conclude in their final technical report that the main contributors

of software code were centralised at the core node of the University of the Western Cape (Ravat, Keats, & Scott, 2005).

2.2.1. Modular tasks facilitate expanded teams

OSS is characterized by non-hierarchical, modular tasks, the use and re-use of existing well tried programming software, and the certainty that peers and users will report bugs in the system to constantly improve the software. Observers have described how OSS, which involves a very large number of contributors but a small group at the core, using simple technologies for coordinating work, and are able to draw upon direct feedback and improvement by users. This is described as "institutional innovation" especially when the programming involves computer program developers and academics (Von Hippel & Von Krogh, 2003a). This open approach to production encourages coherence amongst the virtual team members, there is technological collaboration, the use of standard to ensure interoperability, cultural diversity and openness and contribution to a public good (von Krogh & Spaeth, 2007; von Krogh & Spaeth, 2007; West et al., 2006).

Observers attribute the ability of OSS production to be distributed over a non-hierarchical diffused group of collaborators who might not even know each other to the modular project architecture (West & Lakhani, 2008b). The OSS characteristic "object oriented programming" which is the way in which the program code is divided up into modular components for reusable programming, enables users to solve problems in their local context and in particular to make their own work easier (Von Hippel & Von Krogh, 2003b).

2.2.2. Strong leadership and small core team for governance of the trunk code:

While seemingly chaotic, this approach relies on strong leadership and organisational governance (Lerner & Tirole, 2002). The leadership has to break the projects up into challenging and fun components to attract the right skills and must assemble a critical mass of software to which programmers can react. A determinant of the project success is the visionary leadership, constantly updating the goals as the project evolves and cajoling the teams to avoid forking (ibid). Forking is the development of competing variations of the program software under development, as this can jeopardise the positive network externalities. The modules developed are added on for expanded functions, but the core code is kept small to enable these modular plug-ins. Some scholars have argued that the core leadership resembles hierarchical organisations. (Bonaccorsi & Rossi, 2003a). These core leaders, however, do not delegate tasks, as managers would, however their authority s often reflect this hierarchy or "concentration of contribution" (Ghosh & Prakash, in (Bonaccorsi & Rossi, 2003a). Hierarchies do emerge in some sponsored projects for example in GNOME which has formalized relationships with critical contributors compared with completely community-initiated projects (Dahlander & Wallin, 2006)Mozilla is supported by a non-profit foundation and has a formalised governance structure to help oversee the direction of the project but not day-to-day activities(Dahlander & Wallin, 2006). Common characteristics of all OSS projects are that the applications developers are usually the users, or where the technologies are more infrastructural, like Linux, the commonality amongst the developers is that applications are built on top of the core code by a closely trusted group of "lieutenants" in the community, with Linus Torvalds in the middle as the wise man, representing some governance structure (ibid) and governed by the culture of "create for use".

The other characteristic of OSS production is that the tasks are modular, shaped by the core programme development leaders to create challenges that peers and users like to grapple with and solve (Lerner & Tirole, 2002). Far from chaotic, the use of task coordination tools, the vision of the leadership to avoid attrition or "forking" – namely the development of competing variations -- different teams who need little contact, work on solving problems (ibid). An example of this is the Google Summer of Code projects http://code.google.com/soc/ working with hundreds of Open Source Software and Free Software technology groups that identify tasks that would improve the functionality of programmes. These are parcelled to mentors and students to solve in the three-month Northern Hemisphere summer vacations. Such project-lead task-oriented open-call online-coordination creates a unique organisational structure and governance that are shaped by the open license and ability of its leadership. The OSS programming projects have leaders who create challenges and tasks for collaborating volunteers to participate, debug, write software software and test it. This activity involves the most expert software developers who have been described as the elite amongst software developers. (Lerner & Tirole, 2002)

This modularity of development, far from demonstrating lack of coordination, leads to classical economic division of labour (Garzarelli, Limam, & Thomassen, 2008) that function as if there were a hierarchy. Individual specialisation however does not prevent individuals from competing for tasks that a programmer might not have sufficient programming skills for. These would-be programmers could be users who can study the code and modify it for local use. This he argues demonstrates greater increase in productivity and faster appropriation of benefits from innovation. Garzarelli argues that these benefits can be appropriated not only amongst OSS community but for narrowing the gap between developing and developed countries. This could

lessen the dependency of developing countries on foreign technology and enable them to appreciate the benefit from innovation which contributes to economic growth.

2.2.3. Does the collaborative working model of OSS encourage novice learning?

The OSS approach creates spillovers amongst firms, which is another way of describing free riders and it also means that users benefit from the knowledge. Organisations often have paid employees to participate in the OSS programming networks in order to learn(Dahlander & Wallin, 2006). OSS is described as a "process innovation" in other words involving active participation and therefore learning during the production process.(Weber, 2004) "Like many things about the internet era, open source software is an odd mix of overblown hype and profound innovation" (ibid: 7) The findings so far suggest that the innovative approach to production of OSS has several necessary qualities for the transfer of technology from developed countries to developing countries. However, certain persistent inequalities remain, leading to the question of this thesis. This section will review the literature on how developing country software programmers learn and how this could overcome any of the skills deficits that continue to marginalise them from global OSS projects and programs.

The modular tasks, parcelled up for users or other programmers to use, modify and redistribute suggests that OSS uses a valuable approach for individual programmers to improve their capacities. Collaborating across firms, academia and organisations creates free user-to-user support that can assist programmers and even countries to "punch above their weight" as they access a global code and create modifications that are locally useful, increase domestic productivity and economic growth. The discourse even suggests that these local modules could be redistributed back to the core software it is standards based and interoperable with other programs. The question about the concentration of programming capacity amongst an elite core

should be further investigated as the assumption is that all users would develop code that is a useful contribution back to the core code.

This section will investigate the "institutional innovation" of reaching beyond the firm or organisation to produce OSS. I will also look at the concept of "innofusion" which is a concept of the combination of problem solving using existing technologies for especially for customising technologies. It will discuss OSS licenses and diffusion, user innovation, the modular approach to manage production of complex tasks, user-to-user support and leadership qualities.

Unlike computer hardware development, software development is a labour-intensive industry. Researching the IT industry in Romania lead the authors to conclude that the key constraint to developing a software industry is the level of information technology skills and training that the (Grundey & Heeks, 1998) .Scholars of innovation argue it is a process strongly premised on the experiential knowledge and adaptation of solving problems in "creative cooperation" where tacit knowledge is made explicit.(Leonard & Sensiper, 1999). A new approach in several branches of social and management science is to collect the evidence of how learning takes place. It requires capturing the way problems are formulated, distributed amongst the group and involves how the know-how is captured within the group.

In the literature that I reviewed in Health Information Systems and in OSS there were only a few projects that aimed to develop collaboration amongst programmers in developed countries with implementers in developing countries. Several of the journal papers by implementers of eHealth projects in developing countries reflect on the need to develop local skills for OSS in the HIS (Titlestad et al., 2009)(Staring & Titlestad, 2008)(J. Braa, Monteiro, & Sahay, 2004; Levison & Fraser, 2008)(C. J. Seebregts et al., MedInfo 2010; R. P. Seymour et al., 2010 (forthcoming)) Another source that reflects the implementation challenges in developing

countries is found in the country profiles of countries that are installing HIS (Vital Wave Consulting, 2009)Most of the interventions surveyed involved the cost of US- or Northern-based developer's salaries. In one such project the US-developers salary accounted for 86% of the total project costs. (J. Blaya, Holt, & Fraser, 2008)

The Health Information Systems Program in several provinces in India, South Africa, Mozambique and Sierra Leone, found that the slow internet connection meant that the processes and tools designed by the Norwegian team while in Norway were found to be cumbersome and costly for the Ethiopian team who had access to very slow and costly internet. This severely hampered the creation of the short feedback cycles that characterise many successful OSS projects. However, the email list that was created did represent the first user-to-user assistance. (Staring & Titlestad, 2008) The developers concluded they needed to spend (Staring & Titlestad, 2008) more time in the developing countries with their counterparts to get exposure to the circumstances of these teams. They also invested project funds into face-to-face meetings and global workshops. These meetings were essential to expanding the network.

Examples of building capacities to develop the information systems in developing countries presents some clear opportunities for testing the open innovation model. The challenges with making explicit the different contexts, requirement for guideline documentation and the support required, combine with other development issues such as asymmetries in infrastructure, communication and computing skills. Ways of overcoming these have been described by Staring et al, are face to face meetings, email list serves and side-by-side user-support and development. Seymour et al suggest a more formalized curriculum and coursework with planned employment followed to implement the new learning and systems. However, "innofusion" conceptually suggests that knowledge improves in innovation when there is emphasis placed on solving the

problems innovatively with adapting or re-engineering existing technologies and diffusion of the knowledge at the same time (Titlestad et al., 2009).

2.2.4. Face-to-face meetings promote trust in OSS use, reuse and diffusion

The prototype design described above is a description of open innovation in a developing country context. (Titlestad et al., 2009) The prototype designed in this way becomes a "boundary object" used to manage knowledge across boundaries. Boundary objects are shared between problem solving context (Carlile, P.L. 2002 in (Titlestad et al., 2009). This mutual design in a face-to-face setting has the characteristics of exploration and struggle to make things work, also captured in the concept of "innofusion" (Fleck, J. (1988) in (Titlestad et al., 2009). "Innofusion" is the blurring of the lines between innovation and diffusion when technology is adopted, remodelled, reconfigured and reinvented. The learning occurs through an initial misfit between the product characteristics and the use in the environment leaving room for improvement and operating experience. These processes create knowledge and occasionally result in significant changes (Peine, A. 2008 in (Titlestad et al., 2009). The stages of knowledge acquired through operational experience are summarised as follows:

- When a user adopts technology it is is "learning by trying".
- Remodelling repeated regularly is called "learning by using".
- Once stabilised there is learning on the job and reinventing the technology "learning by doing".

Linking through networks of developing prototypes which are tried and changed requires a "social infrastructure" in the network where users participate and co-design, as well as shape and re-shape the socio-technical outcomes (J. Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007).

Another approach taken to support OSS implementation in Africa was through more formal training (R. P. Seymour, Tang, DeRiggi, Munyaburanga, Cuckovitch, Nyirishema, & Fraser, 2010a) over 11 months, with a curriculum using post graduate computer science students in Rwanda. The program is being prepared for integration into one of Rwanda's universities. In addition to teaching the implementation OSS for medical records keeping, the graduates were placed in jobs by the Ministry of Health to implement what they had learned.

2.3. Impacts of information on governance and states

As envisaged in Heeks' (2010) ICTs-for-development framework that I am using as a heuristic, in this section I investigate what the role of information and information systems development has in relation to development countries, in particular I will investigate the relevance of health information systems. In this section I will investigate the third sub-research question of my enquiry. Is this model of provisioning a public good useful in strengthening the public provisioning of health in developing countries and assumes that the technology is available can be adopted?

Returning to the third research questions of this paper as stated here, and in order to give a general background to the issues of health information systems a review of the literature reveals some imperatives, challenges and limitations for developing countries and their need for systematic health data collection and analysis for informing health service management decisions. This section of the literature review will explore the role of information systems in developing countries and in particular health information systems and why these are important in the development of the state. I will also turn to the issue of public policy concerning the use of OSS as there are developing country implications for making these choices.

This is a decentralized data gathering system for district and national aggregation to monitor basic health indicators. A country's health information system is comprised of multiple data sources, inter alia, the vital registration of births and deaths, population censuses and household surveys, disease surveillance and response as well as information that relates to service statistics, financial data, resource tracking and patient statistics. (World Health Organisation, 2008)These systems have historically been paper-based but with computerisation, rapid ICT advancement and price reductions can achieve various levels of efficiency and sophistication, including creating feedback loops to health care givers, patients as well as policy-level decision-makers.

The need for gathering health information emerged from strategies to implement the historic Declaration of Alma Ata in 1978. This was the outcome of the International Conference on Primary Health Care at which the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF) jointly committed national health systems to introduce the concept of primary health care. Member states need to collect indicators to monitor their commitment to deliver of primary health care. At that time national and international efforts were committed to support developing countries in particular in order to achieve by the year 2000 "an acceptable level of health for all the people of the world". These unmet challenges have since been updated in the UN Millennium Development Goals, further spurring the need to give account for improved health indicators, notably of mother and child health, malaria and infectious diseases.

The focus on primary care since Alma Alta required an implementation approach that enforced decentralisation and the creation of moderately sized district-based health care services that could be monitored and managed. Countries adopting the primary health care model require information for monitoring their progress. The WHO was already collecting mortality and morbidity data from countries, but new indicators required collection such as the burden of

disease, immunization, age, sex, etc. Before turning to the health sector in particular I will review the literature related to the importance of information in governance in developing countries.

2.3.1. Governance and information

The rise of health information systems relates to the allocation of resources as the health of the population is an underlying factor of economic growth. Changes in economic development in turn affect the profile of diseases in relation to the environment in countries(Sachs, 2005)(Vital Wave Consulting, 2009). The transfer of information and resources makes it possible for the state to manage and coordinate social actions. Filing and record-keeping is central to the state's bureaucratic role which creates organisational memory and rational organisation through coordination to improve the public service delivery(Lange & Rueschemeyer, 2005). The state has the convening powers to assign duties to various levels of government for the collection of information for its smooth running (ibid). These ties can break down and failure of information flow can result in inequities in the allocation of resources throughout society (Scott 1998 in(Lange & Rueschemeyer, 2005)). Information is the most powerful means of increasing the voice of the poor in policy making but certainly not sufficient without legal, political and economic means to press for changes to meet the needs of the poor. (Levy, 2004)It is this information that assists in keeping the service delivery chain of policy makers holding the public service providers accountable to consumer demands, in this case the poor who are underserved (ibid).

The literature suggests that developing countries fail to serve the poor because of system failure resulting inter alia from the lack of information between policy makers, service providers and the population.(Keefer & Khemani, Feb 28 2004). The decision-

making processes of these relationships of accountability, summed up in the word governance, break down with lack of information, compromising the formal rules of bureaucracy, especially when the demands on the public services in developing countries escalate(Kohli, 2004; Levy, 2004). Health crises, such as dealing with the HIV/AIDS pandemic, could contribute to further weakening human development outcomes. Without proper record keeping, either paper-based or electronic, allocations of these budgets rely on quantifiable needs. This vicious cycle results in "slow moving, but inexorable, forces of decay" as lack of accountability amongst the political decision-makers, service providers and clients dwindle resulting in poor service delivery to the poor (Levy, 2004) Levy argues that despite a third of their budgets being allocated to health care and education, these resources serve the rich in these countries and fail to reach the poor. Secondly, the funding does not reach the frontline service providers, and even if it does, the frontline doctors, nurses or teachers have weak incentives and low wages and are often mired in corruption and absenteeism etc. Even if highly motivated, frontline staff were caught in facilities where services delivery was unresponsive to the needs in the community, pharmacies were under-stocked for instance. The response from poor people was to avoid presenting themselves at the health centre, or not sending their children to school.

Several innovations have been tried in order to overcome these system failures: governments contracting out the services, or giving concessions to the private sector as well as decentralization to lower tiers of government or even to community management are examples of these approaches. Several efforts, notably by big donors such as the World Bank, to build capacity for improved governance, have proven politically

unachievable and the focus has shifted to more modest initiatives (Levy, 2004). Scholars have tried to identify the latency in developing states and their inability to address poverty challenges, even when financial and technical assistance is available. Often the training efforts to improve the developing states' abilities to govern are driven by donors, and not citizens, requiring higher levels of accountability with their funds. When the systems to collect this information are missing donors often create parallel structures, bypassing the relationship between policy makers and service providers, leading to further lack of motivation from public servants who should be implementing the programs (Levy, 2004).

Some scholars maintain that donor-lead assistance that by-passes government might date back to the failure of structural adjustments that weakened social services in health and education, leading some to argue that support to improve these services should work on the principle that there is "good enough" governance(Grindle, 2002). These interventions should not circumvent the public service by working directly with NGOs. Many efforts by donors for capacity building -- from fiscal management, to improving civil servants administrative capacity, as well as efforts to decentralise authority within the state – point to more structural problems that undermine these efforts, such as lack of delegated authority to lower levels of government (Keefer & Khemani, Feb 28 2004). Another convincing structural perspective comes from the longitudinal organisational sociologists that have demonstrated that colonial legacies imprinted on post-independent bureaucracies have reproduced the colonial powers' lack of service-orientation and pre-occupation to minimize expenditure on public services. Hence, the unresponsiveness of developing states to reducing poverty (Kohli, 2004).

2.3.2. Information and governance in the health sector

The challenges facing the health information system in developing countries is that they tend to be "data-rich" but "information-poor". The data is being gathered but not well managed to strengthen the health system (World Health Organisation, 2008). The WHO calls for research in the area of health information systems implementation to formulate "strategies for overcoming the technical, behavioural and environmental constraints that impeded effective data use at different levels of the health care system." Annually billions of dollars are spent on different aspects of health information by global organisations (Boerma, 2005).

The WHO has guided the design of paper-based systems in developing countries and a visit to even the smallest health centre in a rural African district will reveal large paper registries for collecting information related to the cases in each health facility. District or provincial health information systems aggregate these data from the paper forms. Normally these forms are collected from health units by the trucks that deliver supplies. Statistics are gathered for mortality, morbidity, life expectancy, child mortality, birth attendance, service availability mapping etc by WHO signatory countries. WHO uses the statistics annually to compare countries, and inform national policy makers. However, a country's own information system should rely on multiple data sources, namely, vital registration of births and deaths, population censuses and household surveys, disease surveillance and response, and health management information such as service statistics, financial data and resource tracking.

A multi-donor supported network called the Health Metrics Network, (HMN) concerned with building synergies between the various efforts targeted at low- resources countries was formed to assist "evidence-based policy development, and the planning, management and evaluation of health services." (World Health Organisation, 2008) HMN points out that there has been a lack

of consensus on the usefulness and feasibility of collecting certain data, which has resulted in several overlapping system, or incorrect use of certain instruments, such as using household surveys rather than the population vital statistics for adult mortality. (World Health Organisation, 2008) HMN has provided a framework for governments to acquire the best practice approaches, namely, to assess, plan coordinate and prioritise strengthening health information and policies. This includes agreement of implementation standards for data collection, units of analysis, developing capacities for gathering, analyzing and disseminating the information. (World Health Organisation, 2008)

Implicit in this approach is to develop the national capacity to build such health systems or procure them, and the HMN has.partnered with “pathfinder” countries to create implementation guidelines for and assessment of the framework. It also aims to assist developing countries to improve coordination functions through improved health information systems. Several international initiatives that provide vertical support also require a paper trail and often these forms represent a parallel set of data. For instance the Global Alliance for Vaccines and

Immunization (GAVI), the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) and the President's Emergency Plan for AIDS Relief (PEPFAR), will each be implemented with their own paper-trail requirements to comply with accountability to the donor of how many drugs were dispensed, from which facilities, etc. (Vital Wave Consulting, 2009) This growing external demand for accountability of developing countries imposed a level of information gathering that few developing nations were equipped for. (World Health Organisation, 2008)

Evidence suggests that overburdened health workers find data gathering and administrative

Figure 3 Paper-based health and facilities records in Mozambique

tasks unfulfilling with little feedback to the health centres. This results in low levels of compliance for the data collection and several factors contributing to lack of motivation. These administrative tasks and the volume of paper have resulted in the slow delivery of information, sometimes lagging four, six and even twelve months before the information becomes available at the national level. In addition to workload problems this often results in unreliable information being captured.

