



The Impact of ICT in Public and Private Universities in Sudan

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Abstract This paper examines the impacts of ICT in public and private Sudanese universities. We verify the first and third hypotheses that the use of ICT facilitates connection, networks and collaboration within public and private universities in Sudan, with local, regional and international institutions. We support the second hypothesis that the use of ICT enhances access, production and dissemination of knowledge in Sudanese universities. We support the fourth hypothesis that the use of ICT introduces ‘creative-destruction’ effect by providing opportunities for knowledge production, building connection and organizational changes; but simultaneously also creating hazards to knowledge production and building disconnection for those who do not share the knowledge in public and private Sudanese universities. We show that the most important advantageous related to the use of Internet for enhancing production, creation and transfer of knowledge include increasing digital knowledge for academic and researchers, rapid quantitative and qualitative increase in transferring information, development of new models for disseminating and distributing electronic information, and increase free access to electronic publications for academic purposes. We find that top problem related to the use of Internet is the lack of regular budget for universities libraries to pay for licenses and access to scientific and technical information.

Keywords Information and communication technology · ICT demand · ICT impacts · Public-private universities · Knowledge production · Sudan

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JEL Classification O10 · O12 · O30

Introduction

This paper discusses the importance and impact of ICT in the transformation and production of knowledge in Sudan, notably in public and private Sudanese universities where there is a steady increase in the use of ICT compared to other poor developing countries.

Given the relatively few studies that focus on the interaction between ICT and knowledge, this paper fills the gap in the literature by focusing on Sudan as a new case study and using new primary data on the impact of ICT in transformation and production of knowledge. Different from the limited scope of analysis presented in Nour (2002a, b, 2006), this paper provides more comprehensive analysis of the role of ICT in enhancing knowledge production and transformation in Sudanese universities using the most up-to-date and relevant data.

The aim of this paper is twofold; first, to examine the use of ICT at Sudanese universities and, second, to explain the role of ICT in facilitating transformation, connection, access to, production and dissemination of knowledge in Sudanese universities. The impact of the use of ICT, its potential opportunities and challenges are also discussed. The paper aims to test four hypotheses: (1) the use of ICT facilitates connection within knowledge institutions, namely, in Sudanese universities. (2) The use of ICT enhances access, production and the dissemination of knowledge in Sudanese universities. (3) The use of ICT facilitates collaboration between Sudanese universities and international universities. (4) The use of ICT has both positive and negative effects by providing opportunities for the positive transformation and production of knowledge by building connections and organizational changes, but simultaneously also creating negative effect and hazards to transformations and knowledge production by creating disconnection for those who do not know how to use ICT in Sudanese universities and knowledge institutions.

In our view, this paper makes a relevant contribution to the literature on ICTs for development because it examines the impact of ICT in connections, transformations, creation and transfer of knowledge in higher education institutions (public and private universities). The results of this paper imply that the intensified use of ICT will contribute to enhancing the production, creation and transfer of knowledge, which in turn contribute to enhancing economic development. Moreover, the findings confirm the role of higher education institutions (public and private universities) through the intensified use of ICT in enhancing the production, creation and transfer of knowledge and hence, enhancing economic development.

This paper consists of five sections: “**Introduction**” presents the background of the study; “**Review of Theoretical and Empirical Literature**” reviews and discusses the literature on the significance and impact of ICT; “**Research Methodology**” explains the data and methodology; “**Research Results**” discusses the findings, examines the hypotheses and shows the main results concerning the potential opportunities and challenges that the use and impact of ICT are introducing in transformation and production of knowledge in Sudanese universities; and “**Conclusions**” is provided in the last section.

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, 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; Pohjola 2000, 2001), productivity (cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organization (cf. Bresnahan et al. 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 et al. 1998; Acemoglu 1998). Some of these studies explain the relationship between ICT, IT or computer use and skills upgrading defined by increase either in the incidences of training (cf. Bresnahan 1999) or the share of highly skilled workers (cf. Autor et al. 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 et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu, 1998; Aghion and Howitt 1998; Autor et al. 1998).

It has also been hypothesised 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.¹ For instance, Smith (2000) indicates four approaches to the knowledge economy, in particular, the argument for 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. Foray and Lundvall (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. Foray and Lundvall are almost certainly right when claiming that ICT is playing a new role in knowledge production and distribution but this is a reorganization 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 25 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.²”

¹ See for instance, Quah (2001), Pohjola (2001) and Smith (2000).

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

More recent literature show the general use of ICT in Africa, some studies particularly focus on the use, impact and role of ICT in enhancing higher education institutions in Africa.³

Research Methodology

To examine the four hypotheses on the impacts of ICT across Sudanese universities presented above, this section uses the descriptive approach and primary data based on the university survey (2009), which was drawn from ten public and private Sudanese universities.⁴ The data from the university survey provides information particularly useful for presenting interesting public-private comparative analysis to elaborate ICT role to enhance connection and transformation in Sudanese universities from public-private perspectives and from academic teaching staff, support staff and students' perspectives.

Our analysis of Sudanese universities uses primary data based on the results obtained from the university survey of Nour (2009). The university survey was carried out by Nour “the author”; within Nour’s “the author” project “The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan”.

The field research to collect our primary data was held in the period from March to April, 2009, in Sudan. The sample in the university survey was drawn from ten public and private Sudanese universities located in Khartoum state; the selection and focus of our analysis on Khartoum state was partly because of high potential use of ICT and partly, because of easy access to data facilitated by the Department of Economics, Faculty of Economic and Social Studies, Khartoum University, Sudan.

