A Review of Camara's Education Program in Africa

Monitoring & Evaluation Report

March 2008

Abstract

The aim of this study was to examine how ICT is being used in education in Sub-Saharan Africa. A particular area of focus was the performance and sustainability of refurbished computers sent out by Camara since commencing operations at the end of 2005. Other areas such as the gender differences in computer usage, the suitability of different software packages and the need for ICT training were also evaluated.

The study was based on a survey of 13 schools, colleges and community organisations in Ethiopia, Kenya, Lesotho, Uganda and Zambia. It also made use of the quantitative information and qualitative insights gained by Camara as a result of their work in the area.

The primary conclusion from this survey is that, while there is a huge hunger in African schools for ICT, the availability of these technologies remains limited and their application within the educational sector remains inefficient. Furthermore, even if African schools gained access to ICT, most can not sustain it with current resources.
In order for ICT to be an effective tool of education, it must be made both affordable and relevant to the needs of the local people.

Specific main findings include:

•Africa's ownership of computers and access to the Internet continues to fall further behind that of developed countries.

•The average life of a Camara refurbished computer is between two and three years

•A Camara refurbished computer can be delivered to a school for as little as €55 each but the total cost of ownership of such machines can be four times the initial purchase price.

•Few if any schools have effective maintenance or disposal policies for their hardware.

•There appears to be little gender difference in the access to ICT in the African educational system

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3. ICT IN AFRICA

Abbreviations

ADEA:	Association for the Development of Education in Africa
AISI:	African Information Society Initiative
APC:	Association for Progressive Communications
CAI:	Computer-Aided Instruction
CEO:	Chief Executive Officer
DAI:	Digital Access Index
DOTF:	Digital Opportunity Task Force
ECA:	Economic Commission for Africa
EFA:	Education for All
ETC:	Ethiopian Telecommunications Corporation
FOSS:	Free and Open Source Software
GDP:	Gross Domestic Product
GER:	Gross Enrolment Ratio
GNU:	General Public Licence
HDI:	Human Development Index
HDR:	Human Development Report
IBP:	Internet Backbone Provider
ICT:	Information and Communication Technology
ICT4D:	ICT for Development
ISP:	Internet Service Provider
ITU:	International Telecommunications Union
LTSP:	Linux Terminal Server Project
Mbps:	Mega bits per second
MDG:	Millennium Development Goal
NEPAD:	New Partnership for African Development

NGO:	Non Governmental Organisation
NICI:	National Information and Communication Infrastructure
OECD:	Organisation for Economic Cooperation and Development
O/S:	Operating System
NGO:	Non-Government Organisation
PC:	Personal Computer
PDA:	Personal Digital Assistant
RAM:	Random Access Memory
SAPs:	Structural Adjustment Programs
SNA:	SchoolNet Africa
SNO:	Second National Operator
SNSA:	SchoolNet South Africa
SSA:	Sub-Saharan Africa
TCO:	Total Cost of Ownership
TK:	Telecom Kenya
TV:	Television
UNESCO:	United Nations Educational, Scientific and Cultural Organisation
US:	United States
UK:	United Kingdom
USB:	Universal Serial Bus
WSIS:	World Summit on the Information Society
WWW:	World Wide Web

1. INTRODUCTION

This study examines the use by Camara Education (Camara) of Information and Communication Technology (ICT) in schools in Sub-Saharan Africa (SSA).

Nelson Mandela once said:
"Education is the most powerful weapon we will need [to change the world]." (Kifner 1990)

The problems of poverty, tyranny, corruption, sickness and exploitation still remain firmly entrenched in Africa, and many would argue that the people of that continent are worse of today than they were nearly 90 years ago when Nelson Mandela was born. The idea that education is the road along which Africans must travel in order to change their world is hard to argue against.

This study focuses on the work of Camara and analyses how well refurbished computers sent to Africa by us have been used. It also examines software preferences, training support and gender differences in ICT in education in Africa. The research is based on survey questions administered to 13 institutions in Ethiopia, Kenya, Lesotho, Uganda and Zambia that Camara has worked with over the last two to three years.

Definitions

Information and Communication Technology (ICT) was defined by the ICT4D platform during the World Summit on the Information Society (WSIS), in December 2003 as:

"Those technologies designed to access, process and transmit information in regard to text, sound, data and pictures. ICT encompass the full range from traditional widely used devices such as radios, telephones or television to more sophisticated tools like computers or the Internet."(ICT4D 2004)

As this definition suggests, ICT is sometimes characterised as either 'Old ICT' which includes newspapers, radio, television and fixed line telephones or 'New ICT' which includes mobile telephones, computers and the Internet.

Background to the Study

Camara Education (www.camara.ie) was set up in 2005 to deliver affordable technology to schools and colleges in Africa. Since its inception Camara has sent out approximately 4,500 computers to nine African countries and has trained approximately 2,000 African teachers in basic computer literacy skills. The feedback received by Camara from the recipients of this technology transfer has been largely positive, but has also been anecdotal in nature. We wanted to better understand, in a more systematic manner, how effective our work has been and to use this feedback to improve the products and services we offer.

As has often been the case, projects in Africa don't always work the same way as in developed countries, lessons from outside the region are not always transferable, and what outcomes seem logical to expect do not always come true. Camara believes that applying ICT effectively within the context of Africa is profoundly important. Get it right and the delivery and outcome of education can be fundamentally transformed, get it wrong and enormous amounts of scare resources can be wasted needlessly.

ICT spending accounts for nearly seven percent of all the money spent in the world today (WITSA 2006). There is one computer for every four children in US schools (US Census 2007) and ICT has been explicitly included in the MDGs (UN 2007). ICT, education and Africa are now all integrally linked, but ICT in education is still a relatively new area of research even in developed countries, and its costs and benefits are not yet fully understood. It is hoped that this Monitoring & Evaluation (M&E) study will provide important for Camara's and others' work, information that will increase the probability of getting this intervention right.

Rationale for the Study

Bill Gates, probably the most famous and certainly the richest exponent of ICT once said:

"The mothers are going to walk right up to that computer and say, my children are dying, what can you do?…..They're not going to sit there and like, browse eBay or something. What they want is for their children to live. They don't want their children's growth to be stunted. Do you really have to put in computers to figure that out?….. The world's poorest two billion people desperately need healthcare, not laptops". (Verhovek 2000)

If Bill Gates believes that there are greater priorities for Africa than computers, why is it important for Camara to be undertaking this work? There are several answers to this:

1. The world needs to better understand whether or not ICT is the 'Silver Bullet' that will help Africa tackle its seemingly insurmountable problems. Or will ICT fall on the scrap heap of other great empowering ideas such as Structural Adjustment Programs (SAPs) that ultimately ended up doing more harm than good?

2. Billions of dollars are likely to be spent on ICT and education over the next decade by cash-strapped African governments. For this money to be used efficiently a more rigorous framework must be established to

better understand the costs and benefits of using these tools.

3. ICT, by and large, has been developed in rich countries for rich countries. To be effective in Africa it must be adjusted to take into account local needs and context. To understand what works and why it works in Africa requires some degree of systematic research be carried out in the region.

For Camara, a more scientific study based on hard data is important for several reasons.

1. In order to improve our service to customers we needs a better understanding of what works, what doesn't work and what can be made better in its technology transfer operations.

2. There is an ever increasing amount of cheap refurbished machines being sent to Africa (see Section 3.3 Personal Computers in Africa) from the developed world. It has not been proven that this is a good thing, and arguments can be made that this intervention is as much about transferring the developed world's electronic waste to Africa as about giving aid. This study will help answer how effectively these machines are being used.

3. The majority of NGOs working in the field of technology transfer focus almost exclusively on delivering hardware. This research will examine whether this is enough or whether other inputs such as training and software applications are equally important in order to make more effective use of the hardware.

While this study is not expected to produce conclusive arguments on the effectiveness or otherwise of technology in education in Africa it does hope to establish a base line from which a more scientific assessment of the issues can be made.

Objectives

This work hopes to provide important practical information that will guide Camara and organizations like it the best way in which to deliver sustainable ICT to the educational system in Africa. It is hoped that it will also stir more debate among governments, donors, NGOs, technology providers and recipient organisations and allow the various stakeholders to develop a cheap, sustainable and efficient system of transferring technology from the developed to the developing world.

Specifically this study will provide answers to some of the following questions, answers that are currently not readily available in published research.

1. What is the average life of a refurbished computer in Africa?
2. Who uses the computers and for what purpose?
3. Is there any gender bias in those using ICT?
4. What are the main problems experienced by refurbished machines?
5. What happens to the computers in Africa at the end of their life?
6. Is Linux a viable alternative software package for use in education in Africa?
7. What level of additional support is required by recipients to get the most use out of their hardware?

Support is looked at in terms of: training in the use of computers; maintenance of the computers; and the human resources required in both these areas.

This research will also try to assess the Total Cost of Ownership (TCO) of refurbished computers.

Study Outline

This study is divided into five main chapters.

Chapter two describes the research methodology used in this study and provides a brief overview of each of the 13 institutions who took part in

the survey. This chapter high-lights the main data collection tools applied and some of the problems associated with the data that were received, in particular problems with reliability and consistency.

Chapter three gives a general overview of ICT in Africa. It looks at how ICT fits into the Millennium Development Goals and how Africa compares to developed countries in terms of access to technology - the so called 'digital divide'. This chapter then looks in more detail at four distinct aspects of ICT in Africa: (1) access to hardware; (2) what software is used; (3) the structure of the Internet in Africa; and (4) what are the government policies covering ICT. Finally there are brief profiles presented of the current status of ICT in Ethiopia and Kenya, the two main surveyed countries.

Chapter four examines the use of ICT in education in Africa. It considers the current status of ICT in the region's schools and colleges and gives a brief assessment of the benefits of ICT to education and the associated costs. Finally it explores the lessons learnt from trying to applying ICT in education in Africa. Brief profiles of the educational sectors in Ethiopia and Kenya are also included.

Chapter five described the principal finding derived from this survey. It categorises these findings under five main heading: (1) hardware performance - average computer life and what are the main problems associated with refurbished machines; (2) what software is used and what type of training is given on that software; (3) how the computers are used and who uses them; (4) what staffing is in place for ICT; and finally (5) what are the costs associated with using ICT in schools.

Chapter six presents the main conclusions derived from the literature review and the survey findings. It then goes on to make certain recommendations as to what lessons should be applied when using ICT in education in SSA and also what follow-up research should be undertaken in this area.

2. RESEARCH METHODOLOGY

2.1 Methodological Approach

This study was based largely on the analysis of primary information collected through a sample survey of a number of schools and colleges in Ethiopia, Kenya, Lesotho, Uganda and Zambia where Camara had previously sent refurbished computers to.

Observations were also carried out on approximately half of the institutions surveyed where students and teachers were observed actually using the computers in training situations.

Finally a literature review examining the role of ICT in education and also the prevalence of ICT in Africa was carried out.

2.2 Data Collection Tools

Data was collected using the following techniques:

1. A detailed 'Computer Evaluation Survey' (Survey) containing specific close-ended question (see Appendix 1) was prepared. The questions in this Survey require either: a specific number be supplied; a Yes/No answer; or selection of a number of options from a list. There were also a small number of more open-ended questions. This Survey was under taken in July 2007 during a field trip to the five countries mentioned previously. Some modifications were made to the questions during the field work based on feedback received from respondents earlier in the trip.

2. A set of open-ended questions were also prepared (see Appendix 2) and were posed through a series of interviews. There was some repetition within these questions (i.e. questions being asked in a slightly different way) and with the questions raised in the Computer Evaluation Survey.This was to allow for some form of triangulation of findings.

3. Detailed internal interviews were also undertaken in Camara during the course of 2007.

2.3 Universe Surveyed

Thirteen institutions participated in the Survey (see Table 2.1 below), five each in Ethiopia and Kenya, and one each in Lesotho, Uganda and Zambia. The institutions, all of which had previously been recipient of refurbished computer from Camara, ranged in type from primary schools, secondary schools through to teacher training and other technical colleges. One community development NGO was also surveyed.

Total respondents surveyed	13
Total countries covered	5
Average number of staff per school	46
Average number of students per school	800
% of students who are female	40%
Average number of computers per school	48

Table 2.1 Survey Summary

2.3.1 Ethiopia

2.3.1.1 Aleph Health Science (Aleph)

Aleph is a private, third level college offering diploma courses in various health science disciplines and is based in Awassa, a city some five hours drive south of Addis Ababa the capital of Ethiopia. The college has 50 staff and 1,000 students, 60 percent of whom are female. Aleph received 50 refurbished computers from Camara in August 2006, of which 10 were broken at the time of the survey. The survey and interview were carried out with the one of the two IT teachers in the college, Mr. Israel Deneke.

2.3.1.2 Full Gospel Church School (Full Gospel)

Full Gospel is a church-funded primary school situated in Awassa. It has 21 staff and 381 students of which 45 percent are female. Full Gospel received 25 computers from Camara in August 2006, of which 23 were still

working. According to Camara, Full Gospel is unique among all the computer recipients in that they had kept the original Linux-based Operating Systems on all their computers. The survey and interview were carried out with the sole IT teachers in the school, Mr. Rieyotalem Addseu.

2.3.1.3 Furra College of Business and Development Studies (Furra)

Furra is a tertiary college funded by the regional government of Sidama and offers a range of part-time and full-time business courses. Its main campus is in Yirgalem, a town six hours drive south of Addis Ababa and it has a smaller campus in Awassa. Furra has 127 staff and approximately 1,000 students, half of whom are female. Furra, received 50 refurbished computers from Camara in January 2006, of which six were broken at the time of the survey. The survey and interview were carried out with the deputy head of the college, Mr.Michael Tesfamariam.

2.3.1.4 Harambee College (Harambee)

Harambee is a private, tertiary-level college offering diploma courses in teacher and nurses training. Situated in Nazert, approximately 1 ½ hours drive south of Addis Ababa it has approximately 105 staff and 1,500 students, 47 percent of who are female. Harambee has received two shipments of refurbished computers from Camara totaling 155, 15 of which were broken at the time of the Survey. According to Camara's Technical Director, Harambee operates the most successful computer program among all the Ethiopian computer recipients. The survey and interview were carried out with the owner of the college, Mr. Feyissa Arassa.

2.3.1.5 Sunshine School (Sunshine)

Sunshine is a privately-funded primary school in Awassa. It has 34 staff and 1,000 students all of whom are boys. Sunshine received 25 computers from Camara in August 2006. Of these, 13 were iMACs as opposed to PCs and these were still in their original boxes at the time of the survey so were excluded from the data analysis. The school did not have a full-time IT teacher on staff and so the survey and interview were carried out with the store keeper/lab supervisor in the school, Mr. Keteama Ashine.

