

Now and Then: Internet use in research in sub-Saharan Africa

Adekunle Okunoye
Turku Center for Computer Science TUCS
University of Turku/Computer Science
Lemminkäisenkatu 14 A, 2nd floor
20520 Turku
Finland

Email: adeokun@cc.jyu.fi
(Corresponding author)

Helena Karsten
University of Turku and TUCS
Lemminkäisenkatu 14 A, 2nd floor
20520 Turku
Finland

Email: eija.karsten@cs.utu.fi

Acknowledgements:

We gratefully acknowledge the financial support given by University of Jyväskylä for the empirical study. All those giving their time and thoughts to us during the empirical study in Nigeria and The Gambia deserve our heartfelt thanks. The Turku Centre for Computer Science (TUCS) and especially the Knowledge Management and Data Mining Laboratory within it provide us a supportive and challenging research environment.

Now and Then: Internet use in research in sub-Saharan Africa

Abstract

Internet is increasingly being used to support the work of the research scientists in sub-Saharan Africa and it is changing the ways in which research is being carried out. This article discusses some of the activities before and after connectivity to the Internet in six research organisations in sub-Saharan Africa. We explored Internet use in literature access, communication, collaboration and coordination. The benefits are seen to be improved access to current literature and reduction in searching time and cost, faster communication, ease of collaboration and improved coordination. However, Internet is not fully deployed, due to problems in basic infrastructures, partially insufficient IT expertise, and inadequate funding. Based on this study, we recommend cooperation among research organisations and exploration of cheaper sustainable alternatives in addressing the problems.

1 Introduction

Our area of interest is Internet use in research institutions in sub-Saharan Africa. Before the Internet, knowledge workers such as research scientists in the least developed parts of the world, especially in sub-Saharan Africa, have had difficulties in reaching their colleagues outside the boundary of their organisations and in getting access to current publications (Arunachalam 1998; Arunachalam 1999). The problems with the post, telecommunications, banking, transportation, among others, have made the researchers relatively isolated. Distribution of research results has thus been tedious and time-consuming. The constraints on distributing the research results have led to a certain kind of low visibility. Thus it is not surprising that the least developed parts of the world are often referred to as information have-nots (Arunachalam 1998; Rodriquez and Wilson 2000)

A UNESCO report tells about the problems faced by researchers and scientists in developing countries prior to the Internet:

“The field of scientific research is shrinking in many developing countries. Budgets are becoming tighter. As a result, scientists in developing countries lack proper facilities and equipment for conducting research. Developing country researchers and scientists also lack access to scientific research conducted in developing countries and in industrialized countries. Their work is under-represented in much of the documentation and databases that currently exist. They are also constrained in sharing and disseminating information with different institutions within their country as well as with other countries. The result is that researchers and scientists in developing countries are not able to collaborate on an equal footing with their peers around the world.” (UNESCO 1996)

The number of Internet subscribers in sub-Saharan Africa, our area of interest, has increased from 359,675 in 1998 to 1 million in 2001. (ECA 1999; Jensen 2001) There

are 2.3 Internet hosts per 10,000 people (Table 1). This is still very low when compared to the 603,5 hosts in high-income countries (The World Bank, 2001). Most of the countries in the region have more than one Internet Service Provider (ISP). The countries in our study, Nigeria and The Gambia, have 15 and 2 ISPs, respectively (Jensen 2001).

Series	Sub-Saharan Africa	High Income countries
Gross National Income per capita (current USD)	490	26 440
Telephone mainlines (per 1,000 people) (1998 est.) ¹	13.6	572.4
Personal computers (per 1,000 people)	8.3	345.8
Internet hosts (per 10,000 people)	2.3	603.5
Telephone average cost of local call (US\$ per 3 minutes)	0.07	0.10
Electric power consumption (KWH per capital) (1998 est.)	453.6	8 350.2

Table 1: Sampled statistics of sub-Saharan Africa and High Income countries (The World Bank, 2001)

The infrastructures in sub-Saharan Africa curtail use of Internet. For example, telecommunication services are expensive and unreliable and they often cannot be used as expected (The World Bank, 1999). Also, they are not widely spread (Table 1). In sub-Saharan Africa, there are only 16 phone lines for every 1 000 inhabitants, compared to 583 phone lines in high-income countries (ITU 1999). Some changes are taking place, making the telephone network more usable. For example, the charges are coming down. The average total cost of using a local dialup Internet account for 20 hours a month is now about \$68 which covers usage fees and local telephone time but excludes telephone line rentals (Jensen, 2001), as compared to \$60 for 5 hours a month in 1999 (Jensen 1999). Another major deterrent is electricity: while power lines exist, there may be limitations on the amount of electricity that can be used per day (see Table 1). Also, as a complex system, the electricity network is prone to failures.

