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The Impact of ICT in the Transformation and Production of Knowledge in Sudan

By Samia Satti Osman Mohamed-Nour¹

(December 10th, 2010)

Abstract

This paper focuses on the impact of ICT in the transformation and production of knowledge, notably in Sudan, and discusses the importance of the use of ICT in Khartoum University. It considers how the use of ICT, in particular the Internet, facilitates connections, networks and communication within knowledge institutions in Sudan and regional and international institutions and enhances collaboration between Sudanese universities and others, and its integration in the system of global knowledge production. Research results reinforce the idea that using ICT enhances access, production and dissemination of knowledge in Khartoum University. Finally, our findings support the hypothesis that the use of ICT introduces positive and negative effects by providing opportunities for the transformation and production of knowledge but simultaneously also creates hazards in this transformation and knowledge production: positive transformations include building connections and organizational changes; while the negative transformation is the building disconnections for those who do not know how to use ICT. We find that the most important advantage related to the use of the Internet for facilitating connections and transformations involve increasing digital knowledge for academic researchers by finding information that was not earlier accessible and the rapid quantitative and qualitative increases in transferring available information. In addition to the development of new models for disseminating and distributing electronic information, there is an increase in the creation and transfer of knowledge and an increase in free access to electronic publications for academic purposes. The most serious problem related to the use of the Internet is the lack of regular or inadequate budgets for university libraries to pay for access to scientific and technical information and obtain licences or subscriptions to relevant material.

Keywords: ICT use, ICT impact, knowledge production, transformation, Sudan

JEL classification: O10, O12, O30

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Introduction

This paper focuses on the impact of ICT in the transformation and production of knowledge in Sudan and discusses the importance of the use of ICT notably, in Khartoum University.

1. Aims, Hypotheses and the Structure of the Research

This research paper focuses on the impact ICT is having in the transformation and production of knowledge notably in Sudan where there is a steady increase in the use of ICT compared to other poor developing countries.

This paper aims to contribute to the argument that knowledge is a constituent element in all the four dimensions of ‘connections and transformations in developing countries’: material technologies; technologies of space; technologies of time; and technologies of management. Considering some of the definitional problems surrounding knowledge, one central theme is that knowledge constitutes a technology of (dis-)connection and transformation in its own right. As can be seen by considering collective representations (such as belief systems, myths, ideologies, implicit major orientations of a culture) as forms of collectively managed knowledge and with a view on technologies of connection, it is interesting to concentrate on how state-of-the-art technologies of information and communication are transforming the reality of knowledge production and knowledge management in Sudanese universities, and integrating it progressively in global processes: How does the use of ICT contribute to transformations in the field of knowledge? How are traditional knowledge systems affected by the introduction of state-of-the-art technologies of information and communication? Are they eradicated by the latter or are these affording them a new lease of life under a different format? The paper is consistent with on-going research on connections in developing countries knowledge, notably van Binsbergen’s study that focuses on the current South-North collaboration in the production of knowledge in Africa.

In the light of this background and given the relatively few studies that focus on the interaction between ICT and knowledge, this study may contribute to recent efforts aimed at enhancing the production of knowledge and building the information and knowledge society in the region. It will fill an important gap in the literature dealing with enhancing the role of ICT in knowledge production in African countries. Unlike earlier studies in the African literature that focuses mainly on the ICT market in South Africa (cf. Telecommunications Policy in Africa, 2005; James Hodge; Alison Gillwald; Patricia K. McCormick; Gillian Marcelle; Banji Oyelaran-Oyeyinka and Kaushalesh Lal), this paper attempts to fill the gap by focusing only on Sudan as a new case study and examining the impact of ICT in the

transformation and production of knowledge in knowledge institutions. Different from the brief and limited scope of analysis presented in Nour (2002; 2006), this paper provides a lengthier, broader and more comprehensive analysis of the role of ICT in the production of knowledge and in introducing transformation at Khartoum University using the most up-to-date and relevant data to explain the essential role of ICT in enhancing knowledge production.

The main questions considered in this paper are: How does ICT facilitate connection and transformation in Khartoum University? How does the use of ICT enhance access to and the production and dissemination of knowledge in Khartoum University? How does ICT help Khartoum University to collaborate with international universities and northern knowledge institutions and integrate in the global knowledge economy? What opportunities and challenges does the use of ICT introduce? The aim of this paper is twofold; first, to examine the use of ICT at Khartoum University and, second, to explain the role of ICT in facilitating transformation, connection, access to, production and dissemination of knowledge in Khartoum University. The impact of the use of ICT, its potential opportunities and challenges are also discussed. The paper aims to test the following hypotheses:

H₁. The use of ICT facilitates connection within knowledge institutions, namely in Khartoum University.

H₂. The use of ICT enhances access, production and the dissemination of knowledge in Khartoum University.

H₃. The use of ICT facilitates collaboration between Khartoum University (as an example of Sudanese universities) and international universities.

H₄. The use of ICT has both positive and negative effects by providing opportunities for the transformation and production of knowledge but simultaneously also creating hazards to transformations and knowledge production in knowledge institutions in the African region. In Khartoum University, the positive transformation is building connections and organizational changes, while the negative transformation is creating disconnection for those who do not know how to use ICT.

This paper consists of six sections: Section 1 presents an introduction, Section 2 reviews the theoretical and empirical literature and discusses the significance and impact of ICT, in particular the role of ICT in connections, transformation and the production of knowledge. Section 3 explains the literature on ICT and knowledge-production institutions, notably universities in the African region in general and in Sudan in particular. Section 4

explains the data and methodology applied in this research. Section 5 provides an empirical analysis and results with respect to the use and impact of ICT by examining the hypotheses on the use of ICT in introducing the transformation and production of knowledge in Khartoum University. This section also investigates the potential opportunities and challenges that ICT is expected to create in Khartoum University. The conclusions and policy recommendations for improving the use and impact of ICT in the transformation and production of knowledge within Khartoum University are presented in Section 6.

2. Review of Theoretical and Empirical Literature

The rapid progress in Information and Communications Technologies (ICT) and their impact on the global knowledge economy have intensified in recent years, leading to a new economic system characterized by intensive knowledge production that has attracted a great deal of interest. It has also increased debate on the effects of ICT and the economic opportunities and challenges that ICT imposes on the production and dissemination of knowledge in the global economy, particularly for the developing countries.

The continuous move towards globalization has recently made information and communication technologies one of the most important factors in achieving success as well as in seeking new markets, improving quality, providing better and faster customer service and bringing the flexibility needed to make changes quickly.

The impact of technical changes in knowledge production, economic growth and development has received particular interest in the literature on economic growth. Many recent studies have shed light on the impact of ICT on knowledge production, economic growth, productivity, employment, the organization of work, competition and human capital development.

While the impact of technological progress in general is difficult to measure, the recent theoretical and empirical literature has used indicators to approximate its effect on economic growth and investigate the positive and negative impact (opportunities and challenges) that ICT has had on the global economy. Some recent studies, for example, have used an index of investment or expenditures on ICT, IT, computers and computer equipment and provided robust results showing the various influences on economic growth and development (cf. Jorgenson and Stiroh 1995, Phojola 2000, 2001), productivity (cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organization (cf. Bresnahan, Hitt and Brynjolfsson 1999) and skills upgrading (cf. Acemoglu 1998; Hwang 2000). One interesting finding confirms the importance of ICT for enhancing economic

growth not only directly but also indirectly through the production of knowledge and the complementary relationships between ICT, human capital/skills and skills upgrading. For instance, several studies use indicators to examine the complementary relationships between technological progress (as measured by ICT) and human capital (as measured by the increasing utilization of better-educated workers) (cf. Goldin and Katz 1998; Bresnahan *et al.* 1999; Autor, Katz and Krueger 1998 Acemoglu 1998). Some of these studies explain the relationship between ICT, IT or computer use and skills upgrading defined by the increase either in the incidences of training (cf. Bresnahan 1999) or the share of highly skilled workers (cf. Autor, Katz and Krueger 1998; Bresnahan 1999; Hwang 2000).

On the other hand, various studies discuss the hazards ICT creates for economic development. Most of this literature is based on the idea that technical change is a creative process that creates opportunities for development, while also imposing certain restrictions on development. For example, several studies have highlighted the negative impact and implications of the increasing use of IT or ICT on employment and the labour market (cf. Bound and Johnson 1992; Berman Bound and Griliches 1994; Freeman and Soete 1985; 1994; 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor, Katz and Krueger 1998). Some of these studies point out that, as with most other technical changes, ICT or IT has a labour-saving or skills-biased effect by displacing unskilled labour that results from either the reduction or elimination of basic non-skilled jobs.

It has also been hypothesized that ICT could have adverse effects in the developing world because greater advantages will accrue to the industrialized world from global competitiveness than to the developing world, thus making it hard for less-developed countries to compete on the international market. Furthermore, the rapid evolution of ICT will make it harder for developing countries to bridge the already-widening gap between the developed and developing world. ICT, by increasing inequality in income distribution and thus adding to the poverty of the poor, will have adverse results on the status of the poor. ICT may intensify competition and thus widen the existing digital divide between the developed and developing worlds. The literature indicates a growing but limited effect of ICT diffusion in developing countries due to a lack of investment in the complementary infrastructure such as education, skills and technical skills. (cf. Pohjola 2002; Kenny 2002; Nour 2002b; 2006).

Several studies discuss the role of ICT in enhancing knowledge.² For instance, Smith (2000) indicates four approaches to the knowledge economy, in particular, the argument for

² See for instance, Quah (2001), Pohjola (2001) and Smith (2000).

the positive role of ICT in knowledge “.... Finally, there are those who argue that the knowledge economy rests on technological changes within ICT, since innovation in computing and communications changes both physical constraints and costs in the collection and dissemination of information. So for some, the rise of ICT technologies and the complex of ICT industries are coterminous with the move to a knowledge society. Lundvall and Foray (1996) argue a more sophisticated view: “Even if we should not take the ICT revolution as synonymous with the advent of the knowledge-based economy, both phenomena are strongly interrelated ... the ICT system gives the knowledge-based economy a new and different technological base which radically changes the conditions for the production and distribution of knowledge as well as its coupling to the production system.” Then there is the role of ICT. Knowledge refers to understanding and competence. It is clear that ICT is making major changes to our ability to handle data and information. It is sometimes argued that there is a distinction between knowledge and information, and that the data analysed by ICT is not knowledge in itself and that ICT does not therefore necessarily create knowledge or even extend knowledge. However this distinction between information and knowledge seems to be either a mistake or at least overstated since neither information nor data can exist in the absence of background concepts and a knowledge referent. Nevertheless, ICTs are primarily an information management and distribution resource. An important question that follows is how an information resource relates to the production and use of knowledge in society. Lundvall and Foray are almost certainly right when claiming that ICT is playing a new role in knowledge production and distribution but this is a re-organization of the technical and financial terms on which a resource (information) is available. It does not in itself expand the realms of accessible knowledge, let alone justify talking about a new mode of economic or social functioning. There is an empirical issue here as well, of course. If knowledge is a crucial input and ICT is basic to its production, then seeing that the ICT revolution has been under way for at least twenty-five years, there ought to be some robust relationship between ICT production, ICT investment and the growth of output and productivity. A series of studies have failed to demonstrate such a link.³”

³ This literature on the impact of ICT began in the late 1980s. For an early example, see Martin Neil Bailey and Robert Gordon, 'The productivity slowdown, measurement issues and the explosion of computer power', *Brookings Papers on Economic Activity*, 2, 1988, pp. 347-423. A recent contribution is D. Jorgensen and K. Stiroh, 'Information technology and growth', *American Economic Review*, May 1999, pp. 109-116. For a comprehensive discussion, see Daniel Sichel, *The Computer Revolution. An Economic Perspective* (Washington: Brookings Institution), 1997.