2.3.2 Kenya

2.3.2.1 Bamburi Primary School (Bamburi)

Bamburi is a government primary school on the outskirts of Mombasa, the second largest city in Kenya. It has 25 staff, and 860 students of which 48 percent were female. In February 2006 it received 18 computers from Camara of which eight were broken at the time of the survey. The school is in a deprived area of Mombasa near the large Bamburi cement plant which had promised financial and technical support to the school when they first received the machines from Camara. However it was clear at the time of the survey that no such support had been provided and this was one of the main reasons why, according to Camara, the lab was failing. The survey and interview were carried out with the sole IT teacher at the school, Ms Kulthum Amburi

2.3.2.2 Ganjorni Primary School (Ganjorni)

Ganjorni is a government primary school in a middle class area of Mombasa. The school is well resourced and has 30 staff, and 1,042 students of which half are female. In February 2006 it received 65 refurbished computers from Camara of which 25 were broken at the time of this survey. The survey and interview were carried out with the one of the two full-time IT teachers in the school, Mr Richard Gachemi

2.3.2.3 Iman Shaffy Primary School (Iman Shaffy)

Iman Shaffy is a government-funded Muslim primary school on the outskirts of Mombasa. The school has 15 staff, and 200 students of which 65 percent are female. In February 2006 it received 15 refurbished computers from Camara of which nine were broken at the time of this survey. The survey and interview were carried out with the sole IT teacher at the school, Ms Zakia Osman

2.3.2.4 Muslim Education and Welfare Association (MEWA)

MEWA is a community-based NGO in Mombasa who, as part of its education program, have set up a computer lab offering training programs to the local community. As the only non-school/college in the survey some of its data was excluded from the analyses. At the time of the survey it had just completed a 10-day training program for 200 individuals, 120 of whom were

females. In total it had 42 computers, 29 supplied by Camara in August 2006. The survey and interview were carried out with the head of the IT training program, Mr Hassan Sheba

2.3.2.5 Serani Secondary School (Serani)

Serani is a government-funded boy's secondary school in the centre of Mombasa. The school has 13 staff, and 500 students. In February 2006 it received 10 refurbished computers from Camara of which eight were still working and two were unaccounted for at the time of this survey. The survey and interview were carried out with the sole IT teacher at the school, Ms Rukia Abbas.

2.3.3 Lesotho

2.3.3.1 Pitseng High School (Pitseng)

Pitseng is a government-funded secondary school run by a religious order of sisters. The school, which is located in a small town three hours drive north of Maseru the capital of Lesotho, has 24 staff and 500 students, 68 percent of whom are female. The school has 40 computers in total, half of which were refurbished machines supplied by Camara. All of the Camara machines were working at the time of the Survey. The survey and interview were carried out with the principal of the school, Sister Julliet.

2.3.4 Uganda

2.3.4.1 Kampala Junior Academy (Academy)

Academy is a privately-funded primary school in the capital of Uganda, Kampala. The school has 70 staff and 900 students, of which 56 percent are female. Academy received 10 Camara computers in May 2007, all of which were still working at the time of the survey. The survey and interview were carried out with the sole IT teacher at the school, Mr Kenneth Mwayi.

2.3.5 Zambia

2.3.5.1 Canisius High School (Canisius)

Canisius is a Jesuit secondary boy's school (government-funded), in a rural area four hours drive south of Lusaka the Zambian capital. The school has 43 staff and 740 students. Canisius received 40 computers from Camara in April 2007 all of which were working at the time of the Survey. Canisius is

the only school surveyed that has managed to connect its computer lab up to the Internet. The survey and interview were carried out with the head of computer science at the school, Fr Dhana.

2.4 Potential Data Problems

There are a number of data reliability issues that arose during the data collection process. However with the exception of information on computer costs and lab set-up, the absence of data was not a significant problem in this survey. A much bigger problem however was the fact that some of the data collected was either incorrect or potentially misleading.

2.4.1 Absence of Data

Some of the questions in the Survey required that very specific quantifiable information be presented. Not all of the respondents were able to provide that information, or provide it in a format that was not consistent with that supplied by other respondents. This was particularly true for some of the financial data requested as only five of the 13 institutions were able to give estimates of the costs incurred in receiving Camara computers.

2.4.2 Incorrect or Misleading Data

It is likely that some of the data provided by respondents was either incorrect or misleading, whether deliberately or inadvertently. There may be a variety of reasons for this: they may have given answers they thought Camara wanted to hear; or made up answers to cover the fact they did not have the information. An example of this was the fact that 80 percent of those who responded to the question claimed that Linux was a better operating system than Windows. However the majority giving this answer had actually switched their computers from Linux to Windows since receiving them. This indicated a positive bias towards Linux among those responding to this question.

Another reason why respondents may have given incorrect information was that they did not fully understand the questions. Computers are still a relatively new area for most schools in Africa and it is likely that some of the respondents in the Survey did not understand what was being asked. This was particularly true where the person providing the answers was the principal of the school rather than the IT teacher. For example, in one case the principal claimed that each student received five hours of computer time per week. For a college with 1,500 students and only 55 machines this would have meant the machines running for nearly 20 hours each day – clearly highly unlikely.

Sometimes inconsistencies arose between responses from the survey questionnaire, the open-ended questions and what was observed during the site visit. For example some institutions claimed they had open access to the computer labs during school time. However observing who used the labs during lunch break and informal discussions with students revealed that in fact that access to the labs is very limited and very much at the discretion of the computer teacher.

2.5 Analyses of Data

There are a number of statistical analyses that this research undertook. Using the limited data available it has been possible to extrapolate the average life of a Camara refurbished computer in a school in Africa.

The cost data derived from the Survey was normalized to produce an estimate of the Total Cost of Ownership (TCO) for the computers received by the schools. While the data limitations are significant, understanding of this parameter is crucial in determining how sustainable technology is within the African education system.

In addition to these quantitative results, data derived from this study was used to answer some of the questions described below.

1. **Who uses the computers and for what purpose?**

2. **Is there any gender bias in those using the computers?**

3. **What are the main problems experienced by users of these computers?**

4. **What happens to the computers in Africa at the end of their life?**

5. **Is Linux a viable alternative software package for use in education in Africa?**

6. **What level of additional support is required by recipients to get the most use out of their hardware?**

Responses from the open-ended questions were used to compile a more descriptive analysis of the effectiveness of Camara's computers in schools and colleges in Africa. While it was not possible to use a statistical approach on this information, due to lack of objective data and the relatively small universe being interviewed, responses allowed us to draw conclusions as to how the respondents see computers: what benefits do they see from them; and what are the main problems associated with having them. It also provided useful anecdotal information on how computers are maintained.

3. ICT AND THE DEVELOPING WORLD

Introduction

In 2006, an estimated three trillion dollars or 6.8 percent of global GDP was spent on ICT. This total is expected to rise to four trillion dollars by 2009 (WITSA 2006).

Only one of the top ten countries in terms of ICT spending, China (ranked 6th with spending of $143 million) can be considered a developing country (ibid). Its total spending is growing rapidly and is expected to overtake that of France and the UK by 2009 (ibid). Another developing country, India is also showing significant growth and is expected to be in the top ten by 2009 (ibid). Outside of these two countries most of the developing world remains far behind the developed world in access to ICT, the so called 'digital divide'.

3.1 The Digital Divide

The digital divide is a term used to denote the gap between those who have access to and can use ICT and those that do not. More specifically, as suggested by the Digital Opportunity Task Force (DOTF) the Digital Divide is:

> ***"a reflection of existing socio-economic inequalities which can be characterised by insufficient infrastructure, high costs of access,inappropriate or weak policies regimes, inefficiencies in the provision of telecommunication networks and services, lack of locally created content, and uneven ability to derive economic and social benefits from information-intensive activities"***
> (DOTF 2002)

Today the term Digital Divide is most often used to describe the ICT gap between developed and developing countries. As Table 3.1 (ITU 2006) show, this divide has continued to widen across a range of technologies.

	Mobile Subscribers per 100 Inhabitants		Internet Users per 100 Inhabitants	
	1994	2006	1994	2006
Developing	0.19	10.2	0.03	10.2
Developed	5.2	90.9	2.18	58.6

Table 3.1 Access to Technology: Developed and Developing Countries Source: ITU 2006

It should be noted that the figures for developing countries include the statistics from China and India which have both shown significant growth in technology penetration over the last 10 years. However the digital divide for areas like Sub-Saharan Africa continues to grow even more pronounced with Africa accounting for 28 of the 30 lowest-ranking ICT societies in the world (ITU 2004).

Even within Africa there is a digital divide between North Africa and the rest:

> ***"Sub-Saharan Africa (excluding South Africa), had an average teledensity of one percent, North Africa had a comparable average of eleven percent. Almost three quarters of the continent's fixed lines were found in just six of the continent's 55 countries."***
> (ITU 2006)

3.1.1 The Urban - Rural Digital Divide

Within Africa there exists a substantial and growing digital divide between urban and rural areas. For example, only 12 percent to 22 percent of the population of African countries live in its major cities, however they account for approximately 75 percent of all telephone lines (Dzidonu 2003). In Egypt, urban households are four times as likely to be connected to the Internet and eight times as likely to have a computer as rural households (Shindy 2006)

In SSA (excluding South Africa) less than 20 percent of all rural communities are directly connected to mains electricity (Karekezi et al 2001) and those lucky enough to be offered access to ICT often lack suitable power sources to run the equipment.

3.1.2 The Gender Digital Divide

The UNDP Human Development Report (1999) estimated that women were substantially under-represented among users of ICT and ICT-related services around the world; representing more than 50% of Internet users in only three of the 43 countries surveyed US, Canada and Thailand (Hafkin 2003). In India, Indonesia and Jordan they accounted for 23 percent, 20 percent and six percent of all Internet users respectively.

The percentage of women Internet users in African countries was also generally lower than that of men, indicating a gender bias in ICT access and training (Hafkin and Taggart 2001) (Table 3.2 below). Interestingly women in South Africa appear to be on an equal par with men in this regard.

Country	Women as a % of Total Internet Users	Female Technical Workers as a % of Total Workers
South Africa	**51.0**	**46.7**
Zambia	**37.5**	**31.9**
Uganda	**31.5**	**NA**
Ethiopia	**13.9**	**NA**
Senegal	**12.0**	**NA**

Table 3.2: Women and ICT in Africa (*Source: Hafkin and Taggart 2001)*

Hafkin and Taggart argue that there are multiple reasons for this gender divide including the fact that women have:

- Lower levels of literacy and education than men
- Less time available due to additional household and childcare responsibilities
- Poorer access to financial resources than men
- Less mobility than men so are less likely to travel to ICT centres.
- More restrictions due to social and cultural norms

3.1.3 Digital Access Index (DAI)

The Digital Access Index was designed by the International Telecommunication Union (ITU) to provide a composite measure of the access to ICT for each country. The DAI is based on the availability of

infrastructure, affordability, knowledge, quality and usage and is determined by eight indicators:

- Fixed telephone subscribers per 100 inhabitants
- Mobile subscribers per 100 inhabitants
- Adult literacy rate
- Overall school enrolment
- Internet access price
- Broadband subscribers per 100 inhabitants
- International Internet bandwidth per capita
- Internet users per 100 inhabitants

In the most recent measure of DAI (ITU 2007), 55 countries were considered to have low access to ICT and of these 38 were located in SSA. The country with the highest-ranking DAI (out of 168 countries assessed) was Sweden (0.85), while Ireland (0.69) was ranked number 26. South Africa (0.45) was ranked number 78 and the countries in which this survey was carried out were ranked as follows: Kenya (124); Lesotho (126); Uganda (133); Zambia (134); and Ethiopia (163) respectively.

3.2 ICT and the Millennium Development Goals

ICT is mentioned in Target 18 of Millennium Development Goal 8: 'Build a Global Partnership for Development.'

> ***"In cooperation with the private sector, make available the benefits of new technologies, especially information and communication"*** (UN 2007)

There were no quantifiable goals laid down as part of this Target but three indicators were identified to measure ICT availability:

- Indicator 43. Number of telephone subscribers per 100 inhabitants
- Indicator 44. Number of personal computers per 100 inhabitants
- Indicator 45. Number of Internet users per 100 inhabitants

Figures 3.1 and 3.2 below both show that, based on these indicators, there has been a dramatic growth in the availability of ICT throughout SSA between 1996 and 2005. However this growth has been from a very low base, so overall access to ICT for this region remains the lowest in the world. In Figure 3.1 below the vast majority of the telephone line growth in SSA has been in the mobile sector, in fact the number of fixed lines per 100 inhabitants has actually dropped in many African countries over this time period (ITU 2004).

