

# The use and economic impacts of information and communication technology (ICT) in Sudan

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**The Use and Economic Impacts of Information and Communication  
Technology (ICT) in Sudan**

**By Samia Satti Osman Mohamed Nour**

**Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT)**

email: [info@merit.unu.edu](mailto:info@merit.unu.edu) | website: <http://www.merit.unu.edu>

**Maastricht Graduate School of Governance (MGSoG)**

email: [info-governance@maastrichtuniversity.nl](mailto:info-governance@maastrichtuniversity.nl) | website: <http://mgsog.merit.unu.edu>

Keizer Karelplein 19, 6211 TC Maastricht, The Netherlands

Tel: (31) (43) 388 4400, Fax: (31) (43) 388 4499

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**By Dr. Samia Satti Osman Mohamed Nour**

**(October 30, 2011)**

## The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan

By Dr. Samia Satti Osman Mohamed Nour<sup>1</sup>

(October 2011)

### Abstract (English Abstract)

This paper discusses the use, economic importance and impact of the use of ICT in public and private Sudanese universities. We explain that the use of ICT has grown, despite many obstacles in Sudan. Different from the Sudanese literature, a novel element in our analysis is that we use new primary data from an ICT university survey undertaken in Sudan in 2009. We provide a new contribution and fill a significant gap in the Sudanese literature by examining from demand perspective and from the public-private perspective, the status, pattern, structure and determinants of demand for ICT and the economic impacts of ICT use: the potential opportunities and challenges that ICT is expected to create and role of ICT in facilitating production, creation and transfer of knowledge in public and private Sudanese universities. Our results verify the hypotheses that the use of ICT, mainly Internet, facilitates connections, networks and communication within knowledge institutions in Sudan and with regional and international institutions. The use of ICT also enhances collaboration between Sudanese universities and regional and international universities and integration of Sudanese universities into the system of global knowledge production. Our findings support the hypothesis that the use of ICT enhances access, production and dissemination of knowledge in Sudanese universities. Finally, our findings support the hypothesis that the use of ICT introduces the 'creative-destruction' effect by providing opportunities for transformation and knowledge production, but simultaneously also creates hazards to transformation and knowledge production in knowledge institutions in public and private universities in Sudan: the positive transformation is building connections and organisational changes, whilst the negative transformation is building disconnections for those who do not share the knowledge and do not know how to use ICT. We find that the most important advantages related to the use of Internet for facilitating connections and transformation and enhancing the production, creation and transfer of knowledge include: increasing digital knowledge for academics and researchers through information that was earlier not available or accessible; rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information; development of a new model for disseminating and distributing electronic information, where the information has moved towards the user; increased creation and transfer of knowledge; and increased free access to electronic publications for academic purposes. Our findings indicate that the top problem related to the use of Internet is the lack of, or inadequate, regular budget for university libraries to pay for access to scientific and technical information and have licenses or subscriptions to international journals. We recommend further efforts to be made to facilitate the use of ICT for enhancing knowledge and hence economic development in Sudan.

**Key words:** ICT demand, ICT impacts, public-private universities, knowledge, Sudan.

**JEL Classification:** O10, O12, O30

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<sup>1</sup> Corresponding Author: Dr. Samia Satti Osman Mohamed Nour, Visiting Research Fellow, University of Maastricht, School of Business and Economics (SBE), UNU-MERIT, Maastricht, The Netherlands; and Assistant Professor of Economics, Economics Department, Faculty of Economic and Social Studies, Khartoum University, Khartoum, Sudan. E-mail: [samiasatti@yahoo.com](mailto:samiasatti@yahoo.com); [samia\\_satti@hotmail.com](mailto:samia_satti@hotmail.com). The second draft of this paper was revised during the author's time as a visiting research fellow at UNU-MERIT, Maastricht, The Netherlands, and was presented at the UNU-MERIT workshop (October 21, 2011). The author gratefully acknowledges Maastricht University, SBE, UNU-MERIT for the good hospitality during her visiting research fellowship. The first draft of this paper was originally prepared during the author's time as a visiting research fellow at the African Studies Center (ASC), University of Leiden, The Netherlands, from May to July 2009, and was presented at the meeting of the ASC Research Group on Connections and Transformations: The Social Construction of Linking Technologies in Africa and Beyond, ASC, Leiden, the Netherlands, June 18, 2009. The author gratefully acknowledges ASC for the three months visiting research fellowship. The author would like to thank Professor Mirjam de Bruijn, Dr Rijk van Dijk, Dr Fatma Ibnouf and the participants at the ASC-C&T meeting (June 18, 2009) and the participants at UNU-MERIT workshop (October 21, 2011) for their useful comments on the first draft of the paper. All the usual disclaimers apply.

## Abstract (Arabic Abstract)

### خلاصة الدراسة (باللغة العربية)

#### استخدام تكنولوجيا المعلومات والاتصالات والآثار الاقتصادية المترتبة على استخدامها في السودان

يناقش هذا البحث استخدام تكنولوجيا المعلومات والاتصالات والآثار الاقتصادية المترتبة على استخدامها في السودان، مع التركيز على آثار إستعمال تكنولوجيا المعلومات والاتصالات في إحداث التحول المعرفي ولا سيما في قطاع التعليم العالي وفي الجامعات السودانية العامة والخاصة وذلك نسبة لكثافة الإستعمال ومن ثم أهمية الآثار المترتبة على ذلك. وقد أبرزت نتائج البحث العديد من الأدلة التي تؤكد حدوث النمو السريع والتحول الهيكلي في الطلب على استخدام تكنولوجيا المعلومات والاتصالات في الجامعات السودانية العامة والخاصة وذلك على الرغم من وجود الكثير من العقبات في السودان. من المؤمل أن تساهم هذه الدراسة في زيادة الوعي وتحسين الفهم لأهمية الآثار الاقتصادية لإستعمال تكنولوجيا المعلومات والاتصالات ودورها في تشجيع تطوير وتحويل المعرفة ولا سيما المعرفة الإلكترونية ومساهمتها في التنمية الاقتصادية في السودان. تميزت هذه الدراسة بتقديم مساهمة أصيلة وجديدة لملء فجوة كبيرة في الدراسات في الأدبيات السودانية حيث أنها قدمت تحليلاً كمياً ونوعياً لجانب العرض والطلب مع التركيز على جانب الطلب، وقد استخدمت تحريفاً ومنهجاً أكثر شمولاً لتقييم العوامل المؤثرة في الطلب على استخدام تكنولوجيا المعلومات والاتصالات من جانب مختلف الفئات في الجامعات السودانية العامة والخاصة، كما إعتمدت الدراسة على استخدام البيانات الأولية من مسح استخدام تكنولوجيا المعلومات والاتصالات والذي أجري في الجامعات السودانية العامة والخاصة في العام 2009. وقدمت الدراسة مساهمة جديدة وذلك لأنها أوضحت نمط وهيكل ومحددات الطلب على تكنولوجيا المعلومات والاتصالات، والآثار الاقتصادية والفرص والتحديات المحتملة لاستخدام تكنولوجيا المعلومات والاتصالات ودورها في تسهيل إنتاج وتحويل المعرفة في الجامعات السودانية العامة والخاصة. هذا وقد دعت نتائج البحث صحة الفرضيات التي تزعم بحدوث التحول الهيكلي في الطلب على استخدام تكنولوجيا المعلومات والاتصالات وبأن الطلب على استخدامها في الجامعات السودانية العامة والخاصة يتأثر بعدة عوامل ومحددات تشمل مستوى الدخل، المستوى التعليمي (عدد سنوات الدراسة)، العمر والنوع. كما أكدت نتائج البحث صحة الفرضية التي تزعم بأن استخدام تكنولوجيا المعلومات والاتصالات، ولا سيما الإنترنت قد اسهم بشكل رئيسي في تحسين الأداء وترابط الشبكات وتسهيل سبل الاتصالات داخل مؤسسات المعرفة في السودان وكذلك مع المؤسسات الإقليمية والدولية؛ وان استخدام تكنولوجيا المعلومات والاتصالات قد اسهم في تعزيز التعاون بين الجامعات السودانية والجامعات الإقليمية والدولية ولتنامج الجامعات السودانية في النظم العالمية لإنتاج المعرفة. وبالإضافة الى ذلك فقد دعت نتائج البحث صحة الفرضية التي تزعم بأن استخدام تكنولوجيا المعلومات والاتصالات قد أسهم في تسهيل إنتاج ونشر المعرفة في الجامعات السودانية. وبالإضافة الى ذلك فقد أيدت نتائج البحث صحة الفرضية التي تزعم بحدوث التأثير المزدوج (الإيجابي - السلبي في آن واحد). حيث تمثل التأثير الإيجابي لاستخدام تكنولوجيا المعلومات والاتصالات في توفير مزيداً من الفرص لإنتاج وتحويل المعرفة وفي تسهيل الاتصالات في مؤسسات المعرفة في الجامعات السودانية العامة والخاصة، بينما ومن ناحية أخرى تمثل التأثير السلبي في زيادة الفوارق في

المجتمع وظهور العزلة ومحدودية المشاركة والاستفادة من خلق ونشر المعرفة بالنسبة لبعض فئات المجتمع وذلك إما بسبب محدودية المعرفة باستخدامها ولاسيما للأحيين وذوي المعرفة الإلكترونية المحدودة أو بسبب محدودية الدخل بالنسبة للفقراء الذين لا يملكون المقدرة المالية لإمتلاك تكنولوجيا المعلومات والاتصالات. وفقاً لنتائج البحث فإن أهم المزايا التي تتعلق باستخدام الانترنت لتسهيل الاتصالات وتعزيز إنتاج ونقل المعرفة تشمل: زيادة المعرفة الرقمية للأكاديميين والباحثين من خلال تسهيل الوصول الى المعلومات التي كانت في وقت سابق غير متوفرة؛ الزيادة الكمية السريعة ( من حيث الحد) والتنوع (من حيث الكفاءة والسرعة) في نقل المعلومات المتاحة، وتطوير نموذج جديد لنشر وتوزيع المعلومات الإلكترونية، حيث سهلت انتقال المعلومات باتجاه المستخدم، تشجيع زيادة خلق ونقل المعرفة، وزيادة حرية الوصول إلى المنتهورات الإلكترونية للأغراض الأكاديمية. ومن ناحية أخرى فقد اوضحت نتائج البحث العديد من المشاكل ذات الصلة باستخدام الانترنت واهمها : عدم وجود أو عدم كفاية الميزانية للمكتبات الجامعية لدفع ثمن الحصول على المعلومات العلمية والتقنية، والحصول على التراخيص أو الاشتراكات في الدوريات العالمية. توصي الدراسة بناءً على النتائج التي توصلت إليها ببذل مزيداً من الجهود لتسهيل استخدام تكنولوجيا المعلومات والاتصالات لتعزيز خلق ونقل المعرفة وبالتالي تحسين النمو الاقتصادي والتنمية البشرية في

السودان.

## **Preface and Acknowledgments**

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This research report was originally prepared during my time as a visiting research fellow at the African Studies Center (ASC) at the University of Leiden, the Netherlands (May to July 2009). I am delighted to acknowledge ASC for its three month visiting research fellowship. The second draft of this report was revised during my time as a visiting research fellow at UNU-MERIT, Maastricht, the Netherlands. I acknowledge with thanks the host institute at UNU-MERIT, the School of Business and Economics at the University of Maastricht, for the cooperation and hospitality I received during my visiting research fellowship.

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**List of Abbreviations**

HDR	Human Development Report
GDP	Gross Domestic Products
ICT	Information and Communication Technology
IT	Information Technology
ITU	International Telecommunication Union
UNDP	United Nations Development Programme
WDI	World Development Indicators – World Bank
WITSA	World Information Technology and Services Alliance

# **The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan**

## **Executive Summary**

This research provides an interesting indepth pioneering analysis of demand for and economic impact of ICT from the demand perspective and from public-private perspectives in public and private Sudanese universities. The aims of this research is three fold: first, to examine the status, pattern, structure, trend and determinants of the demand for ICT in public and private Sudanese universities; second to investigate the economic impacts of the uses of ICT, the potential opportunities and challenges that ICT is expected to create for public and private Sudanese universities; and finally to explain the role of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities.

We fill the gap in the literature, since we examine the demand for ICT from public-private perspective in Sudanese universities. Different from earlier studies in the literature that focuses on ICT from the supply perspective, we provide a new and perhaps the first study focused on ICT from the demand perspective, since we examine both the uses and impacts of ICT in public and private Sudanese universities. One advantage and interesting element in our analysis is that we present a more comprehensive analysis from the demand perspective concerning the use and impacts of ICT at the micro level and we compare between public and private universities. Another advantage is that we examine from the demand perspective, the use and economic impacts of ICT after integrating three different perspectives of academic teaching staff, support staff and students. A novel element in our analysis is that we use a new primary survey data at the micro level, which we obtained from the university survey of Nour (2009) which we distributed randomly amongst 131 individuals in 10 public and private Sudanese universities located in Khartoum.

Our findings prove the first hypothesis in Chapter 1 above on the presence of significant public-private differential between public and private universities in Sudan not only in the general characteristics but also in the demand for and impacts of ICT. For instance, our results show that the reported rapid incidence of the observed structural change in the demand for ICT, knowledge about computer and Internet, the importance, structure, trend, and income and prices effects of the demand for the four ICT modes, fixed telephone, mobile telephones, computer and Internet, seems to be more significant for private university staff compared to public university staff. This can be interpreted in relation to the observed

differences in the general characteristics, which imply that monthly income and skill level are relatively higher for private university staff compared to public university staff.

Our findings prove our second hypothesis in Chapter 1 above which implies that demand for the four ICT modes is characterised by considerable dynamism: it shows a dynamic increasing trend and significant structural change over time amongst public and private university staff in Sudan. Our findings indicate that the use of ICT has grown and increased in Sudan, despite many obstacles that are represented in the high cost. For instance, we confirm the incidence of structural change in the demand for ICT by scrutinising the historical use of the four ICT modes which implies that fixed telephone was used earlier as old or more traditional and a long-standing ICT mode, but then there is a gradual and visible shift toward using of other new more recent ICT modes such as computer, mobile and Internet respectively amongst academic teaching staff, support staff and students.

Our results present several interesting pieces of evidences in support of the hypothesis on the incidence of structural change in the demand for the four ICT modes from the demand perspective. For instance, we find that one important piece of evidence on the incidence of structural change in the demand for ICT can be elaborated from our result which indicates that for the majority of all respondents the personal use of mobile telephone, Internet and computer shows an increasing trends, while the personal use of fixed telephone shows an opposite decreasing trend. For the majority the personal use of mobile telephone is growing faster than Internet, computer and fixed telephone respectively. This result seems consistent with the reported increasing trend of the use of mobile and Internet at the aggregate macro level in Sudan and also consistent with the observed increasing trend at the regional and international levels.