A few examples of the mixed successes of programmes for improving the management of health information in Africa highlighted in the discourse make clear how these top-down information systems have imposed not only added burden of data collection but challenges in information management which can upset the equilibrium of existing organisations (Leavitt, 1973 in(Gladwin, Dixon, & Wilson, 2002). In East Africa in the mid-1990s a new program was introduced by USAID to strengthen and advance primary health care management.

The one day trainings across Kenya resulted in confusion over the definition, use and management of the information, which only later was recognized to be introducing wider

organisational change. The new forms of data required, which the health system did not have such as the need for logistics, supplies and financial data at district and health centre level. The new system was not aligned with the ministry's own management capacities and tools, and was rejected. It added layers of complexity to decentralize management, the training materials were externally developed and were seen to be imposing organisational change (Gladwin et al., 2002). While in Chad the introduction of a computerized health information system is described as a model of technology transfer (Foltz, 1993) Gladwin et al argue that the Chad study did not investigate the usefulness of the centralized-focused data collected for health management in the districts.

Decentralisation of health care has resulted in various forms of information systems development. These are patient registries, program monitoring and decision support systems (Tomasi, Facchini, & Maia, 2004). By contributing to better understanding of efficiency and optimization of resources, patient monitoring and analysis of care indicators, information systems optimised the early detection of risks but remained insufficient to improve quality of care. This is partly the result of the lack of standardisation amongst different systems of care, and the tendency to transfer deficiencies of the manual or paper data collection system to the electronic systems. (Clifford, Blaya, Hall-Clifford, & Fraser, 2008)

Standards can be improved with a more bottom-up approach, as was demonstrated in South Africa by the Health Information Systems Program (HISP), a research-oriented program was introduced in 1994 to support the ANC's restructuring of the health information system aligned with the national Health Plan. It followed a participatory approach to consult all levels of the health management system. In an effort to weed out old race-based information standards it aim to introduce data that would be of use at the point of care. It aimed to comply with international

standards for health information such as the International Classification of Disease (ICD). ICD coding requires laboratory testing for certain diseases. Health care professionals were using syndromic diagnosis for sexually transmitted infections (STIs) without laboratory tests, a typical challenge in developing countries. The consultative process helped identify two unique identifying questions that would assist with initiating treatment faster in the absence of these laboratory tests. This innovation contributed to setting a standard for data collection across the country. The innovation therefore made the information more useful at the point of care, but also for nationally aggregated analysis and responsiveness to the disease(J. Braa & Hedberg, 2002).

Several piloting projects have attempted to transform the collection of data to be more useful for the intended users and efficient for analysis in electronic formats. Modest successes have resulted in some African governments seeking the potential of scaling up such efforts. However, the implementation processes are challenging requiring at least standardised collection of information, to achieve useful, comparable and relevant data to improve health services in low income countries.(Braa, Kanter, Lesh, & Seebregts, 2010)

The introduction of electronic health information systems is a recent phenomenon and has been tried and tested, according to one systematic review of developing countries, in 56 instances of 1,947 publications and abstracts selected for rigor and scientific method. Nine kinds of electronic health applications are found: 1) electronic health records; 2) laboratory information management systems ; 3) pharmacy systems; 4) patient registration or scheduling systems; 5) monitoring, evaluation and patient tracking systems; 6) clinical decision support systems; 7) telemedicine systems (for remote diagnosis linking experts to remote sites via camera or email; 8) patient-reminder systems; 9) research of data collection systems (J. Blaya et al., 2008).

Though many of these are pilot projects they were found to have had some level of testing. The outcomes reported were related to *process* indicators such as efficiencies, reduced error rates in data collection, cost reductions, speed, drug data accuracy, drug interactions and drug compliance with national health systems or drug therapy.

A small number of projects in resource poor settings are linking user-focused electronic information to health outcomes, such as better follow-up if individual patient records are kept for monitoring.(Blaya et al., 2008) This information has lead to better management of pharmaceutical supplies for chronic disease support and also to improved patient monitoring, better management decisions and overall improved public health systems outcomes (ibid:1). Paper files make this process laborious and inefficient. Information systems and communications infrastructure can be transformative of these challenges. When health information systems get closer to informing patient care and health policy they can be considered second generation systems (Vital Wave Consulting; 2009:6).

A few studies point to improved cost-benefits from switching to electronic systems and the savings from paper and paper storage for health data (Bridges.org, 2003)(C. J. Seebregts et al., 2009a)(C. J. Seebregts et al., 2009b).

Several examples of public and clinical health outcomes have been reported from improved health information:

- In Lima, Peru, a laboratory tracking systems on handheld computers, where no internet existed, assisted in the early detection of TB in a Partners in Health project to improve treatment outcomes of multi-drug resistant TB and HIV/AIDS in 126 public health centres (J. A. Blaya et al., 2007) The time used for collecting and processing the data decreased by 66%. Smears were processed up to 90% faster as patient sheets were not

duplicated. Similar efficiencies were found to reduce the errors and reduced time(J. Blaya et al., 2008).The PDA laboratory data collection also showed 3% decrease in errors in data collection to compared with control districts where errors doubled.

- Patient-based medical records have proven important to track patients that are "lost to follow-up". The Ampath Medical Record System in 2004 contained 30,000 patient's information in Western Kenya, for managing the quality and efficiency of care to HIV/AIDS patients' two hospitals and eight clinics. Follow up of pregnant women testing positive with patient-level data in the system enabled the outreach group to locate the pregnant mothers to ensure the number of infected babies through mother-to-child-transmission program support(Siika et al., 2005).
- In Malawi only a fraction of HIV positive mothers (19% in one study in Malawi) who received antiretroviral drugs would attend health services to have their infant tested for HIV (Reitinger et al 2007 in (Fraser et al., 2007)). Patient records enabled follow-up to test the newborns who could have lethal consequences without intervention.
- In South Africa's Free State Province anti-retroviral treatment was facilitated by electronic medical records linked via relational data warehouse to the national population death registry. When deaths were registered it could be identified if the patients were still awaiting treatment or whether they were on treatment. (Fairall et al., 2008)Evidence collected demonstrated that patients on treatment had an 86% chance of survival compared to patients who were not yet being treated. (Fraser et al., 2007). Electronic medical records were also useful for checking errors in drug dosages or drug interactions.
- Longitudinal data can assist clinicians' decisions: In Malawi's Lilongwe Central Hospital the electronic order form for pharmaceuticals tracked several error dosages for paediatric

care. The patient weight and age were integrated into the patient management system and this helped eliminate medication calculation errors (Douglas, Deula, & Connor, 2003).

2.3.3. Developing country policies regarding OSS

Interest in OSS from developing countries has surged. In India, for example, the software industry has grown by 30% to 40% annually since 2000 in terms of revenue and employment, with around 250 000 programmers employed. The growth in number of students graduating with programming qualifications in India in absolute terms is growing faster than in the United States (Subramanyam & Xia, 2008)

Several developing countries, notably Brazil, (Camara & Fonseca, 2007) India, China, (Subramaynya, Xia, 2006) and South Africa (Vital Wave Consulting, 2006)have policies and regulations in place to ensure local procurement of software and services. Such policies require concomitant investments into the education sector , public procurement of software and services need to be aligned with the policies and furthermore, policies could create tax benefits for OSS firms. Though crucial to the strategy to strengthen developing countries software and services sector, no significant research has taken place in this regard.

To contextualize these services in the light of the public health sector in small developing country markets consider the costs of procuring information systems in the health sector from proprietary firms that have to developed these systems for large, mainly Anglophone public or private health care systems. Many are at the end of their innovation cycle and as such locked in to ageing technologies that have not remained abreast with the expansion of the internet. Possibly amortising their research and development costs, these firms bid for procurement, often funded by bi-lateral agencies,

usually these procurements are mae in the absence of national information architecture plans and often implement with bespoke systems (Staring & Titlestad, 2008). In addition to the license costs often the customisation costs can increase the total cost of the proprietary system several fold. For instance, when hospital systems already in use are migrated to a new program, this requires the proprietary firm to build application programming interfaces or new modules which need constant updating and debugging. Local customisation of proprietary software, usually developed for the US or Europe, is done under license and usually with expertise that is flown in to developing countries. The cost of licenses is also multiple by the number of users.

These result in several siloed information systems that do not relate to each other, do not follow standards and are therefore not interoperable resulting (C. J. Seebregts et al., MedInfo 2010). Some of these systems remain under the control of the donor agency, or, are given for free use over a limited time and then, after the moratorium period, are locked down and require payment for access to the patient data. The companies building these closed-source solutions can demand further payment to access original data (Levison & Fraser, 2008). This form of vendor lock -in has negative externalities because of government inability to coordinate the information which should be used to guide evidence-based policies. On the other hand, Levison et al (2008) point out that OSS design philosophy allows flexibility; each country can adapt software, translate the software into local languages and simplify local technical support.

A growing number of developing countries are choosing OSS based largely on the potential benefits, with limited evidence of realised economic benefits. The South African Department of Public Service and Administration has a *Policy on Free and Open*

Source Software use for the South African Government(South African Department of Public Service, August 2006). This binds the public service to implementing OSS "unless proprietary software is demonstrated to be significantly superior". The policy also states that all software developed by government would have to be OSS licensed "where possible". This policy was guided by the Government IT Officers Council and the Presidential National Commission on Information Society Development . Studies to motivate the decision were commissioned over the years 2002-2004. In one of these studies the State Information Technology Agency reports that government procurement accounts for 70% of all IT expenditure in the country. This government IT agency puts the annual cost of proprietary software at ZAR3.7 billion (approximately US$ 480 million). As all these licenses are imported the costs could increase with currency fluctuations. Of this the annual multiple-user license fees for the 300 000 workstations costs the government between ZAR1000-ZAR5000 (approximately $130 - $650) amounting to US$350 million-$450 million and $1.5 billion when support and upgrades of public service equipment is considered. (Vital Wave Consulting, 2006)

The South African government adopted a road map for the implementation of OSS in the public sector based on these cost savings (ibid). The policy is particularly focussed on servers, for which Apache, the most popular Web server in the world, would likely be used. The South African OSS working group plans to redirect 10% of state expenditure on licensed software to OSS and to ensure that 60% of all state network traffic servers are able to run OSS.(Mtsweni & Biermann, 2008) There are further targets for schools, government office equipment, skills training for users and chief information officers in public service. The policy is based on a belief that this will foster healthier competition in

the South African information technology market and ensure more customer focus by proprietary vendors (Vital Wave Consulting, 2006).

In Brazil close to 40% of the 1,953 OSS developers that responded to a Ministry of Science and Technology survey had paid jobs to develop OSS products. This was similar to the profile of a European survey. Of these developers only 14% were involved in open source software development, while 20% were involved in government projects to deliver for instance Linux-related services such as security, network management or Web servers and only a third shared their software by putting it back in the public domain (Camara & Fonseca, 2007). The Brazilian study noted that the motives of corporate firms for making use of OSS programs in Brazil appeared to be economic and technical reasons such as cost reduction, greater flexibility to adapt, improved quality, greater independence of suppliers, and greater security were the main motivating factors. Similarly, individual developers were motivated by the opportunity of acquiring new skills, while ideological factors were of minor importance.

2.4. Discussion and Research Questions

In order to answer the question whether the characteristics of OSS are, as the literature review suggests, often contrary to the view that OSS is a pure public good, the research questions that were evolved from the review will be applied to the findings. Similarly I will use the questions that arose from the informatics and organisational management field to find out if the findings corroborate or not the literature that OSS provides a learning environment. Finally, I will use the questions that arise from the governance spheres and the political economic considerations of how improved information leads to better organisation and service delivery by the state. I next turn to a discussion on the methods and epistemology I applied in my research.

This is what gives rise to my main research question, ***How does OSS contribute to socio-economic development***? I have further broken down into three sub-questions that relate to the fields of economics, informatics, and governance that I have identified above into interrelated research questions, which are the following:

1.1 What are the incentives that motivate the computer programmers to consume and produce public goods OSS?

1.2 Is OSS non-rivalrous enabling it to be adapted for use in local developing country settings and therefore can developing countries lessen their dependence on imported proprietary software?

1.3 To what extent do the local implementers in the case study contribute to the development of local adaptations and to what extent do they contribute to the global source code? Or is there a problem with free riding where there are only free users and no contributors to either local or global software solutions in the case study?

1.4 Is OSS always non-excludable, or does the high cost of accessing the internet and appropriating the skills to be a developer preclude its use in developing country contexts?

1.5 What is the role of the sponsor in supporting an OSS community for participating developers and for marketing and recruiting potential contributors?

2. How does learning take place in OSS organisations? (organisational uptake)

3. In addition to contributing to enhanced skills in ICTs, does the use of OSS contribute to improving the provision of publicservices such as health in developing countries?

Chapter 3 Methodology

> The change wrought by networked information economy is deep. It is structural. It goes to the very foundation of how liberal markets and liberal democracies have coevolved for almost two centuries. A series of changes in the technologies, economic organization and social particles of production in this environment has created new opportunities for how we make and exchange information, knowledge and culture. The changes have increased the role of non-market and non-proprietary production, both by individuals alone and by cooperative efforts in a wide range of loosely or tightly woven collaborations. (Benkler, 2006):1-2)

3.1. Introduction

The above quote, in many ways, informs what I do, who I am, and why my profession is compelling. Benkler (2006), a seer of the networked society, an interpreter of how the internet has changed society and the institutions that govern it, certainly gives form and vision to the work I do in the field of international development - supporting ICTs-for-development. However, from my experiences of applying the well heeled and tried concepts of how society is changing due to technology, it is also important to acknowledge that these concepts might be, in some ways, contradictory when applied in the developing world context in which I work. I wanted through my experiences of working in the developing world test the assumptions that inform my work as an international funder for research into the use of ICTs in a developing world context. I will here explain how I situated myself as a participant observer in a project where my involvement grew less but my inquiry increased as I immersed myself in the literature to assess the development impact.

Although my assumptions around programming in the area of ICT-for-development were discussed in the introduction chapter, in this chapter, I feel it is also important to describe how my role in the project, which informs this case study, changed during the course of this study. I

feel it is important to explicitly discuss my role to ensure the reader better understands how I was involved in this project as both as a researcher and a sponsor.

The disclaimer that I add to this study is that the case study and the data collection occurred at a particular place, during a particular time, using direct and electronic means of communication to conduct interviews and collect data. Although, under these particular circumstances, these factors may render this study atypical, I would suggest that limited generalisations can still be warranted from my findings. Although this study can be critiqued for my closeness to the issue and the project I was studying, other studies that inform theory (Raymond, 2000; Lerner and Tirole, 2002) are also being critiqued (O'Mahony, 2003; West & O'Mahony, 2003; Bessen, 2005; Dahlander & McKelvey, 2006; Bitzer, 2006) and the case studies, including the critiques, have informed OSS economic theory.

3.2. Questions

My exploration of the literature was iterative. I explored the literature before the field work, during the fieldwork stage and again after a stage of analysis. The discourse enabled me to raise questions that relate to the public good aspects of OSS and so the first two sub-questions reflect on the economic theory of public goods. The second sub question is more at the level of the organisation of OSS and the final question relates to the state. The readiness and availability sections of the ICT4D value chain will be replaced by my first two sub- questions. In these I will be applying the ideas of OSS as a public good into the context of the OSS project in Mozambique. From the case study I will attempt to answer whether OSS attribution in in a developing world context is a public good, non-rivalrous and non-excludable. I also want to know the benefits of its uptake and diffusion, and further review it in the light of impacts, or potential impacts in a developing state context.

Does OSS contribute to socio-economic development? will be broken down into three sub-questions that relate to the fields of economic, informatics and governance and spelled out at the end of the previous chapter (see section 2.4)

3.3. Methodological framework

I was personally involved in several OSS projects. Researching how community access centres, such as telecentres and school or community laboratories use OSS. We funded a network to support several universities in Sub-Saharan Africa to build OSS for extending the tools available to lecturers and students for interactive education, distance education, multi-national curricula. Repeatedly it appeared the infrastructure and skills divide rendered the use of OSS too difficult in resource poor countries. Universities in South Africa were more able to promote it, but even these proponents often met with resistance. We continued to promote the use of OSS because, in our perspective, the reuse of software clearly provided us with cost-cutting development tools. Our imperative was not only to cut costs, but a commitment to create public good as we are funded by public funds. It was therefore with conviction that we supported these projects, but often did not find the results we were expecting, namely uptake and use in developing countries. The assumptions, as spelled out in the introduction, remained untested.

When this case study commenced I was a Program Officer in the IDRC Johannesburg satellite office, housed at the Development Bank of Southern Africa. I proposed this topic for more in-depth research concerning this apparent paradox. This free resource of world class software prompted us to explore the economic benefits in a range of projects.

After I proposed focusing on this topic to the Humanities ethics committee for an MA in Development Studies at the University of Witwatersrand, I suggested that my proximity to the

project enabled me to get insights that others could not, and that any bias would be countered by reflexive practices and triangulating of data from sources that I did not control. In the year that the research started I moved to Ottawa, Canada to take up a management position at the IDRC headquarters. This change in positions removed me physically from the respondents but also put me at arms length from the projects as I handed my portfolio over to other program officers. Therefore, this change meant that my access to the respondents and the key informants changed from monitoring the project to program oversight, however, this in and of itself did not ensure any scientific objectivity. I propose to use the reflexive method of the extended case study (Burawoy, 1998) which facilitates a dialogue between the theory and generalised and the subjectivity of the observer. I will adapt the questions that emerge from the literature review and apply the theory from them to the case study findings, using the framework that I developed in the literature review based on the ICTs-for-development value chain (Heeks, 2010). In the analysis of the data against the theory derived from the literature, evidence will corroborate or falsify. This method applies a reflexive science to ethnography and enables the extraction of the general from the unique and movement from micro to the macro levels. Reflexive science enables the analysis "to derive understanding from the context effects that pose impediments to the positive science" (Burawoy, 1998)The interview, the survey questionnaire, the context and the external environment are dynamically interacting with the researcher and the event or intervention at which tacit knowledge is being captured are gathered in a way that will be aggregated these through different methods to reflect explicit knowledge.

3.4. Data gathering: Scope and limitations

I do not aim with my study at reducing the risk of reactivity, even if I distance myself from the respondents, because the project itself is an intervention, out of the ordinary, social and

economic factors that expand the everyday choices of the respondents. Nor can I achieve an infinite number of reliable respondents because, while growing, the number of known participants in the project is limited. My study in principle is replicable, but the context has changed, it is a year later, the actors might still be there but they too have changed. Finally, the size of the population I study is not representative, if anything it is the population of OSS computer programmers involved in the project in Mozambique and South Africa, and the main programmers in the US. This purposeful group is the target of my enquiry.