The academic and research communities in sub-Saharan Africa have been quick to see the possibilities of the Internet and they have begun to apply it to their job (Jimba and Atinmo, 2000). Also in the six research organisations we studied, Internet was perceived as having potential to become an important service for research. Quicker access to colleagues around the world, to information and library services, to conference information, were among the looked-for benefits. Therefore, in this article, we focus on how the Internet as a set of information and communication technologies is being used among the research scientists in sub-Saharan Africa.

2 The empirical study

To investigate how information technology infrastructure affects knowledge management efforts of research organisations in sub-Saharan Africa, we conducted a multiple case study (Yin, 1994) between January and March 2001. We carried out our study in six research organisations (see Appendix). We interviewed, observed, and presented questionnaires to 48 research scientists, librarians, and management staffs on knowledge management and use of ICTs. The preliminary overall results of this study are reported in (Okunoye and Karsten 2002). Our study also addressed the means of acquiring and sharing knowledge before and after the introduction of the

¹ There is no data for sub-Saharan Africa in 1999, therefore we use 1998 data for comparison

Internet and how this has influenced the research activities. For this paper, we each coded the interviews on Internet use and compared our interpretations. AO emphasised the potential and the benefits already demonstrated, whereas HK compared the findings with those in her earlier studies (Karsten 1995; Karsten et al. 1997), to see which of the issues mentioned corresponded to those found in Finland. We then revisited the data and came up with the joint interpretation presented here.

3 Internet development histories

In The Gambia, Internet has been available since 1998 after the commissioning of the Internet gateway. The Gambia is a relatively stable society, with reliable electricity and telephone networks. A major player in The Gambia is the GAMTEL, whose aim is to make connectivity cheaper for subscribers. Each ISP has a special set of telephone numbers for dial-up access, which is cheaper than the normal voice call. All ISPs also have a monthly flat rate for dial-up connection, irrespective of the volume of usage. The spread of telecommunication services and high tele-density of The Gambia enables users to have a connection even from the remotest part of the country without any extra cost. This becomes important, as several researchers are located in the upcountry field stations.

MRC. Since most of the senior scientists come from or have been educated in western countries, there has been great use of ICTs at the MRC. The history of using email dates back to the early 1990's with a connection to HealthNet nodes for email services. This was improved later through a connection to *enda.sn* for store and forward services. The commissioning of Internet gateway through the UNDP and Government of the Gambia IIA project in 1998 brought a dramatic change to the Internet services in the organisation, as MRC registered as one of the non-commercial Internet service providers, thereby giving all staff members unlimited access to Internet services.

NARI. Prior to 1998, everything that was happening at NARI concerning Internet services was on individual basis, with some scientists using the GAMTEL/Compuserve and later GAMTEL/Delphi Internet connection, which, due to the cost, did not bring the kind of productivity that was expected. With the low connection cost after the commissioning of the Internet gateway, NARI subscribes to dial-up connections through the local ISP. They can also use various other facilities available within the country to access Internet.

ITC. The Internet service history of ITC is similar to NARI, with individual researchers having email connection either through GAMTEL or COMMIT, a Norwegian ISP, which provided store and forward connection services before The Gambia had the country Internet gateway. The service has improved recently when the organisation has acquired several dial-up accounts through the local ISP.

The history of the Internet in Nigeria is more complex than in The Gambia due to its size and population. Unlike the facilities available in The Gambia, each ISP is responsible for direct connection to the Internet since NITEL, the national telecom monopoly, could not provide reliable Internet gateway services like the GAMTEL in the Gambia.

IITA. IITA is an international organisation, and the history of Internet there is similar to the one at MRC, influenced by the highly educated scientific staff. Before the institute and the nation began to take advantage of the Internet, individual researchers were utilising it in one way or the other. IITA has invested in their own infrastructure for Internet service provision. All the senior scientific staff members have access to Internet services.

NISER. As a national research centre, NISER could not afford the kind of investment required to have unlimited constant access to Internet services but they have a dial-up connection through a local ISP. Research projects are complementing the organisation's efforts by making their own arrangements. Most of the senior scientific staff members have a connection also in their private homes and when necessary, they use a commercial Internet café.

NIMR. NIMR recently got connectivity through a local ISP, when this became available all the senior scientific staff members have access to an email account. NIMR has a subscription to MEDLINE for online access to journal abstracts and staff members also use commercial Internet café.