The interpretation of the above-mentioned evidence on the incidence of structural change in the trend of the demand for the four ICT modes provides another piece of evidence in support of the hypothesis on the incidence of structural change in the demand for ICT, which can be elaborated from the demand perspective along with the respondents' assessment views on the importance of ICT for satisfaction of personal need and utility that highlight the three ICT modes, mobile telephone, Internet and computer, as highly important and value fixed telephone as moderately important. Our findings on the trend and assessment of the importance of ICT indicate different preference of the different ICT modes that can be explained in relation to preference of specific characteristics such as fashion, style and good design, ease of use, cheap price and efficiency and high quality. Our findings indicate that somewhat surprisingly despite the high poverty rate and low per capita income, the reported concern about cheap price comes next to the reported concern about efficiency and high quality. We find that for the majority of the respondents the preference of the use of different modes of ICT is most probably related to preference of specific characteristics such as

efficiency and high quality. This implies that the respondents are much more concerned with efficiency and high quality, which can be interpreted probably because of high skill level and therefore increasing awareness amongst the respondents in public and private Sudanese universities. We find that from all the respondents' perspectives, the most important advantages of using fixed telephone include ease of use for people who are illiterate or have limited electronic knowledge, facilitated communication with Internet and ease of use in work. The most important advantages of using mobile telephone includes easy to carry and move from place to place, easy for waiting calls and messages from other people, facilitated social contact with family, ease of use in work, facilitated social contact with friends, ease of use of SMS and facilitated direct contact and reach of the requested person. The most important advantages related to the use of Internet include facilitated training to improve skill for the use of computer and Internet, enhanced learning, training, skill and capacity for all society, long distance learning from international institutions, R&D skill and efforts and cheap price. In addition, Internet provides advantages such as facilitated study, research, networks and communication, job listings, participation in seminars, conferences and workshops and social and work contact. Our findings imply that because of these multiple advantages for satisfying the needs and utility in an academic setting in Sudanese universities, Internet is followed by mobile as the most important ICT mode that are popular and very widely used amongst academic staff. For the majority of the respondents mobile is preferred because of the characteristics of fashion, style and good design and ease of use, while Internet is preferred because of the characteristics of cheap price and efficiency and high quality. These multiple advantages of mobile and Internet gives further justification for the incidence of the structural change in the demand for ICT in Sudanese universities.

Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our finding that the effect of the costs of expenditure on imposing burden in personal budget is most important for mobile telephone, which is higher than Internet and computer, but less important for fixed telephone. Additional evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our result that the effect of the costs of expenditure on ICT on competing with the expenditures on other goods and services in personal budget is most important for mobile telephone, which is higher than the moderate important effect for Internet and computer and less important effect for fixed telephone. Another piece of evidence in support of our hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings which implies that the effect of the increase in income on increasing the use of ICT is most important for mobile telephone, which is higher than Internet and computer and less important for fixed telephone. Somewhat surprisingly, even for both private staff and support staff the increase in income has an unimportant effect

for the demand for fixed telephone; this implies that fixed telephone tends to be an inferior good and show an inelastic demand with respect to increase in income for both private staff and support staff. Our findings imply that from all the staff's perspective, for the majority the increase in income has an important effect on increasing the demand for the use of various ICT modes, fixed telephone, mobile telephone and Internet, and that the use of various ICT modes tend to be normal goods and their demand varies in the same direction as income. This finding is consistent with the conventional stylised fact on the theoretical literature on the positive income effect or the positive relationship between income and demand, i.e. that increase in income has important positive impacts on increasing the use of ICT. Additional evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our results, which indicate that the effect of the increase in prices in reducing the demand for the use of ICT is most important for mobile telephone, which is higher than Internet and fixed telephone. Our results indicate that from all the staff's perspective, for the majority the effect of the increase in prices has important impacts on reducing the demand for the use of various modes of ICT: fixed telephone, mobile telephone and Internet. This result is consistent with the conventional stylised fact in the theoretical literature on the downward sloping demand curve or the negative price effect or the negative relationship between price and demand. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings which indicate an interesting cross price or substitution effect between the various modes of ICT, i.e. between fixed telephone, mobile telephone and Internet, in particular, somewhat surprising is the substitution effect between mobile telephone and fixed telephone, which is higher than the substitution effect between mobile telephone and the Internet. The relationship between fixed telephone and Internet is somewhat confusing, but for the majority the relationship is in favour or support of the complementary relationship, so this most probably indicates a complementary relationship between fixed telephone and Internet. Our findings indicate that the interesting substitution effect seems to be observed not only between the demand for the various ICT modes, but also between the supplier companies offering ICT services. For instance, our results indicate that the reduction of the prices of ICT offered by ICT competing companies has an important effect in motivating transference of the demand for ICT services offered by ICT competing companies with cheap prices and in reducing the demand for ICT services offered by the current company with high prices. This result is consistent with the conventional stylised facts in theoretical literature concerning the cross price, substitution-complementary effects and rationality of consumers.

We examine from the public-private perspective the research hypotheses on the public-private differential in the supply side of ICT in Sudanese universities. Section 1 defines the main characteristics of the supply side of ICT in Sudan. Section 2 shows an

indepth analysis from the demand perspective the supply side of ICT, methods and places of connection to ICT. Section 3 explains the difficulties on the supply and demand sides and suggestions for relevant solutions. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from the supply side. For instance, next to the well investigated structural change in the structure of the supply of ICT market from monopoly to monopolistic competition with more than one operating companies, we explain further structural change from the demand perspective. We find that the increasing number of operating companies has been in favour of consumers not only by increasing availability of ICT services but also by offering consumers wider options for selection from the different ICT supplier companies. For instance, our results indicate that from all the respondents' perspective, fixed telephone is mainly supplied by Sudatel and Canar, mobile telephone is mainly supplied by Zain and Sudani and Internet services are mainly offered by Sudatel and Sudani. Our findings indicate that the above-observed structural change in the supply side from monopoly by Sudatel to monopolistic competition with many operating companies has been in favour of consumers not only by increasing availability of ICT services, but also by increasing competition between different ICT supplier companies to attract more consumers by offering ICT services with high or improved efficiency, low or cheap prices and also the introduction of price discrimination mechanisms. Our results indicate further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT from the demand perspective in relation to the supply side, for instance our findings imply shift from Sudatel as ICT pioneer company to Zain as new recent ICT supplier company. Our results imply that the justification of this shift or structural change is related to preference of certain characteristics of the supplier company. For instance, our findings imply that from all the respondents' perspective, the preference of the company offering ICT services indicates that Zain is the most preferred company and ranks first compared to other companies because of its distinguished characteristics in terms of fashion, style, good design, efficiency and high quality, ease of use and price discrimination; Zain is also ranked second next to Sudani in terms of cheap price. This result is also consistent with the conventional stylised fact in the theoretical literature concerning the rationality of consumers. Another piece of evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings on the methods of connection to the Internet, which indicate significant shift from connection via dial-up by telephone to connection by ADSL. For instance, our results indicate that from all the staff's perspective, for the majority, the most widely used and common way for connection with the Internet is through ADSL, which is used by near to half of all respondents, followed by connection by wireless, which is used by near to one third of all respondents and finally by fixed telephone which is used by near to one fifth of all

respondents. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings, which imply that from all the staff's perspective, for the majority, in both the home and office mobile telephone, computer and Internet are widely used, while fixed telephone is less often used. Our results indicate that from all the respondents' perspective ICT is often and widely accessed in both the home and office, while Internet café and telecommunication offices are less often widely used compared to both home and offices as common locations for the use of ICT. In particular, both computer and Internet are very often used in office or work place; this is probably because they are offered free of charge in the office or work place for the respondents in public and private Sudanese universities.

Apart from the above observed structural change in the demand for ICT, our findings in Chapter 5 verify the third hypothesis in Chapter 1 above that the demand for the four ICT modes amongst public and private university staff in Sudan is determined by income, education attainment level, age, and gender. Our results prove the fourth hypothesis in Chapter 1 above that the demand for or the use of Internet shows positive significant correlations with the use of telephone; the use of/spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training amongst public and private university staff in Sudanese universities. Our results are consistent with the findings in the theoretical and empirical endogenous growth literature on the correlation between ICT components and human capital.

Finally we explain the impacts of ICT in connection, transformation, creation and transfer of knowledge in Sudanese universities. Our results verify the fifth and sixth hypotheses in Chapter 1 above on the importance and impacts of ICT in facilitating the creation and transfer of knowledge in Sudanese universities. Our results are consistent with the results in the theoretical and empirical literature. We show that the use of ICT, namely Internet, facilitates connections, networks and communication inside knowledge institutions, namely Sudanese universities, facilitates connections with other institutions in Sudan, with regional and international institutions, collaboration between Sudanese universities and international universities, northern institutions and integration of Sudanese universities into the system of global knowledge production. Our findings support the hypothesis that the use of ICT introduces 'positive-negative' effects by providing opportunities for the production, creation and transfer of knowledge, but simultaneously also creating hazards to production, creation and transfer of knowledge in Sudanese universities: the positive effect is enhancing access, production and dissemination of knowledge, building connections and organisational changes; the negative transformation is building disconnections for those who do not share the knowledge and do not know how to use ICT. Our results show that the most important advantages related to the use of Internet for facilitating connections and transformations and

enhancing the production, creation and transfer of knowledge, 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. In addition to development of a new model for disseminating and distributing electronic information, where the information moved towards the user and not the other way around, increased creation and transfer of knowledge and increased free access to electronic publications for academic purposes. Our findings indicate that the top problem related to the use of Internet is the lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, licenses and subscriptions. Finally, the general conclusion of this chapter is that the advantages of using ICT in Sudanese universities are more than the challenges or difficulties. We explain that ICT introduces opportunities and challenges for the creation and transfer of knowledge. One of these challenges or difficulties is that ICT has the capacity to lead to disconnection and to marginalisation of some people. By disconnection we mean the difficulties of getting connected due to the difficulties on both the supply and demand sides. On the supply side disconnection is probably caused by poor availability, inefficiency and interruption or irregular supply of ICT services. On the demand side, disconnection means lack of ability to connect that is probably due to both poverty and therefore, inability to have access to ICT and the lack of adequate skill and knowledge to use ICT, particularly for the poor. This implies that disconnection leads to creating gaps and marginalisation of some people who are poor and lacking access and other people who are lacking skill and knowledge to use ICT. The major ethical and political implications are that ICT, by causing disconnection, has the potential to add a new form of marginalisation and therefore add to the already existing inequalities between the different social groups in Sudan. The major policy recommendation on the demand side is increasing subsidies for the poor to facilitate their access to ICT and increase literacy, skill and knowledge about ICT to improve access to ICT. The major suggestion on the supply side is increasing availability, sustainability and improving efficiency of ICT services. The findings in Chapter 7 are consistent, agree with and add a new case study to contribute to the literature on ICT, higher education institutions and universities in Africa (cf. Durrant, 2004; Beebe, et al., 2003; Olukosh and Zeleza, 2004), universities in Egypt (cf. (Radwan, 2003: Cairo University and other Egyptian universities), Kenya (Thairu, 2003: Kenya Education Network), Kenya and Nigeria (Oyeyinka and 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 are useful to improve understanding of the role of ICT in production, creation and transfer of knowledge in Sudan as a new case study in the literature. In addition in this research we fill the gap in the literature

by focusing only in Sudan as a new case study in the literature; mainly we explain the importance of the use of ICT for facilitating connection within knowledge institutions and for introducing opportunities and challenges for the creation and transfer of knowledge.

Our findings suggest that ICT is leading to significant transformation by facilitating connection, creation and transfer of knowledge in Sudanese universities. The introduction of ICT has the potential to support scientific research activities, improve the ways of acquisition of knowledge, support the restructuring of administration and modernisation of Sudanese universities and facilitate access to electronic publications and online courses and distance learning, help solve the problematic access to limited members in enrolment through distance education, help bridge the knowledge divide by improving accessibility to scientific and technical information, facilitate internal and external connections, improve collaboration between south-south and south-north and create and transfer knowledge. In the future ICT has the potential to continue playing an important role and facilitate connection, creation and transfer of knowledge in Sudanese universities provided that they manage to overcome the difficulties on the supply and demand sides, in particular, improve skill, training and knowledge about ICT and improve availability, sustainability and efficiency of ICT infrastructure (cf. Durrant, 2004). In addition to increasing government spending for the development of ICT infrastructure in higher education and for provision of subsidies to offer adequate regular budgets for university libraries to pay for having licenses or subscriptions and access to scientific and technical information. However, there are both political and ethical issues related to government spending on ICT. As for the political issue, the justification of the commitment of the Sudanese government spending on the development of ICT for the universities, is probably because the universities relate to the elite and their power-position; therefore, when the Sudanese government spends money on ICT it is then 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 the universities, thereby reducing the amount of money it has available for addressing important issues such as poverty and health. This probably implies a disadvantage of ICT, as government spending on ICT draws money away from other urgent targets (the poor). The major implication here is that more spending on ICT, probably implies less spending on social development such as health and poverty reduction, consequently, poverty will continue to increase and the poor will suffer more. Therefore, probably, the challenge would be how to make the right balance and trade off between allocations of government funds to different priorities. The major policy recommendation is to encourage private sector involvement on ICT and to focusing government spending on ICT more towards the beneficiaries of the poor by upgrading their skills, offering more education and

employment opportunities for the poor that will also contribute towards achieving the UN Millennium Development Goal of halving the share of people living in poverty by 2015.

Our findings show that the main problems on the supply sides are the lack of government spending on ICT, lack of or inadequate investment, high costs of offering services, low quality/efficiency of the services, lack of networks, interruption/disconnection of the services, lack of R&D, slow speed of the services, interruption of electricity supply, inadequate capacity of services, lack of infrastructure, uncertainty related to investment in ICT and lack of technical skills. Whereas, the main problems on the demand side are high spread of electronic illiteracy, high cost for offering the services, lack of awareness of the importance of ICT in the new economy and high spread of poverty. Based on these results, our findings indicate that the major recommendations and policies on the supply sides include improvement and increase in R&D, improvement and increase in infrastructure, improvement and increase in efficiency and capacity of services, improvement and increase in speed of the services, introduction of policies to increase collaboration in the field of research and publication and free access to electronic publications for academic purpose in developing countries, introduction of policies to reduce the digital and scientific gap between Sudan and advanced countries in the world, improvement and increase in government spending and investment on ICT, encourage the use of preferential tariff or free access to electronic publications for academic purpose in developing countries, treatment of problem of interruption/disconnection of services, improvement and increase in networks offering the services, treatment of interruption of electricity supply and encouragement and support of private investment to offering services. Whereas, the main recommendations and policy on the demand sides includes, improvement and increase in quality of education and electronic knowledge and eradication of electronic illiteracy, reduced cost for offering the services, improvement and increase in awareness of the importance of ICT in the new economy, improvement and increase in income and eradicate poverty. Therefore, the major policy implications from our results is that it is essential for policy making in Sudan and Sudanese universities to enhance the use and impacts of ICT, mainly by motivating the effective use of ICT for creation and transfer of knowledge, enhancing quality and accumulation of human capital and skill and offering adequate budget for enhancing ICT in Sudanese universities.

**Key words:** ICT demand, ICT impacts, public-private universities, knowledge, Sudan.

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## **The Use and Economic Impacts of Information and Communication Technology (ICT) in Sudan**

### **Chapter 1: General Introduction**

#### **Introduction**

The aim of this chapter is to give a background and a brief general overview of the research problem and to briefly show the importance, relevance, objectives, hypotheses and general structure of the research.

#### **1.1 Research problem, importance, relevance and method**

The rapid progress in Information and Communications Technologies (ICT) and its impacts on the global knowledge economy have intensified in recent years, leading to a new economic system characterised by intensive knowledge production that has attracted a great deal of interest. It has also raised debate on the effects of ICT and the economic opportunities and the challenges that ICT imposes on the production and dissemination of knowledge in the world economy, particularly for developing countries. More recently, the continuous move towards globalisation has made ICT 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. In light of the above background and given the relatively few studies that explain only limited aspects with reference to the status of ICT market in the African countries,<sup>2</sup> it may be useful in this project to examine from public-private perspective, more extensively both the use and economic impacts of ICT and the impacts of ICT in the production, creation and transfer of knowledge in the knowledge institutions, notably universities mainly in Sudan as a case study of the African countries.