The following research tools were used to present the data before analysis:

- Focus group discussion with six computer programmers at the Mozambique OASIS FOSSIL laboratory, University Edouardo Mondlane, Maputo, Mozambique, October 2008 and all of the computer programmers gave consent to be named in the study.
- I conducted three in-depth interviews in person, by skype and by phone and had follow up interviews with two of the key respondents during my data analysis phasse as well. The interviews were conducted in South Africa, Mozambique and by phone and skype from Canada.
- I had one structured set of questions sent by email to two members of the OpenMRS governing body and received a response from one of them.
- Questionnaire 1, *FOSS capabilities in Africa*, was collected electronically on a SurveyMonkey during the 2009 OpenMRS implementers meeting (n=122). The (n=41) responses were exported into Excel spreadsheets. The data was divided into African and non-African responses according the country of residence. This respondents details were verified against the list of all participants provided by the organisers

- Questionnaire 2: *OpenMRS node learning and doing* was collected after sending emails to students at the Mozambican and South African nodes. In some cases several follow-up reminders were also sent. The survey analysis tool for aggregating data and drawing graphs was a paid for function in Monkey Survey and some of the graphs presented are derived from it. The two Questionnaires (Appendix 1 & 2) are also presented in the Monkey Survey format.
- I had several follow-up emails with computer programmers who had respondent do Questionnaire 2 for follow up questions regarding their ability to connect to the Internet at the university and at home.
- The questionnaires indicated the purpose of the study, that I was an MA student at the University of Witwatersrand and that anonymity and would be preserved unless explicitly the respondent would be prepared to be identified. The Questionnaire 2 (Appendix 2) in particular asked the programmers if they wanted to remain anonymous and 87% requested anonymity. I have coded the Mozambique computer programmers Moz programmer 1-6 and the South African programmers SA programmers 1-5. I also asked the core computer programmers in the United States who had been identified in the surveys indicating who had given support whether they wanted to be named or remain anonymous. The emails providing this consent are in appendix 10.
- Content analysis of the transcribed focus group discussion, key informant interviews and email conversations between one of the most active Mozambican implementers and the core development team.
- An ethnographic sketch of one of the OpenMRS implementer and user meeting

The methods of enquiry I use will have effects: I was a participant observer writing an ethnographic sketch, I seemed uninvolved, but there were those who knew me and knew I was a funder of the meeting and I could not control for effects. I interviewed key witnesses, they knew my relationship with the project. I struggled to hold a focus group discussion with respondents who were mainly Portuguese speaking, I asked for translations but when I transcribed the conversations there were blanks where my own English domination was most evident. I then returned with a questionnaire that gave response language a choice and got 100% English responses, though the answers were short, and the silences blanked out, I had limited their choice of response which I acknowledge. I had informal conversations with key informants, over time developing a situational analysis of the ebb and flow of the project.

I launched a survey questionnaire anonymously on the project's website and asked the project's director to announce it, this was probably the most removed I was from the respondents, but following this I sought a subset of respondents who identified themselves as computer programmers of the project and asked if they would respond to more questions. I sent email reminders to them to complete these and they responded, some after several reminders. When the responses from the African students identified the core programmers from North America as their key supporters and not their south African neighbours, I was surprised and visualised these relationships with a social network analysis mapping the interactions (Madey, Freeh, & Tynan, 2002) which is being used widely in the literature to visualise interrelationships and more specifically interactions amongst actors in innovation systems (Spielman, Ekboir, & Davis, 2009).

In emails to these elite core computer programmers in the US who answered the emails of the new young African OSS recruits I asked if they wanted to remain anonymous as Computer

Programmer 1, 2 and 3 etc or whether I could use their first names. I was not surprised when, consistent with theory of OSS the highly skilled programmers recognised an opportunity to signal their worth. They chose to be named in my study even jokingly wanting their names to remain linked to the coded programmer No 1.

I read the technical reports that were being filed to the IDRC for accountability, I had conversations formally and informally over the two years with partners in the project, I attended their presentations when I could. This stretched the observation period over two full years from July 2008 to July 2010. I was inside and outside the project and this in itself might have resulted in some defensiveness in responses and some secrets being shared after the recorded conversations and survey responses were put away.

Before moving to Ottawa, I managed to attend one workshop, hold a focus group discussion, and conduct an interview with one of the key informants, but more importantly, I had been played a role as the funder, was familiar with the organisations that were involved, was able to review technical reports from the project, review the outputs coming from the project, but had to, through the process of this study start to develop a systematic approach and analytical rigour that would help me understand the case in a deeper perspective. When I moved from the field I started to rely on the tools that I would research, on electronic communications via email, an online survey tool, Skype calls, instant message discussions and I browsed the web for a host of open resources such as the online OpenMRS wiki, tools that told me what kind of traffic visited their website, numbers and countries of downloads of the software, and so on.

Key respondents were not always available, despite my apparent access to them. Many of the interviews, conducted at this distance, were mediated, at times anonymous. When I approached people for interviews, I clearly stated that the interest I had was for research for my academic

qualification and not as an employee of the IDRC. This declaration letter is attached in Appendix 10. As an employee of the IDRC, I have had access to the electronic library resources, any recipient we fund enjoys the same privileges. I also self-funded my studies, worked in my own time on the thesis and therefore have no obligations to my employer or the projects concerning the findings.

3.5. Data Analysis

My exploration of the literature was iterative as I explored the literature before my field work, during the fieldwork stage, during the writing stage and again during the revision stage. This confirms that knowledge construction takes place during the writing process(Kamler & Thomson, 2006). The discourse of the different fields that inform my study, from economics, informatics and the political economy, enabled me to raise questions that relate to the public goods aspects of OSS, the organisational aspects of OSS and the political and economic impacts of the use of OSS. These categories emerged from the different fields of literature. I retrospectively found the Heeks (2010) ICTs-for-development value chain that also gave logic to the different domains.

The samples were small in the survey tools and thus delivered small and insignificant statistics, but I found the data in the survey's targeted at the project participants instructive because this provided a longitudinal data gathering of the students I had met a at the OpenMRS meeting in Durban in July 2008, then an expanded group but involving the computer programmers I had met previously but expanded with more students. The same students were asked to fill in the software competency survey and finally through questionnaires aimed at the OpenMRS project participants, I gathered further longitudinal information. In addition to this the key informant interview also introduced me to particular team members. Particular programmers

began to emerge as dominant. My analysis was therefore across the sample but as the same people's responses and others comments about them a pattern emerged that enabled me to identify more dominant members of the group. The quantitative results were useful when identifying that the base of computer programming skills. I found internal coherence amongst the data, although some responses were surprising.

My knowledge construction can be traced to two main stages of writing. The first paper that was submitted for external review and the second, incorporating the imperative for a deeper interrogation of the notion of the public good. While initially it emerged in my concepts, I based my first paper on several hypothesis of my own that would confirm or deny whether learning was taking place in the OSS organisation, that the intervention of the project was temporary but that some sustained effort would be required to promote African participation in open development activities. In my second, more in-depth dialogue with public good theory between my findings and the literature I was more able to sharpen and falsify or nullify the concepts that I had naively applied in my own theory. Extending the concepts of non-depletableness and non-excludability turned my hunches from theorising about the context to theorising more about the system of OSS as a form of production. An assessment of whether social production is located at the core rather than the periphery. (Benkler, 2006)

The approach I will use is that of theory reconstruction. Using Burawoy's (1998) approach to context as the point of departure and not the point of conclusion, in other words the developing country experience of OSS is my departure point and not my conclusion. My conclusions will be filtered through interacting with the theory.

I was not removed from the context, because the context was the Internet and the communications it makes possible. However, I sought other forms of gathering the information

that would have less research effects: I asked to see the email archives of the OSS list serve and some rudimentary text analysis helped corroborate some of the evidence I had collected in surveys. I looked at download statistics and other such data sources that were independent of my respondents to try and assess how active the programming network in Africa was. Even these I do not present as the *sine qua non* of a positivist stance. Instead I have adopted what Burawoy (1998) calls a dialogue between the positivist and the reflexive because each have their limitations.

> "If representation is not feasible, is there any other way of producing generality? Instead of inferring generality directly from data, we can move from one generality to another, to more inclusive generality. We begin with our favourite theory but seek not confirmations but refutations that inspire us to deepen that theory. Instead of discovering grounded theory we elaborate existing theory" (ibid: 16).

Falsifying the hypotheses was Karl Popper's wisdom to suggest that it helps move the science forward offering an opportunity of continual revision and emerging theory (ibid). My tools and enquiry were limited to the individual and the organisation, but the level of the state was visible by proxy. I do not claim that the research shows impact as defined by the ICT-for-development value chain, but the proxy of the state agency, the role of the international donors that are funding the anti-retroviral roll out, demonstrate behaviour that suggests that the software databases that the project developed were not only useful, but worth investing their project funds into. My study stops short of understanding the behaviour of the Mozambique government or the global level actors that rely on information to address areas of policy, governance and power. These are the limitations of my study, but demarcations for future study.

The theory of OSS and its assumptions of inclusion and non-excludability have been put to test. Some evidence is convincing that the collaborative nature of the interactions are

empowering of the periphery, that the elevated status of the programmers results in both private benefits as well as contributing to a public good, albeit with different means of production. But the intervention has not yet ceased, the cycle of funding interaction has not yet stopped, the question of sustained effort and value to the programmers or society at large are yet to be tested beyond the piloting cycle of funded demonstration. Choices made by the computer program originators built in a particular copyright potential for proprietary down-steam returns. These outcomes are yet to emerge and when we extend our theories to engage with the tensions that emerge in the social processes which continue to reproduce knowledge of these social processes. When contribution to the field is made we again return to the cycle of intentions, evidence, theories and change in order to facilitate a better understanding of the unequal networked society

My research topic is all about context, all about how OSS fits into the developing world, away from its proven theoretical underpinnings of the developed world where internet connections are cheap, deliver reliable broadband and the computer programmers take it for granted as the zero-cost of producing a public good.

This is a case study of a particular OSS project, in particular of the group of students in Mozambique who participated, and their interactions with other significant members of the large OSS collaboration. I will continue to draw on the ICT4D value-chain (Heeks, 2010) as it provides a logical model of readiness, availability, uptake and impact. I will adapt the model according to my own research model. As indicated in the literature review there are three levels at which the case study will be presented, namely the production of the software and to what extent being in a developing country influenced the computer programmers ability to participate in the project. The second level of case study will investigate at the level of the organisation how and whether learning took place for these developing country computer programmers. Here the

level of analysis will be organisational and will focus on the interactions between the individuals in the OSS organisation. Finally, the question of the impact of the contribution of the OSS programming will be assessed at the level of the state.

3.6. Conclusion

This chapter served to present the questions and explain the epistimology that underpinned my study. It also helped me describe how I collected the data and how I analysed the data I had to explore the relationship between motivation to participate in producing OSS as a public good, what the organisational learning processes are and find out how this benefits the developing country state. I will now turn to the findings and their analysis.

Chapter 4: Findings and Discussion

Before starting the study I had an intuition that the programmers motivations to participate in the Open Source project was to learn, but I was unsure if the focus that there was on the networking meetings or the workshops around OpenMRS were sufficient to develop the skills required to become implementers of the systems. The other concern I had was that the implementation of systems would need to be approved by the governments and therefore there would be a high level of experimentation with the design before the programs worth could be demonstrated to their governments. I was also intrigued when I learned that the students who agreed to participate in the project were all given stipends to participate in the OSS project. Several of these issues were apparently contradictory to the dominant view of OSS.

The following chapter will present the findings of my study; based on the instruments that I used, as outlined in the methodological chapter, and through the iterative process of writing I have returned to the theory, and at time even augmented the theory, in order to be able to explain my findings. Based on the three levels of enquiry, namely the individual, the organisation and the state, this chapter is organised in the same way that I organised the literature chapter. The first section will investigate the characteristics of the OSS program and whether in the project context its characteristics of non-rivalrous and non-excludable result in it being a pure or impure public goods for the African users. In this section I will look at the motivations to participate, free riders and the role of the sponsor. The second section will interrogate the findings on how the students learned from the way in which collaborative learning is structured organisationally in OSS. Finally, I will discuss findings related to the Mozambique Ministry of Health's interest in and response to the improvement of information systems as a result of the student's software applications development.

4.1. In what ways does the dominant paradigm of public good theory explain OSS in a developing country context?

As was seen in the literature review the dominant view that OSS is produced at zero cost, by highly skilled computer programmers who are either doing it for the intrinsic motives of recreation, user-innovation, reciprocity or the delayed extrinsic reward of a better job or better pay through signalling has been falsified by more recent studies (West & Lakhani, 2003; Dahlander & Wallin, 2006) and from a developing country context in particular (Subramanyam & Xia, 2006). My findings strongly corroborated the other developing country findings. However, I need to make explicit certain assumptions. During the design of the project there was an assumption from the funders perspective, that the students who were going to participate in the project would volunteer their time to the project, but when the project started it became clear that in order to support and retain the undergraduate and graduate students that were participating in the project, employing them was the key incentive for these relatively highly skilled local expertise to be retained for the work that the project and the Ministry had ambitions to accomplish.

4.1.1. What motivates African developers to participate in software production in a developing country context?

Students involved in the OASIS project earn a graduate level student stipend. One of the survey questions to the students working on the adaptations to OpenMRS and other software at KwaZulu University and University Edouardo Mondlane was to establish if they were prepared to use and produce OSS if they were not paid. Half of the eight respondents at both nodes would want to continue being paid for the work; whereas, the other four respondents said income was important but they could continue working on

OpenMRS if they were in other paid and related jobs. It is important to note that none of the respondents were prepared to compete for grants in order to get paid for the work. This disinterest in applying for grants also included one of the South African implementers, who acted as these students' mentor, meaning his salary was more than his regular student stipend. All of the respondents said the income from this project was extremely important.

By July 2010 the MOASIS team of 7 computer analysts and programmers were employed by the project, five of them were working at the Ministry of Health four days out of five, with the fifth day at the university for meetings. They were earning three to four times what they would have earned if they had been employed in the Ministry. According to key informant and head of the Mozambique OASIS (MOASIS) node, Leopoldo Nhamposa explained that government salaries and pay scales are defined, and are very low. He acknowledged that the students, some of whom were working on the honours papers, would have earned a third of what the project was prepared to pay them. Instead they were earning around what a medical doctor would earn in the Ministry. The project salaries, which included a senior advisor and computer laboratory coordinator, had subsequently been funded by Centres for Disease Control which administers the Pepfar fund in Mozambique. Two of the graduates were in full-time employment by a project the Van der Bilt University provincial project in Zambezia implementing an electronic medical record system using OpenMRS.

"Salaries in the government are defined. Salaries are very low. The Ministry is happy that the project team is working inside of government; they can have the human resources. The students are happy to be working for the project because they would not

have worked for the government at those low wages. No ICT people will work for those wages. We need to continue to find the funds to support the project. But slowly the government will have to change its policies and pay the ICT people more," according to Nhamposa.

Being paid to work on the OpenMRS development team was also not unusual in the project. Seebregts, in his interview, confirmed that the original US founders of the software have institutional funding for their day jobs.

> "Until recently, this funding was for other tasks and computer programming was done in spare time or as a side effect of other tasks. In some cases, the job description started to change to include programming development work, in other words their funding was to support their OpenMRS development. External donor funds were obtained to support fulltime developers In some cases, the funding is linked to a particular implementation (Haiti, Peru, Rwanda) and the work done on the core software base is a side effect of the implementation funding." Seebregts interview.

The African nodes were developed as a sponsorship program where students receive salaries. This was important because in this initial year of the coursework, it would not be able to offer a qualification accredited by an academic institution. To attract the strongest candidates there had to be a financial incentive. The African students in the various nodes were either under graduates, doing their honours degrees, and in South Africa there were a few preparing for their Masters of Science degrees.

OpenMRS continues to grow and was accepted as one of 131 mentoring organisations worldwide for the prestigious and competitive Google Summer of Code for 2007, a programme in which Google pays student programmers from around the world to work on quality open source projects over the summer (Seebregts et al., MedInfo 2010) The competitors in the first two years were students from northern universities. The OASIS

project decided to create a similar competition that would only enrol African software programmers. The African internship award was not successful, after three months most of the projects were returned incomplete and it was found that most of the awardees had not given up their jobs to make use of the award, they were therefore not students with free holiday time. It serves as further corroboration of other developing country experience that OSS programmers want to be paid well whether working for the public sector or more likely in a service sector (Subramanyam & Xia, 2006). As indicated by the skills survey, these students already had a high level of skill and, therefore, would otherwise be employed and income earners, if they were not involved in this project. Their requirement for income stems from the reality that many African households would have sacrificed a great deal to educate their children; therefore, once these graduate complete their education and reach employment age they would likely be supplementing the household income or even become the breadwinners for their extended families. Although this point was not explicitly examined in this study, the students' emphatic responses about issues related to income illustrate that their need to earn an income in return for their participation in the OSS project. A key objective of the nodes is to retain the programmers' services either through local enterprise or employment in the countries' ministries of health. This would contribute to the OSS project's sustainability by narrowing the gap between the public good benefits and private benefits to the actors contributing to the public good.

An important contribution to expanding the network of African implementers remains the sponsorship of the students working at the nodes and funding the annual OpenMRS meetings in Africa. Their efforts were being rewarded with basic incomes. Previously an

ex-patriot consultant employed by the Ministry would have implemented new information system needs. The Ministry was also considering the procurement of a custom built system, this would have involved getting expertise from outside of Mozambique to customise a system. As discussed earlier, the students considered these incomes extremely important for them to continue working on the OSS adaptations for local use. In July 2010 I confirmed that the students employed by the project, which has subsequently been funded by the Pepfar programme under the CDC, these students from the project were spending four days out of a five day working week at the Ministry of Health and were earning three to four times what they would have done as Mozambican public servants. The pay structure for their bachelor degrees would not compensate them for their marginal worth to the public service. They were likely earning more than medical doctors in the public service.

The income differential corroborates the findings in India and China that software programmers earn relatively higher incomes than other professionals in the developing world. This could point to the higher demand for ICT skills in developing countries and suggests a recalibration of public service pay scales based on skills and the growing demand in the public service for improved management information systems.

4.1.2. Is OSS always non-rivalrous, can it be locally appropriated in a developing country context?

One consequence of the above finding is that tentatively I must revise my assumption that the private-provisioning of a public good will be undersupplied in the case study – as in some literature about consumers and producers paid to participate -- the producers are compensated for their production of the OSS. In order to remain non-rivalrous the

software use and production should not be depleted. Two ways in which I can test this claim are to establish whether the software can be appropriated into a local context, this is one way of testing this characteristic, according to the literature review (Gambardella & Hall, 2006). Or put another way, is the public good locally appropriable? I will interrogate my findings in the light of local appropriation, in other words was the OSS relevant to the local context and adaptable to the local need for its use? Did the use of the OSS lessen the developing country's dependence on proprietary software?

The second test would be to establish whether the software could diminish in the future. I would have to find out what license the originators chose to protect the source code, in other words, maintaining their right to generate income derivatives in the future in order to fund future development.

Turning to the first test, is the software locally appropriable I discovered that the Mozambique team decided to continue to develop their death registry in software they were familiar with and which was legacy software in use in the Ministry, despite their experience of learning to use the Jave and MySQL interface for OpenMRS. As students they had learned to program in Visual Basic.net (VB.net), the open source component of the Microsoft suite available free on the internet to a level of complexity after which license fees are levied. One argument here is that they were locked-in. Even if they plan to re-engineer their program to OpenMRS when they face challenges of retraining users they have rolled out to, the Mozambican team has chosen a program that will result in a marginal cost to the consumer -- the Ministry -- as it will likely have to purchase the license to unlock more functionalities as soon as the program development requires more

complex functions such as encryption and privacy if patient profiles are to be collected for morbidity data.