To sum up, all the case organisations have connectivity to the Internet, and 89% of the researchers claim that they have access to the Internet. Some of the international organisations operate as a non-commercial ISP with unlimited access to the researchers while all the national organisations connect through the local ISPs with limited access. Centralising the Internet access to a few workstations is a common practice in most of the national organisations, without LAN and a limited number of workstations. Generally, they have all used email and are aware of some other basic services on the Internet.

4 Areas of Internet use

Although there is variation in the extent of use of the Internet among the international and national organisations, we are not concerned in this paper with this comparison. We focus here on the use by the researchers and illustrate Internet application, problems and future possibilities in these organisations. A possible reason that makes the use of Internet work in these organisations, despite the odds posed by their environment, is the level of education and exposure of the researchers themselves. This has been described by Straub, Loch and Hill (2001) as

“.....many individuals who have experience with technically advanced societies become technologically acculturated and thus more accepting of IT. In the arena, this exposure occurs when people become informed or educated about computer systems and application software that are not widely diffused within their own culture. This experience can be formal education experiences such as seminars and courses or informal experiences such as travelling for business or pleasure.” (p.7)

This is absolutely true of the researchers in sub-Saharan Africa. If they do not come from or are educated in a high-income country, they occasionally attend conferences and receive visitors from these countries. Through these experiences they become aware of the use of these technologies.

The experiences of Internet use that we describe below could be attributed to the inherent network effect of the Internet and to the knowledge intensive nature of research work that requires much communication, collaboration and coordination. Prior to the Internet, researchers employed the available means, the then intellectual infrastructure that was rooted in printed matter, the postal system and physical storage. According to Watson (1994), these hindered knowledge workers in creating and sharing information. Considering the environmental facets of space (remote and co-located) and time (synchronous and asynchronous), speed, accuracy, volume, ease of use and combination of media, these systems have several shortcomings. Searching printed materials could be time-consuming even with the use of indexes. Postal system is a slow way of transporting ideas and knowledge. It cannot meet the frequent need of researchers to interact with peers outside national and regional boundaries. Libraries cannot be completely stocked to make the volumes available for users whereas it is technically feasible to have a single electronic copy accessible to several libraries and many readers (Watson 1994). Due to the exposure to IT, shortcomings of the above infrastructures, and the real need of researchers to contribute knowledge in their discipline, they have been able to realise the applicability of the Internet to improve the process of the work.

4.1 Literature Access

Before the availability of Internet, research scientists in most of these organisations relied on their library that is often not well stocked - with the exception of IITA - for their literature review and source of current journals.

“.....Before the Internet, getting references has always been difficult. As you know, the library here is not well stocked, the type of journal we have here are limited. And it means when you need references, you have to fill request through a librarian forwarded to London. That is still done for old journals.” (ED, MRC)

“.....We have the library, but most of the time we search the Internet, I think 90% of the time because the library is not well stocked. So most of the time, we search the Internet looking for update.” (SS, ITC)

Due to poor funding and rising cost of journals, similarly to western universities (Rao 2001), organisations in sub-Saharan Africa have had to reduce the number of journals they subscribe to. For example, NIMR is subscribing to less than 25 titles now, or 30 titles with African journals included. These would appear the main publishing outlet for African research institutes. However, African journals are considered local, and the goal is to publish in internationally widely known journals. Some international institutes such as MRC only publish in international journals. Thus it appears that studies conducted in sub-Saharan Africa can be more available to scientists elsewhere, outside the easy reach of the researchers in sub-Saharan Africa.

“...So you do your research study and publish your result in the best journals like Lancet, Nature and then that's all from your end. And of course those journals are not readily accessible within Africa and therefore you endanger those research findings and they have little impact where it is needed.” (SA, MRC)

Due to unavailability of many publications, many African researchers have relied on personal colleagues abroad, CD-Rom of abstracts, or interlibrary loans in addressing

these problems. In some of the organisations, researchers may take time yearly to conduct literature review abroad.

“That used to be quite a difficult thing, it was a problem, the only way you could get access to journals would be either to go to Europe in person and then you do literature search, I normally go to Wageningen every year, that’s my alma-mater.....” (YA, ITC)

“Those days, we assigned a scientist to travel round the sub-region to do literature review, you see how much that means.” (LJ, NARI)

For many years, they coped with this situation in order to remain competitive and to produce effective knowledge. After the Internet has become available during the past few years, the situation seems to be improved. With many of the journals online, organisations or even individuals can subscribe to the most important ones they need. They can be immediately aware of the recent publications in their field and find a way of ordering those not subscribed to online. Both medical research institutes, MRC and NIMR, subscribe to the Medline for medical abstracts and journals.

