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Can the Internet in tertiary education in Africa contribute to social and economic development?

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ABSTRACT

Poor Internet connectivity is one of the serious underlying causes of the digital divide between developing and industrialized countries, and is hampering the transition to the global information society. The recent emergence of national and regional research and education data communication networks in parts of the developing world have shown large benefits arising from collaboration amongst tertiary education institutes. Africa is currently the most underserved continent in terms of information and communication technologies. Collaboration amongst tertiary education institutes in Africa is essential to make them key players in the enhancement of information and communication technologies for society.

Keywords: *Tertiary education, ICT, development, research & education networks, Internet.*

INTRODUCTION

Technological advancements, global telecommunication and automation have greatly contributed to economic growth in the world over the past decades. However, not all regions, countries and people in the world have benefited equally from the opportunities that information and communication technologies (ICT) offer. Especially rich industrialized countries and several countries in transition have profited from the information age and attained high economic growth figures. The advantages of the information era have been significantly less for developing countries, which generally lack favourable conditions for deployment of new technologies. This difference in access to ICT between the poor and the rich is referred to as the digital divide.

ICT is considered one of the key factors behind sustainable development, not only as a means for automation of work processes in business and industry, as a tool for education and scientific collaboration, and a platform for technological innovation, but also for communication and access to information. It thus contributes to democratic empowerment and poverty reduction (Potter et al. 1999:137). Poverty, poor access to education and lack of public investment capital are commonly believed to be the main causes of the digital divide, however, other causes may be of influence. A basic understanding of the mechanisms of the implementation and the role of ICT in society is necessary to reduce this digital divide, bearing in mind the local circumstances, differences and cultural contexts. This paper focuses on Africa, the most underserved continent in terms of ICT.

Many African countries have defined governmental policies to support ICT, in the past few years. Numerous ICT-initiatives and projects are taking place simultaneously in African countries, supported by the World Bank, the European Commission, the United Nations and many other donors (Hawkins 2005, Steiner et al. 2005).

The United Nations Millennium Declaration (UNMD 2000) contains a commitment to “ensure that benefits of new technologies, especially information and communication technologies” …”are available to all”. In the “Declaration of Principals” for the World Summit on the Information Society (WSIS), held in Geneva in 2003, goals were set for developing “…a people-centred, inclusive and

development-oriented Information Society, where everyone can create, access, utilize and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life.." (WSIS 2003)

The role of education in bridging the digital divide is crucial. In this paper I will describe the key role of tertiary education in the quest for good Internet access to improve information and communication flows, that can contribute to social and economic development.

INTERNET IN AFRICA

Africa's population of approximately 933 million inhabitants represents 14% of the total world population. The estimated number of Internet users[1] in Africa in 2007, is 33 million, which represents 3.6 % of the Internet users in the world. Excluding South Africa (and the North African countries of Morocco, Algeria, Tunisia and Egypt, which have higher Internet usage figures), the penetration of Internet in Sub-Saharan African countries is an average of 2%. Yet, Internet use is growing fast in Africa: more than 600% for the whole of Africa, over the period from 2000 to 2007. This can be compared with the total world Internet usage growth, which was just over 200% in the same period. (Internet World Stats 2007a). The number of Internet users in a country can be considered a "digital indicator" of the adoption of ICT in society, and the integration into the global networked economy.

Table 1: *Population per country, number of Internet users and penetration: percentage of Internet users relative to the total population: (source Internet World Stats 2007a and 2007b)*

	Population in 2007	**Internet users, most recent data[2]**	**Penetration**
Total World	6.574.666.417	1.114.274.426	16.9%
USA	301.967.681	211.108.086	69.9%
China	1.317.431.495	162.000.000	12.3%
Netherlands	16.447.682	12.060.000	73.3%
Total North Africa	153.156.098	12.805.000	8.4%
South Africa	49.660.502	5.100.000	10.3%
SSA	736.925.602	15.871.800	2%

E-READINESS AND DIGITAL INFRASTRUCTURE

The integration into the global networked economy of a country can be assessed by computing "e-readiness" (Bui et al. 2003; Ifinedo 2005). Eight factors are used to evaluate the e-readiness of a country: digital infrastructure, macro economy, ability to invest, knowledgeable citizens, competitiveness, access to skilled workforce, culture, cost of living and pricing, according to Bui et al. (2003).