The importance of improving ICT policies appears from the recent literature that indicates the absence of national information policies, as most of the developing (including African) countries lack information policies that delineate targets and priorities, coordinate the various sectors and formulate strategic alternatives with regard to the creation of infrastructure and the development of human and information resources. The organisational and legislative frameworks for production and services institutions in various fields of information and communication are also lacking interest in the information industry. This has motivated the formulation of national plans to promote infrastructure, encourage foreign and local investment and provide Internet services to schools. Our study therefore may be interesting to contribute to recent efforts aimed at enhancing the production, creation and

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<sup>2</sup> See for instance, Telecommunications Policy in Africa, 2005; James Hodge; Alison Gillwald; Patricia K. McCormick; Gillian Marcelle; Banji Oyelaran-Oyeyinka and Kaushalesh Lal, 2005.

transfer of knowledge and building the information and knowledge society in Sudan and the African region and it will fill an important gap in the literature dealing with enhancing the role of ICT in the production, creation and transfer of knowledge in Sudan and African countries. In this project we will fill the gap in the African literature by focusing only on Sudan as a new African case study, mainly because most of the current literature focuses on the case of South Africa (cf. Telecommunications Policy in Africa, 2005) and indicates that the heavy concentration of ICT market in South Africa and therefore the corresponding impacts are expected to be more important than other African countries. Our research is useful to improve understanding of the role of ICT in production, creation and transfer of knowledge in Sudan as a new African case study. Our research is consistent with - and will add a new African case study to contribute to - African literature on ICT, higher education institutions and universities in: Africa.<sup>3</sup>

Hence, based on the above, this research project focuses on the demand side of ICT, the use and economic impacts of ICT and impacts of ICT in the production, creation and transfer of knowledge in Africa, notably in the case of Sudan. By focusing on this theme the proposed research is expected to contribute to recent research and literature in the demand side of ICT: the demand for and impacts of ICT in knowledge institutions or universities and also to contribute to literature on the dual implications (positive and negative impacts: creative and destruction effects) by presenting new evidence from the use of ICT in knowledge institutions or universities in Sudan.

Different from the brief and limited scope of analysis presented by Nour (2006), this project provides more comprehensive analysis since it examines not only the use and economic impacts (opportunities and challenges) of ICT but also the impacts of ICT in the production, creation and transfer of knowledge in African universities, with particular focus on the case of Sudanese universities. Our analysis is interesting since we focus on the demand side and compare the uses and impacts of ICT in knowledge production institutions from public-private perspectives and after integrating the different perspectives of public and private academic teaching staff, support staff and students in public and private Sudanese universities. Our analysis in this project is interesting and differs from earlier studies, since we present a comparative analysis across public and private universities; we examine the demand and impact of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities. In addition we use the most up-to-date and relevant data wherever available. A novel element in our analysis is that we use new primary survey data at the micro level and we provide a more comprehensive analysis, since we explain from public-private

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<sup>3</sup> See for instance, Durrant (2004); Beebe, et-al. (2003); Olukosh and Zeleza, (2004); universities in Egypt (cf. Radwan, 2003); Kenya (Thairu, 2003; Kenya Education Network); Kenya and Nigeria (Oyeyinka and Adeya, 2003); Mozambique (Massingue, 2003); South Africa (Adei, 2003); Tanzania (Mutagahywa, 2003); and Zambia (Mwenechanya, 2003).

perspectives the demand and impacts of ICT in enhancing the production, creation and transfer of knowledge in knowledge production institutions in public and private universities in Sudan. We admit that next to the analysis of the demand side of ICT and the corresponding economic impacts, it is also essential to investigate the role of the supply side of ICT and the corresponding impacts in facilitating the production, creation and transfer of knowledge in the African countries. But due to lack of relevant data on the supply side, we leave the analysis of the supply side for more indepth study in the future. We observe that the supply of ICT in Sudan is characterised by a somewhat monopolistic structure, as can be seen from the limited number of Internet service providers (ISP) in Sudan as in many other developing countries and most of the African countries (except Morocco, Egypt and Algeria). This limitation in the supply side might have several implications on hindering the acceleration of the production, creation and transfer of knowledge.

To investigate the research problem we focus on Sudan as a case study of African countries; we use the descriptive, quantitative and qualitative approaches and OLS technique, utilising primary and secondary data. Our analysis at the micro level will use primary data obtained from the survey of Nour (2009) that covers ten Sudanese universities located in Khartoum State, 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, University of Khartoum, Sudan. Across these ten public and private universities, the university survey was distributed randomly amongst 131 individuals in the selected ten public and private Sudanese universities located in Khartoum. In addition we use some face-to-face interviews conducted with some of the respondents to the survey in order to support the survey findings on the use of ICT in the Sudanese universities. In addition we use some secondary data on the use of ICT in Sudan to give background about the use of ICT across Sudanese universities.<sup>4</sup>

## **1.2 Objectives, hypotheses and questions of the research**

Hence, based on the above, the aim of this project is three folds; first, to examine from public-private perspective, the status, pattern, structure and determinants of the demand for ICT in public and private universities and second to investigate from the public-private perspective,

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<sup>4</sup> Secondary data for analysis of the determinants, uses and impacts of the uses of ICT in Sudan includes many ICT indicators and related variables include access of population to (Internet, telephone mainlines, mobile/cellular subscribers) personal computers (PC) per capita, ISP 2002, ICT use Index (2002-06), PC units purchasable by GDP per capita, ICT expenditure (% of GDP, per capita \$), costs and prices of ICT, Internet total monthly price (\$ per 20 hours of use), % of monthly Gross National Income (GNI) per capita. Other related variables are GDP, GDP per capita (PPP US \$), GNI, human capital (HDI), average years of schooling, school life expectancy, literacy rates, educational attainment, enrolment at secondary and tertiary education, female literacy rate, female net enrolment in secondary education and gross enrolment in tertiary education. The data was obtained from several useful sources including UNDP-AFDR (2002, 2003, 2004, 2005, 2006), UNESCO-UIS, ESCWA, WITSA, (2002), World Bank, UNDP Human Development Report (2004), World Development Indicators (WDI) database, International Telecommunication Union (ITU) database (2005), Barro and Lee (2001) database for the average years of schooling data, Sudan's Ministry of Higher Education, Ministry of Science and Technologies and Ministry of Information and Communication Technology.

the economic impacts of the uses of ICT: the potential opportunities and challenges that ICT is expected to create for public and private universities, using Sudan as a case study of the African region. And finally to explain the role of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities, as well as collaboration between Sudanese and international and northern universities and creating opportunities and challenges for production, creation and transfer of knowledge in African, namely Sudanese universities. In this project we test the following hypotheses:

1. Significant public-private differential between public and private universities in Sudan in terms of the pattern, structure and trend of the demand for the four ICT modes: fixed telephone, mobile telephones, computer and Internet.
2. The demand for ICT modes is characterised by considerable dynamism: shows a dynamic increasing trend and a significant structural change over time amongst public and private university staff in Sudan.
3. The demand for the four ICT modes amongst public and private universities staff in Sudan is determined by income, education attainment level, age, and gender.
4. The demand for or the use of the Internet shows positive significant correlations with the use of telephone, the use of/spending on IT (computers) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training amongst public and private university staff in Sudan.
5. The use of or spending on ICT has the ability to impose the 'creative-destruction' effect by providing opportunities for development, but simultaneously also creating hazards to development amongst public and private universities in Sudan as a case study of the African region (cf. ITU- WDI Database, 2005; D'Costa, 2003a, b).
6. The use of ICT imposes or introduces the 'positive-negative' effect by providing opportunities for the production, creation and transfer of knowledge, but simultaneously also creating hazards to the production, creation and transfer of knowledge in knowledge institutions in African, namely universities in Sudan.

### **1. 3 Structure of the research**

Concerning the general structure of this project it is composed of six chapters organised in the following way: Chapter 1 presents an introduction; Chapter 2 reviews the theoretical and empirical literature discussing the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the demand for and impacts of the use of ICT in facilitating the production, creation and transfer of knowledge, as confirmed in the new growth literature; Chapter 3 explains the status and impacts of the use of ICT in knowledge production institutions, notably universities in African countries in general and in Sudan in particular; Chapter 4 explains the data and methodology; Chapter 5 provides the empirical

analysis, examining from public-private perspectives the research hypotheses on the public-private differential in the demand for ICT, trend, determinants and impacts of the use of ICT and investigates the opportunities and challenges that ICT is expected to create for the production, creation and transfer of knowledge in Sudanese universities as a case study of African universities; the summary, conclusions and policy recommendations to improve the uses and impacts of ICT in the production, creation and transfer of knowledge in Sudanese universities and in African universities are given in Chapter 6.

## Chapter 2: Overview of Sudanese Economy and the Status of ICT in Sudan

### Introduction

This chapter provides a general overview of the socio-economic characteristics of the Sudanese economy and explains the status of ICT in Sudan. Section 1 provides a general overview of the general socio-economic characteristics of the Sudanese economy, Section 2 explains the status of ICT in Sudan and finally Section 3 provides the conclusions.

### 2.1 Socio-economic characteristics of the Sudanese economy

Concerning the socio-economic characteristics and the use of ICT in Sudan, one important stylised fact on the case of Sudan is that it is large by regional standards, but its economy is small in global terms. For instance, according to the World Bank and the United Nations classification and definition, Sudan is classified amongst the Sub-Saharan African (SSA) countries and amongst the poor, low income and highly indebted countries. For instance, Table 1 below shows the low GDP per capita income in Sudan which is in excess of only the least developing countries, but less than all other world regions. For some time, Sudan's economy has been characterised by low GDP per capita income, the presence of high rates of poverty, unemployment and inequalities in resources sharing. According to the World Bank's classification, Sudan was listed amongst the least developed and highly indebted economies, but in recent years following the improvement in its economic performance, the country has turned from a low income economy into a lower medium income economy according to the World Bank classification. In recent years the increasing dependence on oil has led to sound economic growth. Consequently, Sudan's real economic growth averaged about 9% during 2005-07, putting Sudan among the fastest growing economies in Africa (World Bank, 2008). Despite the fact that in recent years there has been impressive real growth and rapid increase in per capita incomes, emerging vulnerabilities and little progress in social indicators still exist. This is evident from recent United Nations Development Programme (UNDP) statistics on Human Development Indicators (HDI), for instance, according to UNDP (2007) Sudan is still classified amongst the medium human development countries and the bottom of developing countries in terms of HDI (0.516), as it ranked 147 out of 177 developing countries.<sup>5</sup> Sudan's performance in terms of the estimated HDI (0.516), life expectancy (56.5) and GDP per capita (1.949) is above only the least developed and low human development countries, and lags behind all other groups including the developing countries, Arab states,

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<sup>5</sup> The human development index (HDI) provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and enrolment at the primary, secondary and tertiary level) and having a decent standard of living (measured by purchasing power parity, PPP, income). See UNDP-HDR (2006), pp. 238-286.

East Asia and the Pacific, Latin America and the Caribbean, South Asia, SSA, Central and Eastern Europe and the and the Commonwealth of Independent States(CIS), Organisation for Economic Co-operation and Development (OECD), high human development, medium human development, high income, middle income and low income. Adult literacy rate in Sudan accounted for 60.9, which lies below all other groups except the low human development. Moreover, combined gross enrolment ratio for primary, secondary and tertiary school in Sudan accounted only for 37, falling behind all other groups, even the least developed, low human development, and SSA countries. Data from Sudan's Ministry of Finance and National Economy and World Development Indicators (WDI) about the structure of Sudan's economy indicates the dominance of the agricultural (41%, 33%) and services (42%, 53%) sectors and low share of the industrial sector (17%, 14%) over the periods 1992-2000 and 1980-2005 respectively. The structure of the Sudanese economy shows the importance of both the agricultural (71%, 39%) and services (21%, 43%) sectors compared to the industrial sector (9%, 18%) in terms of both the share in total employment (1990) and value added as a percentage of GDP (2002) respectively (cf. World Development Indicator (WDI) database, 2005).

**Table 1- Socio-Economic Indicators in Sudan and other regions in the World 2004**

HDI rank	Human Development Index (HDI) Value	Life expectancy at birth (years)	Adult literacy rate (% ages 15 and older) <sup>b</sup>	Combined gross enrolment ratio for primary, secondary and tertiary schools (%)	GDP per capita (PPP US\$)
Sudan	0.516	56.5	60.9	37 <sup>*</sup>	1,949
Developing countries	0.679	65.2	78.9	63	4,775
Least developed countries	0.464	52.4	63.7	45	1,350
Arab States	0.680	67.3	69.9	62	5,680
East Asia and the Pacific	0.760	70.8	90.7	69	5,872
Latin America and the Caribbean	0.795	72.2	90.2	81	7,964
South Asia	0.599	63.7	60.9	56	3,072
Sub-Saharan Africa	0.472	46.1	63.3	50	1,946
Central and Eastern Europe and the CIS	0.802	68.2	99.2	83	8,802
OECD	0.923	77.8	..	89	27,571
High-income OECD	0.946	79.0	..	95	32,003
High human development	0.923	78.0	..	91	26,568
Medium human development	0.701	67.3	80.5	66	4,901
Low human development	0.427	45.8	57.9	46	1,113
High income	0.942	78.8	..	94	31,331
Middle income	0.768	70.3	89.9	73	6,756
Low income	0.556	58.7	62.3	54	2,297
World	0.741	67.3	..	67	8,833

Sources: UNDP 2006: PP. 283-286.

## 2.2 Background on the importance and diffusion of ICT in Sudan and Africa

In recent years, the diffusion of ICT in the African region has increased significantly. As Table 2 below illustrates, the recent growth rate of the total online population and cellular subscribers in SSA countries during the period 2001-02 has been significant. Table 3 below presents more recent indicators from International Telecommunication Union (ITU) (2004) and illustrates that despite a recent slowdown in terms of both cellular mobile and telephone

mainlines compound average growth rates for the African region, they exceed the world average over the period 1996-2003. Moreover, Table 4 shows that according to UNDP-HDR (2007) data for 1990-2005 diffusion of ICT has been rapid, with that is the Internet faster than mobile and fixed telephone; the use of Internet and telephone landlines in Sudan is higher than SSA but less than the world, whereas the use of mobile in Sudan is less than SSA and world. Moreover, according to the WDI database (2009) data for 2000-07 indicates the fast growth in mobile (21%) which is more than twice the growth in Internet (9.1%) in Sudan; the fast growth in mobile in Sudan is below SSA, but the fast growth in Internet in Sudan is above SSA.<sup>6</sup> As for the use of ICT in Sudan, according to the WDI database (2005) before 2000 the number of users of both mobile phones and Internet (per 1,000 population) were zero and up till the year 2000 both were only one. In recent years, Sudan has shown growing telecommunication networks and Internet services but still the highest prices/most expensive Internet service compared to other African and developing countries. Internet users in Sudan represent about 8.5 % of the African internet users and 0.024% of the world internet users- see Table 5 below.<sup>7</sup>

Table 2- Growth of the 'online' population, Telephone mainlines and Cellular subscribers worldwide, 2001-2002

	Population accessing/ Internet users (per 1,000 people)		Telephone mainlines (per 1,000 people)		Cellular subscribers (per 1,000 people)	
	2001	2002	2001	2002	2001	2002
OECD	332	383.1	523	516	539	588
East Asia and the Pacific	41.4	60.9	122	142	113	159
Central and Eastern Europe and CIS	42.8	71.8	224	226	120	189
Latin America and Caribbean	49	81.2	160	166	162	191
South Asia	6.3	14.9	38	41	7	13
Sub Saharan Africa	7.8	9.6	15	15	28	39
World	79.6	99.4	169	175	153	184
Arab states	15.6	28.0	76	81	58	85

Source: UNDP Human Development Report (2004).