“..... But now I can liase with the Royal Tropical Institute in Amsterdam. I only send keywords of a research topic and they will do the relevant search and send back to me abstracts and I will request for the document I am interested in and they will send it to me. So I have a good link with Amsterdam and I have a good link with the International Livestock Research Institute, headquartered in Nairobi in Kenya but the documentation centre is in Addis Ababa and from there, I get tables of contents of recent journals and if something is of interest to me I send for them by email and they send it back to me.” (YA, ITC)

“...Within the last 2 to 3 years we have access to the Internet which is highly used, the library has three computers dedicated to library clients whereby they can just go and access library database, search CD-ROM network called CD-NET, TEEAL and the Web.” (YA, IITA)

While there are subject or research area specific free information sites on the Internet, with high quality material, some researchers also carry out searches without this kind of help. This kind of undirected searching can be not only time-consuming and tedious, but also bring out low-quality material that has not passed any kind of review process. Thus there is the danger that when no subject specific databases are available due to cost, the researchers will have to settle with reviews on sub-standard literature. However, the enthusiasm over the new possibilities still appears to cloud this dimension of the Internet.

“...Because if you don’t have information available in the country, you can search the Internet and get as much information as you want, the literature, everything. You can do it in your office without going out. ...You can get in touch with people and get information.” (LJ, NARI)

4.2 Communication

Postal services in most of the countries in sub-Saharan Africa are unreliable. This necessitates some of the research organisations to have a foreign post address from which the mail is forwarded through more reliable and expensive private courier companies. Fax and telephone cannot do much, although used extensively.

“The communication system within the Gambia is okay but overseas, there is a problem. Posting takes 3-4 months to reach Nigeria. Communication is quite frustrating. It is a constraint to effectively carry out one’s job.”(GE, MRC).

The use of email has changed the way communication is being done among the researchers. With instant delivery and reliability and some level of security and confidentiality, sending email is considered to be cheaper and more efficient than letters. However, also email might not work always.

“.....Because when you want to disseminate information, you have to do it in a hard way, like having to call people on phone instead of sending one mail to many people at once, you have to do it one after the other, they may not even be on sit. Email will always be their waiting for them.....”(ED, MRC) So I will say the main problem is communication, breakdown of email services, phone is not working, people not having access to phone.... (MS, MRC)

When email is working, it becomes easier to communicate with other scientists that share a common interest and who get their input into the research project. There is a growing virtual network of expertise.

“I have got information sitting on my table from as far as Canada and people have been enthusiastic in answering questions. Access to the Internet can open all those things for you, that is one of the things I have found out, Internationally, Internet opens opportunity for you to get knowledge from very experienced people without leaving your desk.....” (ED, MRC)

The asynchronous nature of email proved very useful in this situation where telephone call requires the availability of the recipient, email can wait in the mailbox. Telephone also easily enables one-to-one communication whereas email enhances one-to-many communication. Thus, the Internet has lowered the information and distribution costs.

4.3 Collaboration and coordination

The attachment capability of email has changed the whole way documents are being shared between researchers. Publications can now be submitted electronically and the process of reviewing and update becomes lot easier.

“.....What we do is that we can send the documents as email attachment to the person who asked for them. Then if the document (the file is large) then we can put the documents on IITA’s ftp site and asked the person to download it from there. It has been working fine.....”(YA, IITA)

Prior to the availability of the Internet, the process of joint editing and writing of research report rely on exchanging hard copy through post or fax. This often extends the publication time of research findings that involved scientists from various locations.

In putting together proposals and in planning projects and events, Internet can be used to coordinate the efforts. For example, when a training programme was organised for physicians and fellow of West African College of physicians by MRC, the whole plan and communication was done via the Internet. It went very well without any delay.

The director of training remarked that it wouldn't have been possible without the availability of email to both the organisers and the participants.

With the availability of information on the WWW, research scientists are able to get access for various source of funding, opportunity and supports for their projects. With the availability of various mailing lists, scientists are kept updated of the events, and useful news. For example, the Programme for Monitoring Emerging Diseases mailing list circulated information to control the spread of Ebola Virus (Press 1996; Madon 2000). A modified copy of proposal can now be sent easily to multiple donors without the burden of copying several times and related costs.

“..... Now that we have Internet in place, what we try to do is to search information on grants, sponsorship, copy it on the system, paste it on the notice board or send it the people that are concern.”(SA, NIMR)

Conference, workshop and seminar notification was not easily obtainable in the pre-Internet era. When notification was sent, it was either late or not at all delivered. There were problems associated with registration and obtaining detailed information, which could be reduced with online registration for conferences and workshops.

Procurement of books and equipments could be done in online stores. Some individuals, for some urgent requirements, can make purchase online without following the usual protocols and delays. Free software can be downloaded instantly and copies shared among researchers.