When considering the e-readiness factor of digital infrastructure, it is clear that building a physical telecommunication infrastructure in Africa will require high investments. Low population density

and large distances between urban centres are unfavourable conditions for the expansion of a continent-spanning communication infrastructure. In such circumstances there is no promise of quick revenues for private investors in country-wide telecommunication infrastructures.

Nevertheless, several studies have shown that lack of financial means for investments are not the main reasons for the absence of a regional Internet infrastructure, as might have been expected. A study of the availability of optical fibre connections on the African continent was carried out in 2004-2005. It was sponsored by the World Bank and the Canadian International Development Research Centre (IDRC), covering the south eastern countries, and was implemented by the Southern Africa Regional Universities Association (Muchanga 2005). This revealed the existence of thousands of kilometres of private high capacity transmission over optical fibre cabling, owned by power utility companies, and other pipeline operators. However, closed governmental policies and regional regulations in many countries have until now prevented the use of this valuable infrastructure for public communication purposes (Pehrson & Ngwira 2006:5).

The real problem that holds back the use of Internet is the high cost for Internet connectivity for end-users in Africa. An African consumer pays, on average, 240 times as much for the same Internet connection as someone in the Netherlands. The high pricing is an obstacle for the deployment of Internet in Africa. The main challenge, therefore, is to bring the costs down.

CAUSES OF THE HIGH PRICE OF INTERNET

It is important to understand the market mechanisms that contribute to the excessively high prices for Internet connections in Africa. Internet infrastructure in African countries is dominated by private telecommunication companies and some monopolistic state companies. In Sub-Saharan countries, access to the rest of the global Internet is exclusively through wireless satellite connectivity termed VSAT, or through submarine optical cable. VSAT dishes connect via a satellite directly to dishes in the US or Europe, and subsequently with the large Internet exchanges in the world, located in e.g. Amsterdam, London, Paris or New York.

A submarine cabling system, called SAT-3/WASC/SAFE was completed in 2002, and has landing points in eight African countries, situated mainly along the west coast (Senegal, Ivory Coast, Ghana, Benin, Nigeria, Cameroun, Gabon and South Africa), and it also connects to Spain, Portugal, India and Malaysia. Most landlocked countries in Africa (with exception of Mali and Burkina Faso) and countries on the east coast are currently not connected to this submarine cabling system.

The VSAT wireless Internet connection appears to be an adequate alternative for Internet in places that cannot access the submarine system. A dish can be easily purchased and installed anywhere. Almost every university in Sub-Saharan Africa is already connected to the Internet via VSAT (Hawkins, 2005).

The downside of VSAT connection is the high price, the inferior connectivity quality and lower bandwidth[3], as compared to optical cable, plus the fact that no local infrastructure is being built. It is estimated that Africa spends 400 million US $ per year on VSAT connections, mainly to international, not African, companies (Drouot, 2005).

Let us consider a case when two users at, for example, the Cape Coast University in Ghana send an email to each other, using email addresses from American providers such as hotmail.com (MicroSoft Corporation) or yahoo.com (Yahoo). While both persons are located on the same campus, the email travels through the VSAT, 4 x 36000 km: to the satellite and through the

exchange point in, for example, Amsterdam, back to the satellite, and again to the campus. The whole travel of the email usually takes only a few seconds, but it represents a disinvestment in terms of building up local capital. The Internet providers and satellite owners are international companies. All the budgets spent on VSAT – connections flow away from Africa, instead of being reinvested in local infrastructure.