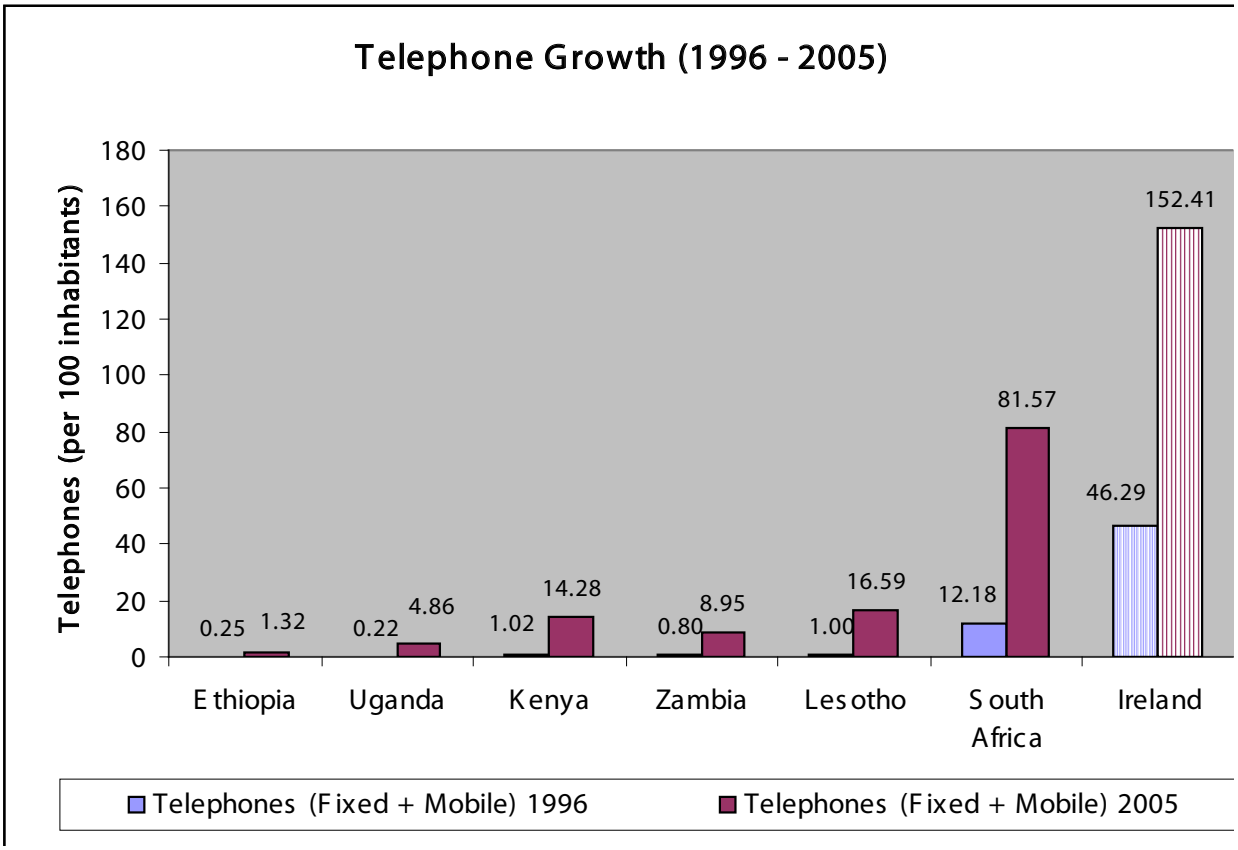


Figure 3.1 Telephone Growth (1996 – 2005) *(Source: ITU 2004 and 2006)*

3.3 Personal Computers in Africa

There are estimated to be nearly seven and a half million computers in SSA today, approximately one computer for every 100 people (ITU 2004). In Ireland there are 53 computers for every 100 inhabitants and in the United States there were over 14 million computers in the nation's schools alone, or one computer for every four children (ITU 2006).

Despite the relatively low level of computer ownership in SSA there has been

significant growth in PC access over the last 10 years (see Figure 3.2) albeit at a much slower rate than mobile phone growth.

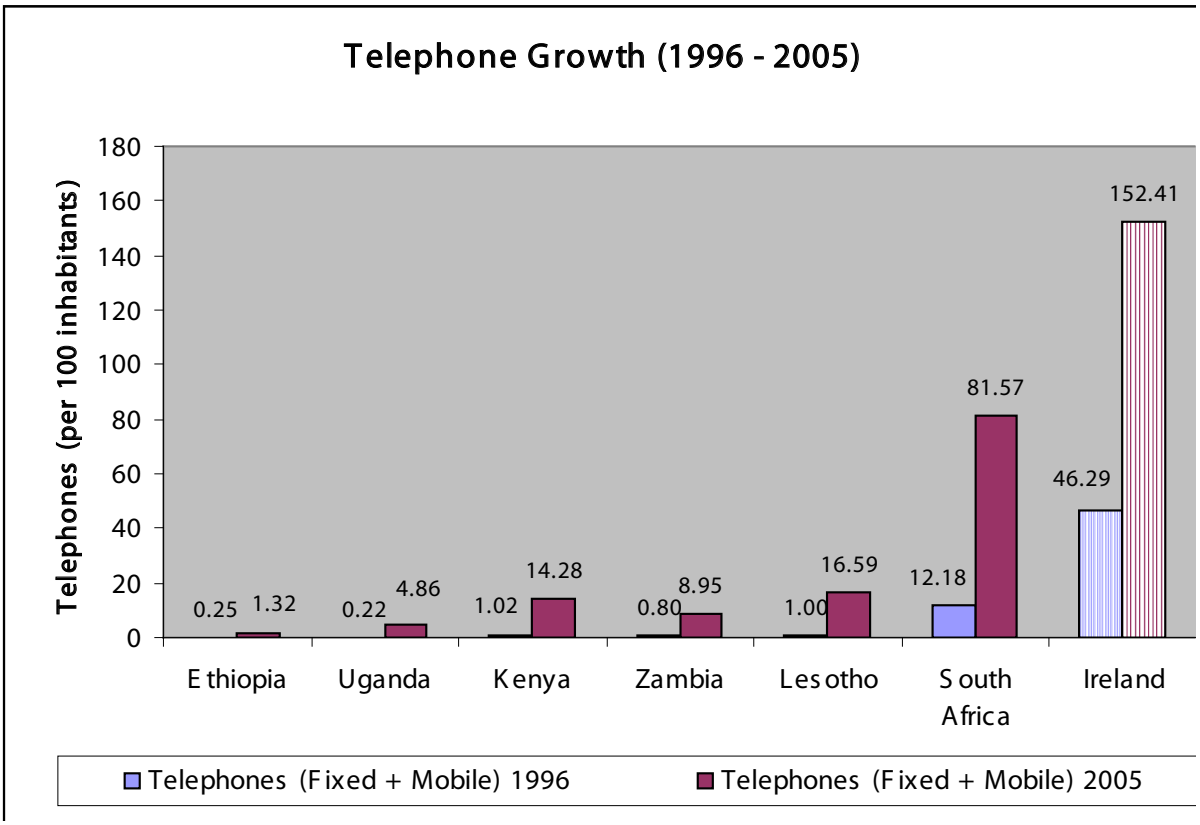


Figure 3.2 PC Growth (1996 – 2005) *(Source: ITU 2004 and 2006)*

Unfortunately growth has not been uniform across the region with many countries reporting less than one computer for every 500 people – Angola, Burundi, Chad, Malawi, Mali and Niger being the most notable (ITU 2004). Today the most computer-rich countries in the region are South Africa (42 percent of all computers in SSA), Nigeria (11 percent), Senegal (8 percent) and Zimbabwe (around 5 percent) (ibid).

3.3.1 Low Cost New Computers

There are very few indigenous computer manufacturers in Africa and most computers are imported, either as new or refurbished machines. However with an entry-level computer costing around $635 (€438) (Mercer PC 2007) - see Section 5.5.1 Cost of a New Computer in Africa - and average GDP per capita of $342 (HDR 2006) this technology still lies outside the income range of most Africans.

A definition of a new computer is:

> ***'A new PC is defined as one in which none of the components has ever been used prior to the assembly of the PC.'***
> (Open Research 2004)

In recent years there have been a number of new product developments designed to bring affordable computing to Africa. However these products are generally in their early stage of development and none have yet been massed produced for the African market. Only time will tell whether any or all will be sustainable.

Probably the most publicised low cost machine is the '$100 computer'. In February 2005, Nicholas Negroponte, founder of MIT Media Labs stated that a group of companies had built an engineering proto-type for a low-cost computer with a 14-inch colour monitor that runs Linux software and cost $100. In early 2007 and after several delays the first 100,000 units were received by the government of Uruguay. Despite this initial production a number of issues have arisen that question the long-term viability of the project: the cost of the computer is now $188 plus shipping; several technology companies have come out strongly against it, most notably Microsoft; and the level of order is substantially below what was predicted – 100,000 versus 150 million by the end of 2008 (Stecklow et al 2007).

This is also not the first time that developed and developing countries have tried to promote cheap computing for the developing world. Other initiatives have included: All-in-One PC (On Point 2007); Hewlett Packard's Shared-Access Computer (Digital Dividend 2004); VolksComputer (Caslon Analytics 2007); PC Gemilang. (Rahman 2004); Peoples PC (Krikke 2003); Personal Internet Communicator (AMD 2007); PCtvt (Markoff 2004); Village PDA. (Lakdiva 2001); and the Simputer (Picopeta 2007).

The reason for showing this long list is to demonstrate that the concept of cheap computers for developing countries is similar to the Holy Grail. Everyone knows how important it is and everyone is trying to find it but, as with the Holy Grail, the answer remains elusive and to date none of these

devices have proved to be commercially viable in the developing world.

3.3.2 Refurbished Computers

An alternative computing source that is becoming increasing common in Africa is the use of refurbished computers. A refurbished computer is

> ***'……. a PC that has undergone some form of testing, troubleshooting, cleaning, repair and/or maintenance. All refurbished PCs are second-hand or pre-owned.'***
> *(*Open Research)

Refurbished computers are generally donated by international NGOs and local corporate donors, or bought directly from overseas commercial providers. They can cover a wide spectrum of quality - from relatively recent models with the latest processor chips and components that have been little used, to computers that are over ten years old and have been completely rebuilt.

UNESCO (2003) estimates that over the next five years, 600 million PCs will be decommissioned in OECD countries. As it can cost up to US$50 (ibid) to decommission such machines, donating them to Africa is increasingly being viewed as an economically attractive disposal option for the original owners.

3.3.2.1 Concerns with Refurbished Computers

While refurbished personal computes are certainly cheaper to buy than new computers (assuming similar specifications) there are a number of concerns that may in the long-term make them less suitable for use in developing countries (Open Research 2004):

- Lack of standardization will result in higher maintenance costs.
- Refurbished computers have a shorter life than new PCs
- Lack of compatibility with newer technologies makes them harder to upgrade.
- Disposal now becomes the problem of the developing world

- Dumping may make it harder to developed an indigenous computer industry

3.3.2.2 Organisations supplying Refurbished PCs

The biggest suppliers of refurbished computers to Africa remain international NGOs: World Computer Exchange (www.worldcomputerexchange.org); Computer Aid International (www.computeraid.org); Digital Links International (www.digital-links.org); and ourselves, Camara being the most well known. A number of commercial African organizations are also expanding in this area, the largest of these being: FreeCom Group (www.freecomgroup.com); DireqLearn (www.direq.org/mambo); and Device Global (www.deviceglobal.com) all based in South Africa.

3.3.3 Total Cost of Ownership (TCO)

There are significant additional costs associated with owning a computer. The concept 'Total Cost of Ownership (TCO)' was developed to quantify such costs. TCO is an important concept for technology in Africa because it highlights the level of resources required, over and above the initial purchase costs, to sustain this ICT. A $100 computer may appear an attractive solution to bridging the Digital Divide but if the TCO to users is five times that amount then this technology will remain outside the means of most Africans.

Technology research firm Gartner, Inc (www.gartner.com) has suggested a comprehensive definition of TCO that covers:

1. **Direct costs:**

- Hardware and software. The initial purchase price plus maintenance contracts, spare parts and all supplies and materials.
- Operations. Labour costs for technical operations and support as well as the help desk and costs for floor space and furniture purchased
- Administration. Finance, human resources and administration.

2. **Indirect costs:**

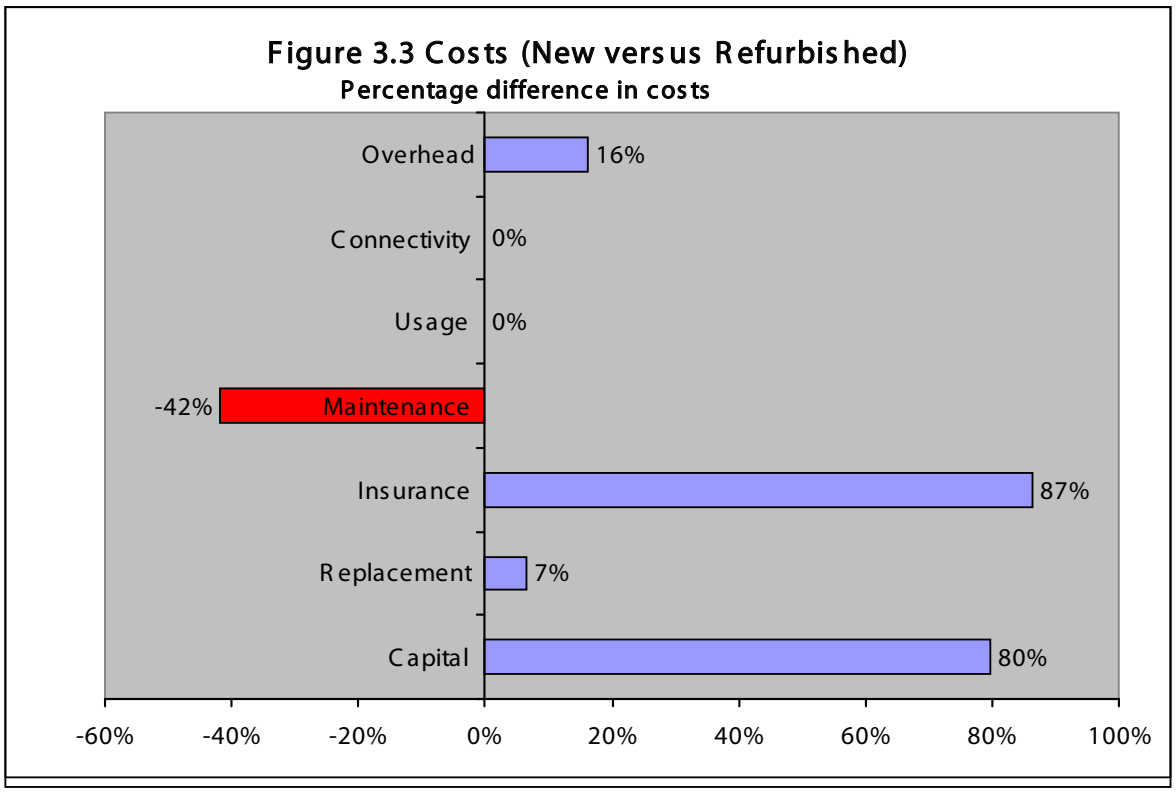
- End user operations. Ongoing end user support within the organization.
- Downtime. When the users are interrupted from their work

3.3.3.2 TCO of Refurbished PCs

While refurbished PCs appear to be an attractive source of cheap computers for Africa, an evaluation of their TCO suggests that their economics may not be as compelling as it first appears. It has been estimated (Bakia 2000) that the total cost associated with running a new computer over a five-year period can be five to six times the initial purchase price of the computer. This extra cost is primarily training, maintenance, upgrades and support.

While the cost of buying a refurbished PC might be considerably lower than buying a new machine, its running costs are likely to be substantially higher due to greater maintenance and shorter life of the older machine. A recent study carried out by SchoolNet Africa compared the TCO between refurbished and new computers for a network with ten computers, a server and printer.

Over five years, new computers prove to be only 16 percent more expensive than refurbished ones, hardly compelling economics to make this the solution to Africa's computing needs (see **Figure 3.3 below**).