While this was not the primary objective of the project, their supervisor, Dr Leopoldo Nhamposa explained that the most important knowledge that the Mozambique team developed through the collaboration, and that this collaboration continues, is in the field of health informatics and the data model that or standard-based logic model. As such the technology they are using appears to be less significant than the operational knowledge they have developed in order to build a health information system. In conclusion, while the software or technology that the Mozambican team chose to program in is ultimately rivalrous, the knowledge that the team learned in order to build the substance of a health information system is non-rivalrous and has resulted in public good that the Ministry of Health benefits from. Despite not using the OSS the team learned from the OpenMRS team about the technology, the tools and through multiple communication such as email, skype seminars, meetings, phone calls, and even cell phone text messages, according to Nhamposa.

> "The students requested support, asked questions, got answers and received the support they needed while attending to different problems to address the real situations they faced in the implementation of systems for the Ministry of Health. The network has linked the students with the Seebregts expertise, the team at Jembi, and other projects that are implementing in Zimbabwe, Rwanda and Kenya.This network has helped us solve local problems." (Nhamposa, telephone interview)

The Mozambique team chose to combine proprietary software and OSS as they continue to develop their OSS Java skills before migrating the Mozambican system to OpenMRS. Another point about the non-rivalrousness is that the data-model OSS programme to create visual interfaces instead in VB.net was the software the

Mozambican students were used to. They could continue to work in the VB.net free software to a point that they would require more complex functionalities. Their modules could not be committed to the OpenMRS core software. The Ministry of Health was so pleased with the first results that it requested the death registry that had so successfully demonstrated the impact on mortality at the Central Hospital of Maputo be rolled out country wide to 80 provincial hospitals, but they were planning, once implemented, to replace the proprietary Visual Basic with Java so that it would be compatible with OpenMRS. It could be argued that the students' learning experiences from their participation in the OpenMRS network enabled them to adapt a combination of softwares for local use, in other words the knowledge they picked up from interacting with the OpenMRS team was non-rivalrous, but they chose a software option that was rivalrous. Furthermore, the collaborative model of learning however did yield some knowledge that was beneficial for the way in which the information system was built.

With regard to the second test to find out if t s to the software license that Regenstrief Institute chose to protect the software with turned out to be the Mozilla Public License which allows for a foundation to earn income from future derivatives from the code source, this is a hedge to ensure sustainability of the community-initiated project in order to allow income to be generated from spin-out projects once the initial phase of software production dries up (West & O'Mahony, 2003). The originators had thus pre-emptively, either through advice or intuitively, considered that the source code could become depleted in future and therefore chose a license to allow for future derivates. However, in an email interaction with the key code writer, Burke Mamlin mentioned that the original intent of keeping the source code in the public domain was clear, but they wanted to

avoid copyleft. Initially the collaborators from Regenstrief Institute and PIH with the help of lawyers decided to (1) create an OpenMRS, Limited Liability Company as a single-member subsidiary of Regenstrief, (2) create the OpenMRS Public License as a slight variant of the Mozilla Public License 1.1, and (3) have all developers who contributed as well as organizations (e.g. RG, PIH) sign their rights to the code over to the OpenMRS, Limited Liability Company.

> Our intent with the Mozilla Public License was to avoid being too copy left, so that modules could be commercialized and we wouldn't completely close the door to a future opportunity where a company wanted to make private/commercial changes to the code base in exchange for a significant contribution to the community such that -- in the community's opinion -- the exception in "open-ness" would be outweighed by the public good of community infrastructure support.
>
> Since that time, our thinking has evolved a bit. While we need to continually support the infrastructure, we don't want to be providing service, which would put us in competition with the very people we want to empower and see succeed. Rather, we need to scale the infrastructure only enough to enable growth without becoming a bottleneck. So, we're working on turning OpenMRS from LLC into a non-profit (e.g., 501c3) and looking toward funding opportunities through granting opportunities aligned with the community road map, secondment of developers, providing certification, and/or training. Regarding the license, our MPL-ish license has served us reasonably well to date; however, we have run into some issues with interactions with commercial groups and plan on re-evaluating our licensing. For example, GPL v3 came out after we had licensed OpenMRS with MPL 1.1 and may provide more flexibility.

The copyright issues are by no means clear to community-initiated projects as they seek to protect the open nature the source code, enable business opportunities and yet retain the potential for sustainable generation of income to ensure the source code remains up to date and technologically relevant or fall prey to obsolescence or worse, get

high jacked for proprietary use and development only. New licenses are emerging to maintain flexibility. The choices expressed in the licensing options clearly demonstrates that OSS is a commons good, that requires community governance to protect the public yet impure commons pool characteristics of the good.

In the conclusion, technological lock in, demonstrates the power of first mover technologies and the business model of progressive licensing. The license choices, on the other hand, of the OpenMRS community demonstrate the concern of future rivalrousness if it fell out of use. Ways of protecting it in the public commons requires high levels of protection of the core code to guard against commercial modules high-jacking the public code. However, some flexibility is required to allow for future streams of income to a non-profit organisation that will protect the source code's future. This is clearly a protection of the potential rivalry of commons goods.

4.1.3. To what extent do the local implementers in the case study contribute to the development of local adaptations and to what extent do they contribute to the global source code? Or is there a problem with free riding where there are only free users and no contributors to either local or global software solutions in the case study?

As mentioned in Chapter 2, the literature review suggests that the OSS model thrives on free riders because they create the positive network externalities for OSS. However, the discourse between the dominant and emergent view on OSS demonstrates that not every user is a programmers, in fact, that there are very low levels of OSS users who adapt the software and put it back in the public domain (Dahlander & McKelvey, 2005; Subramanyam & Xia, 2006). A very important finding that OSS motivations are highest and most predictable in small niches where complex goods are being produced through

the adaptation and appropriation of the OSS in small niche markets (Bessen, 2005). A significant finding from the research is that, though not initially envisaged, an African computer programmer did develop a programming solution that has been approved by the core OpenMRS governing team. Principle Investigator of the OASIS project, Chris Seebregts of Jembi and MRC in South Africa, foresaw that the African nodes were to implement and adapt the OSS for local conditions.

The Mozambique students had spent, at the time of the survey, nine months developing a "Bulk Concept Object", whilst by July 2010 when the final draft of this report was being prepared, they had completed the death registry and had developed a daily web-based reporting tool for cholera. These programs were available on the www.openmrs.org/moasis/ website. They had also completed the translation of the OpenMRS Blue Book or procedures, principles and recommendations into Portuguese and had developed at node disaster recovery and business continuity strategy.

In the survey response of both nodes, 76% respondents said they developed applications. To the question of whether they ever tested or commented on someone in their group's work 60% said yes, and when asked if they had tested or commented on others in the OpenMRS global network, 60% said they had commented on their peers work.

The contribution of only one developer, "dfuterman" (OpenMRS, n.d.), one of the KwaZulu Natal University students was one of 40 developers whose programming developments were accepted into the core program before the release of OpenMRS version 1.6 (OpenMRS wiki March 25, 2010). Daniel Futerman, a respondent to my survey agreed to be named in this research report, has developed a form that will enable

the user of to replace a piece of software that was previously only available from a proprietary vendor. This "form entry html" as is has been named by the OpenMRS team, replaces the need for OpenMRS users to make use a Microsoft product for creating forms called Infopath. A license for one user in Infopath costs US$199. In any hospital environment several licences would be required for each computer using it. Replacing this with software freely available on the internet and bundled with the OpenMRS pack will result in multiple years of cost-saving. The user can now, using web standards for hyper text mark-up language (html), create forms from the OpenMRS data module which can then be completed on-line of off-line or can be printed out for the health care worker to fill in manually. The form entry module acceptance into the core OpenMRS program modules, a decision taken by the governing committee of OpenMRS, will be maintained by the community of users who also participated in the initial debugging phase.

The "form entry html" was a module put out in one of the Google Summer of Code competitions. Daniel Futerman had initially applied to become the summer student, but since his skills had already been recognised by the OpenMRS core coding team, was invited to mentor another which he was also paid for. Collectively they produced the module.

The two nodes in South Africa and Mozambique were set up for capacity building purposes, and at least one of the computer programmers mentored one other, the same computer programmer contributed code back to the core trunk, several applications were developed that are available on the OpenMRS website. The low level of contribution back to the core is not unprecedented, if anything, this is a postive externality that was not expected since the expectation of the students was to implement the new software and

develop adaptations for the OSS to be useful in the local context. The finding that the Mozambique team decided to develop their death registry in VB.net which will eventually incur a license fee, suggest that OSS is more likely to be used for complex public goods

Meanwhile, the South African team has developed OpenMRS modules for use in various implementations ranging from WHO materials on CD's for distribution to member states, and applications interface software to link OpenMRS, which is a patient-based database to the District Health Information System which is an OSS developed by the Norwegians and in use in several developing countries implementing the Health Information Systems Program, also endorsed by the WHO, to collect aggregated statistics. Though not contributed back to the core, these applications are important extensions and make possible more complex customisations in different context. There is therefore little evidence of free riding in the project.

4.1.4. Is OSS always non-excludable, or does the high cost of accessing the internet and appropriating the skills to be a developer preclude its use in developing country contexts?

In this section I will investigate whether the African students were, as suggested in the literature review section 2.1.4, excluded from the accessing and adapting OSS because of the high price of internet connectivity or their lack of skills. If they had to "pay the price" to participate in OSS then it confirms that OSS in a developing country setting is a club good and not a pure public good. While all of the South African students participating in the survey had home and university internet access, only two of the six Mozambican computer programmers had laptops and had internet access both at home

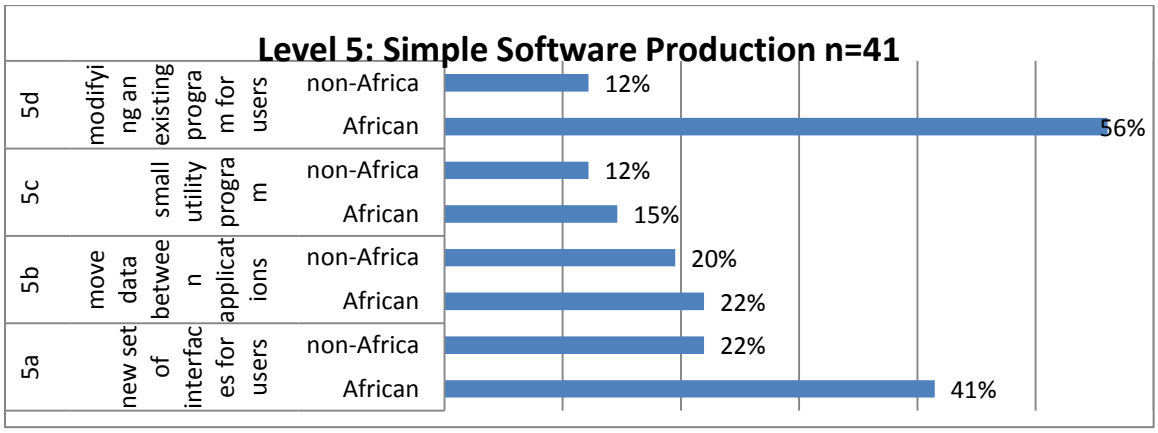
whereas all of them accessed the internet at the university. All of the implementers had completed their bachelor degrees and were pursuing post graduate studies focussed on OpenMRS implementations. The Mozambique team was involved in helping the country's Ministry of Health develop a death registry, starting at the central hospital of Maputo.

In order to establish if the African students had reached the level of competence of programming, in other words, software production rather than just consumption, I decided to use a standard survey designed in the UK by electrical engineers and used in previous research (Grundey & Heeks, 1998: 10, 11) see Appendix 1. I decided to administer the survey amongst a broad cross section of OpenMRS users and to ask recipients to provide the country they were from in order to distinguish between the African and non-African participants of the September 2009 OpenMRS meeting and hack-a-thon.

The survey was introduced at the OpenMRS meeting and a total of 41 responses were completed in the online survey, of which 29 (71%) were Africans and 12 (29%) non-Africans. This was a 34% response rate based on the 122 attendants of which 88 (72%) were Africans compared with 71% African respondents, suggesting that the standard deviation of the sample was within acceptable range. The questionnaire had been placed on the OpenMRS wiki website that was in use during the meeting. Respondents answered all of the questions without knowing they were ranking themselves as the questions prompted answers about their levels of programming proficiency. There are seven levels of assessment in the questionnaire, level 7 being the highest level of software productions capabilities. Level 1- 3 covers basic non-productive skills while levels 4 – 7 cover

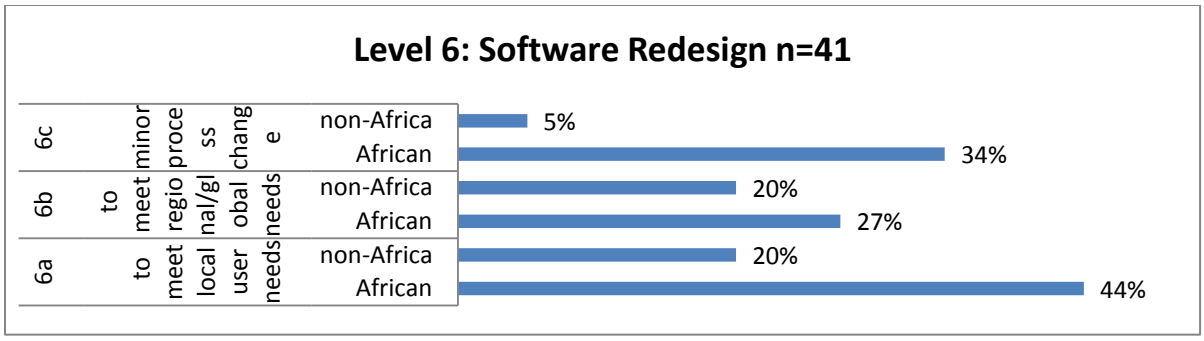
production skills. African respondents features highly in the non-productive catagories of level 1 -- training others to use software (56%) and level 2 – installing and troubleshooting (71%). However, I separated out the various sub-levels of the following, productive capabilities to demonstrate that the African respondents have a variety of basic and advanced software production skills compared with the non-Africans, or the other respondents who came mainly from developed countries and some from Asia. Figure 4 below demonstrates that the Africans attendants were more likely to be involved in modifying software as opposed to creating new software, a finding that perhaps illustrates how focused their work is on adapting software to meet local users' needs. This finding is particularly relevant in light their role in adapting the OSS to created complex public goods relevant to the local context.

Figure 4 Simple Software Production skills African and non-African



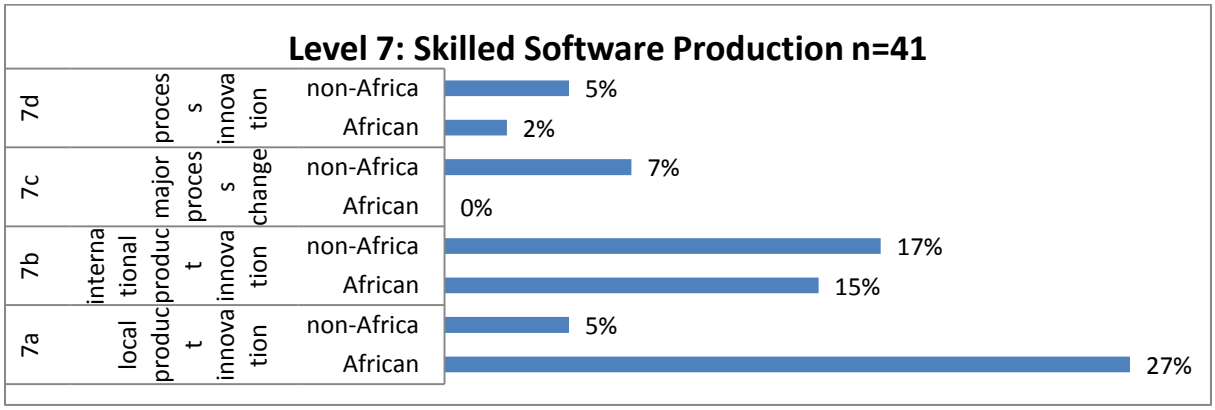
In Figure 5 the indictor for African's adapting software for local use is higher (44%) than their non-African counterparts (20%) and most Africans said they were involved in (5d), modifying an existing program for users. These are considered Simple skills.

Figure 5 Software Redesign capacities of respondents: African and non-African



A significant number of African attendants were level level 6 software producers redesigning software 34% making minor process changes and 27% redesigning in for regional and global users. Figure 6 shows that 27% of the African attendants were involved in level 7 skilled software development for local product innovation: developing a new program to meet local user needs. A much smaller number of Africans (2%) were involved in process innovation whereas 5% of the non-African respondents were process innovators.

Figure 6 Advanced Software Production skills. African and non-African



Based on the findings from these self disclosure surveys, I conclude that the Africans had high levels of skills for performing local adaptation of OSS and moreover, had the skills to show others how to use the software. Furthermore, the finding that these students had connectivity at the university and some even at home suggests that the potential barriers to consuming or

producing OSS were insignificant. OSS in this developing country context was therefore found not to be excludable due to cost, access or skill.

4.1.5. What is the role of the sponsor in supporting an OSS community for participating developers and for marketing and recruiting potential contributors?

As noted in the literature review, there is a role for sponsors in the OSS communities in the developed world in the private sector (West & O'Mahony, 2005) to diffuse new technologies and also to ensure a solid technical foundation for large scale innovation. Funded universities achieve the "best of both worlds" of private-collective production of OSS (Von Hippel & von Krogh, 2003). Yet another role for the sponsor of OSS is to build the capacity of their computer programmers or to control or contribute to standards development (Dahlander & Wallin, 2006). Most importantly, there is evidence that sponsors could impose license conditions that could result in the commons pool resource problems (O'Mahony, 2003). In other words, could the sponsor promote projects that ultimately are not sustainable. The literature seems to suggest that community founded OSS projects remained community managed and with some evidence to suggest that the institution of the licenses and the license choice should be a community decision to avoid the degeneration of the product in the commons when incentives are removed to allow for derivatives from which future property could be derived (ibid).

The evidence presented in the figure 7, including the interest generated from the OpenMRS wiki suggest that the user group is a large and growing community of developers and implementers which have grown since its inception in 2007. The team of core project partners are also very prolific in presenting their project in peer reviewed conferences, amongst donors and are gaining attention in the global health informatics arena. Their advocacy around an enterprise architecture for health information systems in developing countries is gaining traction in developed countries

and resonates even with partnerships that the IDRC has helped to broker, for instance with Canada Health Infoway. Continued sponsorship includes networking the OASIS proponents with projects in Asia also funded by the IDRC as well as in Latin America, the global scope of the IDRCs programming. This continues to extend the IDRC initiated the African diffusion of the OSS project and the attendant open standards uptake in Africa. The core developer group at Indiana University enjoyed funding from the Centres for Disease Control in the US as well as Rockefeller foundation for the initial development of the code. The latter funders have continued to support various other aspects of the program.