3. ICT and Knowledge Production Institutions in Africa and Sudan

Based on the above, this section presents some studies that focus on the relationship between ICT and knowledge production or ICT and higher-education institutions in Africa.

3.1 ICT and Knowledge Production Institutions in Africa

More recent literature has established a link between technologies and society in Africa, in particular focusing on the impact of ICT in connections and transformations and the production of knowledge in Africa.⁴ For example, the literature indicates that knowledge is a constituent element of all four dimensions of ‘connections and transformations in Africa’; material technologies; technologies of space; technologies of time; and technologies of management. When considering definitional problems surrounding knowledge, one central theme is that knowledge constitutes a technology of (dis-)connection and transformation in its own right. This can be seen by considering collective representations (such as belief systems, myths, ideologies, implicit major orientations of a culture) as forms of collectively managed knowledge: It is useful to concentrate on the question as to how state-of-the-art technologies of information and communication are transforming the reality of African knowledge production and knowledge management in African universities and integrating it progressively in global processes: How does the use of ICT contribute to transformations in the field of knowledge? How are the traditional knowledge systems affected by the introduction of state-of-the-art technologies of information and communication? Are they eradicated by the latter, or do these afford them a new lease of life under a different format? Within the context of recent literature, the focus has been on connections in African knowledge, notably van Binsbergen’s discussion of current South-North collaboration in the production of Africanist knowledge and Ndaya’s study that focuses on the production of Africanist global academic knowledge for an African environment.

Ahwireng-Obeng (2000: 3-9) indicates that Africa’s pursuit of a knowledge economy will have to be enhanced by an integrated continental connectivity strategy. The application of ICT could strengthen local educational capacity, support distance education, connect places of learning and research and reduce communications and administrative costs. It can also improve the accessibility of rare manuscripts and artifacts and preserve them electronically.

⁴ See for example, the ASC thematic research project on Connections and Transformations: Linking Technologies and Society in Africa and Beyond, Subgroup 4: Connections in African Knowledge.

Unwin (2004: 150-160) explores the use of ICT in contributing to changes in educational provision in Africa. In the final analysis, arguments about the effects of introducing ICT to African education rest on fundamentally moral questions. Undoubtedly the introduction of ICT is expensive and there are countless other needs in Africa for school buildings with roofs, paper and chalk, desks, clean water and decent salaries for teachers. However, it is not simply a question of either buildings and textbooks, or ICT. The crucial issue is to find ways in which ICT can be incorporated appropriately and sustainably into African educational strategies. Given ICT's potential to reduce the gap in the availability and accessibility of information between those living in 'information-rich' and 'information-poor' places, it is incumbent on the global community to respond to requests for access to information from those who presently lack it. Too often, the introduction of ICT into education across Africa has merely involved putting Microsoft packages into computers in schools. In effect, it has been 'education for ICT', and has failed to use the enormous potential of computers to deliver completely new kinds of learning environments which optimize the multimedia potential availability. It is important to change this approach and replace it by one based on 'ICT for education'.

Durrant (2004: 63-79) indicates that advances in technology, particularly in the areas of electronic publishing and dissemination, have led to new ways of communicating information and knowledge and thus present a huge range of opportunities for developed and developing countries alike. They also bring significant challenges that are most keenly experienced in developing countries. In her view, the challenges include the limited supply of ICT (limitations of printed resources) and a profound lack of access to scholarly publications to meet the increasing demand for ICT (for printed learning and education materials) from the increasing number of students and researchers, rising costs of ICT and the high costs of access to scholarly information, the low speed of ICT infrastructure, their slow transfer rate, low bandwidth, the need for improvement in ICT infrastructure, sustainability, training and skills. On the other hand, the important benefits and opportunities include: helping bridge the knowledge divide by improving accessibility, availability and affordability since the production and dissemination of online resources are different from their printed counterparts, as they are not only cheaper but also are not tied to or limited by physical space: they are accessible from anywhere. In addition to the development of new licensing and purchasing models, there are enhancements to scholarly connection and communications: South-South and South-North contacts and the fostering of partnerships and connections to the wider research community nationally and internationally. In addition to improving the

importance of the services offered by libraries within educational institutions in African and less-developed countries, more affordable and available access to current, high-quality information and e-resources can be provided to meet the needs of students and researchers and improve the skills of librarians and researchers.

Olukoshi and Zeleza (2004: 611) discuss the use of ICT in the African higher-education system, arguing that the revolution of information and communication technologies that is going on offers new opportunities at the same time as presenting challenges. African universities have generally been latecomers to the use of ICT but recently a significant number of universities have begun to enjoy investments in ICT, some from donor sources, others from the state and philanthropic organizations/foundations. Some universities have also invested their own resources in the procurement of new technologies. In all cases, anecdotal evidence suggests that ICT is transforming the ways in which universities work, seeing their revival as veritable centres of research and advanced learning. The Internet has been most widely cited in this regard but even the widespread use of the computer has proved to be a significant new development. At the same time, the ICT revolution that is unfolding brings problems of its own ranging from simple network management problems to more complex ethical issues and the challenge of avoiding technological determinism through a conscious social shaping of the technological tools available. The task for African universities is not simply acquiring and using these technologies: they are striving to produce their own content and to add African ideas and knowledge to the information superhighway. Research on the impact of ICT on the functioning of the African university is, therefore, a fertile area of inquiry waiting to be tapped more systematically in terms of its pedagogical, research, and economic and developmentalist implications.

Beebe *et.al.* (2003) chronicle and analyze the growth of the Internet in Africa, provide descriptions of regional initiatives and highlight the role of ICT in the higher-education sector in selected countries.

Adei (2003: 90, 108-109) discusses the positive and negative impact of ICT and indicates that ICT in African universities could potentially solve the problematic access to limited members in enrolment by using distance education. For instance, the University of South Africa enrolls about 130,000 students in distance-education programmes, which is at least ten times higher than the on-campus enrolment figure. For this blossoming in African higher-education institutions, government policy and the implementation of ICT-related issues will be required in order for the technology to be applied extensively. Moreover, in this era of globalization, ICT can help previously isolated institutions of higher education to plug

into vast educational resources and academic networks. However, this increases the gap between institutions that are online and those that are not.

Radwan (2003) discusses the implementation of initiatives to leverage IT and enhance ICT in higher education in Egypt through the establishment of higher institutes of technology, a higher-educational enhancement project fund, the Egyptian National Scientific and Technical Information Network (ENSTINET), Egyptian Universities Network (EUN), Regional Distance Learning Programme (RDLP), and 'Internet clubs'. These initiatives include, for example, encouraging open education with, say, Cairo University Center of Open Education using distance learning and self-learning techniques via a number of educational tools such as AV rooms, electronic reading and language labs. In addition to the provision of professional training, for instance, the Information Technology Institute (ITI) is providing specialized software application development programmes for new graduates and professional training programmes to meet the needs of the government, ministries and local decision support centres. As well as providing regional information technology software through the Regional Distance Learning Programme (RDLP) that offers distance educational services such as course materials, administration tools and facilities management, the RDLP is involved in the development and delivery of tailored academic web-based programmes to a regional Arab student pool. It links universities, professors and students through its platform, allowing them to customize their learning needs and requirements. And in addition to providing online university courses, a cooperative initiative between the University of Illinois at Urbana Champaign in the US and the University of Ain Shams in Cairo, Egypt has started to offer students in Egypt and elsewhere in the Middle East online chemistry courses in English and Arabic. Menoufeya University also has plans to launch distance-education services using ICT. The Students Online (SOL) initiative is one of the main projects of the Egyptian Internet and info-structure company Nile on Line, which is supported by the Ministry of Higher Education. It helps create a qualitative transformation in methods of learning for Egyptian students, and has reached nine universities including: those in Cairo, Ain Shams, Alexandria, Zakazik, Assiut, Helwan, Tanta, Suez Canal and Mansoura. Tens of thousands students and educational staff have registered for the programme.⁵

Thairu (2003) highlights the use of ICT in connecting higher-education institutes in Kenya and addresses the successful public-private-sector partnership that created the Kenya

⁵ See Radwan (2003), pp. 387, 399, 400-401.

Education Network (KENET), which was formed in 1999 and now connects 16 higher education institutes to the Internet in Kenya.

Massingue (2003) focuses on the development of informatics and the growth of the Internet in Mozambique and the major role played by the Center for Informatics at the Eduardo Mondlane University (CIUEM). CIEUM is the main initiator of ICT developments in Mozambique and runs an ISP, is involved in ICT projects like school-net, telecentres, the government's website, and the formulation of the national information policy, and provides project management for donor-supported ICT projects. It was established primarily to serve the academic community but the impact of its programmes has extended much further into all sectors of Mozambican society.

Oyeyinka and Adeya (2003) have quantitatively compared Internet usage in ten African universities in two countries: Nigeria (four universities) and Kenya (six universities). The study identified trends and issues such as the need for access to online literature resources, the use of cybercafés for better Internet connections, and the desire for more computer terminals in departments. They indicate that cheap access to ICT is as important in the Information Age as cheap access to electricity was in the Industrial Age. However, African countries face structural problems such as low bandwidths, inadequate power supplies and a lack of regional cooperation in Internet infrastructure.

Mutagahywa (2003) focuses on the role played by the University of Dar es Salaam in the growth of the Internet in Tanzania, indicating the importance of the sustainability of ICT resources at three levels: organizational, technical and financial. She discusses the university's role in the development of ICT resources and their deployment in teaching, research and community services. She also evaluates the role played by the university in the development of ICT in not only the education sector but also in other sectors of the national economy. The University of Dar es Salaam deliberately extended the wireless network to government departments to allow officials to access the Internet without having to depend on the telephone network. This reduced the cost of access and encouraged government use of the Internet.

Mwenechanya (2003) outlines the role of the University of Zambia in leading the development of establishing and nurturing full Internet connectivity in Zambia in 1994. For instance, the university had participated in earlier international initiatives to provide an email-based communication forum for NGOs and health workers in a number of African countries. With the experience gained, the university established the first private Internet service provider (ISP) in Zambia, Zamnet Communication Systems, as a separate, fully autonomous

company, but essentially serving the university's research and teaching interests. It is shown that university governance can determine whether the university can effectively deploy the Internet as a tool to advance its objectives in research and education.