“He sent the software via the Internet and I just downloaded it and plugged in my data and completed my analysis.....”(JA, NIMR)

Internal communication before the Internet required a manual distribution list and voluminous photocopying. These still exist and serve their own purpose but with Internet, documents can be shared easily within the organisation through email distribution lists. These are particularly useful as some of the organisations do not even have LAN, but rely on the Internet.

5 Limitations for Internet use

5.1 Insufficient funding

Most of the national research organisations rely on government as the primary source of funds. As the funding level is low, they are limited on the resources they can commit to Internet connectivity and online subscriptions.

Apart from the general cost to the organisation, individual researchers are often expected to bear some costs. With the fact that Internet connectivity is not yet cheap in sub-Saharan Africa, with the estimate of USD68 per month for 20 hours connection, only few organisations have enough funds to provide the access for all the researchers. The alternative is for the researchers to pay for their own access. This has been discouraging the scientists from making use of the Internet fully.

“.....We have, but it is not widely available to everybody, if you understand, it is not widely available for some reasons, cost, which implies

that cost of access is high, even though your have opened it up to everybody, the cost is scaring them off and they are not using it. You have to pay N200 (\$2) for 15 minutes of browsing, some of them use it only when it is very important and critical.”(IB, NISER)

5.2 Low IT literacy

Although using email and browsing the web are simple applications on the Internet, most of the researchers lack the adequate skills. Even when they get training, they would need computers to practice with.

“.....Most of them are locally trained and not exposed to the use of IT equipment right from school. Often time, it is very difficult, if NISER does not have the very serious training programme that would sort of expose the new entrant to the use of the system.....Some of them insist on having training but after you trained them, and there is no computer to practice what they learn, what happens? They forget it. Another thing that I have noticed is that the younger ones are more amenable to change than the older ones, the older one are just thinking of leaving very soon, they wonder why they have to learn new technology now when they will soon retire, okay but the younger ones coming in are more interested.....”(IB, NISER)

“I think there are three things, we need to improve the level of our IT. ... Secondly, we actually need to train people in using IT as information tool and as research tool as well to have improved performance. We need to store more information on them. The level of knowledge and awareness and potential of what IT could do is still pretty limited” (KH, MRC)

5.3 Problems with national infrastructure

During the interview with scientists in all national organisations, they expressed the problem of infrastructure and how it is indirectly affecting their efforts in getting the required knowledge to do their work and hence their productivity. The infrastructure in this context includes the telecommunication, electricity, transportation and banking.

“.....You cannot rely on these gadgets. Suppose you are here now, you want certain information, there is no electricity supply, how do I open my computer to let you have access to information, that is one hindrance. Suppose I want to telephone, the telephone is dead. Even if you write, the postal system is very deficient, what it is supposed to take a day can take a week.” (AA, NISER)

Though the Internet could enable researchers to register for conference online, book hotel online and make purchases online, the payment system often requires possession of a credit card, which is not common in the banking system in sub-Saharan Africa. This limits the chance of the researchers to benefit from these facilities.

5.4 Problems with organisational IT infrastructure

The issue of infrastructure extends to the organisational IT infrastructure required for network connection to the Internet. Most of the national organisations could not acquire the minimum hardware and software required for the connectivity. However, the main problems appear to be in maintaining the infrastructure in working order and in updating the software and hardware to such that the current services on the Internet can be used.

“.....I think it is pretty much that because we are in The Gambia because our collaborators are surprised that we have so much communication problems and don't seem to appreciate how long it takes to fix after a lightning strike.” SA, MRC)

This problem of IT infrastructure is not limited to national research organisations alone. Most of the organisations are affected by lack of technical and managerial expertise to support the efficient running of the IT departments responsible for the Internet. Although the international organisations have the resources to hire expatriates, the general shortage of local experts does affect them, too.

6 Discussion

6.1 Findings of our study

In summary, the Internet can be used to support research in sub-Saharan Africa. With it, there could be improved access to current literature and reduction in search time and cost, faster communication, ease of collaboration and improved coordination. We found that insufficient funding, low IT literacy among staff, problems with the IT function, problems with the organisational IT infrastructure and problems with the national infrastructure (electricity, telecommunications, banking system) put major limitations to Internet becoming a reliable, dependable service, constantly available for all the researchers. Also, there is only low government support for research, lack of training, and lack of technical and managerial expertise.

Most of these problems are tied to money and management, directly or indirectly. When the research institute operates in an environment that is not wealthy enough to provide a safe, reliable, and effective working environment, its possibilities to utilise even its own sufficient funding become limited. Based on our observations and interpretation of the study data, we next discuss what could - and should - be done to alleviate the problems.