Figure 7 Global Traffic rankings and OpenMRS users

How Openmrs.org worldwide traffic rankings:

12,346 Chile

110,463 India

240,979 United Kingdom

334,746 Germany

610,952 United States

Openmrs.org users come from these countries:

28.9% India

16.1% United States

9.3% Germany

6.0% Chile

6.0% United Kingdom

Source. www.a lexa.com accessed 16/12/2009

The statistics are dynamic, on http://www.alexa.com/siteinfo/openmrs.org and demonstrate the number of users of the OSS around the globe, demonstrate that the community of users is vibrant and regularly changes and despite the sponsorship of the African community of users for uptake, African users do not feature in the top 5 groups. These statistics were drawn from the website on 16 December 2009. Six months later the UK and India were the top two countries whose traffic was traversing the OpenMRS site. This suggests that the OpenMRS network of users is growing and not entirely dependent on sponsored participants. Further statistics on the side demonstrate the profile of these users, work and home access is measured and both are significant, other significant indicators are education and or wether the users are male or female.

These users are likely to be in paid work and implementing OpenMRS in their own contexts, hospitals or clinics, according to the key informant interview with Chris Seebregts:

The OpenMRS community is also expanding very significantly in Africa because of the sponsorship of nodes by IDRC, despite this these are not in the top 5 users categories that get mentioned on the alexia web traffic counter. African participation remains negligible. However, Seebregts referred to the role of the sponsor and funding from the IDRC as stimulating in general the growth of the OpenMRS community through the annual implementers and users meeting. He mentioned that two Ugandan programmers, Daniel Kayiwa and Nicholas Musinguzi, had received support to attend the OpenMRS meetings and since then have been active users and producers of applicatons software even though they were not members of any of the OASIS nodes where funded implementations were taking place. The implementers at Makarere University, Uganda, were working on a sister project of OASIS making the link to mobile phones for OpenMRS. Seebregts pointed out there was very likely a significant number of other programmers who came to the meetings, and were using the software but were not sponsored.

One approach that the OASIS project attempted to use to diffuse the software and stimulate interest in Africa was an African response to the Google Summer of Code sponsorship of OpenMRS in the US. As mentioned in the findings under the first question, participants were moonlighting to make more money with the internship program and were unable to finish the work, the certainly did not take time off and were less likely to have computers and connectivity at home to program during their spare time. This attempt failed in Africa.

> "I think we should try to understand why the OpenMRS Internship Program (like the Southern Summer of Code) was not as successful as originally envisaged. Although we attracted significant interest in the program, it is likely that the programming barrier is too high for many African developers working in isolation to

> overcome in order to become productive within the context of OpenMRS. This reflects the mostly low level of basic Java skills as curricula lag behind in Africa's computer science schools. The most significant development is around hubs like the University of KwaZulu-Natal in South Africa and Makarere University in Uganda," explained Seebregts.

Apart from the obvious successes and momentum of the growing network of the OpenMRS network and its open architecture network in Africa which is also expanding to Asia, the high levels downloads of the OpenMRS code globally suggests that the growing number of users find the OSS useful and are solving problems and possibly developing modules for local use. In Mozambique, the mortality register was adopted by the Ministry and was being implemented in all the provinces. The Centres for Diseases Control, a US agency, has committed funding to the project over and above the initial grant from the IDRC for implementing the new mortality register in the provinces.

4.2. How does learning take place in OSS organisations in this African context?

While the interest in the above section was to understand, at the level of the individual, what motivates participation and how through the institutions and norms that govern OSS those motives continue to provide incentive for participation in the OSS project, this next section will investigate the way in which OSS is organised. Based on this the study will present the findings in relation to the theory regarding peer support and 1) mutual learning in OSS, that is strengthened by 2) trust building through face-to-face communications with the global team; and the 3) modular organisation of tasks in the OSS which should lead to local adaptations and customisation.

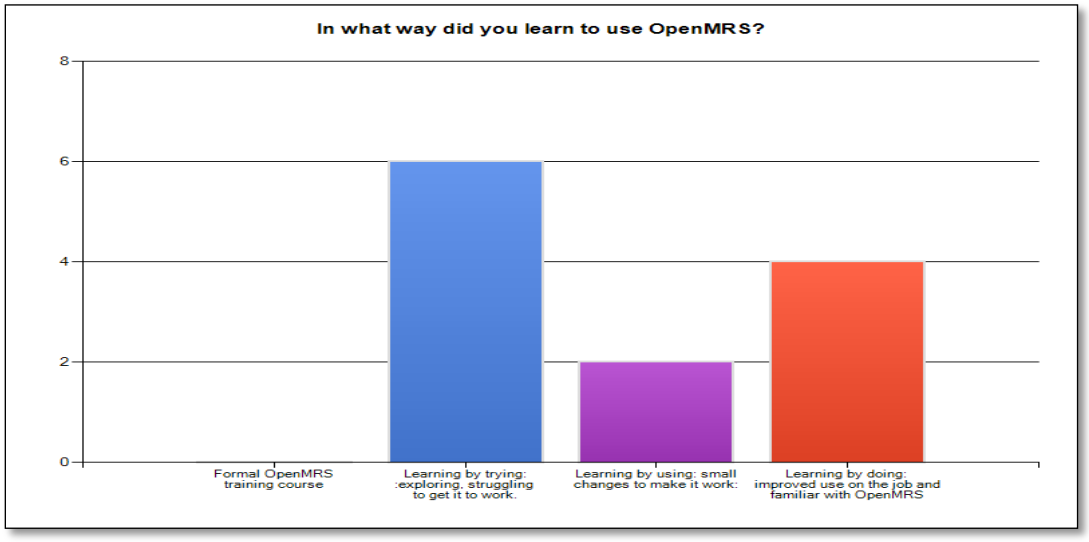
Three forms of interaction amongst the Mozambique, South Africa nodes and the core code writing team in the US were researched. These were

- The annual OpenMRS Implementers meetings which are the face-to-face contact and assistance'
- Email and instant messaging communication were used for ongoing user-to-user support.

4.2.1. Do the modular OSS tasks for local implementation and customisation create opportunities for Africans to participate in OSS?

The government of Mozambique has a science and technology policy linking innovation to poverty alleviation in which ICTs play a crucial role ((Campbell, 29 Oct 2008)) The country's commitment to developing its human resources is evident from the trend set in the previous decade of 1987-97 when 42% of all students enrolled for college and university were science and engineering students. However, the Mozambican respondents to the survey had had no formal training in OpenMRS. They had been exposed to the software at the annual meetings and by being commissioned by the node's project leader, José Leopoldo Nhamposa, to develop a death registry based on OpenMRS. Four of the five Mozambican respondents implementers responded that the way in which they learned to work with the new software was by learning by trying and exploring by struggling to get it work. Only one of these respondents was using small changes that they had applied, and the three strongest contributors at the Mozambique node, Moz Programmer 3, Moz Programmer 4 and Moz Programmer 2 said that they were "learning by doing" the implementations on the job. The three implementers from the South Africa node all responded they learned by doing, but the one implementer who seemed most accomplished, who had been a mentor to other students in the grant competition, and who had developed several modules, including one that was in general use globally, reported that he learned by "trying, using and doing".

Figure 8 How did you learn to use OpenMRS? n=8



Source: SurveyMonkey Analysis tool

The OASIS project has also focused on developing and implementing selected software applications for public health systems in which the overarching goal is to develop modular and interoperable applications that can be applied in various infrastructure settings. Examples of this are the use of mobile phones for data collection or, where systems are not internet dependent but are enabled to synchronize when connections are recovered in unstable power systems. The applications also address small to large scale implementation. These may be either patient-based or interoperable with facilities based information systems such as the District Health Information System, developed in open source by HISP, and able to deliver patient management, aggregated data and indicator repositories supporting district management, and national monitoring and evaluation. (J. Braa et al., 2010 (forthcoming)) Emulating the Google Summer of Code (http://code.google.com/soc/) model in which Google sponsored and stimulated

new programmers to develop software, the OASIS project aimed to apply this to developing countries

The modular tasks that are created by these challenges make it possible for programmers to select and even compete to work on a particular module. Others are developing program solutions through adaptation of the programs for their own contexts, and will be discussed in 4.4.

4.2.2. Is there strong leadership and governance in the OpenMRS leadership and small core team for governance of the code?

The challenges set both in the OpenMRS Internship Program, the meetings where hack-a-thons are encouraged to create collaborative problem solving amongst peers from different countries, as well the small distributed governance structure of the OpenMRS that manages the organisation and approves new releases is evidence of the leadership within the OSS project.

The Internship Program offered successful applicants a stipend to free up time to work on an approved OpenMRS project. It was modelled on the Google Summer of Code, a prestigious award that Google provided to the OpenMRS founders and is awarded annually to innovative OSS projects. The Google Summer of Code, as it implies, is an award for students during the summer months in the North, and attracts mainly students from developed countries. The benefit from the bursary of between US$3 000 and $10 000 is based on the defined challenges prescribed by the OpenMRS project. The bidders would present proposals and on acceptance would be supervised by one of the OpenMRS mentors or developers. The idea with part of the IDRC funding was to leverage the same kind of contribution from developing countries. For various reasons. In

the north these were generally students who could At least one student from the South African node was nominated as a mentor, suggesting a high level of supervisory capacity in software production.

The project did not prove successful as only nine of the 20 awards were made and only 2 interns successfully completed the project. "The rest of the interns either withdrew from the program or didn't reach the mid- point evaluation. We found that many of the interns did not give up their day job or treat the OIP [internship program] as a vacation project. The low success rate probably reflects the fact that a number of interns viewed the OIP as an opportunity to secure a second income and underestimated the requirements to complete the project successfully," (Seebregts, 2008c)

Another important finding about the governance and leadership of the OpenMRs project is that decisions to incorporate adaptations to the trunk code are managed by stringent requirements by the core group of programmers in the US and the governing body which includes Seebregts from Africa. When the African nodes were established the expectation was that African computer programmers would implement and adapt existing code for local use, but not contribute back to the core. This governance of the core is consistent with the view that OSS programmers do not give away their rights, only their code into the public domain (O'Mahony, 2003). The fact that one of the South African computer programmers managed to produce code that was accepted into the core was an unexpected positive outcome.

The OpenMRS core governing team is small, (Burke Mamlin, Paul Biondich, Hamish Fraser and Chris Seebregts, and a representative from the WHO, Chistopher Bailey). There is a core group of developers is based at Regenstrief, Indiana and PIH, Boston.

They hold weekly conference calls; administer a mailing list; wiki site and project tracking to manage the collaboration. (ibid)

The Open Medical Records Systems (OpenMRS) "implementers network" was established with IDRC's support. The idea behind the meetings was to establish the African community, but the participants extended from across the globe and especially always include the initial core group of OpenMRS computer programmers.

4.2.3. Does the collaborative working model of OSS encourage novice learning in the African context?

In the first focus group discussion of the Mozambican students, which took place just after their node was established, several of the students complained that there was insufficient documentation to guide the uninitiated user for starting OpenMRS. As a baseline the following reports the opinions of the Mozambican implementers three weeks after they had installed their laboratory and four months after the Durban meeting where three implementers had worked on their honours project with Carl and the South African students. In a group discussion with six honours students at the Mozambique OASIS node, which took place a few weeks after the laboratory was opened, one of the students, who had been to the Durban 2008 meeting said: "Although OpenMRS is open Carl had to come here to teach us, otherwise we would not have learned by ourselves. It is a complex system for the end user." Yet, he believed the software was "extremely customisable" and "OSS is a good way to develop a kind of solution, such as the death registry for the Ministry of Health, but we can take a lot of time developing it with open source tools. It takes too long. My suggestion is to talk about open source at school, teach it at the university, afterwards we can use it."

Another Mozambique student explained what they do when they have a problem: "First thing is to communicate with the OpenMRS developers (in the United States). We are on line here (at the university), we mail them and they answer back. The first time it took just 20 minutes. They had no solution, as they had not encountered that problem before. Some other guys had the same problem and had not yet solved it."

A third Mozambican respondent said he was more comfortable working in .php which had a large software community and ample documentation to troubleshoot. However, the OpenMRS OSS project was a small community that had not yet created online tutorials or guidelines. The honours student project that they had started four months earlier in Durban at hack-a-thon 4 was not yet completed. They had not yet achieved all their goals.

It is important to note that I administered a questionnaire nine months later to these students in Mozambique in October 2009 and by then they had undertaken the translation of the OpenMRS implementation guidelines into Portuguese. This indicates their effort to make OpenMRS locally approporiable. They ended up developing the death registry in software they were trained it at university, however, their knowledge of health informatics had been greatly improved because of the data model and use of standards in OpenMRS which they applied in their own VB.net solution.

The same questionnaire was administered amongst the South African node students. Three of the five developers fully completed the survey. The South African implementers were programming exclusively in Java; whereas, the Mozambique team was coding in a variety of software languages, suggesting they were working on various software projects. At least one of the South African computer programmers communicated with

OpenMRS developers outside of Africa using an instant messaging tool, another social networking tool free to internet users and dedicated to OSS programmers at "#openmrs IRC channel at freenode.net" (http://freenode.net/pdpc.shtml) which is an instant messaging channel dedicated to OSS programmers. Responding to whether they had tested or commented on others software, one of the programmers worked as a mentor in the Google Summer of Code for the OpenMRS-OASIS team. When asked if the Mozambique and South African students tested each others work and helped with debugging there were several responses to suggest that this kind of collaboration was common place.

Three of the respondents answered that when they sent an email to the listserv they were helped in solving their implementation problems. The results were "a working product" and "to find out new ways of facing and working around similar problems." When asked to name the people on the listserv that helped, the names revealed that some of the developers ask their fellow Mozambican students, others were getting responses from Carl, the OASIS coordinator in South Africa, while three developers indicated they were interacting with the core software developers in the USA. Node Developer 1, who had previously complained of a lack of documentation, in this survey stated: "This year's OpenMRS Hack-a-thon and conference was very helpful. Justin and Ben from OpenMRS gave us good tutorials on OpenMRS development."

When asked if there were individuals amongst the US-based developers or elsewhere that were helpful in solving problems, several names recurred. These names were used to map the social network.

In an effort to triangulate the survey and focus group discussions I turned to email archives to find evidence of these emerging relationships between the young African computer programmers and the founding core programmers. It must be pointed out that the African students surveyed had completed their first degree and were working on honours degrees. The OpenMRS was serving as their applied research project for which they had had no formal training. Open Source Software development was not specifically taught in their under-graduate curricula. As discussed above, the meetings presented them in places of familiarisation with developers in the network and the email listserv was in regular use following the meetings to get further problem solving support.

This support for the Mozambicans came from programmers with whom they had developed relationships during the set up of the FOSSIL node in Maputo. Carl Fourie, a Masters student and coordinator for the students at KwaZulu Natal, who was eventually appointed managing director of the Jembi NGO start-up that would host OpenMRS implementations in Africa. Carl spent three months in the field and in Maputo working with the University of Edouardo Mondlane students. He considered himself a "fire starter" after spending a month in Mozambique to support the implementation of the MOASIS node with training and physically helping to install the computers. This familiarisation with the students is evident in that he was cited as a regular support to a few of the Mozambican students. However, others cited the key developers from the US whom they had met at the OpenMRS meeting in 2009 and were mentors and helped. At least one of the Mozambican implementers regularly participated in the OpenMRS listserv to request help and all of the South African respondents said they were helped

when sending queries for assistance to the list. These emails demonstrate the transfer of knowledge to assist with the local adaption and for the implementer.

According to the response to the survey questionnaire, the Mozambican team was also developing a MOASIS Bulk Concept Object. One of the other Mozambicns said in the survey "This year's OpenMRS hack-a-thon and conference was very helpful. Justin and Ben from OpenMRS gave us good tutorials on OpenMRS development."

The following extracts from emails on the OpenMRS list serv demonstrate how the African students were receiving "free user-to-user support" from the US-based core programmers discussing whether a module version was backward compatible, coming from a student in Mozambique with a response from one of the Indiana University programmers laying out a "road map" of future upgrades and that these will be made compatible with previous versions (see Appendix 5) In reponse to a problem encountered with one of the application features posted to the email list by the one Mozambican that regularly posts questions to the list serv, a response comes from one of the core code writer in the US, saying: "The find patient widget occasionally fails to load for me, on my laptop. Reloading the page, or doing a shift-reload solves this. I haven't seen the issue in production." Yet another exchange signifies the efforts by one of the Mozambique team members to adapt the OpenMRS into Portuguese, the *lingua franca* in Mozambique. A US-based core coder responds: "Wow, strong work …." and with some debugging assistance.

Two Mozabican respondents to the survey mention help they got at the 2009 OpenMRS implementers meeting in Cape Town mentioning the names of two founding members of OpenMRS OSS. It is worth noting that this was the second or third

OpenMRS Implementers meeting that these students had been to suggesting that the process of familiarisation for adapting code for local use a) takes time, b) required several face-to-face meetings to develop confidence and trust before locally relevant adaptations are made, and finally c) benefit from the relationship established to get free user-to-user and ongoing assistance for debugging.

4.2.4. Do face-to-face meetings promote trust for the use, reuse and diffusion of OSS in African context?

A large part of the project budget was being allocated to the annual OpenMRS meetings and it was one of my concerns to find out the value of these meetings, and whether as a funder there was any evidence to suggest that these meetings were necessary for expanding the community of OSS programmers to Africa. There was another initiative, which was less planned and more direct in its assistance to establishing a node in Mozambique which I will first discuss.

The direct assistance in getting the node started in Mozambique was important. Carl Fourie, the Jembi coordinator, rolled up his sleeves and helped move books and install computers at the university in Maputo. He also used problem solving and group tasks to get the team in Maputo started on downloading the software. He was particularly interested to see which of the Mozambican node implementers would take on the leadership and several of the challenges and tasks he set would help him define the “lone cowboys” who were excellent software developers, but worked on their own. Others would emerge from the tasks as team leaders who kept record of tasks to be done and demonstrated coordination skills. Carl described himself as a “fire starter”. He employed a range of team building activities, including training through problem solving. By using

various facilitation methods, he created an *esprit de corps*. The contact with Carl, was able to integrate the new team , was not the key factor to keep the Mozambique implementers interactions

In my own gathering of data I observed and wrote an ethnographic sketch of one of the hack-a-thon activities during an OpenMRS implementers meeting in Durban, July 2008 (Appendix 3). At the beginning of the annual meetings, there is a call for implementing challenges and a task is set to solve the problem in the five days that the meetings in Africa take place. Relationships can be struck between African implementers, other Africans, other implementers from developing countries and foreign experts. These challenges can result in many hour of late night oil being burned, an opportunity for programmers to work collectively in problem solving, and a relationship building exercise. This behaviour is a demonstration of altruism, voluntarism, and signalling of expertise that much of the literature ascribes to the OSS movement, is evident in the gatherings of the OpenMRS meetings.

As a funder I continued to want more evidence that the investment into the meetings had lasting effects beyond the bonhomie of the retreat. The meetings were the starting point of several phases of project funding, and evidence that the IDRC was prepared to invest in networking or community building, a risk that need not necessarily pay off. However, the key proponents of the OpenMRS project aimed to achieve their initial objective which was to diffuse the use of OpenMRS in Africa and to find African computer programmers who would be interested in using the OSS approach.