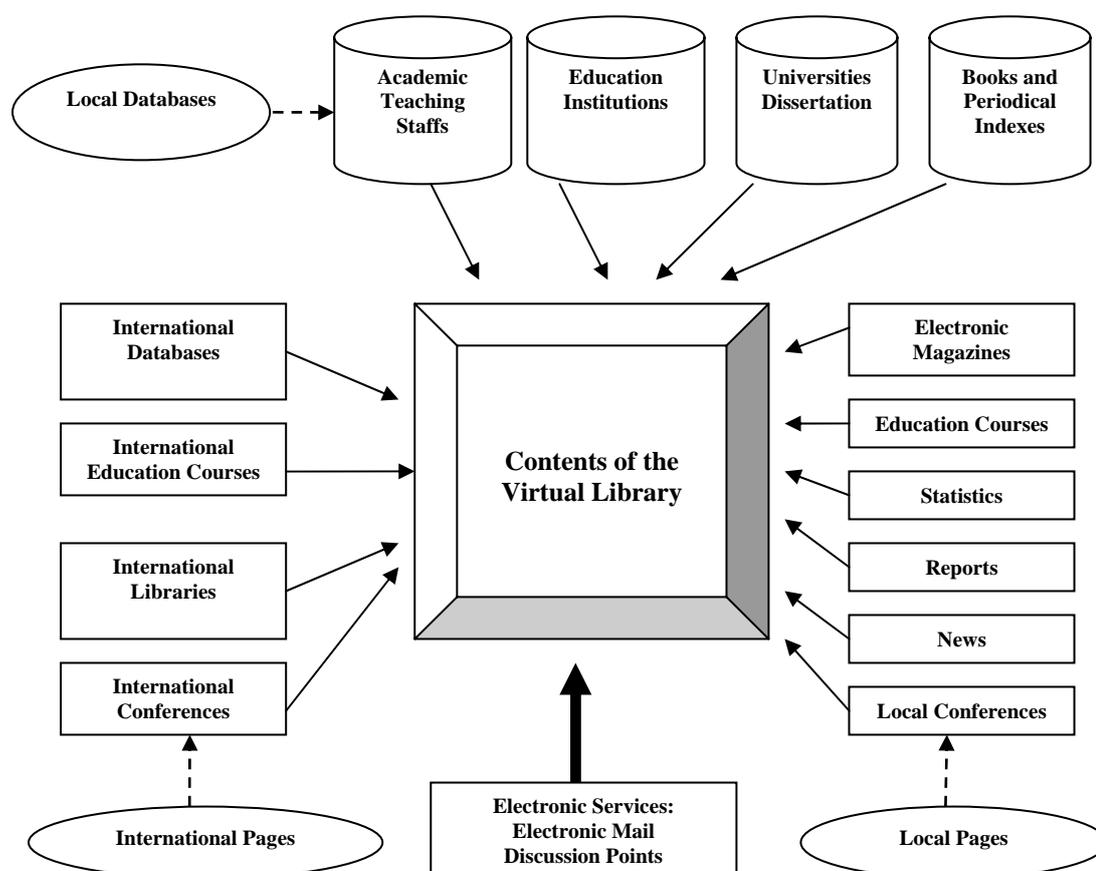
3.2 ICT and Knowledge Production Institutions in Khartoum University

Based on the above literature on ICT and knowledge production in African universities, this section explains the efforts made by Sudan's Ministry of Higher Education and Scientific Research and those taken by Khartoum University to enhance the use of ICT and meet the multiple needs for enhancing connections, the creation and the transfer of knowledge.

Sudan's Ministry of Higher Education and Scientific Research decided to use ICT to establish the Sudanese Universities Virtual Library (SUVL) to provide the academic teaching staff and students with the necessary information for learning, education and scientific research, in addition to making the educational and scientific research output available on line for use in these universities. The SUVL project was implemented in the context of the project of Sudanese Universities Networks (SUN), which aims to support scientific research and educational activities, improve ways of acquiring knowledge, support the restructuring of the administration and the modernization of the Sudanese universities, and facilitate direct access to electronic books, references, magazines, research, courses, lectures and information online by using ICT. The SUVL aims to fulfil the following objectives: to improve ways of offering education and research and making information available in all fields of knowledge to help improve the ability of students, researchers and academic teaching staff to improve the creation and transfer of knowledge and innovation in different fields. It also aims to contribute to achieving the Sudanese government's strategic plans in the field of ICT and to encouraging Sudanese universities and higher-education institutions to achieve their objectives. ICT has been used to introduce change and improvements in education, restructure the education system, modernize, reorganize and digitalize information to facilitate easy access to and allow a rapid expansion in the diffusion of information and knowledge and support production and the contents of local knowledge. The project's main tasks include improving and modernizing the methods of collection, storage and organization of information and knowledge in a digital format and offering easily accessible ways for all to access the information at any time and from anywhere. The SUVL is working to achieve these tasks by linking Sudanese universities and higher education institutions in Sudan to information networks, establishing a virtual library to provide a database and sources of knowledge in different fields for all universities, and offering access to this information

through ICT (email and other electronic methods). It is also providing easy access to information for university students and staff through long-distance education and direct free access to online lectures.

The plan for the implementation of the SUVL library has three phases: the collection and an analysis of data; the design and implementation of the data; and its testing and verification. The first stage was implemented in December 2004, while the second stage started in January 2005 and was completed in January 2006. It witnessed the establishment of the Internet and websites, and the library now includes about 200,000 files. The final stage of testing and verification is in process (August 2009). To facilitate the implementation process, the Ministry conducted a course on network administration for 70 staff from different Sudanese universities to train them in the management and administration of university networks. The information networks and connections were implemented by DATANET. The first stage enabled 30 universities and higher-education institutions in Sudan to be electronically connected to the central network at Khartoum University. The design of the networks not only allows a direct exchange of information between Sudanese universities via the Internet but also offers a special contact address (IP number) for each university to enable it to host its own website and offer electronic services such as email and electronic publications on the World Wide Web. For more details about SUVL, see Figure 1.

Figure 1: Sudanese Universities Virtual Library (SUVL) Process Diagram

Source: Sudan Ministry of Higher Education and Scientific Research⁶

In addition to efforts by Sudan's Ministry of Higher Education, Sudanese universities have established computer and network centres to meet the multiple ICT needs of these universities. For example, Khartoum University set up a computer and information centre that has recently been named the Information Technology and Network Administration (ITNA) to meet the university's multiple ICT needs.

It has implemented several initiatives using ICT to promote knowledge and academic work in the university. For instance, ICT enables Khartoum University to offer free access to the Internet that not only facilitates the building of internal networks inside the university and communication between staff but also improves external connections with other institutions in Sudan and other regional and international institutions. Moreover, the use of ICT enables the ITNA at Khartoum University to have a university website giving online publications and documents. The University Electronic Collections (UEC) includes the electronic version of

⁶ See Sudanese Universities Virtual Library (SUVL): http://www.suvl.edu.sd/content_1/about.htm

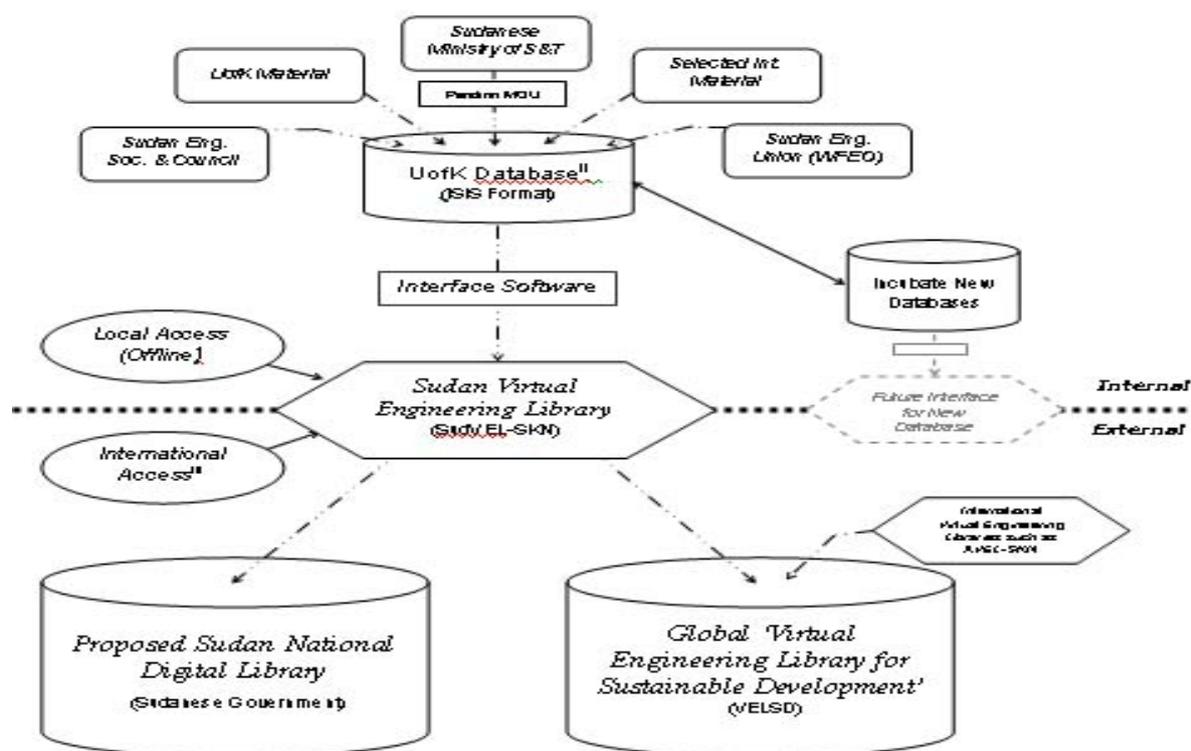
theses, dissertations and books in different disciplines. These services are available only from within the university campuses. Staff members from different faculties in Khartoum University can use its ICT facility to register and offer new courses, with web pages covering many different disciplines. The university's online courses now include not only scientific disciplines such as medicine, medical laboratory services, animal production, agriculture, chemistry and physics, mathematics and chemical and electrical engineering but also other disciplines such as the arts (Arabic), education and university requirements.

In addition, using ICT has enabled Khartoum University to offer online course on Intellectual Property Rights (IPRs) in collaboration with the Distance Learning Program, the WIPO Academy and the World Intellectual Property Organization (WIPO). It enables the provision of distance-learning education and training programmes in intellectual property and creates awareness by promoting and disseminating knowledge in intellectual property. By using ICT, Khartoum University has embarked on an ambitious online distance-learning programme of training trainers to train academic staff members from various faculties in the university. For instance, 24 staff members were trained on diverse issues pertaining to intellectual property during an intensive six-month course to serve as trainers of Intellectual Property (IP) in their respective faculties upon their successful completion of the course and certification by the WIPO Academy. It was conducted online and in the classroom, and demonstrated Khartoum University's ability to conduct distance-learning courses online in cooperation with an international institution, in this case, WIPO.

ICT has enabled the university's Faculty of Engineering and Architecture to establish the Sudan Virtual Engineering Library Sustainability Knowledge Network (SudVEL-SKN). This pilot project is supported by UNESCO in partnership with many international institutes and organizations including the Australian Virtual Engineering Library (AVEL-SKN), the World Federation of Engineering Organisations (WFEO), the Sustainable Alternatives Network (SANet) and the *Foundation Ecole d'Ingenieurs* (EPF) through the International Institute of Women in Engineering (IIWE). The aim of this project is to establish a website in the Virtual Library on Engineering for Sustainable Development as a pilot project. The existing data and information in the field of engineering and sustainable development has been transformed into a digital format and stored in this virtual library, which will be part of the learning environment for the Faculty of Engineering. The library plans to develop it as a part of the university's information network to provide easy and efficient (international) online access to information and knowledge for students, researchers and academic staff. The SudVEL-SKN also aims to make available Sudanese contributions to the UNESCO/WFEO

Virtual Engineering Library for Sustainable Development and contribute to the proposed Sudan National Digital Library. The library is to be a part of the learning environment of the Faculty of Engineering and Architecture containing internal sources and a selection of international materials. The project was implemented in two phases between December 2003 and February 2004. The first phase involved the development of a bibliographic-level prototype of SVEL-SKN including research material and directories of institutions and experts. This involved the integration of existing databases, further selection of relevant international content, the development of the web-interface and usability testing. The second phase of the project focused on the digitization to full text of the extensive library of hardcopy research materials and thesis reports held by the Faculty of Engineering and Architecture. (Such a process will be widely applied in the university.) For more details about SudVEL, see Figure 2.⁷

Figure 2: Sudan Virtual Engineering Library (SudVEL) Process Diagram



Source: http://www2.uofk.edu/SudVEL/Reports/Process_diag.htm

⁷ See Sudan Virtual Engineering Library Sustainability Knowledge Network: <http://www2.uofk.edu/SudVEL/Contents/reports.htm>.