6.2 What needs to be done

Any critical knowledge work activity can only depend on reliable services. Unreliable ITI is necessarily ineffectively utilised, as it can only be used for non-critical functions. For research organisations to build and use ITI, especially the Internet, effectively, they need to find ways to address the limitations found also in our study. Although finding solutions to numerous interwoven problems of organisations requires a multi-dimensional approach, we suggest some solutions to each of the limitations we observed. We use some examples from a high-income country,

Finland, just to bring out the possibilities. The situation in developing countries is likely to be much different; nevertheless, a practical solution along these lines could be worked out. The particular examples were chosen because they focus on cost-effective, low-key, distributed, and easily maintainable solutions.

In the face of insufficient funding, it becomes important for research organisations to find the best ways to utilize the available funds optimally. One way could be by forging alliance with other research organisation within the country (and possibly sub-region) to collectively subscribe to electronic journals and databases, thereby reducing the burden on one organisation. In Finland, the FinElib initiative² has been working for a couple of years in this direction.

Such agreement could also extend to discussing what kind of services should be duplicated or shared among research organisations within the same country. It might be cheaper for a scientist to move within cities to access a service than not having access at all. Research organisations could also form their own Internet provision network with support of government and thereby reduce the cost of connection and guarantee reliable services. Again, a comparable initiative in Finland is the Funet network³. Lower costs and reliable services would make Internet more appealing to the funding bodies of the research organisations. The burden of paying for Internet services could be moved from individual research fellows to the institute, and thus increase willingness of individuals to use it.

Addressing the low IT literacy among the researchers could be somewhat difficult without ensuring that they have the necessary hardware and software to continually put into use what they learnt. In this regard, the research organisations should systematically acquire IT equipment with minimum capacity for Internet connection and other use, with the aim of reducing the ratio of available machines per users.

With the high level of education of researchers, they should be encouraged to adopt self-study using various free training materials, available also via the Internet. In a similar manner, each organisation should develop a long-term strategy to acquire necessary IT infrastructure services, to train their staff members and to maintain a sustainable Internet connectivity. In situations where managing IT within the organisation might seem not realistic, organisations should explore the option of outsourcing.

Even with the readiness of research organisations and researchers to follow the above suggestions, they are still at the mercy of the national government of their country of location. With the unreliable electricity supply in sub-Saharan Africa, research organisations should begin to explore more reliable, environmentally friendly, solar energy. For example, one ISP in The Gambia is running their servers on solar power and they do not depend on the national electricity supply or worry about scarcity of the fuel to run generator. This could also be useful in rural areas once the issue of telecommunications is addressed.

² See <http://www.lib.helsinki.fi/finelib/english/index.html>

³ See <http://www.csc.fi/suomi/funet/index.html.en>

With the dependency of Internet on the telecommunication infrastructure, countries in sub-Saharan Africa could also explore the new advances in wireless technologies, which could be easier to deploy and thus eliminate some geographical barriers and costs associated with wired telecommunication systems. However, this still depends on investment in basic infrastructure, which is currently gaining more attention in the countries in sub-Saharan Africa. For example, GSM is available in almost all countries in the sub-region.

Although major credit cards have begun to surface in most of the countries in sub-Saharan Africa (e.g., Visa is available in The Gambia, Senegal, Ghana, Ivory Coast and MasterCard will soon be available in Nigeria), the problems of payment could also be addressed locally. The local banking industry could explore other payment systems more appropriate for Internet users in the region, to ease online purchase. Several issues, such as trustworthiness, legality and security need to be addressed locally before these approaches can be beneficial in sub-Saharan Africa.

6.3 Future possibilities for Internet use

Along with the current steps towards the use of Internet, research organisations should begin to explore the various applications that are already proving useful in similar organisations in other parts of the world - naturally with due consideration to local realities. Here we present some possibilities, based on our own experiences in doing research both in Africa and in Europe. There are plenty of other software and services besides those mentioned here, and more become available constantly. We only bring up some very basic applications, often taken for granted, but with valuable impact if applied with care. Each organisation should assess the relevancy, adaptability and sustainability of the applications they are adopting, to ensure that they meet the organisational goals. All the suggestions below require reasonable constant connectivity before any major benefits can be achieved. Each organisation should therefore carefully assess their own situation and work out appropriate means for utilising these applications and services, adjusted to local possibilities. Our aim is to increase the awareness and bring to attention some opportunities that could be easily overlooked.

To facilitate better access to current literature, researchers and organisations in sub-Saharan Africa could consider utilising the awareness services available from publishers and libraries. These services make lists of contents of journals, new library services, special offers and special issues on topics of interest. Also, in a number of research areas there are free online article databases.