(Source: SchoolNet Africa 2003)

3.4 Software

Software can be defined as:

> ***"Computer programs; instructions that make hardware work. Two main types of software are system software (operating systems), which control the workings of the computer, and applications, such as word processing programs, spreadsheets, and databases."*** (Microsoft 2007)

There are two sources of software available to African users; proprietary, and Free and Open Source Software (FOSS). The majority of software used around the world is proprietary in nature and probably the best-known example of such software are the operating system (Windows) and applications (Word, Excel, Outlook and Explorer) produced by Microsoft.

For operating systems alone, Microsoft Windows is estimated to have a worldwide market share of over 90 percent (IDC) with the rest of the market being split between the Apple Macintosh and GNU/Linux-based systems. However for some applications, particularly for use on the Internet, FOSS programs have proved more popular: for example the Apache web server that allows computers to deliver web pages has a market share of 65 percent (UNCTAD 2003).

Software development is a huge and profitable industry with earnings of $300 billion annually (ibid). Unfortunately, Africa has only a small indigenous industry centred in South Africa. Heeks (1996) identified a number of significant barriers to the development of an African export software industry:

- Lack of skills
- Lack of infrastructure
- Lack of market information.

Heeks (ibid) suggests that in order to develop this industry, African countries must look to their domestic markets for primary sources of demand. These markets are likely to develop more around local content software rather than general applications that are already dominated by much larger multinational companies.

3.4.1 Free and Open Source Software (FOSS)

With proprietary software, users pay a fee, its source code is not publicly available to developers and it cannot be distributed to other users without agreement of the publishing company. FOSS on the other hand can be defined as:

> ***"Free software is a matter of the freedom of users to run, copy, distribute, study, change and improve the software."***
> (Free Software Foundation)

> ***"Open source means having access to the source code and being able to distribute software according to certain criteria such as: software must be freely distributed; and source code must be included as part of free distribution"***
> (Open Source Initiative)

South Africa's National Advisory Council on Innovation stated the following advantages of open source software over proprietary software (Reijswoud and Topi 2003):

- Reduced costs and less dependency on imported technology and skills
- Affordable software for individuals, enterprises and governments
- Universal access through mass software rollout without costly licensing implications
- Access to government data without barrier of proprietary software and data formats
- Ability to customise software to local languages and cultures
- Lowered barriers to entry for software businesses
- Participation in a global network of software development

However the UK Office of Government Commerce (2004) has identified several disadvantages associated with FOSS:

- Lack of professional support
- Difficulty finding appropriate software

- Poor support documentation
- Few examples of large scale migration from proprietary to FOSS
- FOSS applications can be slow on new hardware.

3.4.1.1 FOSS Operating System and Applications

Linux is a FOSS operating system that was initially released in 1994 and continually upgraded. Linux is freely available to everyone and is seen as the main alternative to proprietary operating systems such as Windows. Linux has found good applications in 'Thin Client' systems; those are systems that use a network server to run all application while the workstations provide only a keyboard, mouse and display. Software from the 'Linux Terminal Server Project (LTSP)' is increasingly being used in educational institutions throughout Africa.

A large number of software applications have been written specifically to run on Linux and these also are distributed freely. Some of the most popular consumer applications are shown in Table 3.3:

Type of Software	**FOSS**	**Proprietary**
Word Processor	OpenOffice	Word (Microsoft)
Spreadsheet	OpenOffice	Excel (Microsoft)
Email	Thunderbird	Outlook (Microsoft)
Web Browser	Mozilla	Explorer (Microsoft)
Encyclopedia	Wikipedia	Encarta (Microsoft)

Table 3.3 Examples of FOSS and Proprietary Applications
(Source: www.sourceforge.net)

FOSS developers believe that their products can replicate all the applications offered by proprietary software. One Dutch organisation, TacticalTech has produced a product, 'NGO-in-a-Box', a suite of FOSS applications aimed at small and medium-sized NGOs. Probably the most popular distribution of Linux today is Ubuntu, which was developed by the Shuttleworth Foundation, an NGO set up by Mark Shuttleworth a South African entrepreneur.

3.4.2 TCO of FOSS versus Proprietary Software

Comparing the TCO of FOSS versus proprietary software is difficult because of the large number of factors affecting performance such as: type of software being compared; what functions is it being used for; and on what type of hardware it is being run. However understanding this parameter is crucial for Africa because of the need to deploy low cost ICT solutions in education and other areas.

In the absence of African specific research, this study has looked at a number of comparative studies that have been completed in developed countries in this area. One study found that Windows was 11 to 22 percent cheaper than Linux over a five-year period in four of the five workload scenarios examined (IDC 2003). However another study (OSIA 2004) found that FOSS systems were 30 percent cheaper than that offered by proprietary products. A further study (Orzech 2002) also found that over three years, the TCO for a Linux system was less than half the cost of a Windows system.

3.5 The Internet in Africa

As of September 2007, there were estimated to be 1,244 million people connected to the Internet globally of which 28 million were in SSA (Internet World Stats 2007). In 1993, South Africa became the first African country to be connected and despite the significant increase in absolute numbers having access to the network since that time, the Internet still only reaches nearly four percent of the total population of the region compared to world-wide coverage of 19 percent (ibid). In Ireland the penetration rate for the Internet is over 50 percent (ibid). The vast majority of Africans access the Internet over a fixed line network, however the number of African Internet users is higher than the numbers who have fixed telephone line service because of the popularity of public access points and cyber cafés.

3.5.1 Internet Connectivity

While the Internet architecture in Africa has a similar structure to that elsewhere in the world it does suffers from a number of inefficiencies that make it substantially more expensive to use:

- The lack of competition among service providers
- Poor national, regional and international connectivity
- Low economies of scale

This lack of infrastructure, manifest in: the low quality and breadth of the local network; limited international bandwidth and the poor level of regional connectivity is one of the primary obstacles to universal connectivity within the region (UNDP). In fact Africans receive less than one bit of international bandwidth each (ITU 2004).

> ***"Bandwidth is the life-blood of the world's knowledge economy, but it is scarcest where it is most needed – on the developing nations of Africa which require low cost communications to accelerate their socio-economic development"***
> (Jensen 2006)

3.5.1.1 National Connectivity

In Africa, the number of population centres that are connected to the existing copper wire telephone network largely determines national connectivity. This fixed-line network which forms the national Internet backbone has historically been controlled by the state-owned national telephone operator acting as a monopoly provider. As such these fixed line systems have acted as bottlenecks for Internet services in much the same way as they did for telephone services. Smaller networks do exist in rural areas, but these are typically connected to the Internet via more expensive satellite systems. Increasing liberalisation of the market, including the licensing of second national operators (SNOs) and the emergence of other private sector companies such as Internet Service Providers (ISPs) has resulted in an increase level of connectivity at national level. Currently there were approximately 419 ISPs registered with the Africa Internet Service Providers Association (Afrispa 2007), 212 of them in South Africa. Many ISPs in Africa have only a couple of hundred users, and are probably not viable in the long-term whereas the largest ISPs (AfricaOnline, UUNet, MediaPost, Swift Global, ISP Mweb) have operations in several African countries.

3.5.1.2 Regional Connectivity

Because there are limited direct connections within and between African countries much of the local and regional traffic (intra-country and intra-region) is first sent to locations in Europe or the US before being transmitted back to the region. Because of this it has been estimated that US$400 million a year is spent in Africa to pay international carriers to bring data from one African country to another.

> ***"The existence of reverse subsidies is the single largest factor contributing to high bandwidth costs,"***
> (Richard Bell 2002)

Currently only ten Southern and West African countries are connected to each other via the SAT3 submarine cable and this lack of regional connectivity is one of the major reasons why Internet costs are higher in Africa than in other parts of the world, and why many African Internet sites are hosted on servers that are located outside the continent

3.5.1.3 International Connectivity

International bandwidth is a measure of the capacity of a country's national network to communicate with networks outside its borders. International bandwidth for all of SSA was 1,088 Mbps in 2002 of which South Africa accounted for 565 Mbps (52 percent of the total), and another six countries account for 312 Mbps (29 percent of the total). There are currently 28 countries in Africa that have no direct international fibre-optic cable connections: 13 in West Africa; 10 in East Africa; and three in Southern and Central Africa (Jensen 2006). Together this means a population of nearly 400 million people that must rely on satellites or other countries' networks to communicate internationally. Because of low international traffic volumes and hence bargaining power, ISPs in Africa have to pay the full cost of the international leased line to the country providing the hub (normally the US or Europe). For example circuits from Europe to Africa cost more than $5000/Mbps/month compared to links between North America and Europe which cost as little as $2.5/Mbps/month (ibid).

3.6 African ICT Policies

Sectors such as education, health and business are becoming increasing aware of the importance of ICT in their future development. In the absence of a national ICT policy each sector tends to formulate plans based on its own needs and visions. This consequently makes it more difficult to integrate these polices in the future into a broad country strategy (APC 2007). In recognition of this the African Information Society Initiative (AISI) and the New Partnership for African Development (NEPAD), have encouraged an increasing number of African countries to adopt National Information and Communication Infrastructure (NICI) policies (ECA 2003) where according to the Association for Progressive Communications (APC),

> ***"ICT policy is the course of action, vision, goals and principles that guide the activities of many different actors in the area of: telecommunications; broadcasting; and the Internet "***
> (APC 2007).

Each NICI plan is expected to focus on five key areas: public administration and governance; education; private sector development, electronic commerce and entrepreneurship; agriculture and natural resources management; health; and other sectors such as tourism. The ECA reported that by March 2007, 34 countries had actually prepared national ICT policies, double the number in 2000 (see Figure 3.4).

Countries with an ICT policy	Countries in the process of developing an ICT policy	Countries where the ICT policy development process is not launched
Algeria	Angola	Equatrial Guinea
Benin	Botswana	Eritrea
Burkina faso	Chad	Guinea-Bissau
Burundi	Cameroon	Liberia
Cape Verde	Central African Republic	Libyan Arab Jamahiriya
Comoros	Democratic Republic of the Congo	Sao Tome and Principe
Congo	Gabon	Somalia
Cóte s'Ivoire	Lesotho	
Djibouti	Sierra Leone	
Egypt	Togo	
Ethiopia	Zambia	
Gambia	Zimbabwe	
Ghana		
Guinea		
Kenya		
Madagascar		
Malawi		
Mali		
Mauritania		
Mauritius		
Morocco		
Mozambique		
Namibia		
Niger		
Nigeria		
Rwanda		
Senegal		
Seychelles		
South Africa		
Sudan		
Swaziland		
Tanzania		
Tunisia		
Uganda		

Figure 3.4. NICI Status Graph *(Source: ECA 2007)*

3.7 Country Profiles

A brief profile of the two main countries surveyed, Ethiopia and Kenya is given below. The statistics describing their level of development, both in general and in technology terms, as compared to Ireland is shown in Table 3.4

	Ethiopia	Kenya	Ireland
General (2004)			
Population (millions)	75.6	33.5	4.1
2015 Projected population (millions)	97.2	44.2	4.7
Life Expectancy (years)	47.8	45.7	77.9
HDI Rank (out of 177)	170	152	4
GDP per head (US$) - PPP	$756	$1,140	$38,827
Technology (2005)			
Telephone Lines per 100 Inhabitants	0.8	0.8	49.5
Mobile subscribers per 100 Inhabitants	0.5	13.5	102.9
Internet Users per 100 Inhabitants	0.2	3.2	33.8
International bandwidth (Mbps)	10	113	24,587
International bandwidth per Inhabitant (bps)	0.1	3.4	5,996
PCs per 100 Inhabitants	0.4	1.4	53.0

Table 3.4: Country Development and Technology Statistics
Source: ITU 2004 and HDR 2006

3.7.1 Ethiopia

Ethiopia is one of the least developed countries in the world today as measured by the Human Development Index. With a large and rapidly growing population it remains one of the poorest on the planet with a GDP per capital that is less than two percent of Ireland's.

In terms of ICT, Ethiopia also remains one of the least developed countries in the world

> ***"which constitutes a serious impediment to economic activity and foreign investment".***
> (EIU Ethiopia 2006).

Ethiopia has one mobile phone for every 200 inhabitants and is also one of the few African countries that have less mobile phones than fixed line phones. What fixed line services are concentrated in the capital Addis Ababa and this therefore means that Internet access is difficult to get outside of the capital. Even within the capital broadband internet access is limited and throughout the country there is less than 0.1 bps in international bandwidth per inhabitant.

Ethiopia has only 300,000 PCs, which for a population of nearly 76 million people means there is only one computer for every 250 inhabitants.

The telecommunications sector is dominated by Ethiopian Telecommunications Corporation (ETC), a state-owned entity and currently the monopoly provider of such services. A recent study suggested that Ethiopia has one of the least market-oriented regulatory systems in Africa and as a result has the highest service charges. Their Regulatory Score, based on a combined score of seven variables measuring market openness is just over seven (out of a total of 25) compared to highest ranked country in Africa, Uganda which scores 23 (Jensen 2004).

Despite this lack of development in the area of ICT the government is currently undertaking substantial investments in the sector. In particular focusing on projects such as:

- Collaborating with Nokia and Alcatel to provide system capacity for a further 1.35 million mobile phone users over the next two years (EIU Ethiopia 2006)
- ETC and partners laying 10,000km of fibre-optic cable to connect up with the submarine cable at Djibouti. This they hope will allow all schools and health centres to be connected to the Internet by 2008 (ibid)

3.7.2 Kenya

Kenya is also one of the least developed countries in the world as measured by the HDI, ranking 152 out of 177 and has a GDP per capita that is less than three percent of Ireland's.

Where Ethiopia lags the rest of Africa in terms of access to ICT, Kenya is one of the leaders. Kenya has the same number of fixed lines per inhabitant as Ethiopia but more than 27 times the mobile subscribers and 15 times the Internet users per head of the population. It also offers 3.4 bps of international bandwidth per person compared to Ethiopia's 0.1 bps.

Despite a population that is of Ethiopia, Kenya still has more computer, 492,000 in total which equates computer for every 70 inhabitants. However this is still substantially less than Ireland where there is one computer for every two inhabitants.

Kenya's telecommunications sector is more open than Ethiopia's as measured by their Regulatory Score (Jensen 2004) of 14 but to a large extent is still dominated by the state-owned company Telkom Kenya (TK). This company controls the fixed line network which is

> ***"small and inefficient, owing to the poor financial condition……. This reflects weak management and significant overstaffing".***
> (EIU Kenya 2006)

The Kenya government appears committed to opening up the ICT market further and is currently undertaking a series of initiatives:

- Privatisation of TK - flotation on the stock markets with a sale of a stake to France Telecom as a strategic investor (France Telecom 2007).