Table 3- Growth rate of Cellular mobile and telephone mainlines worldwide 1996-2003

	Cellular mobile <i>country</i> average growth rate subscribers (%)			Telephone mainlines <i>country</i> average growth rate subscribers (%)		
	1996-2001	1997-2002	1998-2003	1996-2001	1997-2002	1998-2003
World	46.1	40.2	33.4	7.3	6.6	6.3
Average Arab states	89.3	80.6	80.3	11.3	10.4	10.0
Asia	48.5	43.3	38.1	13.7	13.2	13.6
Africa	85.6	74.6	65	9.4	9	8.5
Oceania	24.9	24.3	24.6	2.5	2.4	2.1
America	32.9	28.7	24.8	5.1	3.8	2.4
Europe	56.8	46.3	33.4	3.4	2.6	1.9
World	46.1	40.2	33.4	7.3	6.6	6.3

Source: International Telecommunication Union (ITU) Database 2004

<sup>6</sup> According to the definition of the WDI database (April 2009), mobile/cellular telephone subscriptions are subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network. Post-paid and prepaid subscriptions are included. Source: International Telecommunication Union, World Telecommunication Development Report and database, and World Bank estimates. Note: please cite the International Telecommunication Union for third-party use of this data. Internet users are people with access to the worldwide network. Source: International Telecommunication Union, World Telecommunication Development Report and database, and World Bank estimates. Note: please cite the International Telecommunication Union for third-party use of this data.

<sup>7</sup> See Mohamed Abdelaziz Tangasawi (2007) "Internet Services in Sudan," V 1.0. NTC Workshop on Internet Issues 19 July 2007.

Table 4 - Diffusion of ICT in Sudan compared to the world 1990-2007

	Telephone mainlines (per 1,000 people) <sup>a</sup>		Cellular subscribers (per 1,000 people) <sup>a</sup>		Internet users (per 1,000 people) <sup>a</sup>		Mobile cellular subscriptions (per 100 people) <sup>b</sup>				Internet users (per 100 people) <sup>b</sup>			
	1990	2005	1990	2005	1990	2005	2000	2005	2006	2007	2000	2005	2006	2007
Sudan	2	18	0	50	0	77	0	5	12	21	0.0	1.4	8.5	9.1
Least Developing countries	21	132	(.)	229	(.)	86	0	5	9	16	0.1	0.8	1.3	1.6
developed countries	3	9	0	48	0	12								
Arab States	34	106	(.)	284	0	88								
M&NA							2	22	34	51	0.9	10.6	13.7	17.1
East Asia and the Pacific	18	223	(.)	301	(.)	106								
Latin America and the Caribbean	61	..	(.)	439	0	156								
South Asia	7	51	(.)	81	0	52								
Sub-Saharan Africa	10	17	(.)	130	0	26	2	12	18	23	0.5	2.2	3.3	4.4
Central and Eastern Europe and the CIS	125	277	(.)	629	0	185								
OECD	390	441	10	785	3	445								
High income	450	500	12	831	3	525	51	85	93	100	31.6	60.1	62.9	65.7
Middle income	40	211	(.)	379	0	115	6	30	38	48	1.9	9.2	12.1	15.2
Lower Middle Income							4	23	30	39	1.2	7.0	9.4	12.4
Low income	6	37	(.)	77	0	45	0	7	13	22	0.2	2.9	3.8	5.2
World	98	180	2	341	1	136	12	34	42	51	6.7	16.2	18.6	21.8
Sudan b							2000	2001	2002	2003	2004	2005	2006	2007
Mobile cellular subscriptions (per 100 people)							0	0	1	1	3	5	12	21
Internet users (per 100 people)							0	0	0	1	1	1	8	9

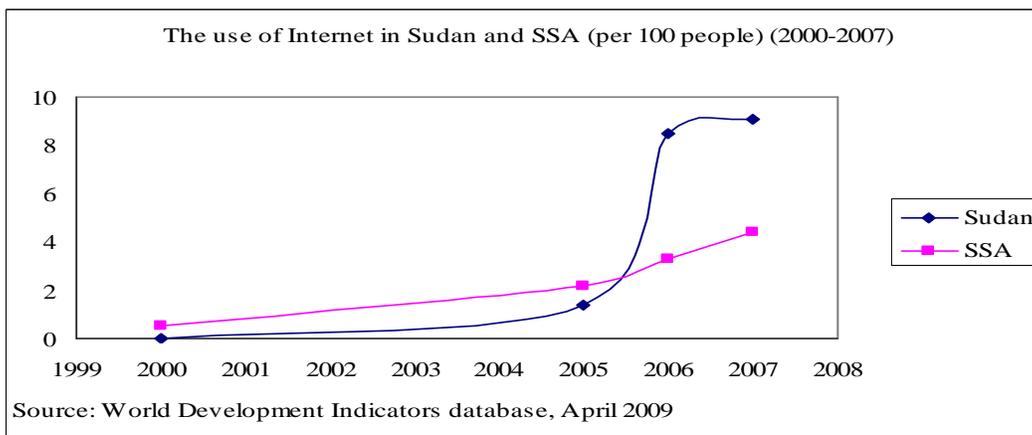
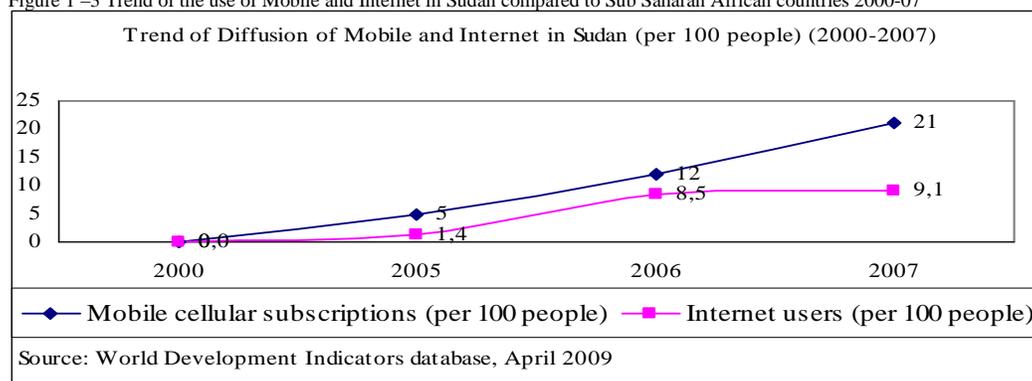
Sources: (a) UNDP- HDR (2007) pp. 275-276. Table 13, (b) World Development Indicators database, April 2009.

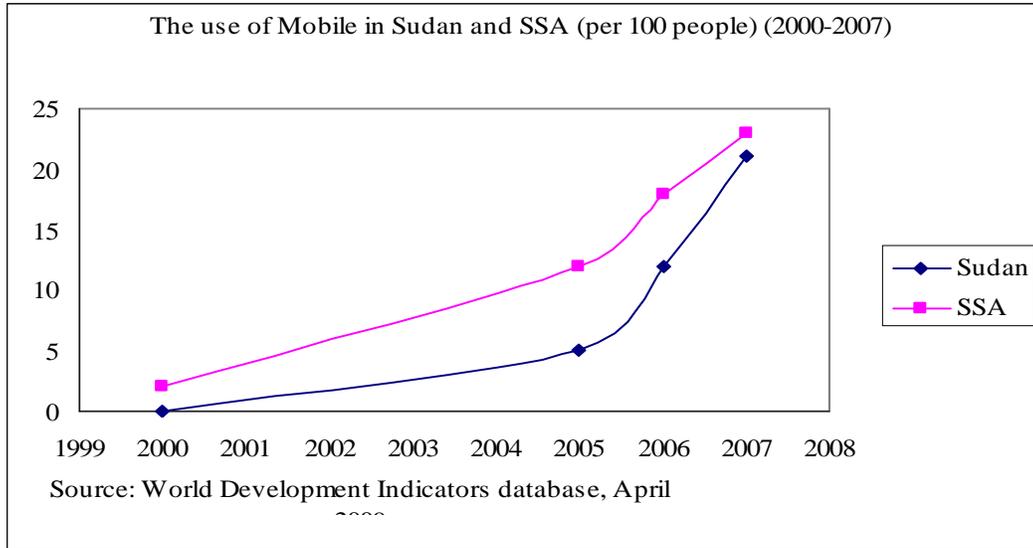
Table 5- The use of Internet and Population Growth in Sudan 2000-07

Year	Users	Population	% Pen	Usage Source	(%) Users in Africa	Use Growth 2000-07
2000	30,000	36,841,500	0.1 %	ITU		
2003	300,000	35,035,677	0.9 %	ITU		
2007	2,800,000	36,618,745	7.6 %	ITU	8.3 %	9,233.3 %

Source: Mohamed Abdelaziz Tangasawi (2007) "Internet Services In Sudan," V 1.0. NTC Workshop on Internet Issues 19 July 2007

Figure 1 –3 Trend of the use of Mobile and Internet in Sudan compared to Sub Saharan African countries 2000-07





### 2.3 Conclusions

This chapter presents an introduction and background to motivate the research and explains some stylised facts, as well as the research problem along with other strategic problems confronting economic development in Sudan. Section 1 explains that Sudan's economy has been characterised by low GDP per capita income, presence of high rates of poverty, unemployment and inequalities in resources sharing. But in recent years following the increasing dependence on oil, structural change in the economy and improvement in the economic performance has led to sound economic growth; Sudan has turned from a low income economy into a lower medium income economy according to the World Bank classification, putting the country amongst the fastest growing economies in Africa (World Bank, 2008). Section 2 explains the status of ICT in Sudan; we show that in the recent years, Sudan has shown growing telecommunication networks and Internet services but still has the highest prices/most expensive Internet services compared to other African and developing countries. We show that UNDP-HDR (2007) data for 1990-2005 indicates the rapid diffusion of ICT; the faster growth of Internet over mobile and fixed telephone and the use of Internet and telephone landlines in Sudan is higher than SSA but less than the world rate, whereas the use of mobile in Sudan is less than both SSA and world. Moreover, WDI database (2009) data for 2000-07 indicates the fast growth in mobile (21%), more than twice the fast growth in Internet (9.1%) in Sudan. Although the fast growth in mobile in Sudan is below SSA rates, the fast growth in Internet in Sudan is above SSA. Our findings indicate that the reported increasing trend of mobile and Internet usage at the aggregate macro level in Sudan seems consistent with the observed increasing trend at the regional and international levels.

## **Chapter 3: Reviews of Theoretical and Empirical Literature**

### **Introduction**

This chapter discusses the theoretical framework: Section 1 reviews theoretical and empirical literature; Section 2 explains the literature on the relations between ICT and knowledge production and higher education institutions in Africa; and Section 3 provides the conclusions.

### **3.1 Reviews of theoretical and empirical literature**

The rapid progress in ICT and its impacts on the global knowledge economy have intensified in recent years, leading to a new economic system characterised by intensive knowledge production that has attracted a great deal of interest. It has also raised debate on the effects of ICT and the economic opportunities and the challenges that ICT imposes on the production and dissemination of knowledge in the world economy, particularly for developing countries.

More recently, the continuous move towards globalisation has 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 impacts of technical changes in knowledge production, economic growth and development have received particular interest in the recent literature focusing on economic growth. In particular, many of the recent studies have shed some light on the impact of IT on knowledge production, economic growth, productivity, employment, work organisation, competitiveness and human capital development.

While it is admitted that the impact of ICT like many other forms of technological progress is difficult to measure, much recent theoretical and empirical literature uses several indicators to approximate their effects in economic growth and investigate both the positive and negative impacts (opportunities and challenges) that ICT has imposed on the world economy. For instance, some recent studies use an index of investment or expenditures on ICT, IT, computers or computer equipment and provide 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 organisation (cf. Bresnahan, Hitt and Brynjolfsson, 1999) and skill upgrading (cf. Acemoglu, 1998; Hwang, 2000). One interesting finding in the literature 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/skill and skill upgrading. For instance, several studies use many indicators to examine the complementary relationships between technological progress, as measured by

ICT and human capital, as measured by the increasing utilisation of higher educated workers (cf. Goldin and Katz, 1998; Bresnahan et al., 1999; Autor, Katz and Krueger, 1998; Acemoglu, 1998). In conjunction with these interpretations, some studies explain the relationship between ICT, IT or computer use and skill upgrading defined by the increase either in the incidence of training (cf. Bresnahan, 1999) or the share of high skilled workers (cf. Autor, Katz and Krueger, 1998; Bresnahan, 1999; Hwang, 2000).

On the other hand, several studies discuss the hazards ICT creates for economic development. Most of this literature is based on the idea that technical change is a creative destruction process that creates opportunities for development, while also imposing certain restrictions to development. For instance, several studies have highlighted the negative impacts and implications of the increasing use of IT or ICT on employment and labour markets (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 raised the issue that, as with most other technical change, ICT or IT has the so-called labour saving or skill-biased effect through the displacement of unskilled labour that results from either the reduction or elimination of some basic non-skilled jobs.

It has also been hypothesised that ICT could impose adverse effects in the developing world because greater advantages will accrue to the industrialised world from global competitiveness than to the developing world, thus making it hard for the less developed countries to compete on the international market. Furthermore, the rapid evolution in ICT will make it harder for the 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 the competition and hence widening the already existing gap and digital divide between the developed and developing countries. The recent literature indicates the growing but limited effects of ICT diffusion in developing countries due to a lack of sufficient investment in the complementary infrastructure such as education, skills and technical skills (cf. Pohjola, 2002; Kenny, 2002).

Several studies discuss the role of ICT in enhancing knowledge.<sup>8</sup> 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 in 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

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<sup>8</sup> See for instance, Quah (2001), Pohjola (2001) and Smith (2000).

ICT industries is coterminous with the move to a knowledge society.”<sup>9</sup> 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.”<sup>10</sup> “Then there is the role of ICT. Knowledge refers to understanding and competence. It is clearly true that ICT makes 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 therefore that the data moved or analysed by ICT methods are not themselves knowledge, and that therefore ICT does not necessarily create knowledge or even extend knowledge. However this distinction between information and knowledge seems to me to be either a mistake or at least overdrawn, since neither information nor data can exist in the absence of background concepts and a knowledge referent. Nevertheless ICT are primarily an information management and distribution resource, and a major question that follows is, how does an information resource relate to the production and use of knowledge in society? Lundvall and Foray are almost certainly right in saying that ICT plays a new role in knowledge production and distribution, but this is a re-organisation of the technical and financial terms on which a resource (information) is available. It does not in itself expand the realm 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<sup>11</sup>”

### 3.2 ICT and knowledge production institutions in Africa

Based on the above, this section presents some studies focused on the relations between ICT and knowledge production or ICT and higher education institutions in Africa. More recent literature establishes a link between technologies and society in Africa, in particular focusing on the impacts of ICT in connections and transformation and the production of knowledge in

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<sup>9</sup> See for instance, Smith (2000), p.4. See Smith, K. (2000) "Innovation indicators and the knowledge economy: concepts, results and policy challenges" Group for Studies in Technology, Innovation and Economic Policy, Oslo, Norway, November 2000.

<sup>10</sup> See B-Å. Lundvall and D. Foray, 'The knowledge-based economy: from the economics of knowledge to the learning economy', OECD Employment and Growth in the Knowledge-Based Economy (OECD: Paris), 1996, p.14. See also Smith (2000), pp.4-5.

<sup>11</sup> This literature on the impacts of ICT begins in the late 1980s, and is continuing. 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. See also Smith (2000), pp.7-8.

Africa.<sup>12</sup> For instance, the literature indicates that knowledge is evidently a constituent element of all the four dimensions of ‘connections and transformations in Africa’: material technologies; technologies of space; technologies of time; and technologies of management. Considering some 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 and implicit major orientations of a culture) as forms of collectively managed knowledge. Concretely, and with a view on technologies of connection, concentrating 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 is the use of ICT contributing 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 focused on connections in African knowledge and the current south-north collaboration in the production of knowledge.