Glass (optical) fibre is the best medium for data transport, and is much more sustainable than satellite wireless, but it requires high initial investments. One optical fibre pair (dark fibre) can nowadays carry 80 Gbps of data, which is 80.000 times the capacity of an Internet connection for an average university in Africa. In each glass fibre duct hundreds of fibre pairs are bundled together, giving a total connectivity of Terabits (1000 Gigabits) per second for one single duct. Nevertheless, the return on investment of optical cable infrastructure is often too risky for private investors.

One of the main goals of the SAT-3/WASC/SAFE cable was the reduction of connectivity costs to the Internet, for the participating nations (Jensen 2006). However, the lowering in price did not happen, because the connection was shared by a closed consortium of dominant telephone companies and telecom state monopolies (Gedye 2006). There was, unfortunately, no Open Access Model or governmental policy or enforcement regulation to break the monopolistic market position of the members, and thus lower the Internet prices (Drouot, 2005).

The east coast of Africa is currently completing its EASSy cable, the East African Submarine cable System, which is expected to be operational in 2007, and runs from Port Sudan (Sudan) in the north to Durban (South Africa). This will complete the fibre loop surrounding Africa, by connecting Djibouti, Somalia, Eritrea, Ethiopia, Kenya, Tanzania, Madagascar and Mozambique (Olawo, 2005).

The submarine cabling systems are a positive step forward in bringing Africa “on-line”, but additional infrastructure is required to connect the inland regions and landlocked countries to the landing points.

As shown by several studies, including the SARUA fibre study (Muchanga, 2005), power utility companies commonly use optical fibre for the operation of their core business; so many investments in expensive infrastructure are already done. This electricity fibre infrastructure might easily be shared by other companies, such as Internet providers, or public user consortia, without affecting the electricity business, and without technical or market constraints. The use of the infrastructure by several (competing) business partners, is not only common in the rest of the world, it is even enforced by Open Access policies and regulations in many countries to prevent monopolies (e.g. the OPTA and the NMA in the Netherlands, Independent Regulators Group (IRG) and the European Regulators Group (ERG) for the European Union).

THE IMPORTANCE OF INTERNET IN TERTIARY EDUCATION

The importance of ICT and Internet in tertiary education is generally recognized. The Internet represents the world’s largest knowledge data base. This information is easily accessible through powerful search engines. The Internet can substitute for expensive hardcopy libraries, and provide access to resources of scientific publications and scholarly information, when students have daily access to computers and the Internet with sufficient bandwidth for downloading and exchanging documents over the network.

The American technology institute MIT (Massachusetts Institute of Technology) has made available complete BSc. and MSc. level curricula that can be accessed and downloaded through the Internet. Their statement on this is: "…While recognizing that people in the developing world — who may benefit most from the open sharing of knowledge — are hindered by a lack of Internet access and connectivity, we must not let this problem obscure our vision of the future, but rather, take it as a challenge: Can the decision-makers of the world's leading educational institutions use what we are doing on our campuses to improve the lives of people around the world? History has proved that education and discovery are best advanced when knowledge is shared openly. We believe the idea of open courseware is an opportunity that we must seize during the next decade" (MIT 2001).

The Internet can also improve collaboration and interaction with research groups in other institutes, regions or countries contributes to quality of research and education. The Association of African Universities (AAU) shares this vision by stating on their website: *"*African universities and researchers are often working in a silo model, insulated from regional actors and drivers of funding and requirements. Through establishing low cost high quality networks a platform for generative discourse can be created leading to improved policy advice, more effective cross pollination of best practices and lessons …" (2007).

Distance learning is already used at many African universities, and fills a clear need for education of people who work during the day, and live in remote areas. Distance learning can be improved significantly by the use of Internet and electronic learning environments.

All the above mentioned activities require adequate Internet connectivity with sufficient bandwidth. To underline this statement, the following goal was set by the Association of African Universities (AAU), at the Conference on African Research and Education Network Infrastructure, held in Tunis, in November 2005; here professor in Telecom Systems Björn Pehrson, from the IT-University KTH in Sweden, mentioned:
"No later than 2008, universities and research institutions in Southern Africa will have access to broadband services and the global Internet on the same level as peers in the developed parts of the world, with a quality of service in the Gbps rather than kbps[4]", (Association of African Universities 2005).