More recently, ICT has enabled the ITNA at Khartoum University to start registering students online. A questionnaire to examine, from the students' perspective, the visibility, value and effectiveness of the new system of online registration that has been implemented in some of faculties (including the Faculty of Engineering) was distributed among 1,000 male and female students in the Faculty of Engineering. The results indicate that 30.2% of the students thought the new online registration system was very good because it offered many facilities and is relatively easy to use compared to the traditional registration system. The findings of the questionnaire indicate that 26.1% of the students considered the new online system satisfactory but felt it needed some improvements in the future to remove the errors it encountered in its first year. The results of the questionnaire indicated that 43.7% of students thought the new system was unsatisfactory because of the technical errors that accompanied its application and the delays it caused in the registration process for many of them.⁸

4. Research Methodology and Method of Data Collection

Based on the above discussion and before going on to examine the hypotheses on the impact of ICT in connections, transformations and the production of knowledge, it is useful to discuss the primary survey data and research methodology used in our analysis in this paper. We use a descriptive approach, utilizing primary and secondary data and in our analysis of the case study of Sudan and primary data based on the results obtained from the Khartoum University Survey (2009).

Field research to collect primary data for the purpose of this research was carried out in Sudan in March and April, 2009. Sudan was chosen as a case study among African countries because it has low but increasing use of ICT compared to other African countries. The survey covered seven faculties in Khartoum University, and the selection and focus of our analysis in Khartoum University was partly because of the high potential use of ICT and partly due to the easy access to data facilitated by the Department of Economics in the Faculty of Economics and Social Studies there.

The sample in the university survey was drawn from seven faculties at the university,⁹ with their selection being based on their significant average share in higher educational and

⁸ See Khartoum University Engineering Association Scientific Secretariat Magazine (April, 2009), p. 3

⁹ Khartoum University Survey (2009) includes students, academic teaching and support staff affiliated to seven faculties in Khartoum University: five faculties of arts and social sciences (A&SS includes the Faculties of Arts, Economics and Social Studies, Law, University Requirements, Business and Management) and two faculties of science and engineering (S&E). The translated Arabic version of the university survey was distributed after the translation of the English version into Arabic to increase the response rate. The design of the questionnaire used in the Khartoum University Survey (2009) is based on the scalar type and multiple-choice questions.

total research activities and production of knowledge. It was also based on their experience and potential contribution towards enhancing the role of ICT in the creation and transfer of knowledge, connections and transformations in Sudan. The questionnaire on “The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan” was distributed randomly amongst 73 individuals: academic teaching staff, support staff and students in the selected seven (five arts and social sciences, and two science and engineering) faculties affiliated to Khartoum University.¹⁰ The selection included males (50%) and females (50%) aged between 20 and 70 years. Since ICT is widely used amongst the youth, the coverage in the university survey focused on young people living in Khartoum State.

The survey aimed to collect micro qualitative and quantitative data to reflect the opinions of the academic teaching staff, support staff and students to assess the role of ICT in the creation and transfer of knowledge, connections and transformations. It was also intended to provide insight to help generate policies to enhance the role of ICT in the creation and transfer of knowledge, connections and transformations. One advantage of the university survey is that it examines the issue from two different fields of specialization: the arts and social sciences, and the science and engineering perspectives. Another advantage is that it integrates the three different perspectives: those of academic teaching staff, support staff and students. Due to their active participation in educational and training activities, the teaching staff, support staff and students provided useful information from both an analytical and a policy perspective. Table 1 presents the composition of the Khartoum University Survey and shows a total response rate of 86%. The rate varied according to the faculties and individuals covered in the survey. For the academic teaching staff, the total response rate was 83% and the weighted response rates by specialization were 80% and 89% for S&E and A&SS respectively.

The share of the S&E and A&SS fields was representative and yielded a different response rate. The total response rates among the support staff and students were 100% in both categories. The data from the university survey is supported by five face-to-face interviews with teaching staff and support staff and students. The purpose of these interviews was to obtain more information to support the findings from the survey concerning the relationship between ICT, connections and transformations in Sudanese universities.

¹⁰ For the implementation of the university survey, a team of part-time researchers from the Department of Economics, the Faculty of Economics and Social Studies at the University of Khartoum were hired to make direct personal contact, handle, distribute and then collect the surveys from individuals. At the request of some of the individuals approached, an additional email copy of the survey was sent to accelerate and increase response rates.

Table 1: Composition of the Khartoum University Survey, 2009

Khartoum University	Number in the sample	Share in the sample	Total response	Response rate (%)	Share in response rate (%)
Arts and Social Sciences (A&SS):					
Economics	20	33%	18	90%	36%
Arts	12	20%	10	83%	20%
Law and University Requirements	6	10%	5	83%	10%
Business and Management	3	5%	0	0%	0
Total Arts and Social Sciences	41	68%	33	80%	66%
Science and Engineering (S&E):					
Engineering	7	12%	6	86%	12%
Science	12	20%	11	92%	22%
Total Science and Engineering	19	32%	17	89%	34%
Grand Total	60	100%	50	83%	100%
Support Staff	3		3	100%	
Students	10		10	100%	
All Khartoum University	73		63	86%	

Source: Author's own calculations based on the Khartoum University Survey (2009)

5. Main Preliminary Findings

The data from the survey provided the information required to test our hypotheses (presented in Section 1) and elaborated on our earlier findings (see Section 3). This section uses the survey data to explain how the use of ICT (mainly the Internet) facilitates connections, has led to opportunities and advantages and had a positive impact but has also led to challenges and difficulties too. It presents a comparative analysis between faculties to elaborate on the role of ICT in enhancing connections and transformations in Khartoum University, as a case study of Sudanese universities from the Arts and Social Sciences (A&SS) and Science and Engineering (S&E) faculties' perspectives. This section discusses the main results.

5.1 Internet, Connection, Networks¹¹ and Communication

The results of the university survey indicate that Internet facilitates networks and communication inside the institution, with other institutions in Sudan, with regional and with international institutions cooperating with Sudanese universities. The importance of the effect of Internet regarding facilitating connection varies between S&E and A&SS faculties' academic teaching staff, support staff and students' (see Table 2).

Khartoum University academic teaching staff's perspectives are consistent with each other and they feel that Internet facilitates connections, networks and communication inside the institution; this is followed by facilitating connection with international institutions and with regional institutions respectively. The effect of Internet in facilitating connection with

¹¹ For the purpose of this paper, the term 'network' means internal connection.

other institutions in Sudan is also mentioned, but somewhat surprisingly with somewhat less importance.^{12, 13, 14} From the support staff's perspective, Internet facilitates connection, networks and communication inside the institution more than facilitating connection with other institutions in Sudan and facilitating connection with regional and international institutions.¹⁵ From the students' perspective, Internet facilitates connections with other institutions in Sudan and facilitates connections with regional and international institutions more than facilitating connection, networks and communication inside the institution.¹⁶

One interesting observation from our findings is that both S&E and A&SS faculties agree on the importance and value of the Internet for facilitating external connection with international institutions, followed by regional institutions and other institutions in Sudan. However their points of view differ in that A&SS faculties value the effect of the Internet in facilitating internal connections and networks higher than the external networks, whereas, S&E faculties present an opposite point of view and value the effect of the Internet in facilitating external connections and networks more than internal networks. The importance and value of the Internet for facilitating connections and internal networks inside the institutions is higher in A&SS faculties compared to S&E faculties. This is not surprising in view of the fact that S&E faculties have probably developed a more favourable ICT infrastructure and managed to provide more facilities, and therefore have a more conducive environment for promoting good external connection and networks. Another interpretation is that, from the S&E faculties' perspective, strong connections and networks with external institutions are probably required to increase and enhance education, learning, teaching and research skills and activities for academic staff in S&E faculties.

Another interesting observation from our findings is that both the support staff and students agree that the effect of the Internet in facilitating external networks is the same regardless of the nature of the different external institutions. However their points of view differ as the support staff value the effect of the Internet in facilitating internal connections and networks more highly than the external networks, whereas students present an opposite point of view and value the effect of the Internet in facilitating external connection and

¹² As indicated by 70%, 64%, 60% and 56% of the respondents among all Khartoum University academic staff respectively.

¹³ As reported by 79%, 64%, 61% and 58% of the respondents among the arts and social-science academic staff respectively.

¹⁴ As indicated by 65%, 59%, 53% and 53% of the respondents among science and engineering academic staff respectively.

¹⁵ As indicated by 67%, 33%, 33% and 33% of the respondents among the support staff respectively.

¹⁶ As reported by 80%, 89%, 80% and 70% of the respondents among students respectively.

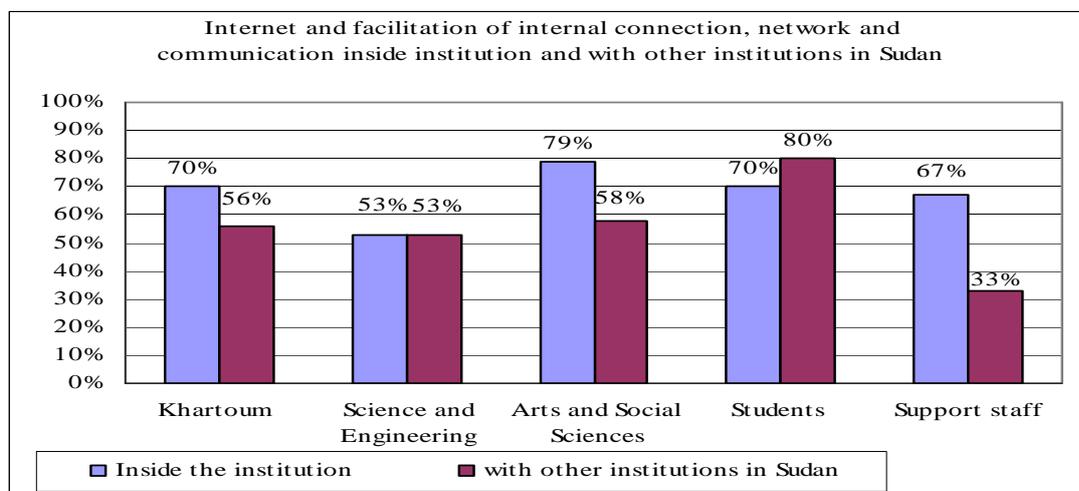
networks more than internal networks. This result is plausible in view of the fact that the support staff are probably more concerned with internal connections in their institutions, whereas students are more interested in broadening their contacts with other international, regional and local institutions in Sudan. From the students' perspective, strong connections and networks with external institutions are required to increase and enhance their educational, learning and research skills.