Ahwireng-Obeng (2000) 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 education capacity, support distance education, connect places of learning and research and reduce communications and administrative costs. It can also improve the accessibility to rare manuscripts and artefacts and preserve them electronically.<sup>13</sup>

Unwin (2004) explores the use of information and communication technology (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 fundamental moral questions. Undoubtedly the introduction of ICT is expensive and there are countless other needs in Africa for school buildings with roofs, for 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 the potential of ICT 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

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<sup>12</sup> See for example, ASC Thematic Research project on Connections and Transformations: Linking Technologies and Society in Africa and Beyond, Subgroup 4: Connections in African Knowledge.

<sup>13</sup> See Ahwireng-Obeng, (2000), pp. 3-9.

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 optimise the multimedia potential availability. It is important to change this approach and replace it by one based on 'ICT for education'.<sup>14</sup>

Durrant (2004) 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 many significant challenges, which are nowhere perhaps more keenly experienced than in developing countries. In her view the challenges include: the limited supply of ICT (limitations of printed resources) and 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 high expensive costs of access to scholarly information; and low speed of ICT infrastructure including slow transfer rate, low bandwidth and the need for improvement of 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 printed counterparts, as they are not only cost-saving and cheaper, but also are not tied to or limited by physical space - they are accessible from any place. In addition there is: development of new licensing and purchasing models; enhancement of scholarly connections and communications (south-south, south-north and foster partnerships and connection to the wider research community, across the country, the continent or the planet); and improvement of the importance of services offered by libraries within educational institutions in African and less developed countries, by providing better affordable and available access to current, high quality information and e-resources to meet the needs of students and researchers and improve skills for both librarians and researchers.<sup>15</sup>

Olukoshi and Zeleza (2004) discuss the use of ICT in the African higher education system. They argue that the revolution of ICT that is going on offers various new opportunities at the same time as presenting challenges. African universities have generally been latecomers to the use of ICT and the reasons for this are many. In recent times, however, a significant number of universities have begun to enjoy investments in ICT. Some of these investments have come from donor sources, others from the state and philanthropic organisations/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 some of the universities work, feeding into their revival as

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<sup>14</sup> See Unwin (2004), pp. 150-160.

<sup>15</sup> See Durrant (2004), pp. 63-79.

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 carries problems of its own ranging from simple network management difficulties, to more complex ethical issues and the challenges of avoiding technological determinism through a conscious social-shaping of the technological tools available. The task for African universities is not simply to acquire and use these technologies, but to strive also to produce their own content, and to add African ideas and knowledge to the information superhighway. Research on the impacts 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.<sup>16</sup>

Beebe et al. (2003) chronicle and analyse the growth of the Internet in Africa, providing descriptions of regional initiatives and especially highlighting the role of ICT in higher education sector in selected countries.<sup>17</sup>

Adei (2003) discusses the positive and negative impacts of ICT and indicates that ICT in African universities has the potential of solving the problematic access to limited members in enrolment through distance education. For instance, the University of South Africa enrolls about 130,000 students for distance education, which is ten or more times the actual on-campus enrolment figure. For this to blossom in all African higher education institutions, government policy and implementation of ICT-related issues will be required in order for the technology to undergo mass application. Moreover, in an era of globalisation, ICT can help formally isolated African higher education institutions plug into vast educational resources and academic networks, while on the other hand increase the gap between higher education institutions that are online and those are not.<sup>18</sup>

Radwan (2003) discusses the implementation of several initiatives to leverage IT and enhance ICT to improve higher education in Egypt by the establishment of a Higher Institute of Technology, higher education enhancement project fund, Egyptian National Scientific and Technical Information Network (ENSTINET), Egyptian Universities Network (EUN), Regional Distance Learning Programme (RDLP) and the 'Internet clubs'. These initiatives facilitate the encouragement of open education, for example, the Cairo University Center of Open Education uses distance learning and self-learning techniques via a number of educational tools, such as audio/video rooms, electronic reading and language labs. In addition to provision of professional training, the Information Technology Institute (ITI) is providing specialised software application development programmes for new graduates and

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<sup>16</sup> See Olukoshi and Zeleza (2004), p. 611.

<sup>17</sup> See Beebe, Kouakou, Oyeyinka and Rao (2003).

<sup>18</sup> See Adei (2003), pp. 90, 108-109.

offers a professional training programme in order to meet the needs of the government, ministries and local decision support centres. In addition to provision of regional information technology software, RDLP through Regional Distance Learning Programme (RDLP), which offers distance educational services such as course materials, administration tools, and facilities management, RDLP, and involves 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 customise their learning needs and requirements. Further to provision of university online courses, for instance, a cooperative initiative between the University of Illinois at Urbana Champaign, USA and 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. Moreover, Menoufeya University also has plans to launch distance education services using ICT. In addition the Students Online (SOL) initiative is one of the main projects of the Egyptian Internet and infrastructure company Nile on line, supported by the Ministry of Higher Education. It helps create a qualitative transformation in the ways of learning for Egyptian students, and has reached nine universities including: Cairo, Ain Shams, Alexandria, Zakazik, Assiut, Helwan, Tanta, Suez Canal and Mansoura. Tens of thousands of students and educational staff have registered in the programme.<sup>19</sup>

Thairu (2003) indicates the use of ICT to connect higher education institutes in Kenya and addresses the successful public-private sector partnership that created the Kenya Education Network (KENET), formed in 1999, which now connects 16 higher education institutes to the Internet in Kenya.<sup>20</sup>

Massingue (2003) focuses on the development of informatics and growth of the Internet in Mozambique and the major role played by the Center for Informatics at the Eduardo Mondlane University (CIUEM). The CIUEM is the main initiator of ICT developments in Mozambique, for instance, it runs an ISP, is involved in various ICT projects like school-net, telecentres, the government's website and formulation of the national information policy, it provides project management for several donor-supported ICT projects; it was established mainly to serve the academic community, but the impacts of its programmes also extend to wider Mozambican society.<sup>21</sup>

Oyeyinka and Adeya (2003) quantitatively compare Internet usage in ten African Universities in two countries: Nigeria (four universities) and Kenya (six universities). The study identifies trends and issues such as need for access to online literature resources, turning to cybercafés for better Internet connections and desire for more computer terminals in

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<sup>19</sup> See Radwan (2003), pp. 387, 399, 400-401.

<sup>20</sup> See Thairu (2003).

<sup>21</sup> See Massingue (2003).

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, but African countries face structural problems such as low bandwidth, inadequate power supplies and lack of regional cooperation in Internet infrastructure.<sup>22</sup>

Mutagahywa (2003) focuses on the role played by the University of Dar es Salaam in the growth of the Internet in Tanzania and indicates the importance of sustainability of ICT resources at three levels: organisational, technical and financial. She discusses the role of the University of Dar es Salaam in the development of its ICT resources and deployed them into teaching, research and community services. She evaluates the role played by the university in the development of ICT in the education sector and 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 net outside the telephone network. This reduced the cost of access and as such encouraged the use of the Internet by government.<sup>23</sup>

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 of Zambia participated in earlier international initiatives to provide an email-based communication forum for NGOs and health workers in a number of African countries. With 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 may determine whether to advance the university can effectively deploy the Internet as a tool to advance its objectives in research and education.<sup>24</sup>

### 3.3 Conclusions

In this chapter we provide a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature on the use and impact of ICT. In Section 1 we review the theoretical and empirical literature and emphasise the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the demand for and impacts of the use of ICT in facilitating the production, creation and transfer of knowledge, as confirmed in the new growth literature. Section 2 shows the literature on the use and impact of ICT in higher education institutions in Africa; in particular, we show the significance and impacts of ICT for enhancing knowledge production in higher education institutions and universities in Africa.

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<sup>22</sup> See Oyeyinka and Adeya (2003).

<sup>23</sup> See Mutagahywa (2003).

<sup>24</sup> See Mwenechanya (2003).

## Chapter 4: Research Methodology and Methods of Data Collection

### Introduction

The previous chapter discussed the theoretical and empirical endogenous growth literature on the demand for ICT and relationship between ICT, creation and transfer of knowledge and economic growth, which we considered as a useful background for the empirical investigation that follows in the next chapters. Before we go into the empirical analysis, it is appropriate to define the methods of data collection and illustrate the composition and operation of the survey in this chapter. In Section 1 we explain the motives for performing the university survey and selection of a case study. Next, we show the selection of the sample and composition of the survey in Section 2 and show structure and design of the questionnaire in Section 3. Section 4 provides the conclusions, advantages and limitations of the survey.

### 4.1 Motivation and selection of a case study

The empirical investigation in this research uses a combination of primary and secondary data covering the university level. We collected our primary data using the university survey and interviews. We explain the reasons for undertaking the survey below, after which we spell out the selection of the case study, the sample, design and composition of the survey. The basic objective of conducting the university survey was to obtain specific information to provide insights into the factors influencing the demand for ICT and the link between the use of ICT and the production or creation and transfer of knowledge in Sudanese universities and to help generate policies to enhance the role of ICT in fostering the production or creation and transfer of knowledge in Sudanese universities. The university survey examines the opportunities and challenges associated with the use of ICT and discusses the implications of this in the production, creation and transfer of knowledge in the ten selected Sudanese universities.<sup>25</sup> 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 to allow a more comprehensive analysis and a deeper understanding of the demand for and status of the use of ICT and their corresponding implications from the demand perspective. We held the survey due to a lack of enough materials needed to investigate the research problem on the use of ICT from the demand perspective at the university level. The survey also aimed to explore, from the different perspectives of academic teaching staff, support staff and students, the importance of ICT in the creation and transfer of knowledge. The survey requested quantitative data to explain the pattern, structure and trend of demand for ICT and spending

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<sup>25</sup> In the appendices, we list the set of questions that were sent out to the sample of students, academic and support staff included in the survey. We present a brief definition of some of the terms used in the questions that were given as a guide to help respondents.

on the use of ICT, as measured by the use of fixed telephone, mobile telephone, computer and Internet, and to assess the relationship between spending on ICT indicators and monthly income and skill indicators, as measured by educational attainment, average years of schooling and experience. Additional information was sought to assess and determine the important factors hindering and those contributing towards enhancing the role of ICT in the creation and transfer of knowledge across Sudanese universities.

To examine the six hypotheses presented in Chapter 1 above, we use the descriptive approach, utilising primary and secondary data. The first hypothesis on the public-private differential can be interpreted from the demand perspective (as measured by the percentage of public and private universities staff accessing and spending on the four ICT modes (fixed telephone, mobile telephone, computer and Internet). To test the first hypothesis we compare the demand for ICT expenditure indicators (cf. WITSA, 2002). To test the third hypothesis, we use the SPSS for Windows and OLS regression, using the percentage of public and private universities staff accessing and spending on the four ICT modes (fixed telephone, mobile telephone, computer and Internet) as a dependent variable, and the monthly income and educational attainment level as measured by the average years of schooling for public and private universities staff as independent (explanatory) variables. To test the second and fourth hypotheses we use and compare both quantitative and qualitative data on the trend and spending on ICT over the past four years. To test the fifth hypothesis on the ‘positive-negative’ or ‘opportunities and challenges’ we use qualitative data on the impact of ICT in public and private universities. We test the hypothesis that on the one hand, the increasing use of ICT amongst public and private university staff has the potential to empower staff, enhance productivity, generate or create additional income and investment, minimise poverty, unemployment and enhance learning, skills and capabilities, gender equality (education and employment opportunities for women) creation and transfer of knowledge and thus accelerate economic growth and sustainable development in Sudan and other countries in the African region. On the other hand, ICT may introduce challenges with regards to intensified competition, allocation of budget for public and private university staff, allocation of public investment in the poor regions and inequality, as well as the elimination of some unskilled jobs (i.e. labour saving or skilled biased effects/skill or biased technical change) (cf. Bound and Johnson, 1992; Berman Bound and Griliches, 1994; Freeman and Soete, 1994; Autor, Katz and Krueger, 1998), increasing regional disparities within Sudan and the African region and furthermore, escalating the already existing gap and inequality between the advanced countries and Sudan and the African region, thus negatively influencing both Sudan and the African region’s development.<sup>26</sup> To test the sixth hypotheses we use qualitative data on the

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<sup>26</sup> See for example, ITU-WDI Database (2005); D’Costa, 2003a, b. At the macro and micro levels spending on ICT has the ability to introduce the creative-destructive effects. On the one hand, the increasing use of ICT has the potential to enhance

impact of ICT in creating opportunities and imposing challenges for the production, creation and transfer of knowledge. The opportunities or positive impacts are facilitating production, creation and transfer of knowledge, building connections and organisational changes, enhancing access, production and dissemination of knowledge, facilitating connections within knowledge institutions, namely universities in Sudan, facilitating collaboration between Sudanese universities and international northern universities, and integration of Sudanese universities into the system of global knowledge production. The challenge or negative impact is building disconnections for those who do not share the knowledge and do not know how to use ICT. In our analysis across Sudanese universities, we use primary data based on the results obtained from the university survey of Nour (2009). The field research to collect our primary data was held in the period from March to April, 2009, in Sudan. We focus on Sudan as a case study of the African countries, because Sudan has low but increasing use of ICT compared to other African countries - see Chapter 2 above. The survey covered ten of the 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, University of Khartoum, Sudan.<sup>27</sup>

#### **4.2 The selection of the sample and composition of the survey**

The sample in the university survey was drawn from ten public and private Sudanese universities.<sup>28</sup> 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 toward 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 in the

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productivity growth, generate or create additional income and investment, promote e-commerce, minimise poverty and unemployment and enhance human resources, skills and capabilities, gender equality (education and employment opportunities for women), R&D efforts, knowledge-based economy and thus accelerate economic growth and sustainable development in the African region. On the other hand, ICT may introduce challenges with regard to intensified competition, allocation of public investment in the poor regions, inequality as well as the elimination of some unskilled jobs (i.e. labour saving-skilled biased effects/skill-biased technical change) (cf. Bound and Johnson, 1992; Berman Bound and Griliches, 1994; Freeman and Soete, 1994; Autor, Katz, and Krueger, 1998), increasing regional disparities within the African region and furthermore, escalating the already existing gap and inequality between the advanced countries and the African region, thus negatively influencing the region's development.

<sup>27</sup> For the implementation of the university survey, a team of part-time researchers from the Department of Economics, Faculty of Economic and Social Studies at the University of Khartoum, were hired to make direct personal contact, determine the contact addresses, then handle, distribute and collect the survey from individuals. On request from some of the approached individuals, an additional copy of the survey was sent by e-mail to accelerate and increase the response rates. The university survey was distributed after translation of the English version into the Arabic language in order to increase the response rate.

<sup>28</sup> The university survey includes students, academic teaching and support staff affiliated to ten public and private universities. The universities included in the survey were: Khartoum University, Sudan University of Science and Technology, Juba University, Al-zaim Al-azhari University and Omdurman Islamic University, Computerman University, University of Medical Sciences and Technology, Sudan International University, Sudan Academy for Banking and Financial Studies and Ahfad University for Women.

selected ten (five public and five private) Sudanese universities located in Khartoum.<sup>29</sup> 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 20-70 years old. Since ICT is widely used amongst the youth population, the coverage in the university survey was focused on the youth population. The sample in the university survey was drawn from the population affiliated to these ten universities and residing in Khartoum state; based on the representation of the universities in the municipalities, the survey was distributed in the following way: Omdurman (one public and one private universities), Khartoum North (two public universities), and Khartoum (two public and four private universities).<sup>30</sup> 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 role of ICT in the creation and transfer of knowledge. It was also intended to provide insights to help generate policies to enhance the role of ICT in the creation and transfer of knowledge. 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 6 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.

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<sup>29</sup> The term respondent individuals in the survey refer to all individuals that returned the questionnaire, including the individuals who did not answer/respond to some questions. This implies that response rates vary enormously across individuals as some individuals did not respond to all questions. This may constitute further limitations, as we explain below.