PROBLEMS IN THE DEPLOYMENT OF INTERNET

In addition to adequate and inexpensive broadband access to global Internet, higher education institutes need proper institutional ICT management. Lack of an ICT strategy and policy often leads to inefficiency in operational and management structures of ICT departments. Sife et al. (2007) describe lack of systematic approach, and lack of awareness and attitude towards ICT at institutional level as one of the challenges for higher learning institutions in developing countries.

Connectivity at African universities is often obtained through expensive VSAT connections, because of lack of a regional optical backbone. The capacity of this VSAT is acceptable, but it is not comparable to an optical connection, and it is unsuitable for broadband document downloading, and data exchange and other bandwidth consuming applications. This capacity is further reduced by inadequate management of campus networks, causing frequent power cuts, service denial, poor security, and virus spread, leading to even lower capacity of Internet to the end-users. This is caused by poor ICT management and insufficient human resource capacity. Other problems in the deployment of Internet are lack of ICT equipment, high licence fees for software, and lack of ICT-skilled teachers, technicians and support staff.

OTHER TERTIARY EDUCATION NETWORKS IN THE WORLD

It is possible to bring the Internet to African society through tertiary education, in the same way that it happened in the rest of the world. The Internet originated in the domain of higher education. Although the technology for interconnection of computer networks was developed for the American military network, important applications such as email and http (i.e. the world wide web), emerged within higher education (Stanton & Stöver 2005; SURFnet 2002). There are successful examples from many countries of how collaborating tertiary institutes have improved the national ICT situation.

In Europe, national research and education networks (NRENs) were established in the 1980s and early 1990s to interconnect universities, mainly for use of email. Networking technologies evolved every year, gradually enabling larger data exchange and more enhanced applications. In 1993 a consortium of European NRENs was formed, called DANTE (Delivery of Advanced Network Technology to Europe) and its first international network of networks was formed, named GÉANT. GÉANT has recently been connected to Asian university networks forming TEIN (Trans-Eurasia Information Network). GÉANT2 and TEIN2, as the second generation networks are named, operate at high data transmission rates, up to 80 Gbps.

In Latin America (LA), a collaboration initiative between several universities led to the formation of a continent wide research and education network in 2005, RedCLARA, through the interlinking of seven existing NRENs (Argentina, Brazil, Chile, Costa Rica, Mexico, Uruguay and Venezuela) and the formation of seven new NREN's (Colombia, Ecuador, Guatemala, Nicaragua, Panama, Peru, El Salvador). RedClara was then connected to GÉANT. The project costs were 12.5 million euros and were financed by the European Commission (80%) and the governments of the participating countries (20%). The backbone is mainly composed of optical cable, and some copper wire (Stanton & Stöver 2005).

The RedClara network interconnects 600 universities in Latin America and 3,500 universities across Europe. The first scientific collaboration projects between LA and EU which directly benefited form this new network were in the field of grid computing, astrophysics and life sciences.

Six groups from Mediterranean universities have taken the first step towards forming an association of Mediterranean NRENS in 2006; these are Algeria, Egypt, Jordan, Morocco, Palestine and Syria (EUMEDconnect 2007).

The Eassy cabling system, that is currently being developed for the east coast of Africa, was at risk of being a copy of the monopolistic system applied by the SAT-3 cable, instead of an Open Access connectivity model (Zuckermann 2006). With aid of the AAU, a consortium was formed in 2006, called Ubuntunet Alliance, composed of 43 universities in south-eastern Africa, to negotiate with the EASSy operating companies, in order to obtain a considerable bandwidth on this cable, against low price. This initiative is supported by the World Bank, which is willing to contribute financially to the Eassy project, on condition that the Open Access will be applied (Balancing Act 2005).
In West Africa, until present, only a few consortia or NREN initiatives exist between universities, or countries. Yet, awareness is increasing, and this might happen in the very near future. Many countries were encouraged by the Ubuntunet Alliance initiative, and have expressed interest in contributing and subscribing to this consortium (Steiner et al. 2005). These are currently Botswana, Burundi, Cote d'Ivoire, Democratic Republic of Congo, Egypt, Lesotho, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe UbuntuNet 2007).