My data from the 2008 meeting gives evidence of the relationships between the two universities, University Edouardo Mondlane (UEM) and the University of KwaZulu

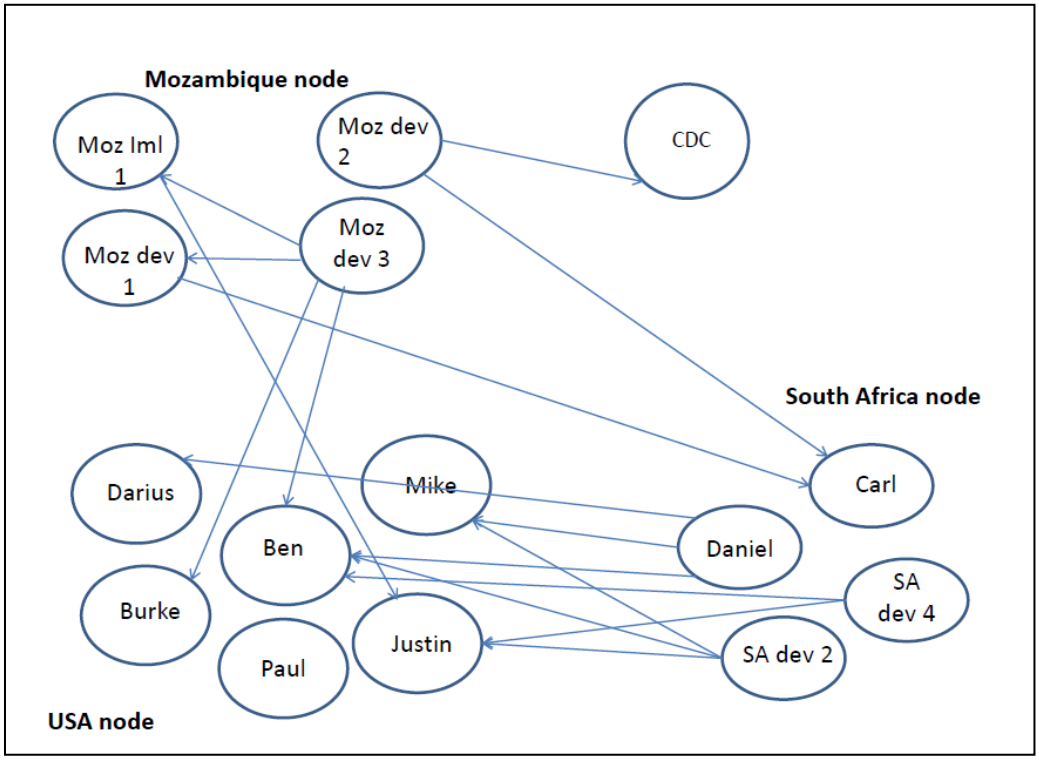
Natal (UKZN). The UEM team posted the challenge of migrating data for the Ministry of Health in Mozambique, with NGO Jembi facilitating the meeting. The volunteers included code-writing expertise of the US Centres for Disease Control (which would, in 2010, fund the roll-out of the mortality register developed by the UEM team), another OSS expert from the Van der Bilt University, which has a health information systems development for Zambezia Province in Mozambique. This private-public collaboration suggest that there is a role for the publically funded universities to solve societal problems using OSS (von Hippel & von Krogh, 2003).

However, based on the text analysis of the email exchanges on the OpenMRS list serve (see 4.2.3) I also concluded that some programmers in the African context were more confident to participate in the online discussions, for a host of reasons that could be further researched, to ask questions on the list serve and get customised user support. The assumption is that based on these relationships, the implementers, once back in their home organisations, follow-up with email requests for help and for testing, as described in the social network map which was drawn after the following implementers meeting of 2009 in Cape Town. This map is intended to demonstrate the kinds of relationships that have resulted in the "The OSS approach, leveraging the complementary assets from other organisations (Dahlander & Wallin, 2006) at both the international and local levels in order to solve problems and provide user-to-user support, transfers knowledge capital to improve productivity.

I used the Social Network Analysis tools to visualise the relationship between the different computer programmers in Mozambique, South Africa and the United States. These are in no way a representation of all OpenMRS interrelationships, just a

representation based on the question on the survey to the Mozambique and South African students which asked: “Who helped you solve the problem?”

Figure 9 Social Network Analysis of the Mozambique, South Africa and US node



As can be seen from the social network analysis visualisation, and for which I have permission from all the people named to use their names demonstrates the connectedness and from where the support comes in this decentralised users and programmers group.

The Mozambican team consulted each other to solve problems while implementing and customising their OSS modules for local use. They also benefited from a modular program developer challenge at one of the OpenMRS implementers’ and users’ meetings. A call to solve a local computing problem at one of the face-to-face meetings brought code writers from South Africa and the US together to volunteer some code to give them a head-start.

This physical meeting can translate into trusting relationships which are enduring and create the cross-organisational and firm relationship to strengthen this open innovation. As pointed out by West and O'Mahony (2005) sponsored community projects are different from those that are programmer-community-initiated. Sponsored projects need to build a community and incorporate external contributions to improve system quality.

The sub-node affiliations, mapped out above in the social network, suggest that some implementers are more comfortable asking for help to solve their coding problems from the core code writers of OpenMRS based in the USA who they had met at the meetings. This was their second and third meetings where these contacts were made. The time that it took to become familiar could be related to confidence levels and language issues. The survey questionnaire asked respondents to name the people they received help from on the listserv. The social map in Figure 14 (above) represents their responses. It is worth noting that the respondents also mentioned the support they got from their compatriots or from Carl Fourie, the Jembi manager in South Africa.

The regular meetings have proven to be an important trust building and networking opportunity of OpenMRS developers, implementers and users. The personal assistance and support provided by the core developers to the Mozambican and South African implementers enabled them to continue requesting support or participating in discussions related to their implementation challenges across national boundaries and continents. According to the survey respondents, the meeting is an important hub that facilitates the developing countries' participation. There is a cost attached to this type of participation though as either international donors need to fund this kind of networking in order to establish the relationships required for ongoing user-to-user assistance, and user

assistance. Communication after the meetings takes place either via the email listserv or instant messaging. Instant messaging via the open source software channel on the internet was in use amongst the South African developers communicating between Cape Town and Durban.

The benefits described above in trust building through face-to-face meetings overcame the isolation that these African students experience as they develop their skills and confidence to participate in the global OSS network. Moreover, the use and re-use, adaptation and problem solving approaches, including localising the software for use in Portuguese, suggests that the innovation and diffusion (innofusion, as discussed in the literature survey) contributed to their growth in knowledge and development. Through their own personal and public contribution, they paid the marginal cost of being able to join the global OSS community, through access costs to the internet and obtaining a level of skills to participate, this quasi-public good nevertheless could be leveraged to create a pure public good for their countries health services. They have contributed to local and global public goods. The OSS approach is therefore a relevant approach to overcome developmental asymmetries, improve the private benefits of knowledge and job opportunities for the students as well as contribute to public goods.

There have been local adaptations that are being used in Mozambique and in South Africa at one provincial hospital implementation produced from OSS, for local use. As defined in 2.1.3this is a local public good with positive externalities. The Mozambican students were working half in the legacy proprietary system, Visual Basic, and half in MySQL an OSS database. They intend to transfer the Visual Basic to Java. The Ministry of Health in Mozambique has accepted the mortality register that was piloted in the

Maputo Central Hospital. It has commissioned the FOSSILab at the university to implement the program in all 10 provinces. The US-based CDC has undertaken to fund the work.

The potential that at least some code developed by a South African student has developed the "html form entry program" that will likely be committed to the core code confirms the finding of the North American and Swedish MSc student (Dahlander & McKelvey, 2005) and the Brazilian survey, namely that few of the code writers commit code back to the global OSS resource (Camara & Fonseca, 2007). It is conceivable that the Portuguese translation undertaken by a developer in Mozambique of terms in the OpenMRS dictionary will also be used at a global level. However, the productivity gains in the example mentioned will lessen the reliance on a proprietary piece of software that OpenMRS users across the world will enjoy these productivity gains and contribution to economic growth. (Garzarelli et al., 2008). However, it is worth noting that in the African developers nodes researched, this was an exception and the outcome of a considerable development focus through the IDRC international donor sponsored laboratory at the University of KwaZulu Natal and an internationally sponsored Google competition. The student in question was also emphatic that he needed to be paid to do the work and could not afford to volunteer his time. The hypothesis I posed is validated. It should be emphasised that these productivity gains in a global sense are contributions to improved productivity from developing country to other developing countries and/or more developed countries as will be seen from rankings in the following section.

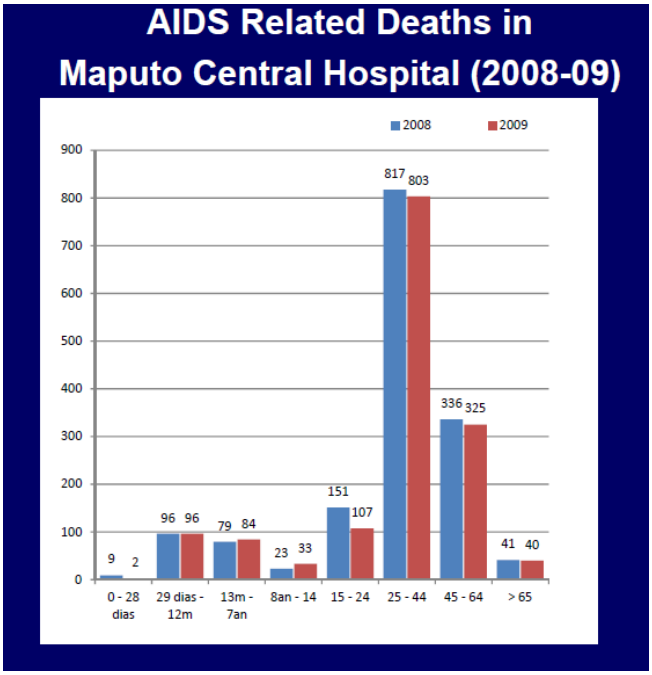
4.3. How does OSS contribute to improved information systems and, therefore, socio-economic development at the level of the state?

In this section I will discuss the impacts on state in a developing country that are observable based on the Mozambique OASIS team's contribution to improved health information. This is the third level of analysis, as laid out in the ICTs-for-development value-chain heuristic, namely the development impact described as the contribution of ICTs to broader development goals (Heeks, 2010). I overviewed the role of information in general and health informatics in particular in the literature review, referring to the cost of these systems to developing states and donors, as well as the opportunity costs as capabilities could be built locally but not with bespoke systems. The most important of the impacts however would be if the state were able to achieve a level of coordination and provisioning of services that are responsive to local needs. I will investigate and present the findings in this light.

In Mozambique, the intention to establish the computer programming node at the university was to develop local human resources that would be able to work on information systems challenges that the Ministry of Health had identified. Until 2009 the Ministry employed an expatriate from Europe who was responsible for all the computer programming required to aggregate the data collected on several paper-based survey forms from district and provincial health units. At the time that the MOASIS project started the students were set the task of developing a death registry for the central hospital in Maputo, it would become the first collation of vital statistics at the country's main hospital, one of the most important ways of measuring mortality as most countries rely on population registration statistics not disaggregated to the point of care. After successfully implementing the development of the death registry at the main hospital, the Ministry of Health was so satisfied by the output that it declared this as a standard for the country and commissioned the MOASIS node to install it all of the 80 provincial hospitals across the country. The graph in Figure 10 below is amongst the first indicators

produced by the MOASIS team. The spike in deaths of people aged 25-44 years provides health management information that is important for the Ministry but also for the continued funding of the anti-retroviral treatment supported by the US government's Pepfar and managed by CDC in Mozambique.

Figure 10: Mortaility statistics for the Central Hospital in Maputo: Database developed by the MOASIS team 2009



The students' time for developing, maintaining and expanding the system, piloted by the MOASIS project, continues to be supported by the project funds, however, the Ministry has taken on the cost of transport and the equipment for the implementation and the five students at the UEM node. The students spend four days out of five working at the Ministry offices, or travelling to field implementations in the provinces, as well as user training employees and trouble shooting. By 2010 the Ministry's two technical staff members had started working with the MOASIS team. A significant finding concerning the basic level of skills that the OpenMRS

workshop attendants responded, there were 27% Africans had advanced software programming skills and were able to adapt software to the local context. (see figure 4 of Level 7 skills, section).

Meanwhile, the Ministry of Health announced that the MOASIS node would become the country's e-Health Centre of Excellence. This is further facilitated by the Centres for Disease Control, the US based presence that has a presence in Mozambique and manages the PEPFAR funding, which is paying for a coordinator, a retired Ministry of Health senior civil servant with 30 years of experience in the ministry's administration of information. The CDC has also committed half of the time of one of its physicians to the MOASIS node and is negotiating office space close to the Ministry's downtown offices for their occupancy. See email communication from Dr. Alessandro Campione, Global AIDS Program Mozambique, US Centers for Disease Control and Prevention and the Mozambique Ministry of Health (Appendix 6). In terms of the ICTs-for-development value chain, these outputs and outcomes can be attributed to development impacts based on the use of applications adapted. The mortality indicators are the outputs that incorporated new information to inform decision-making. The Ministry's decision to implement the system county wide and the CDC's commitment of resources are evidence of quantifiable outcomes to address a burden of disease in the country. It is too early to measure the contribution this might make to the attainment of public goals such as those contained in the Millennium Development Goals, however, the course has been set and the indicators are being collected to ensure some perspective on this in the not too distant future.

The next phase will be to develop other instruments to collect data on morbidity, or the cause of death. This next phase could involve the implementation of an electronic medical records system. At the time this project started the Ministry was in the market for procuring a

health information system. It has now seen that there are locally human resources that can help it in procuring a system, adapting or developing it in a modular step-wise fashion.

Nhamposa, in a key witness interview, who has been an advisor to the Ministry over the past six years, explained that the technology choices were not material to the Ministry, because it was more interested in the results then how the results were achieved.

> "But, I think we convinced them that there are people locally available to learn about the problems and solutions and to do something about it. They (the Ministry) need to cultivate these human resources. These students are now important experts, they understand the Ministry's organisational problems, they participate in the internal meetings, and in the nitty-gritty of the Ministry -- sometimes they find it boring -- but they are discovering the linkages between technology and people," Nhamposa.

The challenges to the Ministry are longer-term: It would decide on future investment in the project and commit budget to it. The role of development funding is to model behaviours that might be useful for developing country's to adopt and in order to integrate functions of this nature the Ministry would have to create a new category of jobs for the new graduates, or a plan to make provision for procuring these services as private provisioning of this service to strengthen the health service (Besley & Ghatak, 2004). The choice of OSS or Proprietary software is at this stage not a felt need, although the Ministry had not yet calculated what a proprietary software system would cost. Nhamposa felt that the country's health information requirement needs were not unique and that the country needed a system that would also integrate the ministry's human resources, finances, planning and so on. In his opinion "the short man" can stand on the "tall man's shoulders" to see the world. New software does not need to be developed for Mozambique's needs, just adapted for local use in other words. He felt that there were likely applications that had been developed for these purposes that the newly developed

expertise of the student's could be engaged in to adapt for local use. By his involvement in the research project and by engaging the graduate students, Nhamposa felt that the university did public-service relevant research and that the public benefited from developing young students to enter careers in ICTs.

> "Previously we did not have people who could help select those tools. We can procure but we need to have eyes and the knowledge to adapt the systems we get, this is work that can take two weeks, two years or 20 years."

Mozambique is the largest recipient of Pepfar funding and the US agency CDC's involvement in MOASIS demonstrates the value of the project for its purposes of reporting on and justifying the continuation of its foreign aid. Mozambicans benefits from this as well, but at this stage the health outcomes from improved information for the HIV/AIDS treatment with anti-retroviral treatment is not available but clearly would demonstrate health outcomes that contribute towards development impact.

Chapter 5: Conclusion: Does OSS contribute to development?

In this final chapter, I will address this study's overarching research question – does OSS contribute to socio-economic development? I will also provide synthesized responses to this study's three sub-questions, which explore three different levels with synthesis of the three different questions as the levels of the individual, the organisation, and the state.

First I will be exploring in this concluding chapter whether the findings in the African case study confirm or falsify the dominant literature view of OSS as a pure public good (Lerner & Tirole, 2000; Bessen, 2005; Bitzer, 2007), or whether in the African context the OSS was rivalrous (O'Mahony, 2003) and/or excludable (Garzarelli, 2004). I will also synthesise the motivations that were important for African OSS programmers to produce, and to contribute their code back to the core (Dahlander & Mckelvey, 2005; Subramanyam & Xia, 2008). Within the context of this public good, is there a role for the sponsor (West & O'Mahony, 2005a; West & O'Mahony, 2008) I will synthesise under the second question whether the way in which OSS is organised resulted in learning for the African programmers (Titlestad et al., 2009). Finally, I will investigate if the software was put to use and whether it contributed to the development impact of linking information with the coordination of improved government and services to the poor (Keefer & Khemani, Feb 28 2004)

I will conclude with the overarching question of whether OSS contributes to socio-economic development or development impact (Heeks, 2010). As I synthesise the findings I will also highlight areas of limitations of my findings, and areas for further study. I will also reflect on the contribution of these findings to the fields of OSS economics, OSS organisation and information in the political economy of developing countries.

5.1 Question 1 : Is OSS a pure public good in the developing world context?

This case study investigated the dominant theories of OSS as a public good in order to determine if these theories sufficiently take into consideration developing country contexts. To explore this question I first explored the South African and Mozambican programmers' motivations for participating in the development of OSS, which can be seen as the private-provisioning of a public good. Then, given this understanding, I explored whether the economic theory of public goods, which understands OSS to be a non-deletable and a non-excludable good applies in a developing country context.

Is OSS a non-rivalrous and non-excludable and therefore a pure public good in the African context or does the production suffer from the undersupply of this privately produced public good or are there other motivations for production? Will it be sustained? Is there a role for the sponsor? What limitations are there to the finding? What about future study? How does this study contribute to the field of economics?

The dominant economic paradigm, that OSS is a pure public good, was falsified in the African case study. The most significant finding from the study was that the computer programmers were motivated by extrinsic motivation -- to earn an income – to consume the free software in order to locally appropriate the software for use in the African context. This is in line with the emergent paradigm of OSS (Dahlander & Wallin, 2006) and corroborates other findings in India and China that computer programmers wish to command high incomes for their expertise (Subramanyam & Xia, 2008). My study did not set out to quantify these incomes or the contribution of the software industry to the national economies, but further study would be required to establish just how high the demand for these skills in the African context is. The case study however does demonstrate that the service sector in African is growing and that OSS can

contribute to it in the developing country context (UNCTAD, 2003). Quantifying this would be important for future study.

My study also did not reveal the shortage of jobs, or the levels of pay they could have commanded in the public or private sectors, but we had some qualifications of the Mozamican student earning capacity: the project needed to secure their involvement with income because they could have gone to the private sector with their Bachelor degrees – far lower qualifications to be doing these jobs than their developed country counterparts (Dahlander & McKelvey, 2006). The public sector jobs they could command would not provide the income levels they demanded. The public sector pay scales did not reflect their worth and no signalling would help change this without the public service policy for employing computer programming and analysis skills being dramatically changed. Governments in Africa will have to dramatically change their public service job categories in order to recruit and retain computer and information scientists in order to improve the public services that depend on improved information for service delivery. Alternatively, provision should be made for the procurement of these skills and services from the Mozambique private or non-profit sector. The demand in the private sector to produce software skills is unknown in Mozambique, a study which could quantify this productive capacity would help identify an emerging sector in the Mozambique economy, as well as the South African economy. This could contribute to the field of identifying the drivers of economic growth in the country.