<sup>30</sup> The selection of sample was quite representative for the population. Since the population in Khartoum state is around 10,000,000 and applying the standard WDI measure (2003) concerning the use of Internet per 1,000 population and use of mobile phone per 1,000 population in Sudan that accounted for 10 per 1000 and 20 per 1000 respectively; that indicates 1 per 100 population using Internet and 2 per 100 population were using mobile phone, i.e. the use of mobile double or twice the use of Internet.

Table 6 - Composition of the ICT university survey in Sudan, 2009

Representation	Institutions			Individuals								
	Number in sample	Total response	Response rate (%)	Academic teaching staff			Support staff			students		
				Number in sample	Total response	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. AUW	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%			
Grand Total	131	112	85%	99	81	81%	5	5	100%	26	26	100%

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

### 4. 3 Structure and design of the questionnaire

In this section we present the general structure and design of the questionnaire of the university survey. As for the structure of the questionnaire in the university survey of Nour (2009), the questionnaire in the university survey was composed of nine sections; the average response rate was higher for the second, fourth and fifth sections, moderate for the eighth and ninth sections and low for the first and third sections.<sup>31</sup> Each of the nine sections in the university survey aimed to request particular information. Section 1 requested general background information about the identification and characteristics of the individuals covered in the survey and also requested quantitative data to measure human capital/skill indicators, defined by skill level or educational attainment (average years of schooling and average years of experience) and average wages (monthly income). Section 2 examined the pattern and importance of the use of ICT. It assessed the pattern of ICT demand across different individuals. Section 3 requested quantitative data on the value and trend of total expenditure on the use of ICT. This section also requested qualitative data and examined the trend of ICT spending and income and price effects related to ICT spending. Section 4 inquired into the difficulties on the supply and demand sides related to the use of ICT. Section 5 investigated the relative importance of the characteristics of the use of ICT. Section 6 inquired the relevant policies for encouraging and supporting the use of ICT. Section 7 sought information to examine the impacts of ICT on labour market. Section 8 examined the impacts and advantages of the use of Internet in facilitating creation and transfer of knowledge. Section 9 investigated the impacts of the difficulties and problems for the use of Internet in creation and transfer of knowledge. The last two sections explained the factors hindering and others

<sup>31</sup> The design of the questionnaire in the university survey includes two types of questions: scalar or categories, and open questions. The distribution of the questions and their corresponding average response rates vary. Most of the questions are of scalar type, followed by open questions; corresponding average response rate is higher for scalar followed by open questions.

contributing towards promoting the use of ICT to enhance the creation and transfer of knowledge in Sudanese universities. Section 10 requested more recommendations for promoting use of ICT to enhance connections and transformation in Sudanese universities.

#### **4.4 Conclusions**

The data from the university survey provides us with the required information, which is particularly useful for presenting a public-private comparative analysis to identify the role of use of ICT to enhance connection and transformation in Sudanese universities from the public-private perspectives. The results of the university survey seem quite representative, since the selection and coverage covers and includes a broad range of institutions and individuals - academic teaching staff, support staff and students - affiliated with or working in the public and private universities, which provides us with relevant data and information that is of considerable use in our analysis. Such coverage also has the advantage of enabling us to compare between universities according to two criteria, i.e. the nature of the institutions (public-private) and the fields of specialisations (arts and humanities - science and engineering). One advantage of the university survey is that it examines the problem after integrating the three different perspectives of academic teaching staff, support staff and students. Another advantage is that, due to their close association to educational and training institutions, the approached academic teaching staff, support staff and students provided some useful information, particularly from both the analytical and policy perspectives. Moreover, the data evaluates the role of use of ICT to enhance connection and transformation in Sudanese universities and policies for the enhancement of the role of ICT to improve creation, production and transfer of knowledge in Sudanese universities. Moreover, the university survey presents some background information, which is also quite useful for a further analysis of universities based on other characteristics such as the geographical location and sector (public-private). Another advantage of the university survey is that it presents more specific but also quite comprehensive data and information that allow us to use a wide range of quantitative data and information for measuring skill and ICT indicators and the link between them at the micro level/ across individuals. In addition, the survey data allows us to approximate and examine the demand for ICT, the relationship between the total spending on the different modes of ICT (fixed telephone, mobile telephone, computer and Internet) and average income and average years of schooling. The main limitation of the university survey is the low response rate from some, probably because some of the academics lacked adequate information to enable them to contribute to a critical analysis of the role of ICT to enhance connection and transformation in Sudanese universities. One major limitation with respect to the university survey is the low response rate for some questions, especially where the answers or data required quantitative measurement. Such problems arose because some of the respondent individuals were unwilling

to provide complete and reliable quantitative data or some of the respondent individuals offered somewhat selective answers. For example, some individuals seemed hesitant to provide information about monthly income and spending on ICT. An intensive follow-up with individuals often improved the quality and quantity of the response rate. However, the hesitance of some individuals compelled us to exclude them when their observations were incomplete, missing and unreliable. Therefore, we used only completed and reliable observations in our estimation and analysis in the next chapters. Apart from this limitation, the data from the university survey remains useful from both the analytical and policy perspectives and is suitable to use in the empirical investigation in Chapters 5 to 7 and also for the policy analysis and recommendations in Chapter 8.

## Chapter 5: The Demand Side of ICT

### Introduction

The data from the university survey presented in Chapter 4 above provides us with the required information that is particularly useful for presenting interesting public-private comparative analysis to examine the demand for ICT in Sudanese universities from public-private perspectives. This chapter discusses the main results from all the universities' academic teaching staff, support staff and students' perspectives. It provides the empirical analysis and examines from the public-private perspective, the research hypotheses on the public-private differential in the demand for ICT, trend and determinants in Sudanese universities as a case study of African universities.

Before we go into the empirical analysis, it is appropriate to define the main characteristics of the respondents, including academic teaching staff, support staff and students in the universities mentioned in Section 1. Next, we present from the demand and consumer perspective an indepth analysis of the use of ICT, pattern, trend, nature, extent, structural change and comparative advantages of the demand for the use of the different modes of ICT in Section 2. We explain and examine the income and price effects of the use of ICT in Section 3. Section 4 provides the conclusions.

### 5.1 Main characteristics of the sample

Before we go into the empirical analysis, it is appropriate to define the main characteristics of the respondent academic teaching staff, support staff and students in the universities in this section. For instance, Table 7 shows the main characteristics (age, position, skill defined by educational level, schooling and experience years, monthly income gender and residence) of the respondents. As for age, for teaching staff the age limit ranges between 22 and 70 (on average 38.298), for the support staff the age limit ranges between 23 and 65 (on average 35.4), for students the age limit ranges between 22 and 36 (on average 27.08). As for position, the majority of the respondent academic teaching staff are assistant professors (32%), followed by teaching assistants (23.5%) and lecturers (20.99%), whilst the minority are associate professors (18.5%) and finally professors (1.24%). For support staff, the majority of respondent support staff are engineers (60%), followed by one chief library staff (20%) and one secretary (20%). For students, the minority of students are working as teaching assistants (30.8%). As for skill defined by educational level, for academic staff, the majority of the respondents are holders of Ph.D. (53.1%), followed by M.Sc. (27.2%) and B.Sc. (16.1%). For support staff, the majority of respondent support staff are holders of B.Sc. (60%), followed by M.Sc. (20%) and Diploma (20%). For students, the majority of the respondent students are holders of B.Sc. (57.7%), followed by M.Sc. (30.8%) and a few are holders of Diploma

(7.69%). As for skill defined by schooling and experience years, for the academic teaching staff the schooling years range between 16 and 22 (on average 20.189), whereas the experience years range between 1 and 40 (on average 16.8). For the support staff the schooling years range between 15 and 19 (on average 16.08), whereas the experience years range between 1 and 35 (on average 9.6). For students, the schooling years range between 15 and 20 (on average 17.304), whereas the experience years range between 0 and 6 (on average 3.57). As for skill defined by monthly income, for academic staff this varies considerably between 50 and 4,500 (on average 1,650.068), for support staff, monthly income varies considerably between 150 and 2,200 (on average 1,270), for students, monthly income for varies considerably between 200 and 1,800 (on average 765.455). As for gender, the majority of the respondent academic teaching staff are male (56%) and the minority are female (44%), the majority of the respondent support staff are male (83%) and the minority are female (17%), the majority of the respondent students are male (65%) and the minority are female (35%). As for residence, near to half of the respondent academic teaching staff are resident in Khartoum (49.4%), followed by more than a quarter resident in Omdurman (28.4%) and finally near to a fifth resident in Khartoum North (19.75%) and a few in other locations (2.5%). For support staff, near to two thirds of the respondent support staff are resident in Khartoum (60%), followed by above one third resident in Omdurman (40%), none are resident in Khartoum North or other locations. For students, near to half of the respondent students are resident in Khartoum (46.15%), followed by above a quarter resident in Omdurman (28.4%) and finally near to a fifth resident in Khartoum North (19.2%) and a few in other locations (3.85%). Our findings prove the first hypothesis presented in Chapter 1 above regarding the significant public-private differential in the general characteristics of public and private university staff in Sudan. For instance, we observe that as for the general characteristics, private university staff probably have more resources and relatively high monthly incomes and skill levels compared to public university staff. We use this result to substantiate public-private differences in demand for and impacts of ICT.

**Table 7 – Main Characteristics of the ICT university survey in Sudan 2009**

University staff	University staff											All staff	Public	Private	Support staff	Students
Faculty	Other university	Khartoum	Sudan	Juba	Azhari	Isalmia	MHUMIDA	Ahfad	Banking	Computerman	International	All average	79%	21%	Support staff	Students
Number	50		6	5	2	1	4	3	2	5	3	81	64	17	5	26
Age	Range	22-70	23-32	35-39	32-33	55	41-54	24-40	29-41	29-39	35-53	22-70	22-70	24-54	23-65	22-36
	Average	41.55	25.8	37	32.5	55	49	31.67	35	32.8	42.67	38.298	38.369	38.23	35.4	27.087
Position	Professor	0.02	0	0	0	0	0	0	0	0	0	0.0124	0.0158	0	0	0
	Associate professor	0.26	0	0	0	0	0.5	0	0	0	0	0.185	0.2063	0.1176	0	0
	Assistant professor	0.36	0	0.2	0	1	0.5	0	0.5	0.2	0.667	0.32	0.3174	0.3529	0	0
	lecturer	0.18	0	0	1		0	0.33		0.8	0.33	0.2099	0.1746	0.3529	0	0
	Teaching assistant	0.18	1	0.2	0	0	0	0.667	0.5	0		0.235	0.2539	0.1764		0.308
Education	Ph.D.	0.66	0	0.2		1	1	0	0.5	0.2	0.667	0.531	0.5555	0.470588	0	0
	M.Sc.	0.2	0.5		1	0	0	0.667		0.8	0.33	0.272	0.2380	0.4117	0.2	0.308
	B.Sc.	0.14	0.5	0.2	0	0	0	0.33	0.5	0	0	0.161	0.1746	0.1176	0.6	0.577
	Diploma	0	0	0	0	0	0	0	0	0	0	0	0.32	0.471	0.2	0.0769
Schooling years	Range	16-27	16-18	19-22	19	22	22-23	16-20	17-22	19-22	21-22	16-27	16-27	16-23	15-19	15-20
	Average	21.225	17.167	20.5	19	22	22.5	18.33	19.5	20	21.667	20.189	19.98	20.4	16.8	17.304
Experience years	Range	1-40	16-18	10-13	5-10	30	15-36	1-20	3-25	3-13	7-28	1-40	1-40	1-36	1-35	0-6
	Average	16.9796	6	11.5	7.5	30	25.75	9.667	9	7.2	16.667	14.026	14.396	13.66	9.6	3.57
Monthly Income	Range	200-3500	50-1000	675-unknown	500-1000	1900	2000-6000	450-1000	600-4000	1150-4500	1385-2500	50-4500	50-3500	450-4500	150-220	200-1800
	Average	1705.68	558.333	675	750	1900	3666.667	816.667	2300	2000	2128.333	1650.068	1117.8	2182.3	1270	765.455
Gender (%)	Male	0.58	0.5	0.8	0	0	0.75	0	1	0.4	0.67	56%	56%	53%	4	17
	Female	0.42	0.5	0.2	1	1	0.25	1	0	0.6	0.33	44%	44%	47%	1	9
Gender Number	Male	29	3	4	0	0	3	0	2	2	2	45	36	9	83%	65%
	Female	21	3	1	2	1	1	3	0	3	1	36	28	8	17%	35%
	Khartoum	0.58	0.5	0	0	0	0.5	0	0	0.8	0.67	0.494	0.508	0.4706	0.6	0.4615
	Omdurman	0.18	0.33	0.6	0.5	1	0.25	1	1	0.2	0	0.284	0.254	0.4118	0.4	0.308
Residence	Khartoum north	0.24		0.2	0.5	0	0.25	0	0	0	0.33	0.1975	0.222	0.117647	0	0.192
	Others- Unknown	0	0.1667	0.2	0	0	0	0	0	0	0	0.025	0.03175	0	0	0.0385

## 5.2 The demand perspective of the use of ICT

This section provides an indepth analysis from the demand perspective. From the demand perspective, we explain the pattern, trend, nature, extent and structural change and comparative advantages of the demand for the use of different modes of ICT, and finally we discuss the income and price effects of the use of ICT.

### 5.2.1 The pattern, trend, nature and extent of the use of ICT

It is useful to start with an assessment of personal knowledge of ICT. On the assessment of the respondents' own appreciation of their personal knowledge about computers, the majority of all academic staff indicate a very good knowledge (40%), this is followed by excellent (31%), good (26%) and weak (4%). The assessment of personal knowledge about the Internet indicates that the majority of all academic staff reported an excellent knowledge (40%), followed by a very good (33%), good (25%) and weak knowledge (1%). On the assessment of the respondent public staff's own appreciation of their personal knowledge about computer, the majority of all public staff indicate a very good knowledge (42%), this is followed by excellent (28%), good (25%) and weak (5%). The assessment of personal knowledge about the Internet indicates that the majority of public staff reported an excellent knowledge (40%), followed by very good (31%), good (28%) and weak (2%). On the assessment of the respondent private staff's own appreciation of their personal knowledge about computers, the majority of all private staff indicate excellent knowledge (41%), followed by very good knowledge (29%) and good (29%). The assessment of personal knowledge about the Internet indicates that the majority of private staff reported an excellent knowledge (41%) and very good (41%), followed by good (18%). On the assessment of the respondent students' own appreciation of their personal knowledge about computers, the majority of students indicate a very good knowledge (38%), followed by excellent (35%) and good (27%). The assessment of personal knowledge about the Internet indicates that the majority of students reported good (35%) knowledge this, followed by excellent (31%), very good (31%), and weak (4%). On the assessment of the respondent support staff's own appreciation of their personal knowledge about computers, the majority of support staff indicate excellent knowledge (80%), followed by very good knowledge (20%). The assessment of personal knowledge about the Internet indicates that majority of the support staff reported excellent knowledge (60%), followed by very good (20%) (see Table 8 below).