DISCUSSION

The problems African universities are facing in their deployment of ICT, aggravated by lack of communication and collaboration with peers, may become a vicious circle. The scientific field is a preferential ground to create a collaborative environment, ultimately promoting scientific and technological development.

Internet connectivity and pricing could be considerably improved by the formation of bandwidth consortia, which cooperate and emit tenders, insist on low prices, and encourage competition between Internet providers. Consortia of tertiary education institutes consist of homogeneous user groups that can also lobby at governmental level. The high prices of Internet connectivity in Africa are a direct consequence of a producer dominated market, too few consumer organizations and lack of governmental policies and regulations enforcing competitiveness.

In many countries of the world, tertiary educational institutes have already organized themselves into consortia to obtain and share resources. These National Research and Education Networks consortia, (NRENs), are important organizations that can influence ICT policies on a national scale and benefit their member institutions (Dyer 2005). The member institutes share the same need for good bandwidth and affordable Internet connectivity, forming a strong consumer group.

Taking the example of the SARUA fibre study (Pehrson & Ngwira 2006), similar studies in other parts of Africa should be carried out, in order to map the available optical fibre connections that might be used as regional backbones.

The next step would be gaining access to these private closed infrastructures. This could be developed in public-private projects, where again consortia of tertiary education institutes can act as strong lobby groups to enforce Open Access, thus making these infrastructures also available for society.

At remote sites where no optical backbone is available, consortia can negotiate for lower VSAT prices, through economics of scale. Moreover, tertiary education consortia can negotiate still other issues, such as favourable licence fees for software.

Because infrastructure that connects research and educational institutes with one another constitutes an indisputable public good, donor investments can be applied without disadvantage and false competitiveness to the private companies. The enforcement of Open Access by governmental legislation policies on the communication infrastructure could be obtained by the lobbying consortium as well, using the examples of many countries where this type of legislation has already been adopted.

CONCLUSIONS

African countries need good and inexpensive Internet services, to become “information societies” in their search for more favourable social and economic conditions.

Tertiary education institutions should be aware of their key role, as contributor to Open Connectivity and of their potential influence in market mechanisms. At this level, user awareness is important as well as knowledge of mechanisms that control the telecommunication market. Examples from peer institutions in other countries are very important. Some countries in Africa are already joining forces, but many are still failing to grasp this opportunity! The human resource capacity problem in ICT must be addressed at both management and at technical and operational

levels. Collaboration between institutes should be encouraged on regional and international platforms.

Governments should apply their legislative authorities to enforce “low price/ high connectivity” business models and encourage competitiveness, so as to prevent monopolistic telecommunication markets. This is essential both for the connection to the global Internet, and for the formation of a regional communication infrastructure, owned by private or state companies.

Donors should be aware of the importance of ICT and Internet connectivity as a motor for economic and social development, and should focus attention on this in their development programmes.

The private telecommunication sector should be aware of the business opportunities that may emerge when Internet penetration increases by low price/high volume business models for connectivity. Last, but not least, all the above mentioned stakeholders should collaborate and focus on the issue that will bring benefit to all: how to bring Africa online.

Endnotes

[1] An Internet user is defined here as anyone currently in capacity to use the Internet, i.e. having access to an Internet connection point, and with the basic knowledge to use it.

[2] The most recent data available on Internet usage per country are estimates as from 2005, 2006 or 2007. From just a few African countries the most recent data are from 2003 (Internet World Stats 2007).

[3] Bandwidth in kbps (kilobits per second), Mbps, or Gbps is the unity in which the amount of digital data transmission per time interval is expressed.

[4] Professor Pehrson was referring to a difference of a factor > 1000 in data transfer rate between African universities and other universities in the World.

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