- Awarding a second national operator licence to a Dubai-based company VTEL (EIU Kenya 2007).

- Construction of a submarine fibre optic cable

4. ICT AND EDUCATION

Technology in one form or another has been applied to education since Socrates introduced the system of teaching by question and answer in 400BC (Benson Clough 1904). Since that time however, major advances in education through the use of technology have been few and far between (Pausch 2002). In the US where there is one computer for every four students (US Census), researchers are still not certain of the long-term benefits of ICT in education.

Despite uncertainly about the benefits of ICT in education, its use is wide spread in the developed world and its importance in developing countries is high-lighted by the quote from Kofi Annan who said:

> **"Ensure the ICT is used to unlock the door to education, whether for young girls in Afghanistan, university students in Uganda, or workers in Brazil, so that they can fully seize the economic opportunities, and live lives of dignity free from want."** (Murphy 2005)

4.1 ICT in Education in Sub-Saharan Africa

4.1.1 Current Status

The statistics of education in Africa are depressing. At the end of 2003 in SSA there are over 44 million children who do not go to primary school, almost equal to the entire school population of the United States. There are 135 million adults who cannot read, 65 percent of who are female. In South Africa, SSA's richest country, spending on primary education per pupil fell from $642 in 1990 to $423 in 2000 compared with the average spending amount for primary education in developed countries of $3,543 per pupil (EFA 2004). UNESCO predicts that of the 35 countries that are in danger of not meeting the Education For All (EFA) goals in 2015, 22 will be in SSA (ibid).

However there is a belief among many NGOs, academic institutions and governments that ICT has an important role to play in helping Africa find

a solution to its educational deficiencies. In a recent survey of African governments' priorities for ICT, education (along with business and trade) was considered to be the most important area of development (APC 2007). Furthermore, this commitment to using ICT in education was explicitly highlighted by UNESCO as one of the key strategies for achieving the EFA goals (UNESCO 2002).

At present there are few statistics to describe how pervasive the use of ICT in education is in SSA. Surveys (Isaacs 2002 and Farrell et al 2007) carried out in selected countries suggest that while the prevalence of computers is growing their penetration into schools remains painfully low (see Table 4.1 below).

Country	Percentage of Schools with computers in 2001	Percentage of Schools with computers in 2006
Ghana	1.4	2.5
Mozambique	0.3	1.1
Namibia	3.9	22.1

Table 4.1 Percentage of African Schools with Computers
Source: Issacs 2002 and Farrell et al 2007

4.1.2 Benefits of ICT in Education

> **"Evidence from large studies ……suggests that use of ICTs ……, is correlated to positive academic outcomes, including higher test scores, [and] better attitudes towards schools…… those most in need of help – low-income, low-achieving students, and students with disabilities – made the most gains. ……, a secondary benefit of ICTs in education is to familiarize new generations with the technologies that have become integral components of the modern world."** (Haddad et al 2002)

The benefits of ICTs' use in education may certainly be proven through rigorous research studies in the United States - the 'large studies' (Schacter 1999) on which this quote is based - but unfortunately there is little hard

evidence at present to prove or disprove this statement in the context of Africa.

Association for the Development of Education in Africa (ADEA) have suggested the following benefits for using ICT in education (Butcher 2003):

- Up-to-date educational resources can be delivered quicker, more cheaply, with more variety to a larger group of people.
- Easier communication between and among teachers, students, administrators.
- Facilitating interaction in resources
- Building and exploiting information bases

Haddad and Draxler (2002) have looked at different 'old' and 'new' technologies and their potentials in different areas (see Table 4.2 below) and argue that the Internet in particular has probably the highest potential among all forms of ICT. Unfortunately the Internet is not yet widely available within the African educational sector.

Technology	Outreach	Flexibility	Sensorial Stimulation	Interactivity
Radio	High	Limited	Audio	Limited
Television	High	Limited	Audiovisual	Limited
Video	Low	High	Audiovisual	Limited
PC	Low	High	Audiovisual	High

Table 4.2 ICTs and their Potential for Education
Source: Haddad and Draxler (2002)

4.1.3 Costs of ICT in Education

4.1.3.1 TCO of New Computers

Whereas no large studies have yet been carried out on the TCO of computers in African schools, a number of studies have been completed in America showing that hardware probably accounts for around 40 percent to 50 percent of TCO (Tables 4.3 to 4.6) (CoSN 2001).

Component	Percent of Total (%)
Computer Equipment	40
Networking and Telephones	13
Training	13
Support	40

Table 4.3 TCO - New Jersey Schools (1997)

Component	Percent of Total (%)
Hardware and Telecommunications	40
Learning Resources (Software)	27
Maintenance and Upgrades	12
Staff Development and support	21

Table 4.4: TCO - California Schools (1996)

Component	Percent of Total (%)
Hardware and Infrastructure	49
Software	9
Staff Development	8
Support	32

Table 4.5 TCO - Hi-tech Schools (1995)

Component	Percent of Total (%)
Hardware and Telecommunications	43
Retrofitting	7
Training	13
Support	33

Table 4.6 TCO - MIT Projections (1994) *(Source: CoSN 2001)*

4.1.3.2 Per Unit Cost of ICT in Schools

In the absence of direct cost data for Africa, this study extrapolates from the work of Potashnik and Adkins (1996) that looked at Computer-Aided Instruction (CAI) in Jamaica, Chile and Belize in the mid 1990s. This work estimated the cost per student of providing this type of education (see Table 4.7 below).

	United States	Jamaica	Chile	Belize
Number of Students	800	300	400	200
Recurrent Cost per Student	US$ 304	US$ 54	US$ 61	US$ 55
Total Cost per Student	US$ 453	US$ 89	US$ 104	US$ 78

Table 4.7 Costs for Computer Aided Instruction in Developing Countries
(Source: Potashnik and Adkins 1996)

The premise of using this study to provide equivalent costs for SSA in 2007 is open to debate as there are many factors that should be taken into account before extrapolating these results: inflation; the falling cost of technology; the higher costs associated with supplying technology to Africa (e.g. the Internet); personnel costs etc. Assuming these factors more or less offset each other and excluding the cost structure in the United States, then the average recurrent costs of providing CAI in developing countries would be $55 to $60 per student with total costs of $75 to $100 per student.

Lewin (2004) estimated that the average unit cost of providing secondary education in Africa is between $100 (lower secondary) and $220 (upper secondary). This suggests that the recurrent costs of providing CAI would account for up to 60 percent of the lower secondary school budget and 27 percent of the upper secondary school budget. Taking the fact that teacher salaries in SSA range from $500 to $1,500 per year (Govender 2004), that means that providing CAI to 500 secondary school students would cost $30,000 annually or the equivalent of employing between 20 and 60 new teachers in the school.

4.1.4 Lessons for ICT in Education

Very few assessments have been carried out to date on the costs and benefits of using ICT in education in SSA. However based on the experience of World Links for Development, a program sponsored by the World Bank to put networked computers in schools in developing countries, Hawkins (2002) suggested ten lessons for the use of ICT in Education in the developing world:

1. Computer labs in developing countries take time and money, but they work.
2. Technical support cannot be overlooked.
3. Non-competitive telecommunications infrastructure, policies, and regulators impede connectivity and sustainability.
4. Become wireless – 'Lose the wires'.
5. Get the community involved.
6. Private-public sector partnerships are essential.
7. Link ICT and education efforts to broader education reforms.
8. Training, training, training.
9. Technology empowers girls.
10. Technology motivates students and energizes classrooms.

4.2 Country Educational Profiles

There is a wide disparity in access to education and educational resources between the developed and developing world. As Table 4.8 below shows there is also a wide disparity between neighbouring Africa countries.

	Ethipoia	Kenya	Ireland
(2005 unless stated)			
Adult Literacy - 15+ (2004)	36%	74%	NA
Female Literacy - 15+ (2004)	23%	70%	NA
Total Education Expenditure as % of GDP (2006)	6%	7%	5%
Education Expenditure per capita (2006)	$63	$86	$1,810
% of Government Expenditure spent on Education (2006)	18%	29%	14%
% completing full course of Primary Education	54%	93%	97%
Primary Pupil/Teacher ratio	72	40	18
Primary Enrolment - Gross Enrolment rate (GER)	91%	108%	104%
Female Primary Enrolment - GER	84%	106%	103%
Secondary Enrolment - GER	31%	48%	112%
Female Secondary Enrolment - GER	24%	47%	117%
Tertiary Enrolment - GER	3%	3%	58%
Female Tertiary Enrolment - GER	1%	2%	65%

Table 4.8 Educational Statistics

Source: UNESCO Institute for Statistics

4.2.1 Ethiopia

Spending on education has grown dramatically since 2000 when Ethiopia's war with Eritrea ended. At that time it accounted for only 9.5 percent of total government spending but today this figure has grown to 18 percent, nearly double that amount. Nonetheless this ratio remains considerably below what is seen in other SSA countries, Kenya in particular.

In terms of educational spending, primary schools took about half the overall budget in 2004. The Gross Enrolment Ratio (GER) in primary schools increased in line with higher spending, growing from 64 percent in 2000 to 91 percent in 2005. Despite this increased enrolment, only 54 percent of those entering school are actually completing their studies, substantially lower than the number in Kenya.

GER in secondary schools rose from 14 percent in 1990 to 31 percent in 2005 but Ethiopia still lags many of the countries in SSA in this area. This trend is also mirrored in tertiary education which saw GER rise from less than one percent in 1990 to three percent in 2005. Through all levels of schooling, Ethiopia education is characterised by a distinct gender gap with females in general appearing to have less access to education than males.

Adult literacy has improved only marginally since 1990, growing from 29 percent to 36 percent currently. Ethiopian literacy rates remain low particularly among women where less than one quarter of the female adult population can read or write.

In order to close the gap in educational accessibility and quality the government of Ethiopia has committed itself to investing heavily in 'e-learning'. Meles Zenawi the Prime Minister of Ethiopia said at an ICT conference in 2005

> **"We were convinced that we should invest every penny we have on securing the next meal for our people. We did not believe serious investment in ICT had anything to do with facing the challenges of poverty that kills. Now I think we know better. We recognise that it is a vital and essential tool for fighting poverty—for beating poverty that kills—and ensuring our survival."** *(Farrell et al 2007)*

Ethiopia has undertaken a number of specific initiatives designed to improve the educational system. Two of these initiatives are described below:

- Nearly all secondary school classrooms have been equipped with plasma screens to which pre-recorded lessons are broadcast via satellite. Ultimately the plan is to deliver the full secondary school curriculum through this media.

- ETC and the private sector have established a 4,000 km fibre optic backbone network designed to connect every school in the country to the Internet (ibid).

4.2.2 Kenya

Spending on education has grown in recent years has risen from 17 percent of total government expenditure in 1991 to over 29 percent in 2006. A significant amount of this money has gone into the provision of free primary education, which was introduced in 2003. This has resulted in an extra 1.6 million children going to school and 93 percent of those completing this schooling (EIU Kenya 2006).

While primary education took the lion's share of the budget (64 percent in 2004) the government is now focused on increasing the number attending secondary and tertiary education which took 25 percent and 11 percent of the budget respectively in 2004. Between 2002 and 2005 the number attending secondary school rose by 148,000 and those going to university by 9,000.

The problem of adult literacy has also been improving albeit slowing, rising from 71 percent in 1990 to 74 percent in 2004. However the level of literacy among women has risen more sharply from 61 percent in 1990 to 70 percent today.

The importance of ICT in education in Kenya was summed up by George Saitoti, the Kenyan Education Minister who said in 2007

> **"In education, the use of ICTs offers new ways in which the quality, effectiveness, and in particular, the flexibility of higher education can be improved. When integrated into education, ICTs have the capacity to improve the delivery of education through distance learning."** *(Farrell et al 2007)*

There are a number of ICT initiatives underway in the country focused on education:

- Kenyan ICT Trust Fund is an NGO set up as a public-private partnership with the goal of setting up computer laboratories in all Kenyan secondary schools with five years (WSIS 2007).

- Kenya Education Network (KENET) was set up to build and operate a high speed IP-based educational network that will connect all of Kenya's educational institutions to the Internet. To date however because of the cost of bandwidth only the universities and national research institutions have been connected (Thairu 2004).

- African Virtual Open Initiatives and Resources (AVOIR) initiative is a collaboration between a number of African universities in eight countries to develop "products and expertise" in FOSS. To date it has developed a number of tools for use in education: KEWL.NextGen, which is an advanced e-learning system; and Chisimba a development tool for creating web applications. (AVOIR 2007)

5. RESEARCH FINDINGS

This study analyses the use of computer technology in 13 Camara-supplied schools and colleges in Africa under five main headings: Hardware; Software and Training; Staffing; Computer Usage; and Costs.

5.1 Hardware

5.1.1 Hardware Failure Rate

Hardware failure rate of the refurbished computers sent to the schools in Africa provides an important measurable indicator of the effectiveness of ICT in the educational system there.

Table 5.1 shows that nearly 80 percent of the refurbished computers supplied by Camara to their five recipient countries since 2006 were still working at the time of the survey. Examining the 10 institutions in Ethiopia and Kenya that have had Camara computers for one year or more, data shows that just over 75 percent of these computers were still working.

	All Countries	Ethiopia and Kenya
Mean (weighted average)	79.2%	75.4%
Median	84.0%	80.0%
Minimum	40.0%	40.0%
Maximum	100.0%	100.0%

Table 5.1 Percentage of Camara Computers Still Working

The range of hardware failure between institutions was wide with one school, the Iman Shaffrey Primary School in Mombasa Kenya having only 40 percent of their computers still working after one year. This was the lowest percentage among all institutions surveyed. Conversely, MEWA which is also located in Mombasa and who received their machines at the same time and

from the same container had 100 percent of their computers still working.

5.1.1.1 Reasons for Hardware Failure

Of the nine institutions that were able to articulate the principal reason for their computer breakdown, seven reported problems with the power unit. Camara attributed much of these power problems to poor wiring and/or instability in the national power grids causing voltage spikes to blow fuses in the power units.

On initial site visits Camara had advised schools receiving computers to use qualified electricians to install and test the labs' wiring prior to receiving the machines and to use 'Power Surge Protection Units' on all equipment. However it was clear from examining the computer labs that some schools had not followed these instructions.