Table 8- Assessment of Personal knowledge about Computer and Internet

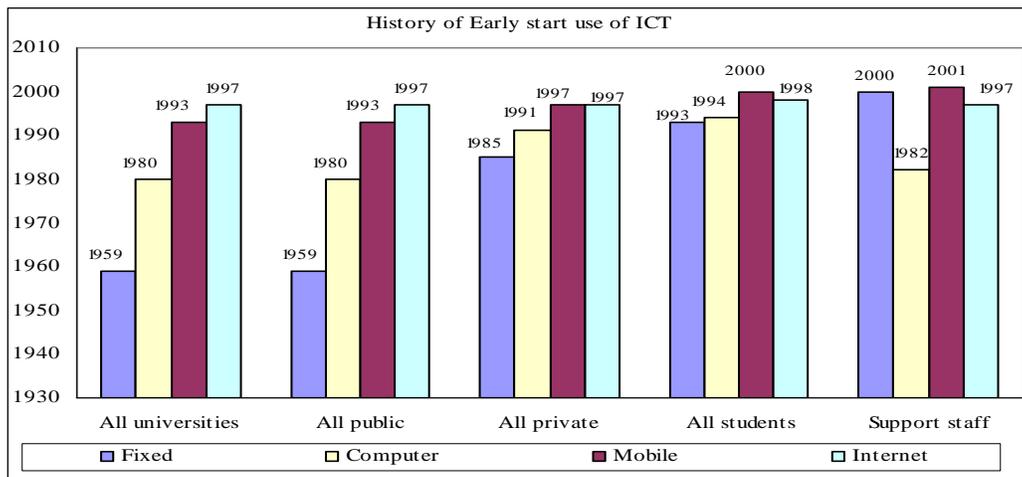
	Computer				Internet			
	Excellent	Very good	Good	Weak	Excellent	Very good	Good	Weak
All academic staff	31%	40%	26%	4%	40%	33%	25%	1%
Public	28%	42%	25%	5%	40%	31%	28%	2%
Private	41%	29%	29%	0%	41%	41%	18%	0%
Student	35%	38%	27%	0%	31%	31%	35%	4%
Support staff	80%	20%	0%	0%	60%	20%	0%	0%

The above-mentioned assessment is not surprising and seems consistent with the observed structural change in the use or demand for different ICT modes. For instance, from all the respondents' perspectives the analysis of the historical use of ICT implies that fixed telephone was used earlier as a more traditional and a long-standing ICT mode, but then there is a gradual and visible shift toward the use of other more recent ICT modes such as computer, mobile and Internet respectively amongst the academic teaching staff, support staff and students (see Table 9 and Figure 4 below).

Table 9 - The demand for ICT from historical Perspective:

	Fixed		Mobile		Computer		Internet	
	Early start	Late start						
All universities	1959	2007	1993	2007	1980	2006	1997	2007
All public	1959	2007	1993	2007	1980	2006	1997	2007
All private	1985	2005	1997	2003	1991	2003	1997	2005
All students	1993	2006	2000	2006	1994	2005	1998	2007
Support staff	2000	2006	2001	2005	1982	2003	1997	2004

Figure 4- The demand for ICT from historical Perspective



The above-mentioned structural change in the demand for the different ICT modes is also substantiated and confirmed from the respondent assessment regarding the various trends of personal use of the different modes of ICT amongst the different respondent groups over the past four years. For instance, from all the staff's perspective, for the majority the personal use of fixed telephone indicated a decreasing trend (78%), this is followed by a few who reported an increasing trend (12%) and finally a constant trend (10%). For the majority the personal use of mobile telephone indicated an increasing trend (88%), followed by few who reported a constant trend (8%), and finally a decreasing trend (4%). For the majority the personal use of computer indicated an increasing trend (75%), followed by few who reported a constant trend (21%), and finally a decreasing trend (4%). For the majority the personal use of Internet indicated an increasing trend (78%), followed by few who reported a constant trend (14%), and finally a decreasing trend (8%).

From the public staff's perspective, for the majority the personal use of fixed telephone indicated a decreasing trend (75%), followed by few who reported an increasing trend (15%) and finally a constant trend (10%). For the majority the personal use of mobile telephone indicated an increasing trend (86%), followed by few who reported a constant trend (8%), and finally a decreasing trend (5%). For the majority the personal use of computers indicated an increasing trend (73%), followed by few who reported a constant trend (23%) and finally a decreasing trend (4%). For the majority the personal use of Internet indicated an increasing trend (71%), followed by few who reported a constant (19%) trend and finally a decreasing trend (10%).

From the private staff's perspective, for the majority the personal use of fixed telephone indicated a decreasing trend (93%), followed by few who reported a constant trend (7%) and finally none reported an increasing trend (0%). For the majority the personal use of mobile telephone indicated an increasing trend (94%), followed by few who reported a constant trend (6%). For the majority the personal use of computer indicated an increasing trend (80%), followed by few who reported a constant trend (13%) and finally a decreasing trend (7%). From the private staff's perspective, for all respondents the personal use of Internet indicated an increasing trend (100%).

From the students' perspective, for the majority the personal use of fixed telephone indicated a decreasing trend (78%), followed by a few who reported a constant trend (13%) and finally an increasing trend (9%). For the majority the personal use of mobile telephone indicated an increasing trend (87%), followed by few who reported a constant trend (9%) and finally a decreasing trend (4%). For the majority the personal use of computer indicated an increasing trend (64%), followed by few who reported a constant trend (27%) and finally a decreasing trend (9%). For the majority the personal use of Internet indicated an increasing trend (79%), followed by few who reported a constant trend (17%) and finally a decreasing trend (4%).

From the support staff's perspective, for the majority the personal use of fixed telephone indicated an increasing trend (40%), followed by few who reported a decreasing trend (23%). For the majority the personal use of mobile telephone indicated an increasing trend (60%), followed by few who reported a constant trend (40%). For the majority the personal use of both computers (60%) and Internet (60%) both indicated an increasing trend (60%) (see Table 10 below).

Table 10- The trends of personal use of the different modes of ICT 2005-08

	Increase	Decrease	Constant
<b>All staff</b>			
Fixed telephone	12%	78%	10%
Mobile telephone	88%	4%	8%
Computer	75%	4%	21%
Internet	78%	8%	14%
<b>Public</b>			
Fixed telephone	15%	75%	10%
Mobile telephone	86%	5%	8%
Computer	73%	4%	23%
Internet	71%	10%	19%
<b>Private</b>			
Fixed telephone	0%	93%	7%
Mobile telephone	94%	0%	6%
Computer	80%	7%	13%
Internet	100%	0%	0%
<b>Students</b>			
Fixed telephone	9%	78%	13%
Mobile telephone	87%	4%	9%
Computer	64%	9%	27%
Internet	79%	4%	17%
<b>Support staff</b>			
Fixed telephone	40%	20%	0%
Mobile telephone	60%	0%	40%
Computer	60%	0%	0%
Internet	60%	0%	40%

The above results indicate that from all the respondents' perspectives, for the majority the personal use of mobile telephone, Internet and computers show an increasing trend, while the personal use of fixed telephone shows an opposite decreasing trend. For the majority the personal use of mobile telephone is growing faster than the Internet, computer and fixed telephone. This result at the micro level seems consistent with the reported increasing trend of the use of mobile and Internet at the aggregate macro level in Sudan and is also consistent with the observed increasing trend at regional and international levels (cf. World Bank World Development Indicators Database, 2009; UNDP, 2007) as we explained in Chapter 2 above.

The above findings prove our second hypothesis in Chapter 1 above which implies that the demand for ICT modes is characterised by considerable dynamism: it shows a dynamic increasing trend and a significant structural change over time amongst public and private university staff in Sudan. The incidence of the observed structural change seems to be more significant and has occurred rapidly for private university staff compared to public university staff. This can be interpreted probably in that private university staff have more resources than public university staff. The above-mentioned trend is somewhat surprising but can be interpreted and elaborated from the demand side and consumer perspectives along with the respondents' views that highlight and highly assess the importance of ICT for satisfaction of their personal need and utility. The respondents reported different assessment for the different modes of ICT, for instance, from all the staff's perspective, for the majority of all respondent academic staff fixed telephone is rated as moderately important (40%) for satisfaction of personal need and utility, followed by those who rated it as slightly important (28%) and few who rated it as unimportant (17%) and only a few who considered it as

excellent (15%) respectively. For the majority mobile is rated as excellent (84%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (15%) and few who rated it as unimportant (1%). For the majority computer is rated as excellent (83%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (16%) and few who rated it as slightly important (1%). For the majority of all respondent academic staff Internet is rated as excellent (86%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (13%) and slightly important (1%).

From the public staff's perspective, for the majority fixed telephone is rated as moderately important (43%) for satisfaction of personal need and utility, followed by those who rated it as slightly important (28%) and a few who rated it as excellent (16%) and as unimportant (13%). For the majority mobile is rated as excellent (86%), for satisfaction of personal need and utility, followed by those who rated it as moderately important (13%) and a few who rated it as unimportant (1%). For the majority computer is rated as excellent (81%), for satisfaction of personal need and utility, followed by those who rated it as moderately important (17%) and a few who rated it as slightly important (2%). For the majority Internet is rated as excellent (86%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (13%) and a few who rated it as slightly important (1%).

From the private staff's perspective, for the majority fixed telephone is rated as moderately important (29%) for satisfaction of personal need and utility, followed by those who rated it as slightly important (29%) and a few who rated it as unimportant (29%) and as excellent (12%) respectively. For the majority mobile is rated as excellent (76%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (24%). For the majority computer is rated as excellent (88%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (12%). For the majority Internet is rated as excellent (88%), for satisfaction of personal need and utility, followed by those who rated it as moderately important (12%).

From the student's perspective, for the majority fixed telephone is rated as moderately important (58%) for satisfaction of personal need and utility, followed by those who rated it as slightly important (25%) and a few who rated it as excellent (8%) and as unimportant (8%). For the majority mobile is rated as excellent (96%) for satisfaction of personal need and utility, followed by a few those who rated it as moderately important (4%). For the majority computer is rated as excellent (87%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (13%). For the majority Internet is rated as excellent (83%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (17%).

From the support staff's perspective, for the majority fixed telephone is rated as moderately important (40%) for satisfaction of personal need and utility, followed by those who rated it as slightly important (40%) and a few who rated it as excellent (20%). For the majority mobile is rated as excellent (40%) for satisfaction of personal need and utility, followed by those who rated it as moderately important (40%) and a few who rated it as unimportant (20%). For all respondent support staff both computer (100%) and Internet (100%) are rated as excellent for satisfaction of support staff personal need and utility.

Our findings indicate that somewhat surprisingly the importance of mobile for students is higher than academic teaching staff and support staff; this is probably because different from academic teaching staff and support staff, students lack regular free access to Internet and this result implies that mobile is more important for young population. Our results show that computer and Internet for support staff is more important than academic teaching staff and students; this is probably because the majority of the respondent support staff are working in network and computer related works (see Table 11 below).

Table 11- Assessment of the importance of ICT for satisfaction of personal need and utility

	Extremely	Moderately	Slightly	Unimportant
<b>All staff</b>				
Fixed telephone	15%	40%	28%	17%
Mobile telephone	84%	15%	0%	1%
Computer	83%	16%	1%	0%
Internet	86%	13%	1%	0%
<b>Public I staff</b>	<b>Extremely</b>	<b>Moderately</b>	<b>Slightly</b>	<b>Unimportant</b>
Fixed telephone	16%	43%	28%	13%
Mobile telephone	86%	13%	0%	1%
Computer	81%	17%	2%	0%
Internet	86%	13%	1%	0%
<b>Private staff</b>	<b>Extremely</b>	<b>Moderately</b>	<b>Slightly</b>	<b>Unimportant</b>
Fixed telephone	12%	29%	29%	29%
Mobile telephone	76%	24%	0%	0%
Computer	88%	12%	0%	0%
Internet	88%	12%	0%	0%
<b>Students</b>	<b>Extremely</b>	<b>Moderately</b>	<b>Slightly</b>	<b>Unimportant</b>
Fixed telephone	8%	58%	25%	8%
Mobile telephone	96%	4%	0%	0%
Computer	87%	13%	0%	0%
Internet	83%	17%	0%	0%
<b>Support staff</b>	<b>Extremely</b>	<b>Moderately</b>	<b>Slightly</b>	<b>Unimportant</b>
Fixed telephone	20%	40%	40%	0%
Mobile telephone	40%	40%	20%	0%
Computer	100%	0%	0%	0%
Internet	100%	0%	0%	0%

The above findings on the trend and assessment of the importance of ICT indicate different preference of different modes of ICT that can be explained in relation to preference of specific characteristics such as fashion, style and good design, ease of use, cheap price and efficiency and high quality. For instance, from all the staff's perspective, in terms of the characteristic of fashion, style and good design, for majority of the respondents mobile (40%) is rated higher compared to computer (37%), Internet (33%) and fixed telephone (6%). In terms of the characteristic of ease of use mobile (62%) is rated higher compared to Internet (46%), computer (42%) and fixed telephone (30%). In terms of the characteristic of cheap

price, Internet (47%) is rated as very much cheaper compared to mobile (36%), computer (30%) and fixed telephone (30%). In terms of the characteristic of high efficiency and quality, both computer (79%) and Internet (72%) are rated higher compared to both mobile (64%) and fixed telephone (32%).

From the public staff's perspective, in terms of the characteristic of fashion, style and good design, for majority of the respondents mobile (41%) and computer (41%) are preferred to Internet (34%) and fixed telephone (8%), in terms of the characteristics of ease of use mobile (64%) is rated higher compared to Internet (50%), computer (45%) and fixed telephone (34%). But in term of the characteristic of cheaper price, Internet is rated very much cheaper (50%), compared to both mobile (38%), computer (34%) and fixed telephone (31%). In terms of the characteristic of high efficiency and quality, both computer (78%) and Internet (72%) are rated high compared to both mobile (67%) and fixed telephone (33%).

From the private staff's perspective, in terms of the characteristic of fashion, style and good design, for majority of the respondent mobile (35%) is preferred to Internet (29%) and computer (24%) and fixed telephone (0%). In terms of the characteristics of ease of use mobile (53%) is rated higher compared to Internet (29%), computer (29%) and fixed telephone (12%). But in terms of the characteristic of cheaper price, Internet is rated as very much cheaper (35%), compared to mobile (29%), fixed telephone (24%), and computer (12%). In terms of the characteristic of high efficiency and quality, both computer (82%) and Internet (71%) are rated high compared to both mobile (53%) and fixed telephone (29%).

From the students' perspective, in terms of the characteristic of fashion, style and good design, for majority of the respondents mobile (58%) is rated higher compared to computer (31%), Internet (27%) and fixed telephone (12%). In terms of the characteristic of ease of use mobile (54%) is rated higher compared to Internet (35%), computer (27%), and fixed telephone (23%). In terms of the characteristic of cheap price, fixed telephone (62%) is rated as very much cheaper compared to Internet (31%), mobile (23%) and computer (15%). In terms of the characteristic of high efficiency and quality, Internet (54%) is rated high compared to computer (46%), mobile (46%) and fixed telephone (19%).

From the support staff's perspective, in terms of the characteristic of fashion, style and good design, for majority of the respondents computer (40%) is rated higher than Internet (20%), mobile (0%) and fixed telephone (0%). In terms of the characteristic of ease of use Internet (60%) and computer (60%) are rated higher compared to mobile (20%) and fixed telephone (20%). In terms of the characteristic of cheap price, Internet (40%) is rated as very much cheaper compared to mobile (20%), computer (20%) and fixed telephone (20%). In terms of the characteristic of high efficiency and quality, Internet is also preferred, both Internet (60%) and computer (60%) are rated higher compared to mobile (0%) and fixed telephone (0%) (see Table 12 below).

From all the staff's perspective, for the majority of the respondents fixed telephone is most preferred because of the characteristics of efficiency and high quality (32%), followed by cheap price (30%), ease of use (30%), and finally fashion, style and good design (6%). For the majority mobile is most preferred because of the characteristics of efficiency and high quality (64%), followed by ease of use (62%), fashion, style and good design (40%) and finally cheap price (36%). For the majority computer is most preferred because of the characteristics of efficiency and high quality (79%), followed by ease of use (42%), fashion, style and good design (37%) and finally cheap price (30%). For the majority Internet is most preferred because of the characteristics of efficiency and high quality (72%), followed by cheap price (47%), ease of use (46%), and finally fashion, style and good design (33%).