The selection of these universities was based on their significant average share in higher educational institutions, total research activities and therefore, the production of knowledge and was based on their specialisation in ICT and other related fields and their experience and potential contribution towards enhancing the role of ICT in the creation and transfer of knowledge in Sudan. The questionnaire on ‘The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan’ was distributed randomly and circulated amongst 131 individuals: academic teaching staff, support staff and students affiliated to ten (five public and five private) Sudanese universities located in Khartoum state. The selection of the individuals was based on a random basis; the coverage of individual in the survey is more comprehensive and includes both males (50%) and females (50%) whose ages are between 20 and 70 years

³ See for example, Telecommunications Policy (2005) 29(7): James Hodge; Alison Gillwald; Patricia K. McCormick; Gillian Marcelle; and Banji Oyelaran-Oyeyinka and Kaushalesh Lal . See also Ahwireng-Obeng (2000), Durrant (2004), Unwin (2004), Olukoshi and Zeleza (2004), Beebe *et-al.* (2003), Adei (2003), Radwan (2003), Thairu (2003), Massingue (2003), Oyeyinka and Adeya (2003) and Mwenechanya (2003).

⁴ The university survey includes students, academic teaching and support staff affiliated to ten public and private universities. The five public universities are: Khartoum University (KU), Sudan University of Science and Technology (SUST), Juba University (JU), Al-zaim Al-azhari University (AAU) and Omdurman Islamic University (OIU). The five private universities are: Computerman University (CMU), University of Medical Sciences and Technology (UMST), Sudan International University (SIU), Sudan Academy for Banking and Financial Studies (SABFS) and Ahfad University for Women (AUW). The university survey was distributed after translation of the English version into the Arabic language in order to increase the response rate.

old. Since ICT is widely used amongst the youth population, the coverage in the university survey was focused on the youth population.

The survey aimed to collect micro-qualitative and quantitative data to reflect the opinions of academic teaching staff, support staff and students with respect to assessment of the demand for ICT and the opportunities and challenges associated with the use of ICT and the implications of this in the production, creation and transfer of knowledge in Sudanese universities. It was also intended to provide insights to help generate policies to enhance the role of ICT in fostering the production or creation and transfer of knowledge in Sudanese universities. The main reason for conducting the university survey was to fill the information gap due to a lack of relevant, reliable and up-to-date information, and to obtain specific information to allow a more comprehensive analysis and a deeper understanding of the use and impact of ICT and their corresponding implications for the production, creation and transfer of knowledge in public and private Sudanese universities. We held the survey due to a lack of enough materials needed to investigate the research problem on the use and impact of ICT at the university level.

One advantage of the university survey is that it examines the problem from the two different public-private perspectives. Another advantage of the university survey is that it examines these problems after integrating three different perspectives of academic teaching staff, support staff and students engaged in both the production and transfer of knowledge in the public and private universities in Sudan. Moreover, due to their close association to educational and training institutions, the approached teaching staff, support staff and students provided some useful information from both the analytical and policy perspectives.

Table 1 below presents the composition of the university survey and indicates a total response rate of 85% for all the survey including all academic teaching staff, support staff and students. The response rate varied according to institutions and individuals covered in the survey. For the academic teaching staff, the total response rate was 81%, and the weighted response rates by sector was 82% and 77% for public and private sectors universities, respectively. The shares of public and private universities are quite representative and yield different response rates. For the support staff and students the total response rate was 100% and 100% respectively. The data from the university 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 university survey concerning the demand for ICT and the role of ICT in facilitating the creation and transfer of knowledge in Sudanese universities.

As for the general structure and design of the questionnaire in the university survey, the questionnaire in the university survey was composed of nine sections, each of the nine sections in the university survey aimed to request particular information. Section 1 requested general background information about identification and characteristics of the individuals covered in the survey. Sections 8–10 examined the impacts and advantages of the use of Internet in facilitating creation and transfer of knowledge; and explained the factors hindering and others contributing towards promoting the use of ICT to enhance the creation and transfer of knowledge and to enhance connections and transformation in Sudanese universities.

One limitation is that the present study covers only Khartoum state, and did not cover all Sudanese states due to time constraint; we hope to cover all Sudanese states in our future research. Another limitation is that the present study covers only ten of the

Table 1 Composition of the ICT university survey in Sudan, 2009

Representation	Institutions			Individuals								
	Number in sample	Total resp-onse	Response rate (%)	Number in sample	Total respon-se	Response rate (%)	Number in sample	Total response	Response rate (%)	Number in sample	Total response	Response rate (%)
Public universities												
1. Khartoum (KU)	77	67	87	60	50	83	3	3	100	14	14	100
2. SUST	6	6	100	6	6	100						
3. JU	10	9	90	6	5	83				4	4	100
4. AAU	5	4	80	3	2	67				2	2	100
5. OIU	5	3	60	3	1	33				2	2	100
Total public	103	89	86	78	64	82	3	3	100	2	2	100
Private universities												
6. A UW	5	5	100	3	3	100				2	2	100
7. UMST	4	4	100	4	4	100						
8. CMU	12	9	75	8	5	63	2	2	100	2	2	100
9. SIU	5	3	60	5	3	60						
10. SABFS	2	2	100	2	2	100						
Total private	28	23	82	22	17	77	2	2	100	5	5	100
Grand Total	131	112	85	99	81	81	5	5	100	26	26	100

Source: Own calculation based on the University survey (2009)

public and private universities located in Khartoum state, and did not cover all public and private universities located in Khartoum state due to time constraint; we hope to cover all public and private universities located in Khartoum state in our future research. Another limitation is related to time elapsed since the University survey was conducted in 2009, it is worth to mention the likely changes in Sudan during the last 5 years because of the quicker transformations in ICT components in Sudan similar to all world developed and developing countries. Despite the time elapsed as the University survey was conducted in 2009, the University survey provides very useful information adequately sufficient for our analysis in this paper.

Research Results

This section uses the university survey data to examine the hypotheses and show the main results concerning the potential opportunities and challenges that the use and impact of ICT is introducing in transformation and production of knowledge in Sudanese universities.