(out of 9 responses)	
Power problems	7
Viruses affecting the Operating System	1
Software not loading properly	1

Table 5.2 Principal Reasons for Hardware Failure

It was noted that damage to the power supplies are generally fatal as it is not possible to open up the power unit to change the damage part. This can be contrasted with the fact that if other components, such as a hard drive, fails they can more easily be swapped out for a replacement.

The incidence of ‘power’ problems as the main hardware issue facing the institutions was reinforced in responses to the question:

> **‘What have been your biggest problems with the computers since receiving them?’**
>
> A typical response:
>
> ***‘Breakdown is normally due to the power supply.’***
>
> Apart from failure of the computer itself, one respondent also mentioned that.
>
> ***‘Keyboards and mice break regularly.’***

Other problems mentioned as causes of computer failure were software related – viruses on the hard drives, or operating systems not loading. According to our expereince these are often less serious problems as it is possible to reload the operating system onto the computer hard drives.

5.1.2 Calculation of Average Computer Life

This survey also attempted to measure the effectiveness of the Camara computers being used by calculating the Average Computer Life of such machines.

5.1.2.1 Normalisation of Data

This study looked at the 329 refurbished Camara computers that had been sent to Ethiopia and Kenya since January 2006. In July 2007, when the survey was carried out it was estimated that 248 of these machines were still working – 81 broken over the 18 month period. However not all of the 329 machines had been in place for the entire 18 months, some had only been used for 17 months and some for 11 months. Using straight line extrapolation (see Table 5.3 below), this study estimated that only 62 machines would have been broken after 12 months which meant that 267 were working at that time.

Number Of Original Machines	Date Computers Set up	Number of Working Machines	Number of Broken Machines	Date of Survey	No. of months Machines in Operation when survey taken	Number of Broken Machines (Normalised to 12 months)
12	Aug-06	8	4	Jul-07	11	4.3
50	Aug-06	40	10	Jul-07	11	10.8
55	Jan-06	40	15	Jul-07	18	9.9
50	Jan-06	44	6	Jul-07	18	4.0
25	Aug-06	23	2	Jul-07	11	2.2
18	Feb-06	10	8	Jul-07	17	5.6
29	Aug-06	29	0	Jul-07	11	0.0
15	Feb-06	6	9	Jul-07	17	6.3
10	Feb-06	8	2	Jul-07	17	1.4
65	Feb-06	40	25	Jul-07	17	17.5
329		248	81			62

Table 5.3 Data Showing the Number of Machines Supplied and Broken

Even though this survey predicts failure rates at only one point in time (12 months after the machines were set up) it is still possible to use these data to extrapolate the average life of a refurbished computer as sent out by Camara. The computer failure rate in subsequent years was calculated using two methods based on: (1) Absolute Failure Rate; and (2) Percentage Failure Rate.

Absolute Failure Rate: Predicts that 62 machines on average will fail every year. For example, maintaining this constant absolute failure rate means that at the end of year five only 20 out of the original 329 machines will still be working (see Table 5.4 below).

Percentage Failure Rate: Predicts that 19 percent of the remaining machines (62 out of 329) will fail every year. For example, maintaining this percentage failure rate means that at the end of year five, 116 out of the original 329 machines will still be working.

Using these data it was then possible to predict how many machines will be broken each year (see Table 5.4).

	Year							
	Start	**1**	**2**	**3**	**4**	**5**	**6**	7
Absolute Failure Rate	329	267	205	143	82	20		
Percentage Failure Rate	329	267	217	176	143	116	94	77

Table 5.4 Machines Still Working

This data was then used to calculate the weighted average life of the Camara computers as shown in Table 5.5

	years
Based on Absolute Failure Rate	2.2
Based on Percentage Failure Rate	3.3

Table 5.5 Average Life of a Camara Computer

This study does not suggest which, if any, of the above methods is likely to give the truest indication of computer failure rate. It can be argued that estimates made by using the Absolute Failure Rate are probably too pessimistic in that, those machines that are going to fail are more likely to fail

early on and once they have survived the initial set-up and learning period the failure rate should slow. On the other hand estimates using the Percentage Failure Rate may be too optimistic in that it suggests that by the end of year seven, some 77 machines out of the original 329 are still working. Given that many of these machines were probably between five to ten years old by the time they were sent to Africa that would suggest a longevity way past what the original manufacturers may have built them for.

While these data provide some indication of the average life of a refurbished computer, this study argues that results should be treated with a certain degree of skepticism in that they are derived essentially from a single point in time and that point relatively early in the life of the machine. In addition the sample universe included computers of widely different ages and specifications.

Having said all that, this study has taken a headline Average Computer Life for refurbished Camara computer as 2.75 years based on the average of the two methods discussed above. As will be shown this number is important when it comes to calculating the Total Cost of Ownership of this technology (see Section 5.5.6 TCO).

5.1.2.2 Comparison with Other Studies

A study by SchoolNet Africa (Butcher et al 2004) suggested that the average life of a new machine was seven years although it is not clear whether this figure is true for all new computers or ones that are subject to African conditions.

This study also suggested that the average life for refurbished machines was between three and five years, depending on whether you take the figures published by Computer Aid International or SchoolsOnline who reported figures of three years and five years respectively. In comparing the two sources it was noted that Computer Aid's estimated were based exclusively on refurbished machines whereas it is not clear now many, if any of SchoolsOnline were. This and the fact the Computer Aid is probably the largest supplier of refurbished machines in the world would suggest that the average computer life of a refurbished machine is probably closer to three

years than five years.

5.1.2.3 Camara Target Computer Life

Camara has stated that it has a target Average Computer Life of four years for the refurbished machines it sends out. Using this target and assuming a typical computer lab set up by Camara (which hold approximately 25 machines) it is possible to estimate the target failure rate that will result in an average four year life for the machines in that lab (see Table 5.6 below).

(for a 4 year Average Computer Life in a 25 machine lab)	
Number of Computers failing per year	2.7
Percentage of Computers failing per year	14.0%

Table 5.6 Camara Breakdown Targets

What this analysis suggest is that, less than three computers (according to the Absolute Failure Rate), or 14 percent of the computers (according to the Percentage Failure Rate) must fail each year in a typical school computer lab of 25 machines to ensure an Average Computer Life of 4 years.

5.1.3 Performance Comparison Refurbished Versus New Computers

Several of the institutions surveyed in this study had both new and refurbished machines installed. While it is outside the scope of this study to carry out a full analysis of the difference in performance between these two groups, the institutions were asked: **'How would you rate the performance of refurbished computers compared to new computers? In what way are they better or worse?'**

Not surprisingly newer machines were rated more highly than refurbished ones in particular with respect to their speed. Comments included:

> ***'New machines are much faster and better on energy consumption.'***
> ***'Performance of refurbished machines is worse - slower.***

Pentium III processor is too slow and they need more RAM.'
'Amount of RAM was too little which meant the computers were too slow.'
'Refurbished machines take time to boot up.'

It is not clear whether the power units in newer models are better able at handling power surges yet this was suggested by one respondent as a clear benefit of getting newer machines:

'Power surges are more likely to break older computers.'

One institution believed that the branded refurbished computers they had received - by 'branded' they meant computers made by recognized western companies such as Dell and HP- were better than the new, but unbranded machines, they had bought from China.

'Refurbished computers are better than Chinese assembled computers. They are stronger – more appropriate for students.'

Another institution also supported this view saying:

'New computers bought in shops in Uganda were not as good quality as refurbished Dell machines – the processor was weak, the power supply blows and they seem to freeze up more.'

Camara staff confirmed that in carrying out maintenance work on this institution's machines, there were a significant number of recently bought Chinese computers suffering from power problems.

One school, once it had received new machines, stopped using the refurbished computers completely. Although it was indicated that this may have been a software issue (the refurbished machines had a Linux package) rather than a hardware issue.

'We only do teaching on the new machines as the old machines have Linux and so were not used.'

5.1.4 Maintenance of Computers

All the schools were asked whether they had some form of written maintenance policy for the computers. Only one institution, MEWA confirmed that they had such a policy, however the existence of this document was not independently verified. It should be noted that this was only organisation where 100% of the Camara computers were still working.

The schools were also asked whether they had a separate room (other than their computer lab) where broken machines could be repaired. Only two institutions reported such a room, Furra College in Ethiopia and Canisius School in Zambia. It was possible to positively verify both of these responses.

		Number of Respondents
% Institutions with a written maintenance policy	7.7%	1 out of 13
% Institutions with a maintenance room	15.4%	2 out of 13
Biggest maintenance problems:	Power	7 out of 12
	Viruses	5 out of 12

Table 5.7 Maintenance Procedures

These schools were also asked who undertook the maintenance of their machines, and of the 13 responses: five said the maintenance was carried out internally; four used external technicians; and three used a mixture of both. Some of the responses given by the institutions to the questions, **What type of maintenance policy do you have? Who is responsible for it?** are given below

> ***'Try and fix the machines ourselves. If that doesn't work we call outside maintenance technicians who are expensive. If they can not be fixed they are put in store.'***

'Computers are checked internally. If they can't be fixed they are reported to a manager who brings someone in from out side.'

'We have no proper maintenance procedures. Try to fix them ourselves and so far have not come across any problems we can not fix.'

'Try to repair internally and use parts from other computers. Do not get some one from outside as they are too expensive.'

Most troubling in all the responses given to this question was the fact that one school said that they didn't carry out any maintenance on the computers and once they stopped working they were just left there.

The main issue with bringing some one from outside the school to fix the IT problems was the considerable expense incurred in doing so. Camara records show that there were a number of other problems in addition to costs that they had come across in terms of schools employing external maintenance technicians.

- Very often these technicians had to travel from the capital city to a remote area which very often meant considerable delays in fixing the problems.

- There were cases of external technicians replacing valuable computer parts (RAM, hard drives) with inferior components.

- One of the most common solutions to a software problem was to reload the operating system. Very often an inappropriate (and illegal) system was installed which dramatically worsened the performance of the computer.

In this survey the schools reported two problems that required the most maintenance attention: power failure; and viruses affecting the operating system. With respect to power failure, a visual inspection of some of the broken machines showed that this indeed was a major problem. Despite

some attempts by Camara technicians (largely unsuccessful) at replacing faulty power units there was very little that could be done to maintain the machines that had been affected by this problem.

Our study also showed that computer viruses were a major maintenance problem for most schools. Despite the fact that most computer labs were not connected to the Internet, the wide spread presence of viruses on floppy disks and USB keys and the absence of anti-viral protection on computers meant that viruses spread very easily. Most schools that had computers affected by viruses just reloaded the operating system back onto the machines albeit causing all of the computer's existing files to be deleted In several schools Camara had to recover some of the Office files (exam results, class lists) on the administrations computers that could not be accessed because of viruses.

5.1.5 Disposal of Computers

One institution, MEWA had received newer equipment from Camara and had then passed on its unwanted but still working machines to other schools in the area.

In nearly all the schools that had broken machines the preferred disposal method was to either to keep the machines in place in the computer lab or put them in storage rooms within the institution. Several such storage rooms were visited during the survey.

		Number of Respondents
% with written disposal policy	7.7%	1 out of 13
Most popular disposal method	Kept in storage	8 out of 11

Table 5.8 Disposal of Computers

Institutions receiving computers from Camara are required to sign a form committing them to disposing of computers in an environmentally friendly manner. Camara reported that it had not come across any cases where its computer had been dumped by schools. In fact:

> ***'A broken computer was still better than no computer at all. If left in place it at least gives the illusion of a fully functioning computer lab.'***

In visiting Iman Shaffrey school in Mombasa where only 40 percent of the machines were working it was noted that all the broken machines were still kept in situ covered up.

5.2 Software and Training

5.2.1 Operating Systems

The surveyed institutions were asked which operating system (O/S), a 'Windows-based O/S' or a 'Linux-based O/S' they used predominantly. Over half, or seven out of the 13, used Windows predominantly despite the fact that the Camara machines they had received had all come preloaded with a Linux-based O/S. Camara confirmed that on receiving the computers many institutions had immediately reloaded the Windows O/S. The reason cited for doing this was unfamiliarity with the Linux O/S already pre-installed on the machines. It should be noted that the six institutions that still predominantly used Linux had converted some of their machines to Windows, particularly in their administrative areas.

All 13 institutions were asked if they had all necessary licences for Windows but only two confirmed they had, and of these, only one was able to show the actual licence certificate. All other schools and colleges in the survey confirmed that they had either knowingly used pirated copies of Windows, or had not checked with the external technician who had loaded the program as to the validity of their licences.

		Number of Respondents
% using predominately 'Windows' O/S	53.8%	7 out of 13
% who have the 'Windows' licence	15.4%	2 out of 13
% who think Linux is better than 'Windows'	80.0%	8 out of 10
What items would improve Linux:	More training materials	5 out of 10
	More teaching in Linux	3 out of 10
	Similar desktop to Windows	3 out of 10
	Making it easier to understand	3 out of 10

Table 5.9 Software Operating Systems

Institutions were asked if they preferred Linux or Windows as a software package, with 80 percent of those who expressed a preference saying that Linux was 'Better' or 'Much better' than Windows. This was somewhat unusual in that many of the institutions who claimed they preferred Linux had actually switched over from Linux to Windows. The author believes that because this survey was associated with the work of Camara, and because Camara had heavily championed the virtues off Linux over Windows, that the respondents expressed a significant positive bias in reporting their preference for Linux.

Institutions were asked what areas of the Linux package could be improved to make it more attractive to users. As Table 5.9 indicates half of the respondents wanted 'More training materials' in the use of Linux. Other areas of improvement included:

'More teaching in Linux';
'Making Linux easier to understand'; and 'A desktop environment that was closer in appearance to Windows.'

In an interview with Camara staff several other points were made with respect to the preference of operating system used.

1. Camara had sent out two different Linux packages: SuSE 6.1 and Edubuntu 6.0. This had caused confusion in some institutions who then decided to put a single package - Windows - on all machines.

2. The institutions were heavily influenced by external technicians, the majority of whom were not familiar with Linux, nor did they have a monetary incentive to reload Linux. As a consequence those schools who relied predominantly on external advisors almost always used a 'Windows' package.

3. The difference in desktop environment was a major hurdle in getting schools to use Linux. Some would turn on their machines once and because it didn't look like a familiar Windows background they did not investigate the Linux package any further.

5.2.2 Software Applications

This survey also looked at what software applications were used in the schools and colleges. By far the most popular application on the computers was its 'word processing' function and this was one of the first tools taught to students in the labs. Playing computer games and Camara's Wikipedia, (a web-based free encyclopedia pre-loaded on Camara's computers) also proved popular applications. In its training program, Camara used many of the computer games in the Linux package as a means of introducing new users to the concepts of the keyboard and mouse.