A study like that in the hands of the OECD or UNCTAD, or the development banks in Africa, could help influence policy related to investment in these productive sectors. The implications could relate to the level of support given to universities to strengthen their software engineering courses with OSS curriculum or in general; it could influence the public and private

grants to universities and might strengthen the interaction between universities in the private sector in strengthening the national innovation system; it could influence the public sector promotion of the software industry; it could affect the public procurement procedures to favour local expertise and software production; We learned that in their project-paid jobs, the Mozambican software engineers were probably earning close to or more than doctors employed by the Ministry of Health. Any one of these public policy outcomes could result in significant socio-economic impacts for the country.

The Mozambique team's decision to program in software that they were more familiar with under the pressure of time to deliver a death registry for the Ministry compared with their South African counterparts who were motivated to struggle and learn how to use the OSS code of OpenMRS cannot be quantified. This study did not, however, undertake a cost-benefit analysis of the use of OSS in the public sector, nor a comparison of OSS versus the implications of choosing a proprietary system, as the Mozambique team has done. Furthermore, there is insufficient evidence to conclude that the license conditions chosen by OpenMRS would be more beneficial in the long run for industry in Mozambique, the intention is there to enable income from derivative modules. However, further research would be required to understand the benefits in the ICTs-for-development value chain related to local enterprises in Africa taking on the opportunity of creating the services and modules while ensuring that the core system code remains in the public domain. A study of this nature could also consider OSS contribution to economic growth. This kind of cost benefit analysis could be extremely significant for the countries.

From the point of view of the public health impact of improved information systems for the the Mozambique Ministry of Health its ability to mobilise more funds from the Pepfar

programme should be researched in the future in order to understand the contribution of these service improvements to the ultimate societal goals of improved health care. Further research is certainly required to track whether, through the OASIS project Mozambique can demonstrate that by 2015 it was able "to halt the spread of HIV/AIDS and begin to reverse the spread", one of the Millennium Development Goals. If ICTs-for-development can be shown to contribute to the attainment of these lofty societal goals, then projects like OASIS and MOASIS will have demonstrated how from the humble beginnings of this public good, learning and development have been able to contribute to fighting poverty and crippling disease. Creating the causal linkages between these factors will convince governments, funders and programmers alike of the societal impacts of their work.

Another significant finding is that the high cost of connectivity and the requirement for high levels of complex software development skills did not prove to render participation in OSS excludable. I have concluded that other studies of OSS in the developed world have made assumptions about the level of qualifications of the computer programmers and that the base qualifications of users in the developed world was considered to be a Masters of Science (Dahlander & Mckelvey, 2005). With lower levels of formal tertiary education the African students had clearly hold their own in the global world of OSS despite the limitations , and though connectivity at home could not be assumed, access to the Internet at the university and in the Ministry of Health, suggest once again that the motivations for participating in the production of software that these potential barriers to participation identified by Garzarelli (2004) in theorising that OSS is a club good, proved insignificant.

However, it is clear from the interests of the OpenMRS license conditions that the OSS is a commons good that requires strong protection and future income for protecting its public domain

as well creating derivative income opportunities and service opportunities. The idea of securing an income stream for OpenMRS and for its service providers opens a whole field of enquiry for future research and the role of these price mechanisms for maintaining the social production (Benkler, 2006) or the collective innovation (von Krogh & von Hippel, 2006) in the public sector universities not only in the developed North but also in the South.

The downstream retention of benefits from copyright are in my opinion more significant in indicating that the OSS indeed belongs to the impure public goods, but falls in the commons pool (O'Mahony, 2003). The code of the software can be used by anyone in the African context, it is non-excludable, but it is rivalrous in that its downstream derivatives are protected by copyright (ibid; (Gambardella & Hall, 2006)These benefits could result in better private benefits for the maintainers of the software (ibid & ibid), but they could also ensure that the commons pool of the software production remains in the hands of the state and its responsibility for improved health information management (World Health Organisation, 2008)These downstream longer-term benefits must also be researched in both from an economic perspective, from the health sector in order to discover is there are health outcomes that can be reported, and from the field of governance which is the political economy.

In order to answer the question of whether there is a role for the sponsor, the case study demonstrated that the contribution to creating a technical solutions that result in standardised software solutions for, in this instance, the health sector will result in network externalities later on, and should be researched in future studies. The role of the sponsor in developing an African community to initiate code has already yielded a return, namely Africans are contributing back to the global code. Sustaining and maintaining the sponsorship to ensure that both of these benefits continue would be difficult for one funder, but this role modelling has demonstrated that either

the public or the private sector could play this role. This future study is relevant from the economics of science and innovation and its impacts on society.

5.2 Question 2 - Learning

An important finding emerged from the analysis of the sponsor's role and relates to this study's second question, which focuses on the issue of the applied learning processes made possible when consumers of the OSS become producers. Based on the organisation in OSS this intrinsic motivation contributes to the development process. In relation to learning, it appears that the unconventional learning approaches, which in this particular context were supported by the sponsor, used in the OSS model are worth supporting. This finding emerged from the South African and Mozambican students' contributions to developing software applications that responded to local adaptation and were also in global demand. This point illustrates that the sponsorship of meetings, student stipends, and support that evolves through the trusted relationships is necessary, especially at the incubation phase of building a network of implementers and users in Africa. These resulted in innovative ways of learning, and diffusing the processes of the software production (Titlestad et al., 2009)particularly through the development of human networks that have both private and public benefits. The use of the OSS technologies and methods were necessary but not sufficient for building human capabilities able to solve African health information needs to improve the state.

The learning motivations for the Mozambican and South African computer programmers appeared to be a secondary motivation, however this study did not ask the respondents to rank the importance of income with earning, this is a limitation, and should certainly be studied in any future perspectives in this or other OSS projects in Africa and compared with even the programmers in other countries within the same network. It could yield interesting large sample

trend analysis of the importance of OSS as a learning organisation and could be studies from the field of organisational management or the economics of OSS.

The high levels of complex software capacity found in the sample of the Africans that participated in the OpenMRS meetings is also a surprising result which could be further researched to find out how representative they are of national populations and to what degree each of the African economies is potentially able to strengthen their service sectors with software production skills. This could indicate a shift in productive sectors and policy implications for developing countries in a globalised economy.

Evidence in the case study that South African and Mozambican programmers were fully prepared to donate their code to the public domain as long as they were paid to do the job has policy implications for countries that plan to use policy incentives. For the developing country programmers, they were extrinsicaly motivated to participate in OSS programming because of employment. This finding contrast with the standard paradigm that OSS is a pure public good, which reports that developed country programmers are intrinsically motivated to participate in OSS programming because of learning, sharing, and enjoyment. On the other hand, one of the positive public externalities and privately benefits from participating in the OSS project enabled Mozambican and South African computer programmers to benefit through learning and improving skills and motivation to be part of the production of complex tasks of software adaptation and production. Further study is required to establish on a larger scale the motivation of African OSS consumers and producers. However, the on-the-job learning experiences were authentic and has lead to experiential learning, and leverage of expertise in the developed world to solve local development problems in improving health services delivery.

The findings from my case study suggest that, although available for use, the Mozambican programmers chose software that will eventually result in the procurement of a license, thus they chose a product that is non-rivalrous when used for basic adaptation, but has a strong license that must be paid for as soon as the more advanced features for the product are required. The Mozambican Ministry of Health will eventually have to pay for the use of proprietary software. However, from this project, they learned how to apply the new knowledge of implementing a health system, which is a highly complex use of knowledge, standards, and software, -and this learning was achieved through the OpenMRS collaboration. It is, therefore, not only software that is diffused in this way but also knowledge and this knowledge can be conceptualized as a pure public good. The management of this knowledge in developing an interoperable standardised approach to health information management is more important than the technology used to produce analysed data. However, the computer programmer students in South Africa, from where there came a real contribution back to the core code and several other applications developed using OpenMRS. This suggests that there was no free riding which could result in the under-provisioning of the private good, but which as we saw above, builds network externalities for OSS diffusion.

In addition to exploring whether OSS is a non-deletable good – I questioned whether OSS is also a non-excludable, something which the literature in the dominant paradigm of economic theory also suggested about this phenomenon. Interesting, my findings appear to demonstrate that the computer programmers paid the price to participate in the developing country context. This means that they acquired the necessary level of education to become computer programmer. This education also allowed them to both produce software as well as have access to private or organisational level internet connectivity – at home, the university, or both locations, which

therefore illustrates that the issue of exclusion from OSS, particularly from lack of education and internet connectivity was not an issue in this particular context. These two components – education and internet connectivity - are the assumed qualifications of developed country OSS computer programmers; yet, these assumptions are very rarely made explicit by other observers. This study's findings illustrate that OSS, even in a developing country context is non-excludable, and that neither education and nor lack of internet access resulted in excludability.

Another concern throughout the research was whether the sponsors were playing a necessary role in supporting these computer programmers, specifically in terms of their learning experiences and, perhaps, most importantly, their salaries. A key focus in this area of the study was on what would happen if our funding was not replaced by other public sector funding to support the same initiative.

Another important conclusion is that the funder's role of expanding the community that initiates the software to include actors from developing countries appears to have been beneficial. There is a role for public policy and firms to take on this role of enabling and sponsoring OSS in developing countries.

5.3 Question 3 – State Development

Under this final section I will synthesis my conclusions about the state and how it has benefited form OSS as a public good, OSS as an organisation of learning, and improved information management. As discussed in the previous chapter, improved health data lead to improved mobilisation of international donor support of the public health sector. On a lesser scale, this case study illustrated that Africans can contribute to global development in OSS; can develop code that contributes to the core OSS and, thus, are not merely free riders. They are

capable of developing complex local adaptations that result in useful solutions to national developing problems such as improvement of health systems through improved management information and decision support. The improved health management information system illustrated in this case study could be shown to improve its management of resource allocation in line with the burden of disease in the country. It is important to note though, that the health outcomes from the health information system have yet to be demonstrated as these impacts will only be understood through research that has yet to evolve.

However, this finding is only indicative of areas for future study because the impacts of the improvements in the health service need to be mapped against improvements in the health system. As mentioned earlier, this creates room for understanding how OSS contributes to the MDG's. There is furthermore a branch of the economics of global public goods emerging, which is concerned with these grand narratives, such as climate change. The concepts of global public goods, the role of public funds and the importance of global and national information systems are emerging. This study did not even attempt to address these global issues, but indications suggest that there is a growing demand from national and global governance systems that seek greater clarity on the role of public and private resources and the global public good.

The overall question of this study, Does OSS contribute to socio-economic development? Can be answered in the affirmative. The study illustrated that there is the potential a software production sector in one two countries that represent the opposite poles of the African continent: Mozambique is a least developed country that has shown steady growth in the past few years, but is yet to define itself I the high tech industries, despite its aspirations. This case study seems to suggest that the country has the human capital to achieve economic growth. South Africa on the other hand is the most developed country on the African continent and can lead in demonstrating

that the software industry both as a productive sector as well as a service sector has great potential. Moreover, OSS can be harnessed as a formal and non-formal way of strengthening the skills of these professionals. Finally, OSS provides a greater spectrum of choice not only to the producers of the software but also the consumers, and that includes the public and private sectors. This then concludes my case study and analysis, that OSS provides an important contribution to Africa's development.

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Appendix 1: Questionnaire on OSS comptabilities in Africa

Based on Scale of Software Technological Capability (Grundey and Heeks, 1998:11)

Level 1. Non-production operational capabilities

- 1a: Using a system of menus
- 1b: Using a conventional package (e.g. word processor)
- 1c: Choosing a software package
- 1d: Training others to use software

Level 2: Non-production technical capabilities

- 2a: Filling a package with situation-specific data (e.g. spreadsheet)
- 2b: Filling a package with situation-specific data (e.g. database)
- 2c: Installing and troubleshooting software

Level 3: Basic production

- 3a: Making copies of an existing software product

Level 4: Adaptation without production

- 4a: Creating a situation-specific application from a package (e.g. creating menus and queries with simple programming; using macros; developing Web pages)

Level 5: Simple software production

- 5a: Creating a new set of interfaces for users
- 5b: Creating a program to move data between applications
- 5c: Creating a small utility program
- 5d: Modifying an existing program to meet user needs

Level 6: Software redesign

- 6a: Redesigning a program to meet local user needs
- 6b: Redesigning a program to meet regional/global user needs
- 6c: Minor process change: modifying the software production process

Level 7: Skilled software production

- 7a: Local product innovation: developing a new program to meet local user needs
- 7b: International product innovation: developing a new program to meet regional/global user needs
- 7c: Major process change: redesigning the software production process
- 7d: Process innovation: designing a completely new software production process

Questionnaire derived from the levels of software capabilities and administered anonymously on the OpenMRS website

Copy of FOSS capabilities Africa

1. Which option best describes your technical capabilities as a software user

	Response Percent	Response Count
Using system menus	9.8%	4
Using a conventional package (eg word processor)	2.4%	1
Choosing a software package	22.0%	9
Training others to use software	**65.9%**	**27**
answered question		41
skipped question		0

2. When using software, what best describes your capabilities:

	Response Percent	Response Count
Filling a package with situtation-specific data (eg spreadsheet)	4.9%	2
filling a package with situation-specific data (eg database)	19.5%	8
Installing and troubleshooting software	**75.6%**	**31**
answered question		41
skipped question		0

3. When choosing to use software, do you....

	Response Percent	Response Count
make copies of an existing software product	30.8%	12
create a situation-specific application (create menus, queries using with existing programming; using macro's developing web pages)	68.2%	27
answered question		39
skipped question		2

4. Have you ever produced software as....

	Response Percent	Response Count
local product innovation: developing a new program to meet local users needs	29.3%	12
International product innovation: developing a new program to meet regional/global user needs	31.7%	13
major process change: redesigning the software production process	4.9%	2
process innovation: designing a completely new software production process	9.8%	4
never produced software	19.5%	8
Other (please specify)	4.9%	2
answered question		41
skipped question		0

6. Are you involved in software production to.....

	Response Percent	Response Count
create a new set of interfaces for users	53.7%	22
creat a program to move data between applications	36.6%	15
create a small utility program	29.3%	12
modify an existing progra to meet user needs	58.6%	24
do not produce software	17.1%	7
answered question		41
skipped question		0

8. Do you ever redesign software to....

	Response Percent	Response Count
meet local user needs	62.5%	26
to meet regional/global user needs	47.5%	19
for minor process changes modify the software production process	30.0%	12
never redesign software	20.0%	8
answered question		40
skipped question		1

7. What best describes you in relation to OpenMRS....

	Response Percent	Response Count
a clinical user	3.0%	1
a manager and decision-maker	12.1%	4
a trainer	6.1%	2
an implementer to assist users	18.2%	6
an implementer adapting OpenMRS for local or international use	**24.2%**	**8**
a redesigner of OpneMRS for local or regional needs	18.2%	6
an OpenMRS software developer	18.2%	6
Other (please specify)		6
answered question		33
skipped question		8

8. When did you get involved with OpenMRS?

	Response Percent	Response Count
less than a year ago	**27.5%**	**11**
one year ago	25.0%	10
two years ago	12.5%	5
three years ago	17.5%	7
longer	15.0%	6
never	2.5%	1
answered question		40
skipped question		1

8. While your identity will remain anonymous for research purposes, indicate if you are prepared to do a follow-up questionnaire by providing your email address below.

	Response Percent	Response Count
Name:	100.0%	34
Company:	97.1%	33
City/Town:	94.1%	32
State:	52.9%	18
Country:	94.1%	32
Email Address:	91.2%	31
Phone Number:	76.5%	26
answered question		34
skipped question		7

Appendix 2. Questionnaire OpenMRS node learning and doing

OpenMRS node learning and doing

1. If you cannot answer the question in English can you help from someone to assist in the response? Si vous ne pouvez pas répondre à la question en anglais pouvez-vous aider par quelqu'un pour aider à la réponse?(google translate:-)

	Response Percent	Response Count
Oui / Sim	100.0%	8
Non / Não	12.5%	1
answered question		8
skipped question		0

2. In what way did you learn to use OpenMRS?

	Response Percent	Response Count
Formal OpenMRS training course	0.0%	0
Learning by trying: :exploring, struggling to get it to work.	76.0%	6
Learning by using: small changes to make it work:	25.0%	2
Learning by doing: improved use on the job and familiar with OpenMRS	50.0%	4
answered question		8
skipped question		0

OpenMRS node learning and doing

How important is it that this project is sponsored, in other words the project pays you to participate?		
	Response Percent	Response Count
Extremely important, I would not be able to do this work without being paid to do it.	50.0%	4
Important, but I could do it while doing something else, like working for another software company, the university or for MISAU.	50.0%	4
Less important. I would compete for a grant in order to keep on working on this project.	0.0%	0
Not important at all. I spend most of my time writing open source code and will participate in this project even if there was no pay.	0.0%	0
I would participate even if I were not paid to participate because I like developing Open Source software.	0.0%	0
answered question		8
skipped question		0

3. Which applications do you spend most of your time working in?

	Response Percent	Response Count
OpenMRS	12.5%	1
MySQL	12.5%	1
Java	50.0%	4
Apache Tomcat	0.0%	0
php	0.0%	0
model basico (proprietary)	0.0%	0
Other (please specify)	25.0%	2
answered question		8
skipped question		0

4. If you are working in OpenMRS and its applications how did you get help when you got stuck?

	Response Percent	Response Count
Asked someone at MOASIS FOSSIL	0.0%	0
Sent an email to the OpenMRS list.serv	83.3%	6
Contacted the following person	16.7%	1
Name the person		1
answered question		8
skipped question		2

5. Did you solve the problem?

	Response Percent	Response Count
Yes, someone here at my university gave me help.	0.0%	0
Yes, someone from the list.serv gave me help.	**100.0%**	**8**
Yes, without help from others.	0.0%	0
No, I have not yet solved the problem.	0.0%	0
answered question		8
skipped question		2

6. If you solved the problem, what was the result?

	Response Count
	3
answered question	3
skipped question	6

7. If not what is still needed to solve the problem?

	Response Percent	Response Count
Still waiting for someone to help me	0.0%	0
Still working on the problem	0.0%	0
Need more training	0.0%	0
Other (please specify)		0
answered question		0
skipped question		8

8. Name the people in the OASIS, and /or OpenMrs networks that have been the most helpful to you in achieving your goals.	
	Response Count
	7
answered question	7
skipped question	1

9. Have you commented on other developers trial code? Have you tested any and given responses?			
		Response Percent	Response Count
Yes, I have tested it and commented on it.		60.0%	4
No, I have not tested it.		60.0%	4
	Give reason for your answer.		7
	answered question		8
	skipped question		0

10. Have you tested any other applications developed by the OpenMRS group of developers from South Africa, Mozambique or the US?