Internet, Connection, Networks and Communication

The results of the university survey indicate that the Internet facilitates connection, networks and communication inside the institutions, with other institutions in Sudan, with regional and international institutions. The importance of the effect with regards to connection varies from all, public and private universities academic teaching staff, support staff and students' perspectives, as we explain below, see Table 2.

For example, from all universities academic teaching staff's perspective, Internet facilitates connection, networks and communication inside the institution, this is followed by equivalent effect in facilitating connection with regional and international institutions and finally, the effect in facilitating connection with other institutions in Sudan is also mentioned, but somewhat surprising with somewhat less importance.⁵ From the public universities academic teaching staff's perspective, Internet facilitates connection, networks and communication inside the institution and similarly connection with international institutions, this is followed by connection with regional institutions and finally with other institutions in Sudan respectively.⁶ Whereas from the private universities academic teaching staff's perspective, Internet facilitates connection, networks and communication inside the institution, this is followed by connection with regional institutions, connection with other institutions in Sudan, and finally connection with international institutions respectively.⁷ From the support staff's perspective, Internet highly facilitates connection, networks and communication inside the institution, which is higher than the equivalent effects in facilitating connection with other institutions in Sudan and connection with regional and international institutions.⁸ From the students' perspective, Internet facilitates connection, networks and

⁵ As indicated by 64, 60, 60 and 54% of the respondent all universities academic staff, respectively.

⁶ As indicated by 61, 61, 58 and 52% of respondent public universities academic staff, respectively.

⁷ As reported by 76, 71, 65 and 59% of respondent private universities academic staff, respectively.

⁸ As indicated by 80, 60, 60 and 60 of the respondent support staff, respectively.

Table 2 Internet, connection, networks and communication in Sudanese universities

	All (%)	Public (%)	Private (%)	Students (%)	Support staff (%)
Inside the institution	64	61	76	65	80
With other institutions in Sudan	54	52	65	69	60
With regional institutions	60	58	71	69	60
With international institutions	60	61	59	69	60
Number of respondents	80	63	17	5	26

Source: Own calculation based on the University survey (2009)

communication inside the institution, but somewhat surprising it is with somewhat less importance than the higher equivalent effects in facilitating connection with other institutions in Sudan and connection with regional and with international institutions.⁹

One interesting observation from our findings is that both public and private universities agree on the importance and value of Internet for facilitating connection and internal networks inside the institutions. The importance and value of Internet for facilitating connection and internal networks inside the institutions is higher in the private universities compared to public universities, which may not be surprising in view of the fact that private universities most probably have developed and owned more favourable ICT infrastructure and managed to provide more facilities and therefore more conducive environment for promoting good connection and internal networks. Another interpretation is that promotion of internal connection and network is probably used by these private universities to compete with other universities in attracting more qualified academic teaching and support staff and qualified students.

Another interesting observation from our finding is that both the support staff and students agree on the fact that the effect of Internet in facilitating external network is equivalent regardless of the nature of the different external institutions. However their points of view differ in the fact that the support staff value the effect of Internet in facilitating internal connection and networks higher than the external networks, whereas, students present an opposite point of view and value the effect of Internet in facilitating external connection and networks more than internal networks. This result is plausible in view of the fact that support staff most probably are more concerned with internal connection inside their institutions, whereas students most probably are more interested in broadening their connection, namely external connection with other international, regional and local institutions in Sudan. From the students' perspective strong connection and network with external institution is probably required for increasing and enhancing educational, learning and research skills for students.

ICT (Internet) Impacts: Opportunities and Challenges

The results of the university survey indicate that from all universities academic teaching staff, support staff and students' perspectives, Internet leads to several positive impacts, opportunities and advantages, but also leads to other negative impacts, challenges and

⁹ As reported by 65, 69, 69 and 69% of the respondent students, respectively.

difficulties. This section explains first the opportunities and advantages and then the challenges and difficulties, see Tables 3–4 and Figs. 1–8.

ICT (Internet) Opportunities and Advantages

From all universities academic teaching staff, support staff and students' perspectives, Internet leads to many positive impacts, opportunities and advantages—see Table 3.

From all universities academic teaching staffs' perspective, the Internet provides many opportunities and advantages for facilitating connection and transformation and enhancing the production, creation and transfer of knowledge. For instance, the top opportunities and advantages include increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible, rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information and development of a new model for disseminating and distributing electronic information, where the information moved towards the user (Figs. 1–2).¹⁰ In addition to increase creation and transfer of knowledge, increase possibility of introduction of research outside academic fields, increase free access to electronic publications for academic purposes (Fig. 2) and create linkage and contact between people with common interests in different activities related to increase of knowledge.¹¹ Other advantageous are improve intellectual capacity that was earlier not available, increase 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 preserve of heritage for future generations, encourage and increase process of integration in world and international knowledge (Fig. 3), develop social capability and so acquisition of knowledge and learning new skills from others and facilitate preparation of unlimited copies with cheap price in the Internet instantaneously without having affecting the quality with the possibility of rapid transferring copies to any place in the world.¹² In addition to introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research and introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally.¹³ In addition to increase the use of long distance learning, training and education (Fig. 3), introduction of change in the role of libraries by the use of the digital documents, introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advice users for the use of electronic data, information and documents, save of time and easy performance of work related to production and transfer of knowledge, encourage knowledge about other cultures and facilitate contact between academic teaching staffs' colleagues and students in academic institutions.¹⁴ Furthermore, it increases integration of higher education and research sector in implementation, assessment and regulation of ICT sector, facilitates introduction of the world for production of knowledge and academic works conducted by Sudanese and reduces the need for the users to use the services of information professional to have direct access

¹⁰ As indicated by 95, 94 and 91% of the respondent all universities academic staff, respectively.