Publishing only in high-end international journals, as some of the institutes claim to do, is slow and subscribing to these might be beyond the means of research institutions in sub-Saharan Africa. Thus the findings might not end in local use. Publishing in e-journals might be a feasible alternative, due to increasing journal prices, reduced library budgets, increasing costs in printing, and declining value of local currencies against dollar. E-journals are easily accessible, easy to publish, time saving, and low cost (sometimes free). The main problem with e-journals is still their low status in academic ranking systems, thereby low-quality articles tend to drift into them. Publishing or reading low-quality research cannot be the goal for any researcher. However, this could also work for the benefit of the developing countries,

which could build their own research communities around these e-journals. Instead of having low-ranking global e-journals, it is possible to have high-quality journals, specific for sub-Saharan Africa.

Chat, a free, synchronous communication system, can be used once there is Internet connection. A group of researchers can arrange meetings and discussions via this system. In addition to this, various applications now support awareness of users' presence on the Internet, based on preset parameters, which handle privacy and disturbances. This service tells who is currently online to respond to enquiries.

Discussion lists, news services, and distribution lists are another way that researchers could make better use of the Internet. These applications enable researchers to discuss issues of interest, seek opinion of their colleagues on issues of common interest, answer questions, and provide information and announcements. Where there is availability of required hardware and software, a basic videoconferencing system such as NetMeeting could be used for face-to-face meetings. This could improve interaction among researchers and reduce time and cost of travelling for meetings.

Researchers in sub-Saharan Africa could also benefit from the developments in mobile IT to support their communication and collaboration with their colleagues in the rural field stations and even in urban locations. One of the organisations we studied is already considering using the wireless technology to build a virtual private network (VPN) between the headquarters and six different locations upcountry. The researchers could also begin to explore the use of Voice over IP to collaborate with their counterparts abroad. In this way they could bypass the problem-ridden and expensive to use telephone network. While having knowledge of conferences is important, most often the travel costs debar the researchers from participating physically in most of these conferences. The researchers could begin to explore the opportunities provided by Webinar⁴, BSCW⁵ and similar applications to discuss their findings and to participate in virtual seminars.

For the researchers in sub-Saharan Africa to fully benefit and take advantage of the opportunities that the Internet provides, the government and the organisation's leadership have to be committed to continuous provision and improvement of the Internet services by improving other infrastructures, to providing funds for training and to developing local capabilities to support ICT in general and the Internet in particular. We suggest that research organisations in sub-Saharan Africa begin to explore the use of various Internet applications to consider what could be done and to gain insight into future possibilities.

7 Conclusions

We have presented how the researchers in sub-Saharan Africa have been using Internet to support some of the research activities in the areas of literature access, communication, collaboration and coordination. We highlighted some of the problems confronting them in this. The issues of other infrastructures, low government support for research activities in sub-Saharan Africa, insufficient training, and lack of

⁴ <http://www.mongoosetech.com/events/events.html>

⁵ <http://bscw.gmd.de>

technical and managerial expertise require attention. We have also discussed some opportunities and considerations for future Internet use. While the efficiency of the researchers could be improved by the use of the Internet, the problems of using it have to be eliminated before clear effects on productivity and quality can be expected (Jimba and Atinmo 2000).

These experiences from research organisations in sub-Saharan Africa imply that more attention needs to be paid before the full benefit of Internet could be realised in countries with similar infrastructural and environmental problems. However, a major lesson from this study is that organisations do not necessarily have to wait until they acquire a state-of-the-art Internet connectivity and applications before they can start making the use of it, as demonstrated in our cases. A little can go a long way. We further confirm the importance of Internet for organisational development and productivity also for research organisations, and not only for on-profit organisations and national governments in developing countries.

8 References

Arunachalam, S. (1998). "Information Age Haves and Have-Nots." Educom Review, **33**(6), 40-44.

Arunachalam, S. (1999). "Information Technology: What does it mean for scientists and scholars in the developing world." Bulletin of the American Society for Information Sciences, **25**, 21-25.

Economic Community of Africa (ECA) (1999). "National Information and Communications Infrastructure (NICI) Indicators: An overview of the African ICT Sector 1998." Available from <http://www.un.org/depts/eca/adf/nici/nici%20indicators.htm> [Accessed June 6th 2001]

ITU (1999). "World Telecommunication Development Report" International Telecommunication Union: Geneva, Switzerland.