	Response Percent	Response Count
Developers from	12.5%	1
South Africa	37.5%	3
Mozambique	12.5%	1
Zimbabwe	0.0%	0
Rwanda	0.0%	0
USA	25.0%	2
elsewhere	0.0%	0
Yes	25.0%	2
No	60.0%	4
If yes, name applications you have tested in OpenMRS		3
answered question		8
skipped question		0

11. Has your team developed any other applications in OpenMRS?

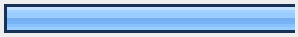
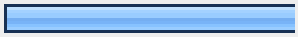
	Response Percent	Response Count
Yes	75.0%	6
No	25.0%	2
If yes, name the application and who developed it?	0.0%	0
Other (please specify)		2
answered question		8
skipped question		0

12. How easy or difficult do you find it is working in OpenMRS?

	Response Percent	Response Count
Very difficult	0.0%	0
Difficult	0.0%	0
Need help	50.0%	4
Working in OpenMRS	0.0%	0
OpenMRS developer	50.0%	4
answered question		8
skipped question		0

13. Do you require formal training in OpenMRS or any elements of the system, and which part in particular do you require formal training in?

	Response Percent	Response Count
Foundations:	12.5%	1
Basic Web Design	0.0%	0
Basic Java Programming	0.0%	0
Advanced Java Programming	25.0%	2
OpenMRS implementation experience	37.5%	3
Enterprise Java Programming	50.0%	4
OpenMRS Development	62.5%	5
Collaboration tools like skype, wiki, twitter, blogs	12.5%	1
Medical Informatics	100.0%	8
answered question		8
skipped question		0

14. How important is it that this project is sponsored, in other words the project pays you to participate?			
		Response Percent	Response Count
Extremely important, I would not be able to do this work without being paid to do it.		50.0%	4
Important, but I could do it while doing something else, like working for another software company, the university or for MISAU.		50.0%	4
Less important. I would compete for a grant in order to keep on working on this project.		0.0%	0
Not important at all. I spend most of my time writing open source code and will participate in this project even if there was no pay.		0.0%	0
I would participate even if I were not paid to participate because I like developing Open Source software.		0.0%	0
		answered question	8
		skipped question	0

15. My level of qualification

	Response Percent	Response Count
High School	0.0%	0
Bachelor	100.0%	6
Masters	0.0%	0
PhD	0.0%	0
What degree and where did you obtain this qualification?		4
answered question		6
skipped question		3

18. Please provide your name for my research records. However if you want it to remain confidential answer the last question in this survey.

	Response Percent	Response Count
Name:	100.0%	8
University or other	62.5%	5
City/Town:	100.0%	8
Country:	100.0%	8
Email Address:	100.0%	8
Skype address	62.5%	5
answered question		8
skipped question		0

17. I concent to being interviewed by Heloice Emdon for the purpoce of her ctudy on Health Information Management Cyctemc in Africa: Building oomputer coftware ckillc and other externalitiec. I underctand that:

	Response Peroent	Response Count
Partiolpation in thic interview ic voluntary.	100.0%	8
That I may refuce to anower any queotionc I would prefer not to.	87.5%	7
I may withdraw from the ctudy at any time.	75.0%	6
No information that may identify me will be included in the research report, and my responces will remain confidential.	87.5%	7
Name		6
answered question		8
skipped question		0

Appendix 3: The Hack-a-thon: An ethnographic sketch[2]

The minor conference room in one of Durban's promenade hotels simmers with movement. Chairs are randomly arranged in small and medium sized clusters, the conference goers look casual. Colours abound as men in shirt sleeves and several women in casual attire collect to speak in small groups. The numbers in the room remain steady. With lunch plates being brought into the room, lunch, laptops, keyboards become an interchangeable activity as a few women and men find time to return to their online life. After lunch a large configuration of chairs sprawls pear-like through the middle of the room.

I locate the three Mozambican computer science graduates that I am later introduced to. They are sitting with a young African woman honours graduate in computer science from KwaZulu Natal University. The three Mozambican men each sit in front of a laptop along the assembly of tables set up like a makeshift internet café. The Mozambicans Moz Programmers 1 2 and 3 and the South Africans Carl Fourie and the SA programmers 1, 2 and 3 seem fatigued. I later discover they worked on the problem with little sleep through the night.

The man with the bushy red moustache and khaki vest, the ones photojournalists wear, says he comes from the CDC Atlanta. He describes himself as an old hand at code writing for health information systems at the Center for Disease Control. He volunteered his time to the overnight team at the hack-a-thon to develop an API for the Mozambique team to take home. They were finding it impossible to transfer the data from the Access database in the Ministry of Health into the OpenMRS MySQL database. They had used the legacy database they had developed for the start of a death registry for the Central Hospital in Maputo known as the SISROH project. They

[2] This ethnographic note was inspired by Sean Ó Riain's "Net-working for a Living: Irish Software Developers in the Global Workplace" in Burawoy, M. 2000.

had brought their problem to the OpenMRS code-fest. Carl Fourie, coordinator of the African partnership and general manager of Jembi, the NGO developed to host the OASIS project's outreach arm, created the code-fest challenge – the hallmark of developer get-togethers.

Now Carl is making an announcement, his voice booms over the microphone, the only one in the room used for plenary announcements. I jostle past the camera-man filming the event to get a view. The bright light shining through the overhead projector lights the group up as they stand in front of the large meeting room. The other spontaneous sessions hush. Several participants bring their chairs to the front and sit down to listen. The group squint as the sharp light of the LCD shines into their eyes. It's like an award ceremony. Carl explains how the transfer of data application, normally an expensive application to develop to get two software packages to talk to one another, and to transfer the data between databases, will be tried out when they go back to Maputo.

Appendix 4: List of key stakeholder interviews and focus group discussion

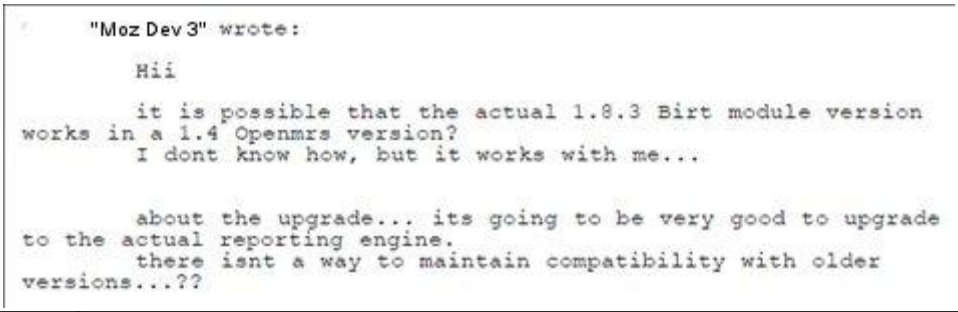
1. Focus Group Discussion held at the FOSSIL lab, MOASIS, Faculty of Mathematics, 17/10/2010, stored as **Moasis team interview.mp3**, transcript stored as **Moasis transcript Draft 1.doc**

2 List of key stakeholders interviewed

Carl Fourie	In person, Johannesburg, 14/10/2008, interview carl_2.mp3 14/10/2008 transcript Transcript Carl.docx 1/12/2009
Chris Seebregts	By email: 21/11/2009; 29/07/2010
Leopoldo Nhamposa	By email: 22/10/2009 By phone: 19/10/2010
Burke Mamlin	By email: 14/12/2009; 31/07/2010

Appendix 5: OpenMRS list serv conversations: Free user-to-user support from the US to Mozambique

Figure 11: Free user-to-user support



"Moz Dev 3" wrote:

Hii

it is possible that the actual 1.8.3 Birt module version works in a 1.4 Openmrs version?
I dont know how, but it works with me...

about the upgrade... its going to be very good to upgrade to the actual reporting engine.
there isnt a way to maintain compatibility with older versions...??

-----Original Message-----
From: implementers@openmrs.org on behalf of Justin Miranda
Sent: Fri 5/29/2009 4:05 PM
To: openmrs-implement-l@LISTSERV.IUPUI.EDU
Subject: Re: [OPENMRS-IMPLEMENTERS] BIRT report module upgrade coming soon (NEED FEEDBACK)

Yes, 1.8.3 BIRT *should* work in OpenMRS 1.4 as long as there were no API changes between 1.3.4 (the required version) and the version of 1.4 that you are using. That should be the case anyway, as we have a rule that states that the no methods should be removed/changed between minor versions (i.e. from 1.3 to 1.4).

As for the reporting engine, I have noticed some issues with backwards compatibility between minor versions of the BIRT Designer and Runtime Engine that make it advisable (read: necessary) to upgrade. But this only means that if you upgrade to the BIRT 2.3.2 designer, then you need to upgrade to the BIRT 2.3.2 runtime engine as well. The reason you might do this is because there's a bug fix or feature in the 2.3.2 designer that you really need.

At a minimum, I think we'll continue to support BIRT 2.2.2 in upcoming releases of the BIRT module because of the heavy download burden of the BIRT runtime engine and designer. That means, if you don't want to upgrade the BIRT designer to 2.3.1 or 2.3.2 ... don't worry ... you'll still be able to run the BIRT report module and reports created in version 2.2.2 as the module gets upgraded to the latest version of OpenMRS (i.e. 1.4 and 1.5).

Here's a potential roadmap (minus new features):

BIRT Module v2.0 - Upgrade to OpenMRS v 1.4
BIRT Module v2.1 - Upgrade to BIRT Runtime 2.3.1 (using OpenMRS v1.4)
BIRT Module v2.2 - Upgrade to BIRT Runtim 2.3.2 (using OpenMRS v1.4)
BIRT Module v2.3 - Upgrade to OpenMRS v1.5

Justin

Figure 12: Finding new software: user-to-user support

From: implementers@openmrs.org on behalf of "Moz Dev 3"
To: openmrs-implement-l@LISTSERV.IUPUI.EDU
Subject: [OPENMRS-IMPLEMENTERS] Schedule an Encounter
Date: Thursday, May 14, 2009 2:16:09 PM

Hi everyone

I need to know if anyone have a module that schedule a patient encounter with the healthcare provider (medic)... something like an appointment, so the medic can have is own agenda...

Do anyone have anything that do something similar...??

Thanks

From: implementers@openmrs.org on behalf of Darius Jazayeri
To: openmrs-implement-l@LISTSERV.IUPUI.EDU
Subject: Re: [OPENMRS-IMPLEMENTERS] Error with message_properties in pt
Date: Tuesday, May 12, 2009 8:28:56 AM

Hi "Moz Dev 3",

The find patient widget occasionally fails to load for me, on my laptop. Reloading the page, or doing a shift-reload always solves this. I haven't seen the issue in production.

-Darius

Figure 13 Localising OpenMRS into Portuguese

On Tue, 2009-05-12 at 17:01 +0200, "Moz Dev 3" wrote:
> Hi everyone
>
> I made a translation of the message.properties to portuguese because
> the actual message_pt.properties is not complete...but after the
> translation and using the message_pt.properties that a have translated
> my patient search form stop working as expected, as shown in the
> attachement...
> When i use the other message_pt.properties (not completed) the form
> works fine...
>
> I have attached the message_pt.properties , if someone can have a look
> and give me a tip i would love it...
>
> Thanks

From: implementers@openmrs.org on behalf of Ben
To: openmrs-implement-l@LISTSERV.IUPUI.EDU
Subject: Re: [OPENMRS-IMPLEMENTERS] Error with message_properties in pt
Date: Tuesday, May 12, 2009 10:08:36 AM

Wow, strong work "Moz Dev 3" The translation files are getting pretty large, so I'm sure it takes a while to step through it!

There are a few errors you will need to correct and I'm not sure if they are causing the javascript to fail:

1)
Person.age.unknownIdade desconhecida
should have an equals sign in it

2)
I see a lot of double double quotes: <input type=""text""...

View the javascript errors that PatientService.js or PersonSearch.js or OpenmrsSearch.js is causing. In firefox, its Tools-->Error Console

Save/Open the js files in a program that can read javascript and look for syntax errors.
http://localhost:8080/openmrs/scripts/dojo/src/widget/openmrs/PatientSearch.js
http://localhost:8080/openmrs/scripts/dojo/src/widget/openmrs/PersonSearch.js
http://localhost:8080/openmrs/scripts/dojo/src/widget/openmrs/OpenmrsSearch.js

Ben

Appendix 6: Email confirming MOASIS will become an e-Health Institute of Excellence, Maputo

From: Alessandro Campione [mailto:alessandro.campione@XXXXXX]
Sent: 01 April 2010 12:54 PM
To: Chaitali Sinha
Subject: Re: M-OASIS becoming the eHealth body in Mozambique

dear Chaitali
MOASIS is in a very positive momentum and basically:

· have a signed 5 year renewable memorandum with the MoH where it state that MOASIS is the reference organisation for e-health.

· have e local team of 6 professionals, 4 of them based inside the MoH

o Leopoldo = principal investigator

o XXXX = coordinator (30 years experience in moz HIS)

o XXXX = implementer (5 years exp. in hospital info system) Moz 1

o *Moz Programmer 1* = programmer

o *Moz Programmer 2* = programmer

o *Moz Programmer 3* = programmer

. have the permanent support of specialised technical assistance (Jembi team and myself) and if needed of other experts in short missions.

· have more then 13 ongoing project:

1. hospital-based mortality system, deployment in 11 hospital (2010)
2. National workshop on standards;
3. Support Hospital Inpatient Data Aggregation System
4. Support the Maputo Central Hospital System
5. Manica Province e-Health architecture definition
6. MoH Website maintenance
7. Mozambique HIV Patient Monitoring System Assessment
8. Maintenance and update "Módulo Básico-SIS"
9. Develop, pilot and/or deploy the cholera surveillance system SIS-CHOLERA
10. support the development of the national general e-health architecture
11. development of the national inventory of infrastructures and service system
12. support the review or new development of HIS subsystems (TB, HIV, Mental health etc.)
13. support for the development and deployment of the MoH data warehouse

· have a an internal development program that is including:

o 5 years strategic plan

o annual operational plan (attached)

o administrations tools

o job descriptions and organigram

o foundation document

o general procedures and roles guide

finally this is the text under revision in the MOASIS strategy to become the e-health institution in the next 2-4 years:

The main strategy is to actively support the development and future extension of the present local capacities of M-OASIS in order to create an **e-Health Centre/Institute of Excellence**, based at the UEM. This **E-Health Centre/Institute of Excellence (M-OASIS)** will provide services to any public and private organization, developing innovative e-health projects, offer specialized training in the HIS, provide technical support to develop the national Health Information System Strategy for 2009 – 2014 and act as the reference organization for developing and maintaining e-health architecture and standards.

The **E-health Centre/Institute of Excellence M-OASIS** lacks commercial and political interest and is well-placed to support the design of a general or local e-health architecture for the Ministry of Health as well as the development of requirements and the evaluation and the certification of informatics products and projects. Particular attention will be applied to the development of academic and on the job training in order to assist with the development of local resources capable of developing and maintaining systems to create a dynamic e-health market.

The M-OASIS **e-Health Centre/Institute of Excellence** will actively support the connection between the public, the private and the academic sectors in the field of e-Health, promoting projects of mutual interest and creating opportunities to share experiences, learning about the Mozambican HIS and the instruments and procedures in place, as well as the needs of the different actors, the particular social and environmental conditions and the best technologies to be used. The main strategy is to generally sustain the development of the HIS, supporting the public, the academic and the private sectors or any other active component of the Mozambican society involved in the development of the HIS with a mutually-beneficial strategy.

So everything is going in the right direction, we are a little bit concern about the financial resources to guarantee more support in term of human resources and continuity of the project. It would be a disaster if in a year this incredible effort and achievement would crash.
regards
Dr. Alessandro Campione
Global AIDS Program Mozambique
US Centers for Disease Control and Prevention - Columbia University
www.misau.gov.mz

Appendix 7: Letters of Consent

Letter requesting consent

I, _____, consent to being interviewed by Heloise Emdon for the purpose of her study on Health Information Management Systems in Africa: Influences and externalities for improved governance in health service delivery in selected African states

I understand that:

- Participation in this interview is voluntary.
- That I may refuse to answer any questions I would prefer not to.
- I may withdraw from the study at any time.
- No information that may identify me will be included in the research report, and my responses will remain confidential.

Signed _____

Date: _____

Place: _____

Appendix 8: Emails providing consent to use names

OpenMRS node, members from the USA

From: Paul Biondich [xxxxx]
Sent: December 14, 2009 9:55 AM
To: Heloise Emdon
Cc: Ben Wolfe; Michael Seaton; Darius Jazayeri; Ben Wolfe; Justin Miranda; Burke Mamlin
Subject: Re: [OPENMRS] Social network

Hah, not surprising... my head is increasingly in the clouds, but feel free to use my name to note that. :)

-Paul

From: Burke Mamlin [xxxxxx]
Sent: December 14, 2009 9:52 AM
To: Michael Seaton
Cc: Darius Jazayeri; Heloise Emdon; Ben Wolfe; Justin Miranda; Paul Biondich
Subject: Re: [OPENMRS] Social network

While "Developer 1" does have a nice ring to it, using my name is fine too. However, I would ask that any mistakes I might have made on the list be attributed to the name "Ben."

-Burke

Fine by me J

On Dec 14, 2009, at 9:08 AM, Michael Seaton wrote:

Fine by me J

On Dec 14, 2009, at 9:50 AM, Heloise Emdon wrote:

Hi all

thanks so far for agreement, Ben since you are at the centre of it all, may I twist your arm to agree to have you name "Ben" there?

As for Paul, none of the SA or Mozambique coders mentioned him so that is why none of the arrows run to him.

Heloise

From: Ben Wolfe [xxxxx]
Sent: December 14, 2009 9:40 AM
To: Michael Seaton
Cc: Darius Jazayeri; Heloise Emdon; Ben Wolfe; Justin Miranda; Burke Mamlin; Paul Biondich
Subject: Re: [OPENMRS] Social network

Can you attach the social network model again? It didn't to make it with Darius' forward.
Yep, feel free to use my name. If thats not possible, I request to be Developer #1. ...or should it be #1 Developer? ;-) Ben

---

From: Darius Jazayeri [xxxxx]
Sent: Monday, December 14, 2009 12:24 AM
To: Heloise Emdon
Cc: Ben Wolfe; Justin Miranda; Michael Seaton; Burke Mamlin; Paul Biondich
Subject: Re: [OPENMRS] Social network

Hi Heloise,

I think your email did go to the list, but that's actually supposed to our very-rare-announcements list. (I probably shouldn't have sent my email that you replied to to that list in the first place, actually.)

I'm ccing Ben, Justin, Mike, Burke, and Paul, in case they didn't get your email from below.

-Darius

Fine by me J

On Sun, Dec 13, 2009 at 11:45 PM, Heloise Emdon <xxxxx> wrote:

Hi Darius

Thanks, do you know if the other email went to the list? I am not sure I am a subscribed member.

regards

Heloise

From: Darius Jazayeri [XXXXXX]
Sent: December 13, 2009 10:00 PM
To: Heloise Emdon
Subject: Re: [OPENMRS] Social network

Hi Heloise,

Feel free to use my name.

-Darius

Fine by me J

On Fri, Dec 11, 2009 at 3:45 PM, Heloise Emdon <xxxxx> wrote:

Hello Ben, Justin, Darius, Mike, Burke and Paul

I am including here a social network model, extracted from some research I have done towards a thesis in development studies. I am wondering if it would be ok, in describing the OpenMRS collaborative amongst the Mozambique and South Africa and US nodes if I use your first names. I am trying to demonstrate the support networks that come from the list-serv interactions.

For now the graph will be used in this dissertation, please let me know if I can use your first names the way I have. If you are uncomfortable I could call you Developer 1, 2, 3 etc

Kind regards

Heloise Emdon