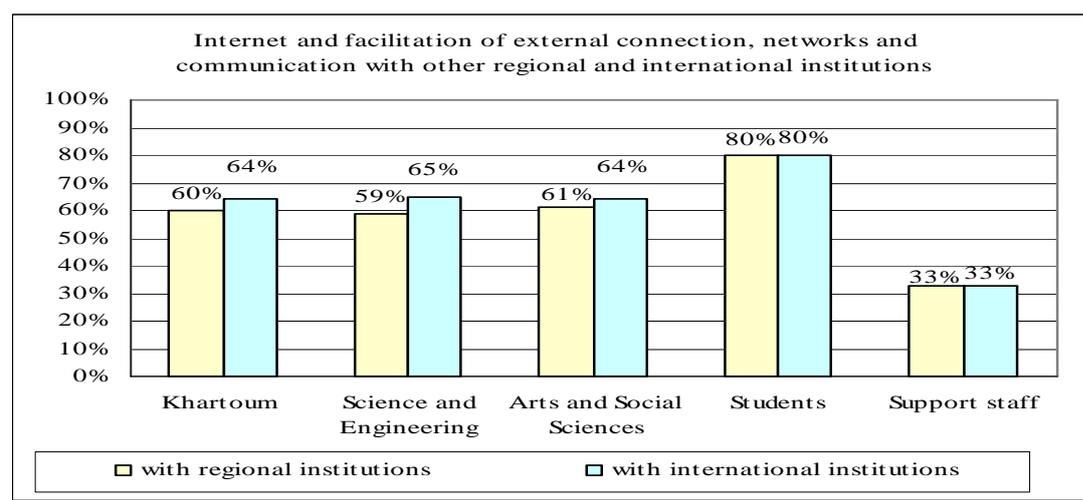
Table 2: Internet, Connections, Networks and Communication in Khartoum University

	Khartoum	Science & Engineering	Arts & Social Sciences	Students	Support staff
Inside the institution	70%	53%	79%	70%	67%
With other institutions in Sudan	56%	53%	58%	80%	33%
With regional institutions	60%	59%	61%	80%	33%
With international institutions	64%	65%	64%	80%	33%

Source: Author's calculations based on the Khartoum University Survey (2009).

Figures 3-4: Internet and Facilitation of Internal and External Connections, Networks and Communication





5.2 ICT (Internet) Impact: Opportunities and Challenges

The results of the survey indicate that among all Khartoum University academic teaching staff, support staff and students, the Internet has had a positive impact and produced opportunities and advantages, but had also produced challenges and difficulties. This section explains first the opportunities and advantages and then the challenges and difficulties (see Tables 3 and 4).

5.2.1 ICT (Internet) Opportunities and Advantages

For all Khartoum University's academic teaching staff, support staff and students, the Internet has had a positive impact, with the most important advantage being related to the use of the Internet for facilitating connections and transformations and enhancing the production, creation and transfer of knowledge including digital knowledge for academic purposes. This facility was previously not available or accessible, nor was the rapid quantitative (in number) and qualitative (efficiency and speed) transfer of information. In addition to the development of a new model for disseminating and distributing electronic information, there has been an increase in the creation and transfer of knowledge and in the amount of free access there is to electronic publications for academic purposes. Other opportunities and advantageous are viewed differently by different groups (see Table 3).

All Khartoum University teaching staff feel that the Internet provides many opportunities and advantages to facilitate connections and transformations and enhance the production, creation and transfer of knowledge. For instance, increased digital knowledge for researchers, which was not available or accessible before, and the rapid quantitative and

qualitative increase in transfer was beneficial.¹⁷ In addition to developing a new model for disseminating and distributing electronic information, the increase in the creation and transfer of knowledge, increased possibilities for introducing research outside academic fields, increased free access to electronic publications for academic purposes and improved intellectual capacity were also advantageous.¹⁸ Encouraging and increasing processes of integration in the international exchange of knowledge and creating links and contacts between people with common interests in different activities related to increase of knowledge were other advantages.¹⁹ Others are an increase in the possibility of digital and electronic dissemination of old documents not only for the dissemination of scientific culture but also to preserve original and rare documents and the Sudanese heritage for future generations. Internet help also develops social capabilities and the learning of new skills from others and facilitates the preparation of unlimited cheap copies instantaneously without affecting the quality and provides the possibility of a rapid transfer of copies to any place in the world.²⁰ In addition to the introduction of important changes in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically, there is also an increased integration of higher education and the research sector through the implementation, assessment and regulation of the ICT sector. This encourages knowledge about other cultures and facilitates contact between academic teaching staff and students in academic institutions.²¹ In addition to introducing a change in the role of libraries by using digital documents, there have been changes in the role of workers in libraries. Their traditional roles have made way for a new one in which they offer advice to users regarding the use of electronic data, information and documents. This reduces the need for users to use the services of information professionals to have direct access to information.²² In addition to introducing new ways and modern techniques to improve quality and efficiency in education and scientific research, the Internet has increased the use of long-distance learning, training and education.²³ It also reduces the monopoly in the creation of knowledge earlier dominated by universities and researchers, increases the possibility of the electronic dissemination of academic documents and commercial benefits, and facilitates the transfer of protected materials on the Internet and digital networks and the use of materials across borders. It also

¹⁷ As indicated by 98% and 96% of the respondents among Khartoum University's academic staff respectively.

¹⁸ As indicated by 94% of the respondents among Khartoum University's academic staff.

¹⁹ As reported by 92% of the respondents among Khartoum University's academic staff.

²⁰ As indicated by 90% of the respondents among Khartoum University's academic staff.

²¹ As reported by 90% of the respondents among Khartoum University's academic staff.

²² As indicated by 88% of the respondents among Khartoum University's academic staff.

²³ As indicated by 86% of the respondent among Khartoum University's academic staff.

reduces the need for users to go to a library or documentation centre to access information/data.²⁴ Finally, it facilitates change by reducing the use of hard copies and assists in the management of Intellectual Properties Rights (IPRs) and prevents piracy.²⁵

From the support staff's perspective, the main opportunities and advantages include increased digital knowledge for academic and researchers, the rapid quantitative and qualitative increase in transferring available information, and improved intellectual capacity that was previously not available through, more long-distance learning, a reduced monopoly in the creation of knowledge that used to be dominated by universities and researchers, increased possibilities of electronic dissemination of academic documents, added commercial benefits and increased free access to electronic publications. Besides the introduction of important changes in technologies of distribution, dissemination, evaluation and the storage of data and information electronically, there have been changes in the role of libraries due to the use of digital documents, the new roles of staff who now offer advice to users on how to use electronic data, information and documents. Creating linkages and contacts between people with common interests is related to an increase of knowledge and saves time and effort in the production and transfer of knowledge. Encouraging knowledge about other cultures, developing social capability and thus acquiring knowledge and learning new skills from others reduces the need for users to use the services of information professionals. In addition, it facilitates the management of Intellectual Properties Rights (IPRs) and prevents piracy, facilitates the preparation of unlimited cheap copies on the Internet instantaneously without affecting quality, with the possibility of transferring copies to any place in the world and protected materials via the Internet and digital networks across borders. This is followed by the need for production of knowledge and academic works conducted by the Sudanese. In addition there are increased possibilities for the digital dissemination of old documents, not only to the scientific community but also to preserve original and rare documents and the country's heritage for future generations.²⁶ From the support staff's perspective, the Internet has, to a lesser extent, introduced new ways and modern techniques for improving the quality and efficiency of education and scientific research with the introduction of research from other academic fields, more integration of higher education and the research sector in the implementation, assessment and regulation of the ICT sector, and it has encouraged processes of integration in international knowledge, facilitated contact between the academic teaching

²⁴ As reported by 84% of the respondents among Khartoum University's academic staff.

²⁵ As reported by 82% and 76% of the respondents among Khartoum University's academic staff respectively.

²⁶ As reported by 67% of the respondents among the support staff.

staff and students in academic institutions and reduced the need for users to go to a library or documentation centre to access information/data.²⁷

From the students' perspectives, the main advantages and opportunities include the rapid quantitative and qualitative increase in transferring available information, improved intellectual capacity, increased possibilities for research and more social capability, and the chance to acquire knowledge and learn new skills from others.²⁸ This is followed by the development of a new model to disseminate electronic information, increased integration of higher education and the research sector by implementing, assessing and regulating the ICT sector and the increased possibility of electronic dissemination of academic documents, also for commercial benefit.²⁹ In addition to the increased creation and transfer of knowledge, there has also been an introduction of change in the role of libraries with the use of digital documents, increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible, and the introduction of change in the role of staff in libraries.³⁰ In addition to the introduction of new ways and modern techniques to improve education and scientific research, there has been the introduction of important changes in techniques of distribution, dissemination, evaluation and the storage of data and information and increased free access to electronic publications for academic purposes.³¹ To facilitate the spread of academic work conducted by the Sudanese, encourage and increase processes of integration in international knowledge systems, knowledge about other cultures is encouraged and this creates links and contact between people with common interests in different fields.³² In addition, it facilitates contact between academic teaching staff and students in academic institutions, the preparation and rapid transfer of information to any place in the world and the transfer of protected materials via the Internet and digital networks and the use of materials across borders.³³ In addition to increasing the use of long-distance learning, training and education, there is a reduced monopoly in the creation of knowledge that used to be dominated by universities and researchers and increased electronic dissemination of old documents not only for dissemination of research but also to preserve original and rare documents and preserve the Sudanese heritage for future generations.³⁴

²⁷ As indicated by 33% of the respondents among the support staff.

²⁸ As reported by 100% of the respondents among students.

²⁹ As reported by 90% of the respondents among students.

³⁰ As indicated by 90% of the respondents among students.

³¹ As indicated by 90% of the respondents among students.

³² As indicated by 90% of the respondents among students.

³³ As indicated by 90% of the respondents among students.

³⁴ As reported by 80% of the respondents among students.

Moreover, the introduction of ICT has facilitated the management of Intellectual Properties Rights (IPRs) and helped prevent piracy. It also reduces the need for users to use the services of information professionals to access information and the use of hard copies.³⁵

One interesting observation from our findings is that all academic staff agree on the importance and value of the Internet in providing opportunities for the creation and transfer of knowledge in Khartoum University. The Internet has provided more opportunities to facilitate the transfer of knowledge in S&E compared to A&SS faculties. The only exception is related to the importance of the Internet in facilitating a rapid quantitative and qualitative increase in transferring available information, increasing digital knowledge for researchers by finding information that was earlier not available and that has increased the integration of higher education and the research sector. The value of the Internet in S&E compared to A&SS faculties may not be surprising in view of the fact that S&E have probably developed and owned a better ICT infrastructure and would have managed to provide more facilities and therefore more a conducive environment for opportunities in the creation and transfer of knowledge. Another interpretation is that promotion of the Internet for facilitating the creation and transfer of knowledge is probably required to increase and enhance education, learning, teaching and research activities among the academic staff in S&E faculties.