¹¹ As reported by 90% of the respondent all universities academic staff.

¹² As indicated by 89% of the respondent all universities academic staff.

¹³ As reported by 88% of the respondent all universities academic staff.

¹⁴ As indicated by 86% of the respondent all universities academic staff.

Table 3 The impacts, opportunities and advantages of the use of Internet in facilitating creation and transfer of knowledge

Internet opportunities/advantages	All (%)	Public (%)	Private (%)	Support staffs (%)	Students (%)
Increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible.	95	94	100	80	81
Rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information	94	92	100	80	92
Development of a new model for disseminating and distributing electronic information, where the information moved towards the user	91	89	100	80	92
Increase creation and transfer of knowledge	90	89	94	80	85
Increase possibility of introduction of research outside academic fields	90	88	100	60	88
Increase free access to electronic publications for academic purposes	90	88	100	80	81
Create linkage and contact between people with common interests in different activities related to increase of knowledge	90	88	100	80	77
Improve intellectual capacity that was earlier not available	89	89	88	80	92
Increase 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 preserve of heritage for future generations	89	86	100	60	77
Encourage and increase process of integration in world international knowledge	89	89	88	60	77
Develop social capability and so acquisition of knowledge and learning new skills from others	89	86	100	80	85
Facilitate preparation of unlimited copies with cheap price in the Internet instantaneously without having affecting the quality with the possibility of rapid transferring copies to any place in the world	89	86	100	80	73
Introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research	88	84	100	60	81
Introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally	88	84	100	80	81
Increase the use of long distance learning, training and education	86	84	94	80	77
Introduction of change in the role of libraries by the use of the digital documents	86	83	100	80	85
Introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advice users for the use electronic data, information and documents	86	83	100	80	77
Save of time and easy performance of work related to production and transfer of knowledge	86	84	94	80	77
Encourage knowledge about other cultures	86	84	94	80	77

Table 3 (continued)

Internet opportunities/advantages	All (%)	Public (%)	Private (%)	Support staffs (%)	Students (%)
Facilitate contact between academic teaching staffs colleagues and students in academic institutions	86	84	94	60	77
Increase integration of higher education and research sector in implementation, assessment and regulation of ICT sector	85	83	94	60	88
Facilitate introduction of the world for production of knowledge and academic works conducted by Sudanese	85	84	88	60	81
Reduce the need for the users to use the services of an information professional to have direct access to information/data.	85	83	94	80	77
Reduce monopoly in creation of knowledge earlier dominated by universities and researchers	84	80	100	80	81
Increase possibility of electronic dissemination of academic documents and for commercial benefits	84	80	100	80	81
Facilitate transfer of protected materials in the Internet and digital networks and the use of materials across borders.	84	81	94	80	77
Introduction of change by reducing the use of written paper	79	75	94	40	62
Reduce the need for the users to go to a library or documentation centre to have direct access to information/data.	78	75	88	60	73
Facilitate management of Intellectual Properties Rights (IPRs) and preventing piracy.	74	70	88	80	69
Number of respondents	80	63	17	5	26

Source: Own calculation based on the University survey (2009)

to information/data.¹⁵ In addition, it reduces monopoly in creation of knowledge earlier dominated by universities and researchers, increase possibility of electronic dissemination of academic documents and for commercial benefits and facilitate transfer of protected materials in the Internet and facilitate digital networks and the use of materials across borders.¹⁶ In addition to introduction of change by reducing the use of written paper, reduce the need for the users to go to a library or documentation centre to have direct access to information/data and facilitate management of intellectual properties rights (IPRs) and preventing piracy.¹⁷

From the support staffs' perspective, the top opportunities and advantages, include increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible and rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information, improve intellectual capacity that was earlier not available. In addition all opportunities and advantages for facilitating and enhancing connection, transformation, creation and transfer of knowledge that highlighted above by academic teaching staff are also highlighted by support staff.¹⁸

¹⁵ As reported by 85% of academic staffs in all the respondent universities.

¹⁶ As indicated by 84% of the respondent all universities academic staff.

¹⁷ As reported by 79, 78 and 74% of the respondent all universities academic staff, respectively.

¹⁸ As reported by 80, 60 and 40% of the respondent support staff, respectively.

Table 4 The impacts of difficulties and problems for the use of Internet in hindering creation and transfer of knowledge