Jensen, M. (1999) "The Status of African Information Infrastructure" Economic Commission for Africa. Available from <http://www.uneca.org/adf99/codipap1.htm> [Accessed August 8th 2001]

Jensen, M. (2001). "The African Internet - A Status Report" Available from <http://www3.sn.apc.org/africa/afstat.htm> [Accessed June 29th, 2001]

Jimba, S. and Atinmo, M. (2000). "The Influence of Information Technology Access on Agricultural Research in Nigeria." Internet Research: Electronic Networking Applications and Policy, **10**(1), 63-71.

Karsten, H. (1995). "It's like everyone working around the same desk": Organizational Readings of Lotus Notes. Scandinavian Journal of Information Systems, **7**(1), 3-32.

Karsten, H., K. Lyytinen, V. Heilala and J. Tynys (1997). "The impact of user support in successful groupware implementation: Case Tasman to support paper machinery

delivery." ECIS'97, The 5th European Conference on Information System, 19-21.6.1997, Cork, Ireland, 1286-1300.

Madon, S. (2000). "The Internet and Socio-Economic Development: Exploring the Interaction." Information Technology & People, **13**(2), 85-101

Press, L. (1996). "The Role of Computer Networks in Development." Communications of the ACM, **39**(2), 23-30.

Rao, M. (2001). "Scholarly Communication and Electronic Journals: Issues and Prospects for Academic and Research Libraries." Library Review, **50**(4), 169-175.

Rodriguez, F. and Ernest, J. (2000). "Are Poor Countries Losing the Information Revolution?" InfoDev Working Paper, May 2000. Available from <http://www.infodev.org/library/wilsonrodriguez.doc> [Accessed August 29th 2001]

Straub D., Loch K., and Hill C. (2001). "Transfer of Information Technology to Developing Countries: A Test of Cultural Influence Modelling in the Arab World" Journal of Global Information Technology Management, **9**(4), 6-28

The World Bank Group, (1999). "World Bank Report 1998/99 Knowledge for Development. Available from http://www.worldbank.org/ks/html/pubs_pres.html [Accessed April 3rd 2000]

The World Bank Group. (2001). "World Development Indicator." Available from <http://devdata.worldbank.org/data-query/> [Accessed August 29th 2001]

UNESCO (1996). "Information and Communication Technologies in Development: A UNESCO perspective." UNESCO Secretariat, Paris. Available from <http://www.unesco.org/webworld/telematics/uncstd.htm> [Accessed July 10th, 2001]

Watson, R. (1994) "Creating and Sustaining a Global Community of Scholars." MIS Quarterly, **18**(3), pp. 225-231.

Yin, R. K. (1994) *Case Study Research: Design and Methods*, 2nd ed. Sage Publications: Newbury Park, CA.

Appendix: The six organisations studied

Name of the Institute/Homepage	Areas of Research	Location/ Country	Staff/ Expatriate	Sites	National/ International	Sponsors (Some)	Informants
Medical Research Council (MRC) www.mrc.gm	Medical	Banjul/ The Gambia	600 / 30	Fajara, Basses, Farafenni, Keneba, Bansang, Walikunda	International	MRC/DFID, IARC, EU, WHO, IARC, Glaxo-Wellcome, SKB, and others donors	Researchers (2) Programme leaders (2) Library personnel (1) IT personnel (2) Management staff (3)
National Agricultural Research Institute (NARI) www.narigambia.org	Agri-cultural	Brikama/ The Gambia	211 / 0	Brikama, Sapu and Yundum	National	Government of The Gambia and international donors	Researchers (5) Programme leaders (3) Library personnel (2) IT personnel (1) Management staff (2)
International Trypanotolerance Center (ITC) www.itc.gm	Agri-cultural	Banjul/ The Gambia	122 / 22	Banjul, Bansang Keneba	International	The Gambia, EU, ADB, IDB, IDRC, USAID, FAO, World Bank, IAEA, IFS, foreign governments	Researchers (3) Programme leaders (1)
International Institute of Tropical Agriculture (IITA) www.iita.org	Agri-cultural	Ibadan/ Nigeria	1400 / 100	Ibadan, Onne, Kano, Cotonou, Kampala, Cameroun	International	World Bank, FAO, UNDP, national and private donors	Researchers (1) Library personnel (1) IT personnel (1) Management staff (1)
Nigeria Institute of Social Economic Research (NISER) www.niser.org	Social Economic	Ibadan/ Nigeria	500 / 0	Ojo Road, UI Campus	National	Federal government of Nigeria and other donors	Researchers (4) Programme leader (2) Library personnel (1) IT personnel (1)
Nigeria Institute of Medical Research (NIMR) http://www.homestead.com/nimr_ng/	Medical	Lagos/ Nigeria	130 / 0	Yaba, Lagos	National	Federal government of Nigeria and other donors	Researchers (5) Programme leaders (2) Library personnel (1) IT personnel (1)