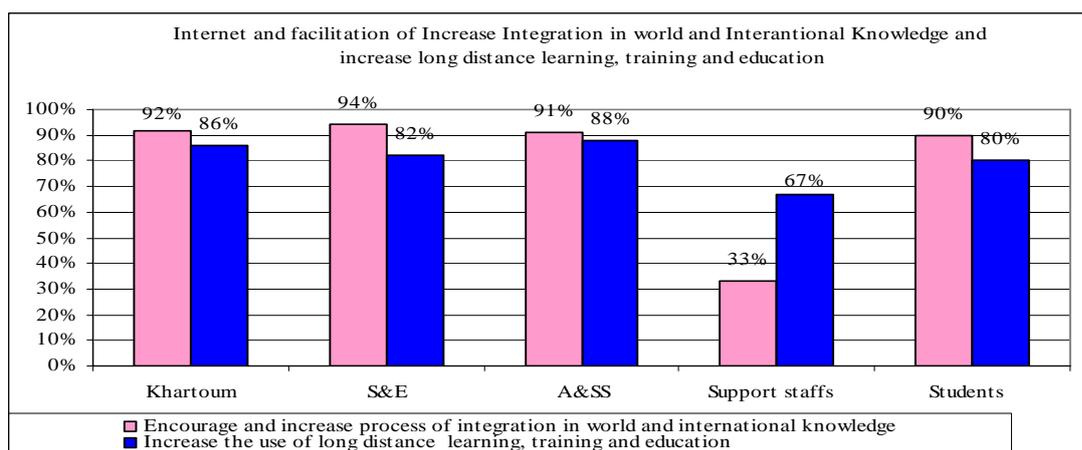
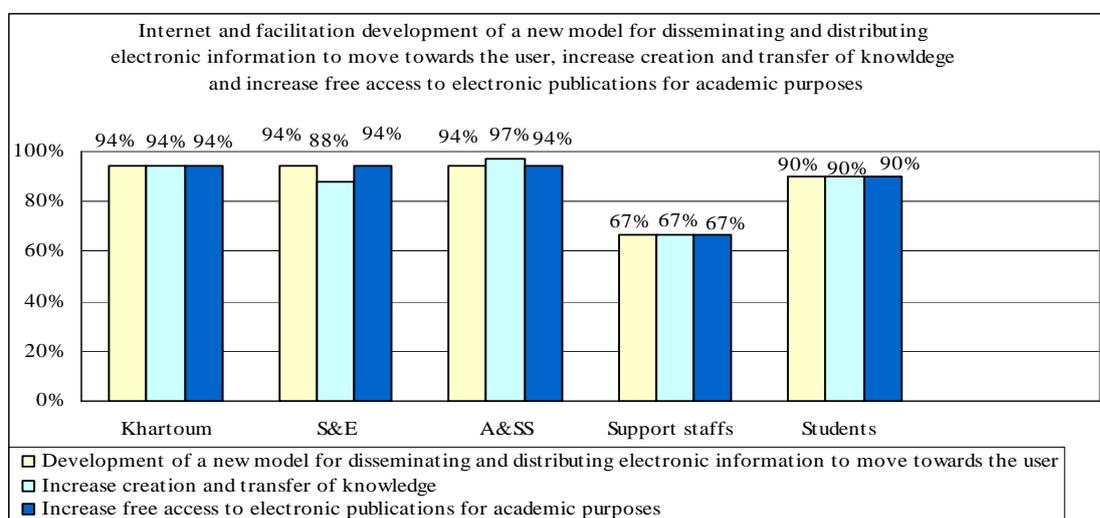
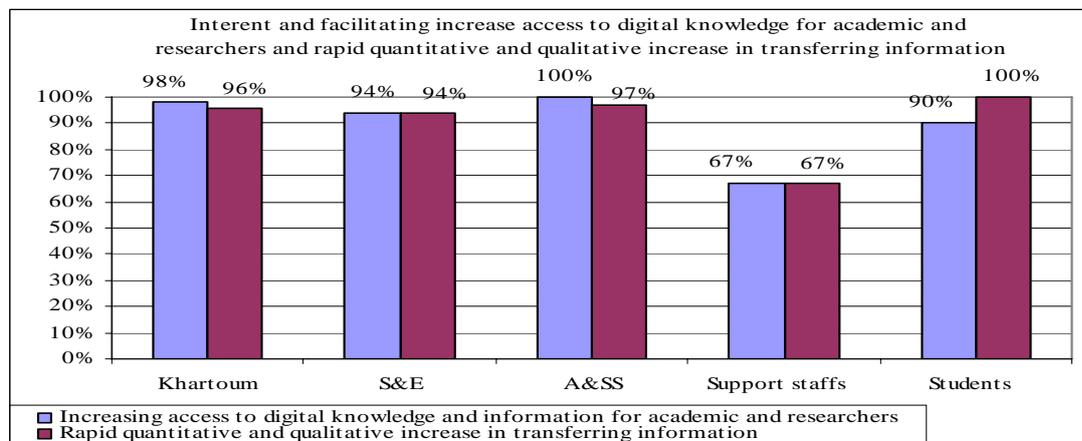
³⁵ As indicated by 80%, 80%, 80% and 70% of the respondents among students respectively.

Table 3: The Impact, Opportunities and Advantages of the Use of the Internet in Facilitating the Creation and Transfer of Knowledge

Internet opportunities/advantages	Khartoum	Science and engineering	Art and social sciences	Support staff	Students
Rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information	96%	94%	97%	67%	100%
Increasing digital knowledge for researchers by finding information not earlier available or accessible.	98%	94%	100%	67%	90%
Improved intellectual capacity	94%	94%	94%	67%	100%
Introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research	86%	94%	82%	33%	90%
Increased integration of higher education and research sector in the implementation, assessment and regulation of the ICT sector	90%	88%	91%	33%	90%
Increased creation and transfer of knowledge	94%	88%	97%	67%	90%
Increased use of long-distance learning, training and education	86%	82%	88%	67%	80%
Reduced monopoly in creation of knowledge earlier dominated by universities and researchers	84%	82%	85%	67%	80%
Increased possibility of introduction of research outside academic fields	94%	88%	97%	33%	100%
Increased electronic dissemination of academic documents for commercial benefit	84%	76%	88%	67%	90%
Increased possibility of digital and electronic dissemination of old documents not only for dissemination of scientific culture, but also for preserving original and rare documents and Sudanese heritage for future generations	90%	94%	88%	67%	80%
Increased free access to electronic publications for academic purposes	94%	94%	94%	67%	90%
Introduction of important changes in techniques of distribution, dissemination, evaluation and storage of data and information electronically	90%	100%	85%	67%	90%
Introduction of change in the role of libraries by the use of digital documents.	88%	94%	85%	67%	90%
Introduction of change in the role of library staff from traditional roles to a new role giving advice on the use of electronic data, information and documents	88%	94%	85%	67%	90%
Facilitate introductions for Sudanese academic work	88%	94%	85%	67%	90%
Encourage and increase processes of integration in world international knowledge system	92%	94%	91%	33%	90%
Create linkages and contact between people with common interests in different activities	92%	94%	91%	67%	90%
Save time and facilitate production and transfer of knowledge	90%	94%	88%	67%	90%
Introduction of change by reducing the use of written papers	82%	82%	82%	67%	70%
Encourage knowledge about other cultures	90%	94%	88%	67%	90%
Develop social capability and acquisition of knowledge and new skills	90%	94%	88%	67%	100%
Development of a new model to disseminate electronic information.	94%	94%	94%	67%	90%
Reduce the need for users to use the services of information professionals when accessing information/data.	88%	88%	88%	67%	80%
Reduce the need for users to go to a library or documentation centre to access information/data.	84%	88%	82%	33%	80%
Facilitate contact between academic teaching staff and students in academic institutions	90%	94%	88%	33%	90%
Facilitate the management of Intellectual Properties Rights (IPRs) and prevent piracy.	76%	88%	70%	67%	80%
Facilitate the preparation of unlimited cheap copies on the Internet without negatively affecting quality	90%	94%	88%	67%	90%
Facilitate transfer of protected materials on the Internet and digital networks and the use of materials internationally	84%	88%	82%	67%	90%

Source: Author's own calculations based on the Khartoum University Survey (2009)

Figures 5-7: Internet and its Impact in Facilitating Opportunities for the Creation and Transfer of Knowledge



5.2.2 ICT (Internet) Challenges, Problems and Difficulties

Khartoum University academic teaching staff, support staff and student also felt that the Internet had had a negative impact too and posed some challenges. The teaching and support

staff thought that the main problem related to the use of the Internet was a lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, authors' rights and licences or subscriptions. They also saw problems with access to scientific and technical information. Other problems are viewed differently by different groups as explained below (see also Table 4).

All Khartoum University teaching staff' thought that the main problems related to the use of the Internet were the lack of or inadequate regular budget for universities libraries to pay for access to scientific and technical information, authors' rights and licences or subscriptions was a serious problem as was the isolation of those who do not know how to use the Internet and those who worry about their families, especially children, wasting time on the Internet, SMS, videos and entertainment facilities.³⁶ This is followed by the problem of access to scientific and technical information for the creation and transfer of knowledge and the difficulty of distinguishing between original and unoriginal documents with the risk of users selecting unreliable information. Due to inadequate technical skills, institutions worry about staff wasting work time when using the Internet, and using it for personal reasons.³⁷ In addition to the high cost of acquiring licences to access electronic libraries for individuals and institutions, there is a lack of clear objectives, strategic planning, assessment policies and evaluation programmes.³⁸ These are in addition to the problems of adjusting original documents and the impact on authors' moral and financial rights and hindering the management of Intellectual Properties Rights (IPRs) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users and the difficulties of correcting and controlling digital and electronic documents in digital libraries.³⁹ In addition there are difficulties regarding increased training for library staff to ensure they have adequate knowledge about the electronic use and distribution of information and to be able to redirect information from producers to users, increased training and knowledge for users to ensure the relevant use of the electronic information and an increased demand for technical and engineering education related to ICT.⁴⁰ In addition to overcoming the problem of copyright and obstacles concerning dissemination, there is also the problem of the high costs demanded for the use of information and difficulties of ensuring regular access to the

³⁶ As indicated by 90% of the respondents among Khartoum University's academic staff.

³⁷ As indicated by 88% of the respondents among Khartoum University's academic staff.

³⁸ As reported by 86% of the respondent among Khartoum University's academic staff.

³⁹ As reported by 86% of the respondents among Khartoum University's academic staff.

⁴⁰ As indicated by 86% of the respondents among Khartoum University's academic staff.

Internet.⁴¹ There is also the problem of preventing the spread of viruses and a lack of enthusiasm to improve efficiency and promote institutions of higher education and scientific research due to limited electronic knowledge and widespread electronic illiteracy, the poor service offered to users and a limited number of available references.⁴² Other difficulties include a lack of enthusiasm for electronic publishing, the risk of the spread of electronic piracy, creating gaps (related to training and the financial ability to communicate) between those who own and those who do not have Internet technology, a lack of access to credit cards and a lack of security in their use and inadequate electronic capacity.⁴³

The support staff feel that the main problems are inadequate regular funding for universities libraries to pay for access to scientific and technical information, authors' rights and licences and subscriptions. In addition, there is a lack of clear objectives and strategic planning, a lack of enthusiasm for the use of the Internet to improve and increase efficiency and promote institutions of higher education and scientific research due to limited electronic knowledge and widespread electronic illiteracy. As well as the difficulty regarding increased training for library staff to ensure they have adequate skills to deal with the electronic distribution of information, there is increased demand for technical and engineering education related to ICT and difficulties preventing viruses.⁴⁴ Other problems include a lack of enthusiasm for electronic publications, the risk of electronic piracy, the difficulty of regular access to the Internet, limited modern references and worries about staff wasting working hours on the Internet for personal reasons. There is a problem distinguishing between original and new documents, the risk of using unreliable information, and the ease of adjusting original documents and its impact on authors' moral and financial rights. This hinders the management of Intellectual Properties Rights (IPRs) and there is the concern of piracy when transferring adjusted unoriginal documents for users.⁴⁵ Other problems include the high cost of acquiring licences for access to electronic libraries for individuals and institutions, overcoming the problem of high costs for using information and the problem of copyrights and obstacle to dissemination and the use of these sources. There are also difficulties regarding correcting and controlling digital documents in electronic libraries and inadequate electronic capacity.⁴⁶ There are also problems with assessment policies and evaluation

⁴¹ As reported by 84% 82% and 82%, of the respondents among Khartoum University's academic staff.