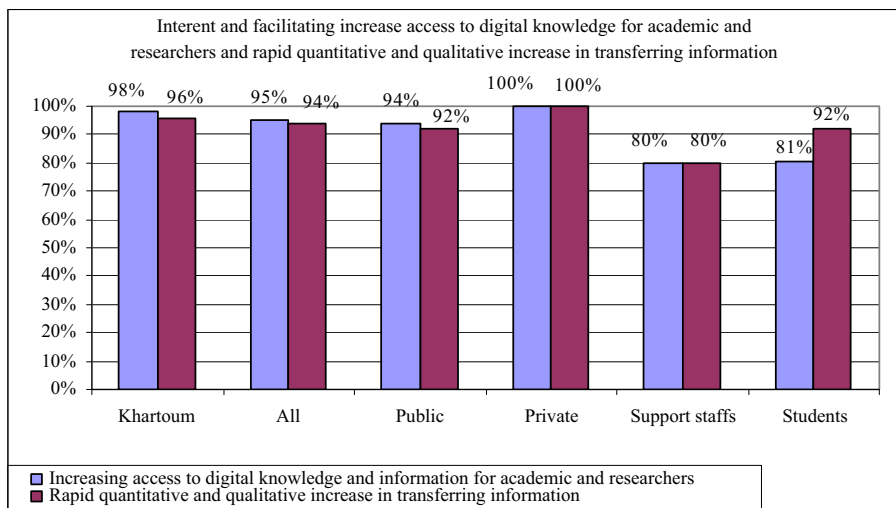
Internet challenges/ difficulties	All (%)	Public (%)	Private (%)	Support staffs (%)	Students (%)
Lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author's rights and have licences or subscriptions	88	84	100	80	77
Difficulty of regular access to Internet	84	81	94	60	65
Inadequate and lack of the required technical skills	84	81	94	40	73
Creation of isolation for illiterate who do not know how to use the Internet	84	83	88	60	65
Increase training for workers in the libraries to enable them to own adequate knowledge for the electronic use and distribution of information and for redirecting information from producers to users	84	80	100	80	73
Easy change and adjustment of original documents and impacts on author's moral and financial rights and impacts on hindering management of Intellectual Properties Rights (IPRs) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users	84	83	88	60	69
Increase worry of families of waste of time of their children on Internet, SMS, video, welfare and entertainments facilities	84	83	88	40	73
Increase worry of institutions of waste of working time of their workers on Internet, personal e-mail and use for personal purposes	83	83	82	60	69
Difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries	83	80	94	40	54
Problem of access to scientific and technical information for creation and transfer of knowledge.	83	81	88	80	88
Increase training and knowledge for users to ensure relevant use of the electronic information	83	80	94	60	69
Increase demand for technical and engineering education related to ICT	83	80	94	80	73
Lack of clear objectives and strategic planning	83	81	88	80	58
Lack of assessment policies and evaluation programmes	81	78	94	60	69
Difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information	80	81	76	60	73
High costs of acquiring licences for access to electronic libraries for individuals and institutions	79	78	82	60	65
Difficulty of overcoming the problem of high costs paid for using information	79	78	82	60	69
Creating gap (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology	79	75	94	40	77
Limited and lack of modern available references	79	75	94	60	58
Lack of enthusiasm for the use of Internet to improve and increase efficiency and promotion of institutions of higher	77	72	94	80	77

Table 4 (continued)

Internet challenges/ difficulties	All (%)	Public (%)	Private (%)	Support staffs (%)	Students (%)
education and scientific research due to limited electronic knowledge and wide spread of electronic illiteracy					
Difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources	77	78	71	60	65
Difficulties of preventing programmes of spy and spread of viruses	77	73	88	80	65
Poor or lack of services offered to users	75	73	82	40	58
Lack of enthusiasm for electronic publications	74	70	88	60	62
Risk of spread of electronic piracy	74	72	82	60	65
Lack of access to credit cards and lack of security in their use	70	72	65	80	65
Inadequate electronic capacity	68	67	71	40	58
Number of respondents	80	63	17	5	26

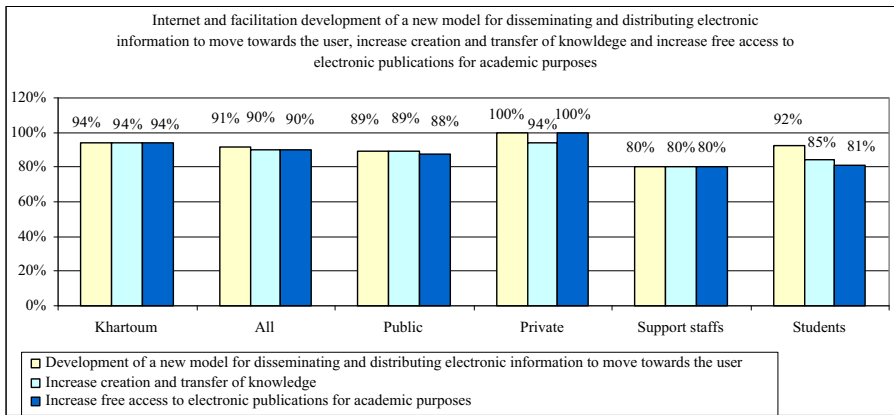
Source: Own calculation based on the University survey (2009)

From the students' perspectives the top advantage and opportunities include rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information, improve intellectual capacity that was earlier not available and development of a new model for disseminating and distributing electronic information, where the information moved towards the user. This is followed by increase integration of higher education and research sector in implementation, assessment and regulation of ICT sector and increase possibility of introduction of research outside academic



Source: Own calculation based on the University survey (2009).

Figure 1 Internet and facilitating increase access to digital knowledge for academic and researchers and rapid quantitative and qualitative increase in transferring information



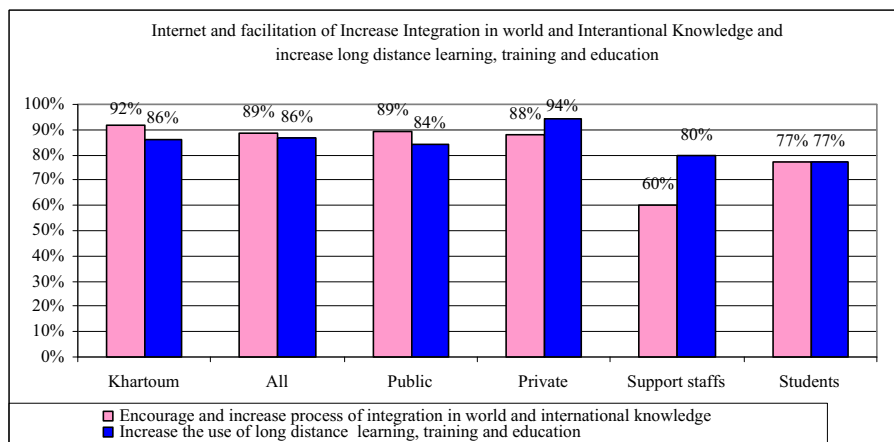
Source: Own calculation based on the University survey (2009).