		Number of Responses
Most popular computer applications used	Word Processing	11 out of 12
	Computer games	4 out of 12
	Wikipedia (Encyclopedia)	3 out of 12

This survey asked the institutions: ***'What other application software would you like on the computers?'***

There was a wide range of applications mentioned which ranged from general educational software to more specific applications covering multimedia, accounting and music players. Some of the responses are shown below:

> ***'More educational software.'***
> ***'More teaching software.'***
> ***'Different games for children.'***
> ***'More typing tutors and more training programs.'***
> ***'Publisher[a multimedia package]. Physics materials and other sciences.***
> ***'Accounting packages. Corel Draw.'***
> ***'Chatting Software.'.***
> ***'Graphic and web design packages.'***
> ***'Visual Basic [a programming package]'***

None of the schools said there was a problem getting access to application programs. The author confirms that through personal observations, access to cheap copies of these applications, particularly in the cities, is relatively easy. Some of these packages could be bought for under €5 each whereas the retail cost in Ireland for a package such as 'Publisher' is closer to €150 (Amazon)

Only one school said that they had everything they needed in terms of software applications.

5.2.3 Training

		Number of respondents
Respondents	Word Processing	11 out of 12
Do you have enough trainers?	54% said Yes	7 out of 13
Do you have adequate training materials?	23% said Yes	3 out of 13
Biggest problems with training	Not enough computers	6 out of 13
	Not enough teaching materials	3 out of 13

Table 5.11 Training

5.2.3.1 Trainers

All of the schools surveyed had full-time computer trainers on their staff. Occasionally they would also use teachers from other parts of the teaching staff as part-time instructors.

Schools were asked whether they had a sufficient number of trainers to run an IT teaching program for the school and to look after the computer lab. Just over half, or 54 percent said that they had suggesting that a sizeable minority did not have sufficient trainers. This finding somewhat conflicted with the responses given to a more open-ended question on staffing where in response to the question: **'Can you get enough qualified staff to support the computers?'** (see Section 5.3 Staffing) most said that they had no problems.

5.2.3.2 Training materials

In terms of access to training materials only three out of the 13 institutions in the survey said that they had sufficient materials.

This outcome was confirmed by the responses supplied to the questions:
'What training materials do you use? Are they adequate?'
Generally institutions replied that there were inadequate materials available, and in large number of cases schools relied on their teachers to create their own manuals.

> ***'No materials we just use blackboard and computers.'***
> ***'Teacher prepares poor lesson plans. They do not have materials.'***
> ***'Basic training manuals are prepared by the instructors.'***
> ***'Purchase books and copy them but there are not enough however. Big shortage of teaching material.'***

This survey also asked the question:
'Where do you get the materials from?' In response the schools mentioned that they came from a variety of sources.

> ***'Materials downloaded from Internet.'***
> ***'Books downloaded from Internet (Linux in particular) but there are not enough of them.'***
> ***'Use papers from colleges. Get examples – e.g. exam papers, letters to show them how to type.'***

In only one case was it mentioned that the Ministry of Education provided a curriculum which allowed teachers to develop their own materials.

> ***'Basic training manual and ICT books from general business. Ministry of Education gave curriculum and teachers develop material from this.'***

5.2.3.3 Training Problems

Institutions found that the biggest problems they faced in providing proper computer training within their schools was a lack of computers (six out of 13) and insufficient teaching materials (three out of 13).

5.2.3.4 Training – Gender Equality

In terms of measuring gender equality in the training program, institutions were asked: **'How much do women participate in the training courses?'** The majority of those who responded said that participation was the same for boys and for girls, with two saying girls participated better than the boys.

However one female computer teacher said

> ***'There is little participation of girls –we would prefer to give opportunity to the boys because boys will go further.'***

5.3 Staffing

This study looked at the staffing levels and the quality of the staff in 12 of the institutions surveyed. One institution, MEWA is a community-based organization rather than a school and does not have a full time student or teaching population and so was excluded from this particular part of the analysis.

Average Number of Full-time Staff per Institution	**2**
Average Computer Staff as % of Total Staff	**4%**
Staff per 100 Computers	**3.9**
Staff per 100 Students	**0.2**

Table 5.12 Full-time Computer Staff

Each school had on average two full-time computer staff. This translated into nearly four staff for every 100 computers which indicates a high level of staffing for the available equipment but probably reflects a lack of equipment rather than the abundance of IT teachers. Average computer staff as a percentage of total staff is four percent and there is approximately two IT teachers for every 1,000 students.

One school with 13 full-time teaching staff, 500 students and only 10 computers claimed to have three full-time computer teachers giving it a ratio of one teacher for every three computers. It was not possible to independently verify this claim.

The survey also looked at the quality of the IT staff employed by the schools.

The majority of IT staff (in 10 of the 13 institutions surveyed) had either a degree or diploma in computer science. Only one school employed an IT teacher who had no formal qualification in computer science.

(out of 13 responses)	
Diploma	**7**
Degree	**3**
Certificate	**2**
No Qualification	**1**

Table 5.13 Level of IT Staff Qualifications

In response to the question:

> ***'Can you get enough qualified staff to support the computers?',***

only one institution said it could not get enough staff. In general institutions felt that while it was relatively easy and inexpensive to get staff, however the quality of available candidates may be inadequate.

> ***'Staff are enough.'***
> ***'Now can get graduates from different universities.'***
> ***'Not expensive to get staff.'***
> ***'Skill of the trainers is not high enough. Their skill is usually based on theory rather than practical knowledge.'***

Camara confirmed in its interview that many computer graduates, even at the degree level have little practical knowledge of computers due to poor access to technology at the tertiary colleges.

The relative ease with which schools can get qualified staff is somewhat at odds with the fact that only 54 percent of those responding saying they had adequate trainers. This inconsistency could be attributed to lack of resources available to schools for getting properly qualified IT staff.

5.4 Computer Usage

5.4.1 Computer Knowledge

The survey asked each institution what percentage of students and teachers knew how to use a computer. The results, which showed only 64 percent of teachers were able to use a computer compared to 77 percent for the students, were surprising for two reasons:

1. The survey was carried out either during, or after the period that Camara had completed its computer literacy course for the schools' teachers. According to Camara most of the teachers would have participated in the course yet responses to this survey suggested that less than two thirds were reported to be computer literate.

2. The relatively low ratio of computers to students (one computer for every 17 students) and the relatively short time they have had access to them suggests that if 77 percent of them were computer literate they must be getting this training outside of the school. Again this seems unlikely given the relative shortage of computers in general in Africa (see Chapter Three: ICT in Africa).

% of staff who know how to use a computer	**64%**
% of students who know how to use a computer	**77%**

Table 5.14 Computer Knowledge

It was not possible to independently verify whether the figures quoted for students were accurate as they were not questioned during this survey, but the institutions were independently asked: **'Who are the main users of the computers? Teachers? Students?'** All of the institutions reported that it was the students rather than the teachers that were the main users of the Labs.

One reason why the percentage of computer literate teachers may be relatively low is that only a quarter of the institutions surveyed actually used the computers as part of their teaching work. Those that did, used them primarily in administrative areas such as exam preparation, and preparing class lists. None of the schools used them for teaching other subjects, for project work or for research. In interviews with Camara staff they had not come across cases where the national curriculum was taught through computers.

Schools were asked: **'What do you use the computers for?'**. Most schools reported that, at the moment the computers are used primarily for teaching basic computer literacy courses. However when asked **'What plans do you have for them in the future?'** many wanted to expand the training to offer a proper certified course to their students. In the words of one institution: **'Give us a course with certificates.'**

Other areas of expansion were also mentioned which included:

> **'More advanced computer training to staff and to the community.'**
> **'Want to use the lab for communication purposes.'**
> **'Want to be affiliated with other colleges for advanced courses.'**
> **'In the long-run would like to use them to teach other subjects.'**

One institution, a teacher training college that had not had computers 18 months ago had very progressive and specific plans to expand its programs:

> **'We want to expand the training by establishing new campuses. Extend the basic computer education down to kinder-garden. In two years we may have a degree program in IT – software engineering and hardware engineering.'**

5.4.2 Computer Access

Results from the survey showed that the institutions' computer labs are generally used every week-day with students receiving on average one hour and 10 minutes tuition on the machines per week. Assuming a 40 minute average class period this equates to 1 ½ periods per week spent in the computer lab.

The schools were asked: **'Do students and teachers have open access to the labs?'** Generally it was reported that there was open access during the students' break and free time. However Camara's own observations were that access was limited with often the IT teacher being the only person present during break time. IT teachers reported that there was huge demand from the students to get access outside of normal class time.

		Number of Respondents
Median days per week computers used (days)	**5**	
Median hours per week students use computers (hours)	**1.2**	
% Institutions who use computers as part of other classes	**25%**	**3 out of 12**
% Institutions who allow external people to use computers	**23%**	**3 out of 13**

Table 5.15 Computer Access

5.4.2.1 Community Access

Observations made by Camara suggested that many of the surveyed schools contained the only computing facilities within the local area. However despite having control over this valuable resource, few of the schools (only three out of 13) made their computers available to the local community outside of school hours. Camara pointed out to several of the institutions that opening up the labs would have many benefits to the local community (including

parents of the students), as well as offering a potential source of income for the school to help support the running cost of the lab.

5.4.2.2 Gender Access

Institutions were asked: **'How much of the time are computers being used by men versus women?'.** There was no clear indicator that there was a gender disparity with seven of the ten institutions saying that they both made equal use of the machines.

	Number of Respondents
Equal use of computers	**7 out of 10**
Women use more	**2 out of 10**
Men use more	**1 out of 10**

Table 5.16 Gender Access

One school did say however that they would like to:

'Have more programs for girls.'

Moreover information was also sought on: **'Who gets more value out of the computers?'.** Some specific comments in response to this question suggested that women were more eager to learn about computers than men and made more use of them:

'Women are quicker than men at learning about computers.'
'The women keep coming back asking about further courses.'
'Women are more interested because they will use them in offices when they go to jobs.'

In one school which had both a male and a female IT teacher, the man thought that boys were better at computers while the women thought that girls were better!

5.4.3 Computer Qualifications

Very few of the institutions surveyed provided a formal IT qualification, either to their teachers or to their students. The two institutions that did, Harambee and MEWA ran relatively short courses supported by their own certification rather than an internationally recognized certification such as the International Computer Driving Licence (ICDL 2007).

		Number of Respondents
% Institutions who provide a formal qualification	**15%**	**2 out of 13**

Table 5.17 Computer Qualifications

In July 2007, Camara ran a two day basic computer literacy course called 'Skillbuilder' that was the equivalent of a FETAC level 3 Computer Literacy Course (FETAC 1997). Camara staff estimated that approximately 1,500 teachers, administrators, community leaders and students took the course at the end of which they received a Camara certificate. The course covered basic computer operations and use, and provided an introduction to word processing, spread sheets and drawing applications. On completing the course candidates were able to:

> ***'Understand the essential elements of computer hardware and software; operate common computer applications; demonstrate good work habits in the use and care of the computer and related equipment'*** (ibid)

5.4.4 The Internet

This survey asked institutions: **'How important is access to the Internet to developing your computer program?'** Only one lab had full internet access - in Canisius Secondary School in Zambia - but all felt that it was important for their computer programs and responded that they would like to have access in the long-run. All the institutions in the survey had access to fixed telephone

line service so in theory could have connected the labs up to the Internet; however lack of resources were the limited factor in doing so.

Despite this, respondents felt the Internet was important for them, in particular for accessing information and for communicating with others.

> **'Internet access is very important in particular for sending emails and for chatting.'**
> **'Our teachers want to continue with education and to do courses and get information from the Internet.'**
> **'We want to use it to become affiliated with other colleges who have the Internet.'**
> **'Want to use it to communicate – in particular with schools in other countries.'**

Other respondents were quite specific on what applications they would use if they were connected.

> **'We can get more information – for example, about the government.'**
> **'Use the Internet for development of our web site and getting courses in networking.'**
> **'We would use it for our science projects.'**

5.5 Costs

This study acknowledges that the cost data offered here has not been independently verified, except for that data from Camara's own internal records. Only in Ethiopia has it been possible to obtain more than one set of cost data and the range presented for such data is in some cases large. As a result this cost data is indicative at best and should only be used to draw broad conclusions.

5.5.1 Cost of a New Computer in Africa

The cost of a new entry-level computer purchased online in South Africa is €438 including VAT but excluding delivery charges. This cost also includes a two-year walk in warranty (that is you can bring the computer back to the shop to be fixed). The breakdown by component is shown in Table 5.18 below (Mercer PC 2007).

Description	Cost (€)
Total Hardware	**€270**
Total Software	**€168**
Total Cost	**€438**

Table 5.18 Computer Equipment Cost

It is not possible to compare this cost with the equivalent cost of an entry level computer in Ireland as none of the individual components are exactly alike. However the lowest cost Dell computer bought online in Ireland in December 2007 was €499 including VAT and delivery charges (Dell 2007).

5.5.2 Cost of a Refurbished Computer – Delivered to Africa

The largest UK supplier of refurbished computer to Africa is Computer Aid International who charge a fee of £39 per machine, excluding shipping, to the recipient organisation. This equates to approximately €65 - €70 per computer delivered to a port in Africa assuming a €10 per computer shipping fee. It should be noted that these figures represent actual prices paid for the

computers by the end users in Africa but do not describe the costs incurred by Computer Aid to refurbish and transport them.

Based on management accounts, Camara estimates that it costs just over €55 to collect, refurbish, clean, pack and ship a computer from Ireland to a port in Africa. Nearly 40 per cent of these costs go in salaries: technical director; workshop manager; volunteer coordinator. The next biggest costs are for workshop rent and the costs of actually sending the containers to the African port. A break down of these costs is shown in Table 5.19 below.

	Per Unit Cost	% of Total
Salaries	**€21.97**	**39.5%**
Workshop Rent	**€13.64**	**24.5%**
Container Shipments	**€9.38**	**16.9%**
Packaging	**€3.00**	**5.4%**
Utilities	**€2.88**	**5.2%**
Capital Costs	**€1.67**	**3.0%**
Other	**€3.05**	**5.5%**
Total	**€55.59**	**100.0%**
LESS: Recycling Fee Received	**€20.00**	
Total Net Cost	**€35.59**	

Table 5.19 Unit Cost of Sending a Refurbished Computer to Africa

Camara charges a recycling fee of €20 per machine from the Irish organizations it receives computer from. They estimate that this is a little bit below what it would cost those same organizations to recycling their obsolete equipment with an authorized recycler. Netting this recycling fee against the €55 unit cost total (see Table 5.19) means that Camara can deliver a refurbished computer to Africa for approximately €35 per machine.