⁴² As indicated by 78% of the respondents among Khartoum University's academic staff.

⁴³ As reported by 76%, 76%, 76%, 72% and 72% of the respondents Khartoum University's academic staff respectively.

⁴⁴ As indicated by 67% of the respondents among support staff.

⁴⁵ As reported by 67% of the respondents among support staff.

⁴⁶ As indicated by 33% of the respondents among support staff.

programmes, the poor services offered to users and inadequate technical skills among staff. There is a growing gap between those who do not know how to use the Internet and do not have access to the technology and increased worries among families about children wasting their time on the Internet.⁴⁷

From the students' perspective, the main problem is gaining regular access to scientific and technical information.⁴⁸ In addition to a lack of enthusiasm for the Internet to improve efficiency and promote institutions of higher education due to limited electronic knowledge and widespread electronic illiteracy, there is a gap (related to training and financial issues) between those who can access the Internet and those who cannot.⁴⁹ Other problems are inadequate regular budgets for university libraries, inadequate training for library staff, and a lack of technical skills and finances to cover the high costs demanded for using information.⁵⁰ In addition to the difficulty of distinction between original and unoriginal documents and the risk of using unreliable information, other problems mentioned were the lack of assessment policies and evaluation programmes, electronic piracy, the poor service offered to users, a lack of access to credit cards and lack of security in their use, and the feeling of isolation among those who do not know how to use the Internet.⁵¹ Other problems included the high costs of acquiring licences for electronic libraries and time wasting among children and staff members during work time.⁵² Also mentioned were a lack of enthusiasm for electronic publications, difficulties overcoming the problem of copyright and the dissemination and use of these sources, and preventing viruses.⁵³ Other difficulties involve training, how easy it is to change and adjust original documents and the impacts on authors' moral and financial rights and managing Intellectual Properties Rights (IPRs), and preventing piracy when transferring adjusted unoriginal documents for users.⁵⁴ In addition to a lack of clear objectives and strategic planning, there are limited modern references available, difficulties correcting and controlling the digital and electronic documents in electronic libraries and inadequate electronic capacity.⁵⁵

One interesting observation from our findings is that both S&E and A&SS academic staff agree on several problems related to the use of the Internet and that are hindering the

⁴⁷ As indicated by 33% of the respondents among support staff.

⁴⁸ As reported by 100% of the respondents among students.

⁴⁹ As indicated by 100% of the respondents among students.

⁵⁰ As reported by 90% of the respondents among students.

⁵¹ As reported by 80% of the respondents among students.

⁵² As indicated by 80% of the respondents among students.

⁵³ As reported by 70% of the respondents among students.

⁵⁴ As reported by 70% of the respondents among students.

⁵⁵ As indicated by 60%, 60% and 50% of the respondents among students.

creation and transfer of knowledge in Khartoum University. For example, academic staff in Science and Engineering and Art and Social Sciences faculties have similar opinions about the problem of distinguishing between original and unoriginal documents and users risk using unreliable information, and worries about staff wasting work time on the Internet.⁵⁶ However, other complaints are viewed differently. For example, the number of complaints among the academic staff in arts and social sciences faculties is higher than in science and engineering faculties on several issues. These include, for example, access to scientific and technical information for creating and transferring knowledge, a lack of enthusiasm for the use of the Internet to improve efficiency and promote institutions of higher education and scientific research, and widespread electronic illiteracy. As well as a lack of enthusiasm for electronic publications, there is inadequate regular budget for university libraries to pay for access to scientific and technical information, authors' rights and have licences and subscriptions. In addition to the difficulty of regular access to the Internet and limited references, there is the difficulty of overcoming the problem of dissemination and the use of sources, the high costs of acquiring licences for access to electronic libraries and the spread of viruses and worries about people, especially children and staff, wasting time on the Internet.

However the number of complaints among academic staff in science and engineering faculties is higher than among their counterparts in arts and social sciences faculties in other areas. These include, for instance, complaints about the poor service offered, the high costs of using information and the lack of clear objectives, strategic planning, assessment policies and evaluation programmes. In addition to the gap between those who can access the Internet and those who cannot, there are difficulties controlling electronic documents in digital libraries, inadequate electronic capacity and a lack of technical skills among staff but an increased demand for technical and engineering education related to ICT. Complaints about most of these problems, and others mentioned above, have corresponding implications and hinder the creation and transfer of knowledge and are higher in number in S&E than in A&SS faculties. This is somewhat surprising in view of the fact that S&E faculties are more likely to have developed and own more favourable ICT infrastructure and facilities and therefore would offer a more conducive environment to meet the challenges in the creation and transfer of knowledge.

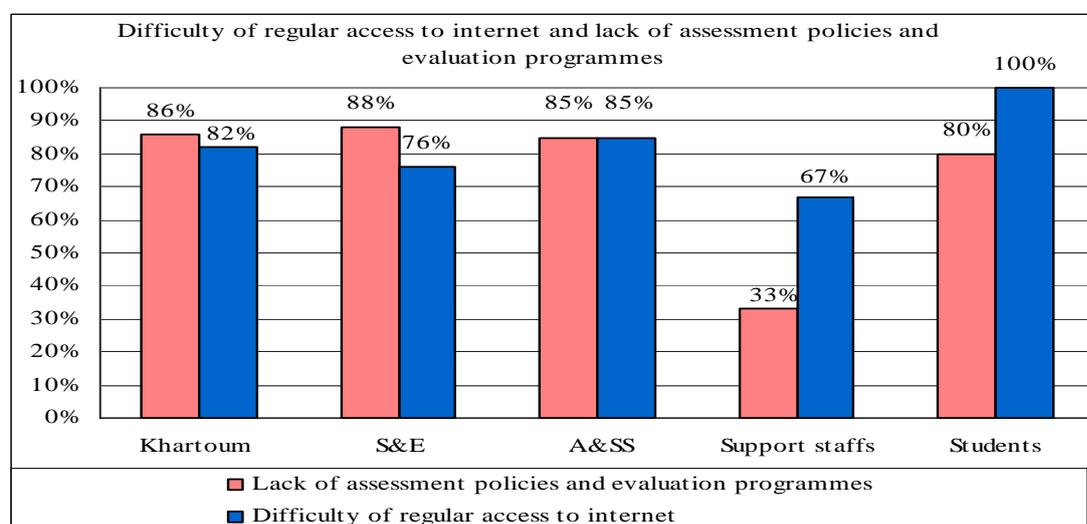
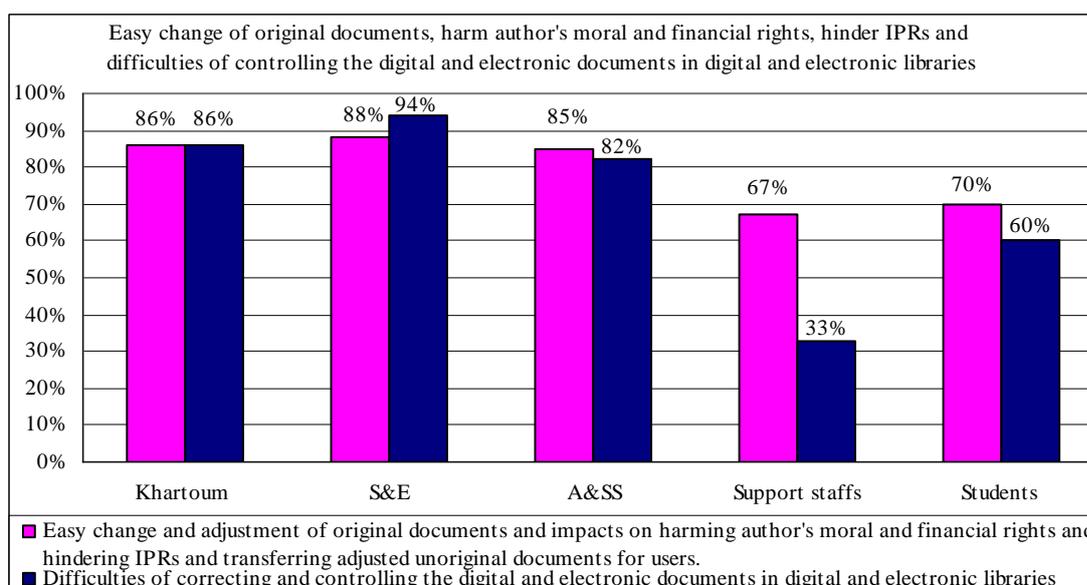
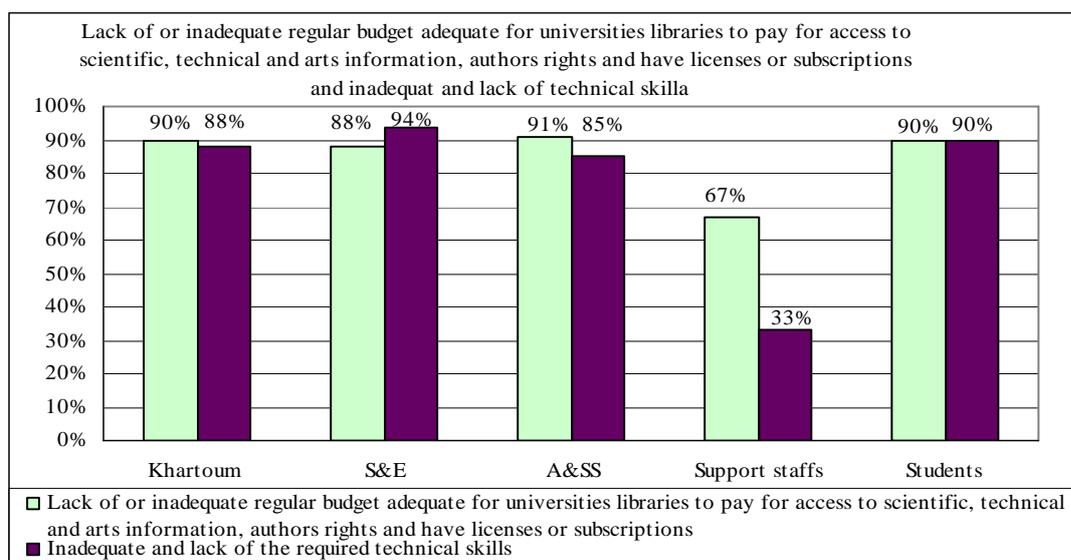
⁵⁶ As indicated by 88% of the respondents among the academic staff at Khartoum University.