Figure 2 Internet and facilitation development of a new model for disseminating and distributing electronic information to move towards the user, increase creation and transfer of knowledge and increase free access to electronic publication for academic purposes

fields. In addition to increase creation and transfer of knowledge, introduction of change in the role of libraries by the use of the digital documents and develop social capability and so acquisition of knowledge and learning new skills from others. Moreover, all opportunities and advantages for facilitating and enhancing connection, transformation, creation and transfer of knowledge that highlighted above by academic teaching staff are also highlighted by students.¹⁹

One interesting observation from our findings is that both public and private universities agree on the importance and value of Internet for providing many opportunities and advantageous for facilitating creation and transfer of knowledge in the Sudanese universities. The importance and value of Internet for providing many opportunities and advantageous for facilitating creation and transfer of knowledge is higher in the private universities compared to public universities, which may not be surprising in view of the fact that private universities most probably have developed and owned more favourable ICT infrastructure and managed to provide more facilities and therefore more conducive environment for providing many opportunities and advantageous for facilitating creation and transfer of knowledge. Another interpretation is that promotion of opportunities and advantageous of Internet for facilitating creation and transfer of knowledge is probably used by these private universities to compete with other universities in attracting more qualified academic teaching and support staffs and qualified students. The only exception is related to the importance of Internet in increasing integration in the world and international knowledge, as the public universities values it higher than the private universities. This is probably because, majority of the public universities are elder and have already established a good repetition and relationship with the world and international knowledge institutions whereas the majority of the private universities—probably except Ahfad—are relatively younger and only recently started to build repetition and relationship with the world and international knowledge institutions.

¹⁹ As indicated by 92, 88, 85, 81, 77, 73, 69 and 62% of the respondent students, respectively.



Source: Own calculation based on the University survey (2009).

Figure 3 Internet and facilitation of increase integration in world and international knowledge and increase long distance learning, training and education

ICT (Internet) Challenges, Problems and Difficulties

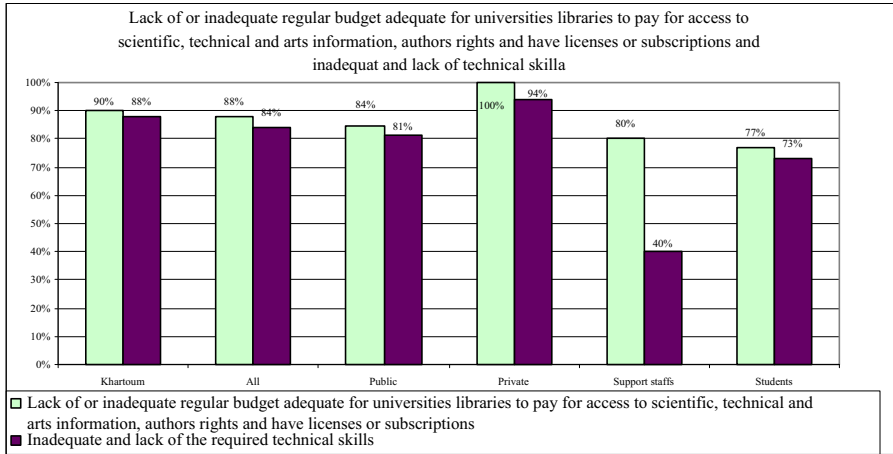
From all universities academic teaching staffs, support staffs and students' perspectives, Internet leads to some other negative impacts, challenges and difficulties—see Table 4.

From all universities academic teaching staffs' perspectives, the top problem related to the use of Internet is the lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author's rights and have licences or subscriptions (Fig. 4).²⁰ This is followed by the difficulty of regular access to Internet, inadequate or lack of the required technical skills, creation of isolation for illiterate who do not know how to use the Internet and increase training for workers in the libraries to enable them to own adequate knowledge for the electronic use and distribution of information and for redirecting information from producers to users (Figs. 4, 6 and 7). In addition to the problem of easy change and adjustment of original documents and impacts on author's moral and financial rights and impacts on hindering management of intellectual property rights (IPRs) (Fig. 5) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users. In addition to the problem of increase worry of families of waste of time of their children on Internet, SMS, video, welfare and entertainments facilities.²¹ In addition to increase worry of institutions of waste of working time of their workers on Internet, personal e-mail and use for personal purposes, difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries (Fig. 5) and the problem of access to scientific and technical information for creation and transfer of knowledge (Fig. 8). In addition to the difficulties of increase training and knowledge for users to ensure relevant use of the electronic information, increase demand for technical and engineering education related to ICT and the problem of lack of clear objectives and strategic planning.²² Other difficulties include lack of assessment

²⁰ As indicated by 88% of the respondent all universities academic staffs.

²¹ As reported by 84% of the respondent all universities academic staffs.

²² As indicated by 83% of the respondent all universities academic staffs.



Source: Own calculation based on the University survey (2009).

Figure 4 The lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author’s rights and have licences or subscriptions and inadequate and lack of the required technical skills

policies and evaluation programmes (Fig. 6) and difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information.²³ In addition to the problem of high costs of acquiring licences for access to electronic libraries for individuals and institutions (Fig. 8), difficulty of overcoming the problem of high costs paid for using information, creating gap (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology (Fig. 7) and limited and lack of modern available references.²⁴ In addition to the problem of lack of enthusiasm for the use of Internet to improve and increase efficiency and promotion of institutions of higher education and scientific research due to limited electronic knowledge and wide spread of electronic illiteracy, difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources and difficulties of preventing programmes of spy and spread of viruses.²⁵ Other problems include poor or lack of services offered to users, lack of enthusiasm for electronic publications, risk of spread of electronic piracy, lack of access to credit cards and lack of security in their use and inadequate electronic capacity.²⁶