5.5.2.1 Subsidised Price

However Camara does not charge the recipient organization the full cost for the refurbished computer. Rather it charges a flat fee of €5 per computer

delivered to a port in Africa, effectively subsidising each machine by €30.

> ***"For €5 a recipient can get a machine with somewhat lower specifications than a new computer but certainly adequate enough to allow the school to use them in their educational program."***(Camara Management Accounts)

A comparison of the specifications for a refurbished computer against a new computer delivered to Africa is shown in Table 5.20 below.

Component	New	Refurbished (minimum specifications)
Processor	**Pentium IV**	**Pentium III**
RAM	**512MB**	**256MB**
Hard Drive Size	**80GB**	**10GB**
CD/DVD	**CD ROM**	**CD ROM**
Monitor	**15" CRT**	**15" CRT**
Keyboard	**Yes**	**Yes**
Mouse	**Yes**	**Yes**
Warranty	**2-year Walk -in**	**None**
Operating System	**Windows XP**	**Linux Edubuntu**
Office Package	**Microsoft Office**	**OpenOffice**
Total Cost (ex. Delivery)	**€438**	**€35**

Table 5.20 Computer Specification Comparison

5.5.3 Cost of a refurbished computer - Delivered to the school

Once delivered to Africa the Camara computers become the responsibility of the recipient organization. That organization then incurs additional costs such as: port fees; internal transportation to the end destination; and government taxes before they get the computers to their final destination.

It was not possible to calculate an average value for the additional costs incurred in getting the computers from the port to their final destination for two reasons:

1. Different port charges, distances to be traveled, and government taxes mean that there is no consistency in data.
2. Few of the surveyed organizations were able to supply sufficient data to accurately calculate the final cost of the computers delivered to their schools.

However taking these limitations into account and using what data does exist suggests that port charges and internal transportation together could add a further €10 to €30 per computer in additional costs to the schools depending on what port the machines are being delivered to and how far the port is from their final destination.

Ignoring government taxes (only Ethiopia requires government taxes to be paid on refurbished computers and the level of charges varies from zero to approximately €50 per computer) and taking €20 as a mid-point cost of getting the computer from the port to its final destination, the net cost of getting a Camara computer to a school is approximately €55.

Computers for Africa, a US NGO charges $75 per computer delivered to a major African city. This equates to approximately €50 - €55 per computer, including port charges and internal transportation, very much in line with the Camara total.

5.5.3.1 Affordability

The rationale around Camara's €5 subsidised fee is that it takes into account the wide disparity in income levels between Ireland and countries in Sub-Saharan Africa, and sets a price level where the cost of buying a refurbished computer in Africa is equivalent to buying a new computer in Ireland. This calculation is demonstrated in Table 5.21 below.

If actual amounts are adjusted to account for the income differential between Ireland and Sub-Saharan Africa, that is actual African costs are pro rated

upwards based on the difference in GDP per capita (HDR 2006), the equivalent price for buying a refurbished computer would be between €499 (with subsidy) to €1,097 (without subsidy). According to Camara, the subsidy means that

> ***"Even though we don't believe in giving away these wonderful tools for nothing, a subsidy is justified in that it makes technology widely available to education in Africa and allows even the poorest schools to afford computers in the class room."***

	Actual Cost (€)	2004 GDP per Capita (PPP US$)	Equivalent Cost (€)
SSA - With Camara Subsidy	**€25**	**$1,946 (SSA)**	**€499**
SSA - Without Camara Subsidy	**€55**	**$1,946 (SSA)**	**€1,097**
Ireland - New Dell Computer	**€499**	**$38,827 (Irl)**	

Table 5.21 Equivalent Cost of a Computer

5.5.4 Cost of Setting up a Computer Program

Only in Ethiopia were there sufficient data points to determine the cost of setting up a computer lab, costs that included: electrical wiring, ventilation, security, decorating the room and furniture. This study normalized these costs based on the number of computers in each lab.

The survey produced a wide disparity in costs between the different Ethiopian institutions with computer lab set up costs ranging from seven euros to €46 per computer - the median cost being €17 per computer and the average cost being €21 per computer.

5.5.5 Cost of Running a Computer Program

There are a number of costs associated with running a computer lab, the largest being the cost of hiring an IT trainer/supervisor. The average cost of hiring an IT supervisor/trainer in Ethiopia is €905 per year and the range being €679 to €1,131 per year (three institutions reporting).

In addition to the cost of hiring an IT trainer/supervisor, the school's have other computer-related operational costs including electricity, maintenance and supplies. The average yearly running cost, including the cost of a single IT person, for a computer lab based on the three Ethiopian schools that reported was approximately €2,250 per year. This equated to approximately €45 per computer per year.

Again these figures are indicative at best and it is likely that average running costs per computer is likely to be lower the more computers that are in the lab. Also different salary levels and prices for electricity mean that costs in other countries are likely to be different to those in Ethiopia.

5.5.6 Total Cost of Ownership (TCO)

Given the limitations in cost data available, this study has defined the TCO over the life of the computer to include: (1) the initial cost of buying the computer; (2) the cost of getting it from the port to the school; (3) the cost of setting up a computer lab; (4) the cost of operating that lab over the life of the machine; and (5) the cost of disposing of the machine at the end of its life.

It was not possible to estimate the cost of disposal of electronic equipment in Africa, so this author has proposed a cost of €5 per machine, this being approximately the cost for Camara to dispose of such equipment in Ireland.

The total cost for a school that wanted to set up a computer lab using refurbished computers that currently have an average life of 2.75 years and without any form of subsidy (see Section 5.1.2 Calculation of Average Computer Life) would be €225 per computer (see Table 5.22 Total Cost of Ownership below).

(per computer)	With Camara Subsidy	Without Camara Subsidy	% of TCO (without subsidy)
Net Cost of Computer to Africa	€5	€35	17%
Cost from Port to School	€20	€20	10%
Cost of Setting up Computer Lab	€21	€21	10%
Cost of Running Lab	€124	€124	60%
Average life of computer (years)	2.75	2.75	
Cost per year of running lab	€45	€45	
Estimated Cost of Disposal	€5	€5	2%
Total Cost of Ownership (TCO)	€175	€205	100%
TCO per year	€64	€74	

Table 5.22 Total Cost of Ownership

What this analysis also shows is that, on an annual basis, a school should look at budgeting approximately €65 - €75 per computer to run a computer lab, and included in this amount is the cost of buying the machines.

What is probably not fully appreciated by the schools receiving computers is that even, while the cost of buying a refurbished computer is relatively low, it only represents a quarter of the total cost of effectively operating that machine over its life.

5.5.7 Costs versus Benefits

It was not possible at this time to put a financial value on the benefits that the students and teachers receive who are using computers as part of their educational program. However this study asked the institutions: **'How important are computers in your institution? Do they justify the costs?'**

Without exception all respondents believed that the computers were very important for their institutions and that even though they could not quantify them, that the benefits out-weighted the costs. Typical responses included:

> ***'Yes computers justify the cost. Their benefit is much greater than the costs.'***

One institution, a community group which charged people for the use of their computers, while agreeing that, the benefits outweighed the costs believed that more work needed to be done in order to sustain their program financially.

> ***'Computers are a challenge to sustain economically. We need to run four sessions (two hours each) per day, five days per week each week. As we can not do this for all weeks the only alternative is to raise fees.'***

Institutions were also asked: **'Have the computers helped you? In what way can computers help you, your teachers and your students?** All the institutions responded that the computers had helped them with the words 'computer literate' and 'capacity building' being used most often to describe the benefits.

> ***'Students are now more aware and computer literate than before.'***
> ***'Children are now computer literate – particularly those who do not have computers at home. Teachers have also benefited by using them.'***
> ***'Computers have allowed us to build capacity in ICT for staff and students.***

Other benefits described by the schools include

> ***'Students had never seen computers before now they have a very proud sense of ownership.'***
> ***'Students knowledge is increased.'***

‘ Administration has become more efficient.’

Outside of the class room, institutions believe that the impact on the wider community is also important.

‘Parents have become very interested in computers and are much more willing to support them.’

Some institutions said that one of the very tangible benefits the computers have shown is that they act as a type of magnet, attracting new students to their schools. A specific response being:

‘Computers have helped us to attract more students.’

Camara suggested that some schools use the computer lab like a **‘trophy room’.**

‘One school in particular had 20 computers, none of which worked but they were left in place so that schools could claim that they had computing facilities.’ (Camara)

5.5.8 Sustainability

One of the major issues faced by schools in Africa who are introducing new technology into their educational program is the sustainability of such technologies. Part of the answer to the question of sustainability was addressed in Section 5.5.6 Total Cost of Ownership; this survey also looked at it from a wider point of view by asking the institutions: **‘Do you have enough resources to maintain the computers sent to you? What else do you need? What are the main things you lack to advance your computer program?’**

Only three out of the 10 Ethiopian and Kenyan schools stated that they had enough resources to maintain their computer program with several stating that they needed more money.

'No we do not have enough resources. We would like to form an IT committee to get more money.
'We need to raise the fees or have more people attending training to support the program.'

Others did not mention money specifically but did say that they needed other types of resources – all of which it can be argued are readily available with enough money.

'No do not have enough resources. We need more spare parts and more training for the teachers – in networking and software administration.'

'We would like the Board to form an IT committee and help get some one to maintain the computers.'
'We don't have enough software or books.'
'Not enough money or expertise.'

So why it is clear that schools see the benefits of computers and they can now obtain them at affordable prices, their long-term sustainability is still not guaranteed.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The aim of this study was to examine how ICT supplied by Camara was being used in schools in Sub-Saharan Africa. A particular area of focus was the performance and sustainability of Camara's refurbished computers. Other areas such as the gender differences in computer usage, the suitability of different software packages and the need for ICT training were also evaluated.

The primary conclusion from this research is that, while there is a huge hunger in African schools for ICT, the availability of these technologies remains limited and their application within the educational sector remains inefficient. Furthermore, even if African schools gained access to ICT, most can not sustain it with current resources. In order for ICT to be an effective tool of education, it must be made both affordable and relevant to the needs of the local people.

1. While it is widely recognised that there is a large and growing digital divide between Africa and the developed world, there has been significant improvement in the access to ICT for Africans over the last decade with most of this improvement coming in the area of mobile phones usage. Though there has been growth in computer ownership this growth has been much slower, and access to potentially the most powerful ICT of all, the Internet remains very poor.

2. The reasons for lack of growth in some ICT areas are two fold: inadequate policy formulation by African governments means that there is no coherent plan for making ICT readily available; and even with a plan, the relatively high costs of these new technologies means they remain outside the range of most ordinary Africans. While many attempts have been made to provide low cost computing for Africa, none to date have been commercially sustainable.

3. Arguments still rage between the best hardware and software alternatives available to Africa – which is cheaper and better in the long-run; new computer or refurbished computers; proprietary software or free and open source software? As yet no firm conclusions have been reached in this argument.

ICT has become more accessible in Africa yet its impact on education has been slight.

1. While the educational needs for Africa remains high, the prevalence of ICT in schools in Africa remains painfully low, primarily due to their relatively high cost.

2. Despite numerous studies identifying positive results from the use of ICT in education in developed countries, there is little empirical evidence to suggest what, if any, benefits there might be in Africa. Whether this is due to the fact that ICT in education in Africa just does not work, or more likely because there is a lack of data from large-scale long-term ICT educational programs, the fact remains we don't know yet if ICT in education in Africa is worth investing in.

3. While the benefits are not clearly defined, the cost of providing Computer-Based Instruction (CBI) in schools in Africa may be considerable. Using direct comparisons with schools in developing countries, CBI in Africa could cost up to $60 per student per year, which in the context of a total annual school budget of $100 per student per year is not sustainable.

On a more micro level, the small universe of schools and colleges surveyed as part of this study suggested a number of interesting conclusions about the use of ICT in education:

1. One of the keys to making ICT accessible to schools in Africa is the price of technology. This research has shown that the cost of a single new computer in Africa is a quarter of the average GDP per capita of the region, putting it well outside the range of most

Africans. A refurbished computer however is over 12 times cheaper than a new computer making it much more affordable for African schools.

2. Whereas refurbished machines have two disadvantages over new machines, these disadvantages are easily surmountable:

   a.They have lower component specifications. Yet for teaching basic computer literacy and using simple software applications it is not clear if high specification equipment justifies the additional costs.

   b.The average life of a refurbished computer is much less than for a new machine, between two and three years. However with proper lab setup and good maintenance procedures these problems can be minimised to extend the average life of refurbished machines.

3. Within the African educational system there are no procedures in place for the proper maintenance of equipment or the disposal of obsolete computers. There is a justifiable criticism that international organisations that just send over refurbished machines to African schools are dumping unwanted electronic equipment there. Most organisations do not yet have a sustainable plan about how to address this issue but one option suggested by Camara is the creation of recycling facility as part of a local refurbishment centre.

4. Proprietary software, in particular the Windows Operating System and Office suite of applications are the most popular software currently being used in African schools. The majority of this software is currently not licensed and can be obtained at a very low price locally. Because of this low cost and general familiarity with the product, alternative software packages such as Linux are finding it much harder to be accepted within the educational sector.

5. Whereas it costs as little as €55 for an African school to receive refurbished computers, the total cost for owning those computers over their life may be four times that amount. As a result, the

sustainability of a school's computer program is determined largely by ongoing operational costs rather than the initial purchase price. Schools that have not accounted for this fact have generally struggled to sustain this technology.

6.2 Recommendations

This study concludes by making two recommendations.

1. Even though there remains considerable problems in transferring ICT from developed countries to Africa, not least of which is its sustainability, efforts must be made to adapt these ICTs to fit into the realities that exist in Africa today. Affordability and relevance are the two key components of this work. ICT should be adapted so that its costs reflect the national income of the country in which it is being used. Also more of the development of ICT should be transferred over to African countries who better understand the needs of their own people.

2. On a more practical note, much more quantifiable research needs to be carried out, particularly in terms of measuring the costs and benefits of using ICT in education in Africa. This area is too important not to be subjected to rigorous research. The reality is that international donors and African government are likely to be spending significant amounts in this area in the future and without this research much of this money may be wasted.

Two areas of potential study are:

a. A more detailed TCO study based on actual computer lab data from schools

b. An assessment of the performance of children who rely on CBI compared to the performance of children who rely on traditional teaching methods

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