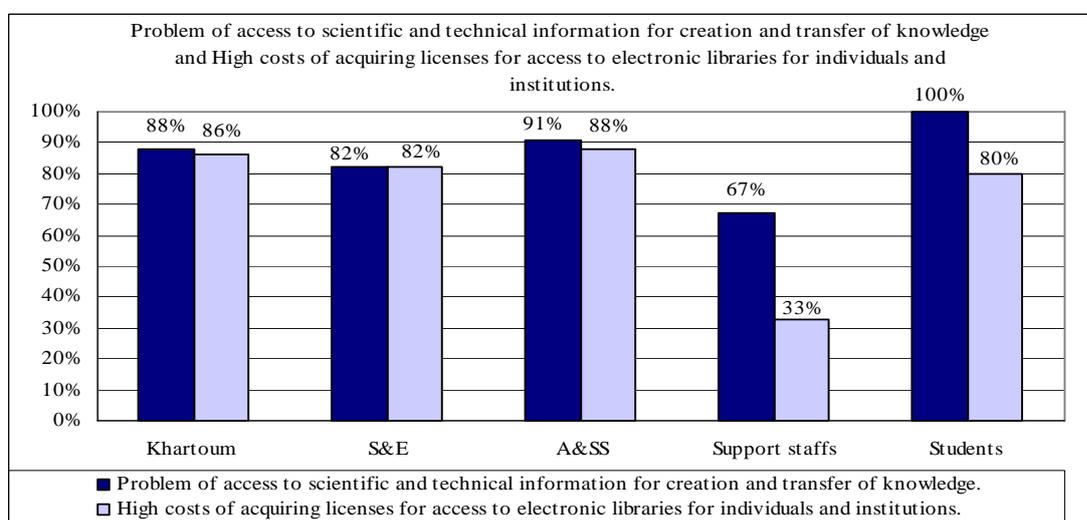
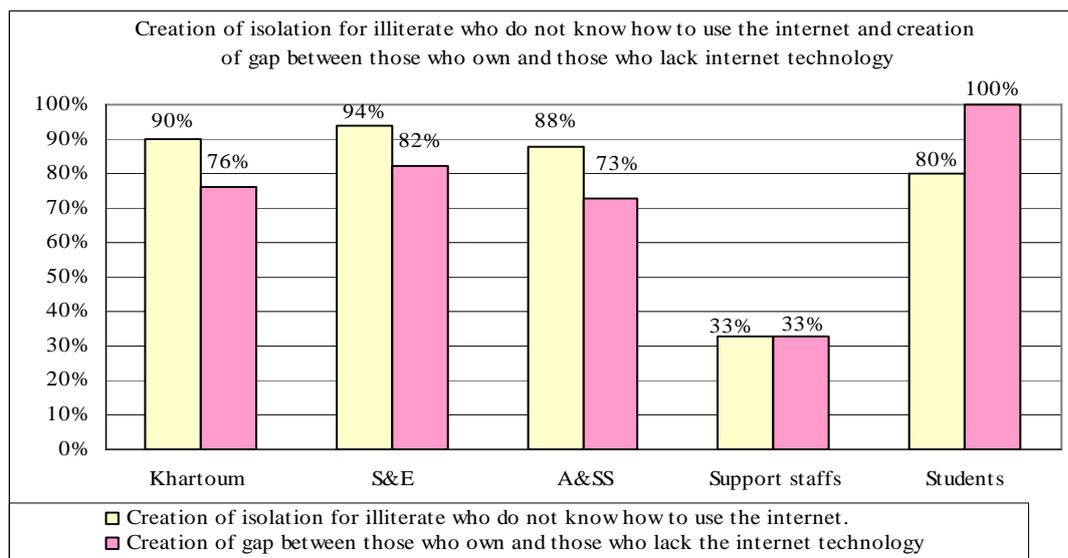
Table 4: The Impact of Difficulties and Problems in the Use of the Internet in the Creation and Transfer of Knowledge

Internet challenges/difficulties	Khartoum	Science and Engineering	Art and Social Sciences	Support staff	Students
Problem of access to scientific and technical information for creation and transfer of knowledge	88%	82%	91%	67%	100%
Lack of enthusiasm for the use of the Internet to improve and increase efficiency and promotion of institutions of higher education and scientific research due to limited electronic knowledge and widespread electronic illiteracy	78%	65%	85%	67%	100%
Lack of enthusiasm for electronic publications	76%	59%	85%	67%	70%
Risk of spread of electronic piracy	76%	71%	79%	67%	80%
Difficulty of overcoming the high costs paid for using information	82%	94%	76%	33%	90%
Lack of access to credit cards and lack of security in their use	72%	76%	70%	67%	80%
Lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, authors' rights and have licences or subscriptions	90%	88%	91%	67%	90%
Creating gap (related to training and financial ability to communicate) between those who can access Internet technology	76%	82%	73%	33%	100%
Lack of clear objectives and strategic planning	86%	94%	82%	67%	70%
Lack of assessment policies and evaluation programmes	86%	88%	85%	33%	80%
Difficulty of regular Internet access	82%	76%	85%	67%	100%
Limited or lack of modern available references	78%	76%	79%	67%	60%
Poor or lack of services offered to users	78%	88%	73%	33%	80%
Difficulty of overcoming the problem of copyrights and obstacles to dissemination and use of these sources	84%	82%	85%	33%	70%
High costs of acquiring licences for access to electronic libraries for individuals and institutions	86%	82%	88%	33%	80%
Isolation among those who do not know how to use the internet	90%	94%	88%	33%	80%
Difficulties of preventing spread of viruses	78%	76%	79%	67%	70%
Increased worry of families about children wasting their time on the internet, SMS, video, welfare and entertainments facilities	90%	88%	91%	33%	80%
Increased worry of institutions about staff wasting work time by using the Internet for personal reasons	88%	88%	88%	67%	80%
Difficulties of correcting and controlling digital documents in electronic libraries	86%	94%	82%	33%	60%
Inadequate electronic capacity	72%	76%	70%	33%	50%
Increased training required for library staff regarding the electronic use and distribution of information from producers to users	86%	88%	85%	67%	90%
Increased training and knowledge for users to ensure relevant use of electronic information	86%	94%	82%	67%	70%
Increased demand for technical and engineering education related to ICT	86%	88%	85%	67%	90%
Inadequate technical skills	88%	94%	85%	33%	90%
Difficulty distinguishing between original and unoriginal documents and risk of users using the wrong or unreliable information	88%	88%	88%	67%	80%
Changes and adjustments of original documents and the impact on authors' moral and financial rights, the management of Intellectual Properties Rights (IPRs) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users.	86%	88%	85%	67%	70%

Source: Author's own calculations based on the Khartoum University Survey (2009)

Figures 8-12: The Impact of Using the Internet in the Creation and Transfer of Knowledge





6. Conclusions

This working paper has focused on the impact of ICT in connections, transformations and the creation and transfer of knowledge in Sudan, taking Khartoum University as an example of an institution of higher education in Sudan. It considered the results of research undertaken there into the impact of the use of ICT in the transformation and production of knowledge.

Two hypotheses about how the use of ICT facilitates connections within knowledge institutions and collaboration between universities, in this case between Khartoum University and other Sudanese universities and universities worldwide, and the integration of Sudanese universities in the system of global knowledge production were verified. The results of the Khartoum University Survey of 2009 indicate that the Internet facilitates connections, networks and communication within the institution (Khartoum University), with others in

Sudan, with regional institutions and with international institutions. The second hypothesis that the use of ICT was found to enhance access, production and the dissemination of knowledge was confirmed, and Khartoum University's academic teaching staff, support staff and students thought that the most important advantages the Internet brought were providing information that was previously not available or accessible and a rapid quantitative and qualitative increase in transfers of available information. In addition, the development of a new model to disseminate and distribute electronic information, whereby the information moved towards the user, increases the creation and transfer of knowledge. They valued the increase in the free access they had to electronic publications for academic purposes. All Khartoum University academic teaching, support staff and students put the lack of a regular budget for university libraries to access scientific and technical information, authors' rights and have licences or subscriptions as a major concern. A final hypothesis, that the use of ICT introduces positive and negative effects by providing opportunities for transformations and knowledge production but simultaneously also creating hazards to transformations and knowledge production in Khartoum University was also confirmed: the positive transformation is building connections and organizational changes, while the negative transformation: is disconnection for those who do not share the knowledge accessed and/or do not know how to use ICT.

ICT introduces opportunities and challenges for the creation and transfer of knowledge. One of these challenges is that ICT has the capacity to lead to disconnection and the marginalization of some people. Disconnection implies difficulty in getting connections due to problems on both the supply and demand sides. On the supply side, disconnection is caused by poor availability, inefficiency and the irregular supply of ICT services. On the demand side, disconnection means an inability to connect that is probably due to both poverty and, therefore, the lack of opportunity to have access to ICT and of adequate skills and knowledge about how to use ICT. This implies that disconnection can lead to the creation of gaps and the marginalization of some who are poor and lacking access and others who may lack the skills and knowledge required to use ICT. The major ethical and political implications are that ICT, by causing disconnection, has the potential to add a new form of marginalization and thus add to the already existing inequalities between different social groups in Sudan. The major policy recommendation on the demand side is to increase subsidies for the poor to facilitate their access to ICT and to increase literacy rates, skills and knowledge about ICT in order to improve access to it. The major suggestion on the supply side is increased availability, sustainability and efficiency of ICT services.

The findings in this paper are consistent with the African literature on ICT, higher-education institutions and universities in Africa (cf. Durrant 2004; Beebe *et-al.* 2003; Olukosh & Zeleza 2004), universities in Egypt (cf. Radwan 2003: Cairo University and other Egyptian universities), Kenya (Thairu 2003: Kenya Education Network), Kenya and Nigeria (Oyeyinka & Adeya 2003), Mozambique (Massingue 2003: Eduardo Mondlane University), South Africa (Adei 2003: South Africa University), Tanzania (Mutagahywa 2003: Dar es Salaam University) and Zambia (Mwenechanya 2003: Zambia University). Our results help to improve understanding about the role of ICT in the production, creation and transfer of knowledge in Sudan and provide a new African case study. In addition, this paper fills a gap in the African literature by focusing only on Sudan as a new African case study, explaining the importance of the use of ICT in facilitating connections within knowledge institutions and introducing opportunities and challenges for the creation and transfer of knowledge.

The findings here suggest that ICT is leading to significant transformation by facilitating connections in the creation and transfer of knowledge in African universities. ICT supports scientific research activities, improves the acquisition of knowledge, supports the restructuring of administration and the modernization of African universities, facilitates access to electronic publications, online courses and distance learning, helps solve problematic access to limited members in enrolment through distance education, bridges the knowledge divide by improving accessibility to scientific and technical information, and facilitates internal and external connections, South-South and South-North collaboration and the transfer of knowledge. In the future, ICT has the potential to continue playing an important role by facilitating connections and the creation and transfer of knowledge in African universities provided that they manage to overcome the difficulties on the supply and demand sides. In particular, improved skills, training and knowledge about ICT and better availability, sustainability and efficiency of ICT infrastructure are needed (cf. Durrant 2004). In addition there needs to be increased government spending on the development of ICT infrastructure in higher education and subsidies for an adequate regular budget for university libraries to pay for licences, subscriptions and access to scientific and technical information. However, there are political and ethical issues related to government spending on ICT. As for the political issue, justifying the commitment of the Sudanese government to spending on the development of ICT for the universities is easy because the universities relate to the elite and their positions of power. When the Sudanese government spends money on ICT, it is sponsoring its own elite. In addition to the political issue, there is also an ethical issue. If the Sudanese government spends scarce resources (i.e. money for development) on the

development of ICT for universities, it thereby reduces the amount it has available to address important issues such as poverty and health. This is a disadvantage of ICT, as government spending on ICT takes money away from other urgent target groups (i.e. the poor). The major implication here is that more spending on ICT means less spending on social developments, such as health and poverty reduction. Poverty will continue to increase and the poor will continue to suffer. The challenge, therefore, is how to strike the right balance when allocating government funds to different priorities. Our major policy recommendation is to encourage private-sector involvement in ICT and to focus government spending on ICT more towards the beneficiaries of the poor by upgrading their skills and offering them more education and employment opportunities, which could contribute to achieving the UN Millennium Development Goal (MDG) of halving the number of people living in poverty by 2015. The general conclusion is, however, that there are more advantages than disadvantages to using ICT in Sudanese and African universities.

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