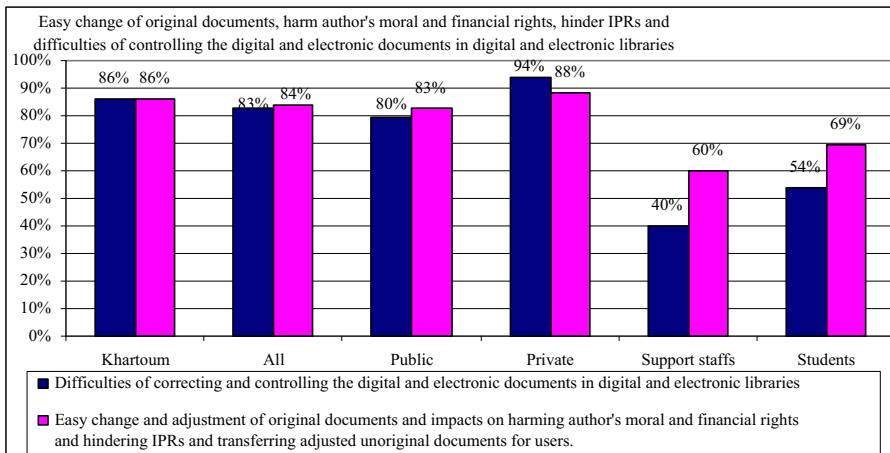
From the support staffs’ perspectives the top problems related to the use of Internet include lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author’s rights and have licences or subscriptions) and the problem of access to scientific and technical information for creation and transfer of knowledge, in addition to, lack of clear objectives and strategic planning, lack of enthusiasm for the use of Internet to improve and increase efficiency and promotion of institutions of higher education and scientific research due to limited electronic knowledge and wide spread of electronic illiteracy and lack of access to credit cards and lack of security in their use. In addition, all problems and difficulties

²³ As reported by 81 and 80% of the respondent all universities academic staffs, respectively.

²⁴ As indicated by 79% of the respondent all universities academic staffs.

²⁵ As indicated by 77% of the respondent all universities academic staffs.

²⁶ As reported by 75, 74, 74, 70 and 68% of the respondent all universities academic staffs, respectively.



Source: Own calculation based on the University survey (2009).

Figure 5 Easy change of original documents, harm author's moral and financial rights, hinder IPRs and difficulties of controlling the digital and electronic documents in digital and electronic libraries

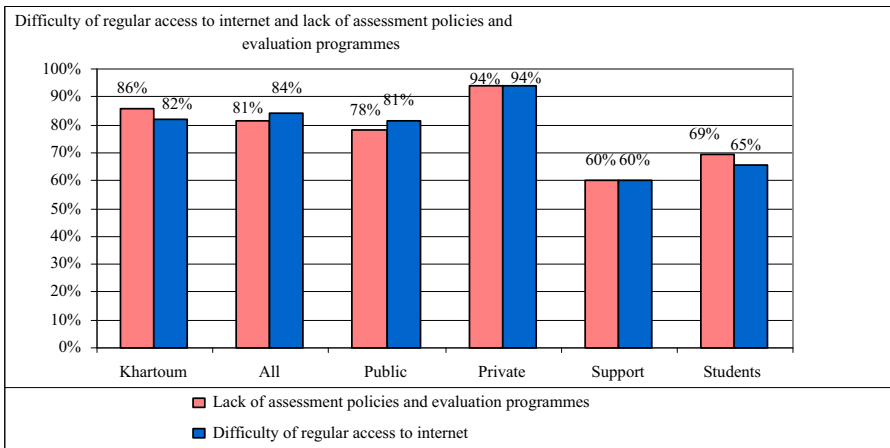
hindering the use of ICT for facilitating connections and transformation and enhancing the production and transfer of knowledge that highlighted above by academic teaching staffs are also highlighted by support staffs.²⁷

From the students' perspective the top problem related to the use of Internet is the problem of access to scientific and technical information for creation and transfer of knowledge, in addition to lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author's rights and have licences or subscriptions, lack of enthusiasm for the use of Internet to improve and increase efficiency and promotion of institutions of higher education and scientific research due to limited electronic knowledge and wide spread of electronic illiteracy and creating gap (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology. In addition, all problems and difficulties hindering the use of ICT for facilitating connections and transformation and enhancing the production and transfer of knowledge that highlighted above by academic teaching staffs are also highlighted by students.²⁸

One interesting observation from our findings is that both public and private universities agree on availability of several problems and challenges related to the use of Internet that hindering the creation and transfer of knowledge in the Sudanese universities. The complaint about most of these problems and difficulties and their corresponding implications in hindering the creation and transfer of knowledge is higher in the private universities compared to public universities. This is somewhat surprising in view of the fact that private universities most probably have developed and owned more favourable ICT infrastructure and managed to provide more facilities and therefore more conducive environment for meeting the challenges, solving the problems and difficulties hindering creation and transfer of knowledge.

²⁷ As indicated by 80, 60 and 40% of the respondent support staffs, respectively.

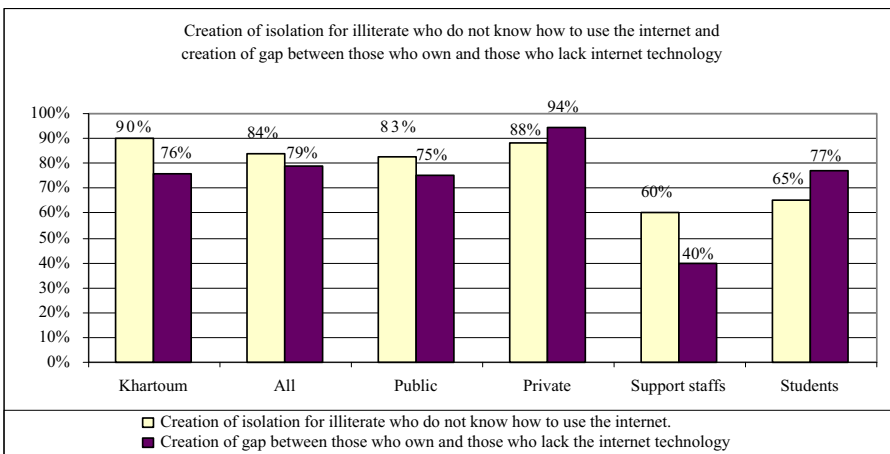
²⁸ As indicated by 88, 77, 73, 69, 65, 62, 58, 58, 58, 58 and 54% of the respondent students, respectively.



Source: Own calculation based on the University survey (2009).

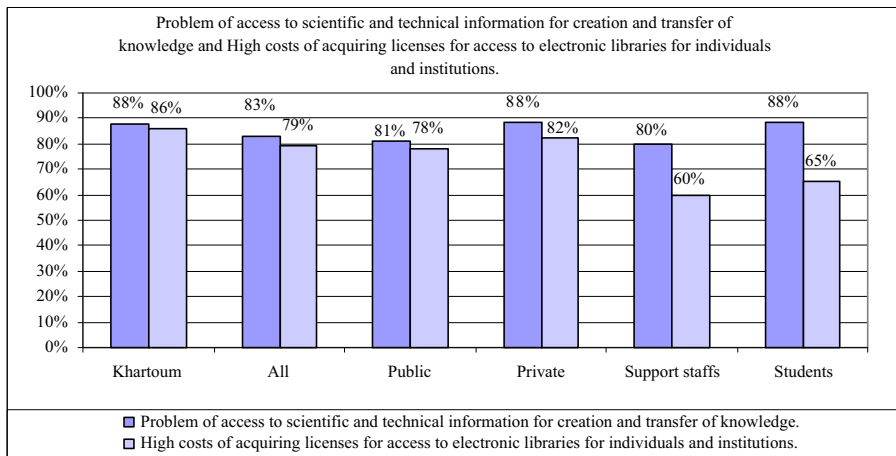
Figure 6 Difficulty of regular access to Internet and lack of assessment policies and evaluation programmes

In our view, it would be interesting to explain the theoretical and practical implications by explaining the link between the survey’s results, and (1) the role of knowledge as a dimension of development, and (2) the way in which these results matter to the field of Sudanese education. On the first dimension, we explain the theoretical implications and explain that knowledge is not only important per se—but it matters, following Sen’s capabilities approach, as a key component of the overall ability of people to fulfil their own plans. Our results provide theoretical implications implying that the intensified use of ICT will contribute to enhancing the production, creation and transfer of knowledge, which in turn contribute to enhancing economic development. Development essentially relies on a very broad range of knowledge, knowledge is essential to each stage in the development process. According to the World Bank, the application of knowledge is now



Source: Own calculation based on the University survey (2009).

Figure 7 Creation of isolation for illiterate who do not know how to use the Internet and creation of gap between those who own and those who lack Internet



Source: Own calculation based on the University survey (2009).

Figure 8 Problem of access to scientific and technical information for creation and transfer of knowledge and high costs of acquiring licences for access to electronic libraries for individuals and institutions

recognized to be one of the key sources of growth in the global economy, the increased importance of knowledge provides great potential for countries to strengthen their economic and social development by providing more efficient ways of producing goods and services and delivering them more effectively and at lower costs to a greater number of people. On the second dimension, we explain the practical implications and explain the contribution of the paper to practice (not only to the literature on ICTs for development) since these results matter highly to potential policy recommendations. Our findings provide practical implications confirming the role of higher education institutions (public and private universities) through the intensified used of ICT in enhancing the production, creation and transfer of knowledge and hence, enhancing economic development. We provide practical implications and practical evidences concerning the impacts of ICT in higher education institutions (public and private Sudanese universities). Our results provide practical implications implying that the use of ICT facilitates connection, networks and collaboration within public and private universities in Sudan, with local, regional and international institutions. Our findings provides practical implications implying that the use of ICT enhances access, production and dissemination of knowledge and provides opportunities and challenges for knowledge production in Sudanese universities. The major policy recommendations is the increasing spending on ICT for enhancing production, creation and transfer of knowledge in higher education institutions (public and private Sudanese universities) and hence enhancing economic development in Sudan.

Conclusions

This paper has focused on the impact of ICT in connections, transformations, creation and transfer of knowledge in Sudan, taking ten public and private universities as an example of institutions of higher education in Sudan. It uses new primary data and fills the gap in the literature by focusing on Sudan as a new case study.

Two hypotheses about how the use of ICT facilitates connections within knowledge institutions and collaboration between universities, in this case between Sudanese universities and universities worldwide, and the integration of Sudanese universities in the system of global knowledge production were verified. The results of the Sudanese universities survey of 2009 indicate that the Internet facilitates connections, networks and communication within institutions (Sudanese universities), with others in Sudan, with regional and international institutions. The second hypothesis that the use of ICT was found to enhance access, production and dissemination of knowledge was confirmed, and Sudanese universities' 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 Sudanese universities 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 Sudanese universities 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.

Our results that ICT introduces opportunities and challenges for the creation and transfer of knowledge provide theoretical implications consistent with the 'creative-destruction' effect theory. 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, this theoretical and practical implications is consistent with the theoretical and practical literature related to digital-divide as discussed in the international literature. The major practical, 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 practical implications related to the findings here suggest that ICT is leading to significant transformation by facilitating connections in the creation and transfer of

knowledge in Sudanese universities. ICT supports scientific research activities, improves the acquisition of knowledge, supports the restructuring of administration and the modernization of Sudanese 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. Another practical implication is that in the future, ICT has the potential to continue playing an important role by facilitating connections and the creation and transfer of knowledge in Sudanese 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, another practical implication is that 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 policy 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 UN sustainable development goal (SDG) of ending poverty/ no poverty by 2030. The general conclusion is, however, that there are more advantages than disadvantages to using ICT in Sudanese universities.

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