From the public staff's perspective, for majority of the respondents fixed telephone is most preferred because of the characteristics of ease of use (34%), followed by efficiency and high quality (33%), cheap price (31%) and finally fashion, style and good design (8%). For the majority mobile telephone is most preferred because of the characteristics of efficiency and high quality (67%), followed by ease of use (64%), fashion, style and good design (41%) and finally cheap price (38%). For the majority computer is most preferred because of the characteristics of efficiency and high quality (78%), followed by ease of use (45%), fashion, style and good design (41%) and finally cheap price (34%). For the majority Internet is most preferred because of the characteristics of efficiency and high quality (72%), followed by cheap price (50%), ease of use (50%), and finally fashion, style and good design (34%).

From the private staff's perspective, for the majority fixed telephone is most preferred because of the characteristics of efficiency and high quality (29%), followed by cheap price (24%) and ease of use (12%). For the majority mobile telephone is most preferred because of the characteristics of efficiency and high quality (53%), followed by ease of use (53%), fashion, style and good design (35%) and finally cheap price (29%). For the majority computer is most preferred because of the characteristics of efficiency and high quality (82%), followed by ease of use (29%), fashion, style and good design (24%), and finally cheap price (12%). For the majority Internet is most preferred because of the characteristics of efficiency and high quality (71%), followed by cheap price (35%), ease of use easy for use (29%), and finally fashion, style and good design (29%).

From the students' perspective, for the majority fixed telephone is most preferred because of the characteristics of cheap price (62%), followed by ease of use (23%), efficiency and high quality (19%), and finally fashion, style and good design (12%). For the majority mobile telephone is most preferred because of the characteristics of fashion, style and good design (58%), followed by ease of use (54%), efficiency and high quality (46%) and finally cheap price (23%). For the majority computer is most preferred because of the characteristics of efficiency and high quality (46%), followed by fashion, style and good design (31%), ease

of use (27%) and finally cheap price (15%). For the majority Internet is most preferred because of the characteristics of efficiency and high quality (54%), followed by ease of use (35%), cheap price (31%), and finally fashion, style and good design (27%).

From the support staff's perspective, for the majority both fixed telephone and mobile telephone are most preferred because of the characteristics of cheap price (20%) and ease of use (20%). For the majority computer is most preferred because of the characteristics of efficiency and high quality (60%) and ease of use (60%), followed by fashion, style and good design (40%) and finally cheap price (20%). For the majority Internet is most preferred because of the characteristics of efficiency and high quality (60%) and ease of use (60%), followed by cheap price (40%), and finally fashion, style and good design (20%) (see Table 12 below).

Table 12- Assessment of preference of specific characteristics related to different modes of ICT

	Fixed	Mobile	Computer	Internet
<b>All staff</b>				
Distinguished characteristics				
Fashion, style and good design	6%	40%	37%	33%
Cheap price	30%	36%	30%	47%
Easy for use	30%	62%	42%	46%
Efficiency and high quality	32%	64%	79%	72%
<b>Public staff</b>				
Distinguished characteristics				
Fashion, style and good design	8%	41%	41%	34%
Cheap price	31%	38%	34%	50%
Easy for use	34%	64%	45%	50%
Efficiency and high quality	33%	67%	78%	72%
<b>Private staff</b>				
Distinguished characteristics				
Fashion, style and good design	0%	35%	24%	29%
Cheap price	24%	29%	12%	35%
Easy for use	12%	53%	29%	29%
Efficiency and high quality	29%	53%	82%	71%
<b>Students</b>				
Distinguished characteristics				
Fashion, style and good design	12%	58%	31%	27%
Cheap price	62%	23%	15%	31%
Easy for use	23%	54%	27%	35%
Efficiency and high quality	19%	46%	46%	54%
<b>Support staff</b>				
Distinguished characteristics				
Fashion, style and good design	0%	0%	40%	20%
Cheap price	20%	20%	20%	40%
Easy for use	20%	20%	60%	60%
Efficiency and high quality	0%	0%	60%	60%

The above findings indicate that from all the staff's perspective, for the majority the preference of the use of different modes of ICT is most probably related to or implies preference of specific characteristics such as efficiency and high quality. This implies that the respondent consumers are much more concerned with efficiency and high quality, which is not surprising given the high awareness amongst the respondents. The above findings indicate that Internet is the most widely used, most popular and most important ICT mode amongst academic staff for satisfying their needs and utility in an academic setting in Sudanese universities; it is somewhat surprising that the value of preference of the specific

characteristics of Internet is higher than mobile, which is also very widely used. The preference of different modes of ICT is related to preference of different characteristics such as fashion, style and good design, ease of use, cheap price and efficiency and high quality. For instance, from all the staff's perspective, for the majority mobile is preferred because of the characteristics of efficiency and high quality, ease of use and fashion, style and good design, while Internet is preferred because of the characteristics of efficiency and high quality, cheap price and ease of use.

### 5.2.2 Comparison between different advantages of the different modes of ICT

In addition to the above-mentioned advantages for the preference of the use of the various modes of ICT, the respondents indicate further advantages for the use of different modes of ICT. For instance, despite the above-reported significant structural change in the demand for ICT modes, from fixed telephone to mobile telephone and the Internet, assessment from few of the respondents indicates preference of the use of fixed telephone because of some specific important advantages related to the use of fixed telephone compared to mobile and Internet in facilitating fulfilment of personal utility. For instance, from all the respondents' perspective the most important advantages of using fixed telephone include: ease of use for people who are illiterate or have limited electronic knowledge; facilitated communication with Internet; ease of use in work; facilitated work contact with other institutions in Sudan; facilitated social contact with family; cheap price and low usage cost; facilitated work contact with colleagues inside the institution; and personal privacy. In addition the less important advantages include facilitated work contact with regional institutions, social contact with friends and work contact with international institutions and others respectively<sup>32</sup> (see Table 13 below).

Table 13- Assessment of importance of the use of fixed telephone compared to mobile and Internet in facilitating fulfilment of personal utility

	All	Public	Private	Students	Support staff
Ease of use for people who are illiterate or have limited electronic knowledge	78%	75%	88%	95%	40%
Facilitate communication with internet	76%	74%	82%	91%	0%
Ease of use in work	76%	72%	88%	91%	40%
Facilitate work contact with other institutions in Sudan	73%	72%	76%	91%	80%
Facilitate social contact with family	72%	72%	71%	91%	40%
Cheap price and low usage cost	72%	70%	81%	91%	40%
Facilitate work contact with colleagues inside the institution	72%	65%	94%	95%	80%
Preserve/ keep personal privacy	71%	69%	76%	68%	40%
Facilitate work contact with regional institutions	67%	68%	65%	82%	80%
Facilitate social contact with friends	66%	61%	82%	82%	40%
Facilitate work contact with international institutions	60%	62%	53%	75%	40%
Others	67%	100%	50%	33%	0%

The above-reported significant structural change in demand, from preference for fixed telephone to preference for mobile telephone, is probably related to some specific important

<sup>32</sup> As indicated by 78%, 76%, 76%, 73%, 72%, 72%, 72%, 71%, 67%, 66% and 60% of all respondent staff respectively. As indicated by 75%, 74%, 72%, 72%, 72%, 70%, 65%, 69%, 68%, 61% and 62% of public staff respondents respectively. As indicated by 88%, 82%, 88%, 76%, 71%, 81%, 94%, 76%, 65%, 82% and 53% of private staff respectively. As indicated by 95%, 91%, 91%, 91%, 91%, 95%, 68%, 82%, 82% and 75% of respondent students respectively. As indicated by 40%, 0%, 40%, 80%, 40%, 40%, 80%, 40%, 80%, 40% and 40% of respondent support staff respectively.

advantages of using mobile telephone compared to fixed telephone and Internet in facilitating fulfilment of personal utility. For instance, assessment from all the respondents' perspective indicates that the most important advantages of using mobile telephone include: easy to carry and move from place to place; easy for waiting calls and messages from other people; facilitates social contact with family; ease of use in work; facilitates social contact with friends; ease of use of SMS; facilitates direct contact and reach of the requested person; and helps to control spending through prepaid services. In addition, other less important advantages are: facilitates work contact with colleagues inside the institution; ease of transfer of account from place to place; facilitates work contact with other institutions in Sudan; facilitates work contact with regional institutions reduces spending; facilitates communication with Internet; facilitates work contact with international institutions; and provides entertainment and others respectively<sup>33</sup> (see Table 14 below).

Table 14- Assessment of importance of mobile use compared to fixed telephone and Internet in facilitating fulfilment of personal utility

	All	Public	Private	Students	Support staff
Easy to carry and move from place to place	95%	95%	94%	96%	80%
Easy for waiting call and messages from other people	95%	95%	94%	91%	80%
Facilitate social contact with family	95%	95%	94%	87%	80%
Ease of use in work	95%	97%	88%	87%	40%
Facilitate social contact with friends	92%	93%	88%	86%	80%
Ease of use of SMS	92%	93%	88%	100%	80%
Facilitate direct contact and reach of the requested person	91%	91%	88%	100%	40%
Control spending through prepaid services	89%	89%	88%	83%	40%
Facilitate work contact with colleagues inside the institution	84%	92%	59%	83%	80%
Easy for transfer of account from place to place	84%	84%	82%	100%	40%
Facilitate work contact with other institutions in Sudan	81%	84%	69%	78%	80%
Facilitate work contact with regional institutions	76%	78%	71%	78%	80%
Reduce spending	69%	68%	73%	82%	80%
Facilitate communication with internet	66%	68%	60%	68%	67%
Facilitate work contact with international institutions	61%	60%	65%	73%	40%
Provide entertainment	38%	40%	29%	65%	0%
Others	88%	83%	100%	100%	0%

The above-reported significant structural change in demand from preference for fixed telephone to preference for Internet is probably related to some specific important advantages of using the Internet compared to fixed telephone and mobile telephone in facilitating fulfilment of personal utility. For instance, assessment from all the respondents' perspective indicates that the most important opportunities and advantages related to the use of Internet include: offers cheap price and low costs; enhances R&D skill and efforts; enhances long distance learning from international institutions; facilitates training to improve skills for the use of computers and Internet; enhances learning, training, skill and capacity for all of society; enhances learning, training, skill and capacity for women; enhances production, creates investment opportunities; and encourages electronic commerce. In addition the less

<sup>33</sup> As indicated by 95%, 95%, 95%, 95%, 92%, 92%, 91%, 89%, 84%, 84%, 81%, 76%, 69%, 66%, 61%, 38% and 88% of all respondents staff respectively. As indicated by 95%, 95%, 95%, 97%, 93%, 93%, 91%, 89%, 92%, 84%, 84%, 78%, 68%, 68%, 60%, 40% and 83% of respondent public staff respectively. As indicated by 94%, 94%, 94%, 88%, 88%, 88%, 88%, 88%, 59%, 82%, 69%, 71%, 73%, 60%, 65%, 29% and 100% of respondent private staff respectively. As indicated by 96%, 91%, 87%, 87%, 86%, 100%, 100%, 83%, 83%, 100%, 78%, 78%, 82%, 68%, 73%, 65% and 100% of respondent students staff respectively. As indicated by 80%, 80%, 80%, 40%, 80%, 80%, 40%, 40%, 80%, 40%, 80%, 80%, 80%, 67%, 40%, 0% and 0% of respondent support staff respectively.

important advantages include creation of employment opportunities for women, creation of employment opportunities for youth, creation of employment opportunities for the poor and offers welfare and entertainments facilities respectively. While on the other hand the most important challenges related to the use of Internet include: increased competition and competitiveness; increased demand for technical and engineering education related to ICT; exclusion and reduction of unskilled jobs; increased employability of only high skilled labour; and difficult for use by people who are illiterate or have limited electronic knowledge. In addition, the less important challenges include: increased inequality between rich and poor (those who own and those who do not own Internet technology); creates a burden for allocation and distribution of limited government resources between poor regions; increased underdevelopment and digital gap between Sudan and advanced world countries; creates other side effects for health; increased inequality and disparity and imbalanced development between states in Sudan and others respectively<sup>34</sup> (see Table 15 below).

Table 15- Assessment of the importance of the use of Internet compared to fixed telephone and mobile in facilitating fulfilment of personal utility and for creating some opportunities and challenges

	All	Public	Private	Students	Support staff
<b>Opportunities:</b>					
Cheap price and low costs	96%	94%	100%	87%	40%
Enhancing R&D skill and efforts	95%	97%	88%	95%	40%
Enhancing long distance learning, from international institutions	93%	93%	94%	86%	80%
Facilitate training to improve skill for the use of computer and internet	92%	93%	88%	95%	40%
Enhancing learning, training, skill and capacity for all society	92%	91%	94%	83%	80%
Enhancing learning, training, skill and capacity for women	84%	84%	82%	65%	40%
Enhancing production, creating investment opportunities and encourage electronic commerce	79%	79%	82%	95%	40%
Creating employment opportunities for women	77%	79%	69%	87%	0%
Creating employment opportunities for youth	75%	75%	76%	54%	0%
Creating employment opportunities for poor	67%	69%	59%	52%	0%
Offer welfare and entertainments facilities	65%	63%	71%	74%	40%
Others	83%	75%	100%	50%	0%
<b>Challenges:</b>					
Increase competition and competitiveness	89%	90%	86%	89%	40%
Increase demand for technical and engineering education related to ICT	88%	93%	69%	89%	40%
Exclusion and reduction of unskilled labours jobs	77%	80%	67%	70%	40%
Increase employability of only high skilled labour	77%	79%	69%	87%	40%
Difficult for use with people who are illiterate or have limited electronic knowledge	74%	77%	60%	95%	80%
Increase inequality between rich and poor (those who own and those who do not own internet technology)	71%	72%	69%	68%	0%
Create burden for allocation and distribution of limited government resources between poor regions	66%	66%	67%	73%	80%
Increase underdevelopment and digital gap Sudan and advanced world countries	65%	64%	69%	80%	40%
Create other side effects for health	58%	60%	50%	63%	0%
Increase inequality and disparity and imbalanced development between states in Sudan	54%	56%	46%	83%	40%
Others	80%	75%	100%	50%	0%

<sup>34</sup> As indicated by 96%, 95%, 93%, 92%, 92%, 84%, 79%, 77%, 75%, 67%, 65%, 83%, 89%, 88%, 77%, 77%, 74%, 71%, 66%, 65%, 58%, 54% and 80% of all respondent staff respectively. As indicated by 94%, 97%, 93%, 93%, 91%, 84%, 79%, 79%, 75%, 69%, 63%, 75%, 90%, 93%, 80%, 79%, 77%, 72%, 66%, 64%, 60%, 56% and 75% of all respondent public staff respectively. As indicated by 100%, 88%, 94%, 88%, 94%, 82%, 82%, 69%, 76%, 59%, 71%, 100%, 86%, 69%, 67%, 69%, 60%, 69%, 67%, 69%, 50%, 46% and 100% of all respondent private staff respectively. As indicated by 87%, 95%, 86%, 95%, 83%, 65%, 95%, 87%, 54%, 52%, 74%, 50%, 89%, 89%, 70%, 87%, 95%, 68%, 73%, 80%, 63%, 83% and 50% of all respondent students respectively. As indicated by 40%, 40%, 80%, 40%, 80%, 40%, 40%, 0%, 0%, 0%, 40%, 0%, 40%, 40%, 40%, 40%, 80% 0%, 80%, 40%, 0%, 40% and 0% of all respondent support staff respectively.

In addition to the above advantages, assessment indicates the importance of the use of Internet because of its further specific important advantages for fulfilment of personal utility, such as facilitating study, research, network and communication, looking for jobs, participation in seminars, conferences and workshops and social and work contact. For example, from all the respondents' perspective, Internet aids study by facilitating search for books and literature for study purposes, improving understanding and facilitating search for electronic information, improving knowledge, training and learning skills, facilitating search for chances to study abroad and others respectively. In addition Internet aids research by facilitating search for books and literature for research, search for electronic information for research, improving research skills for research, facilitating research collaboration between colleagues for research and facilitating publication of research and others respectively. Furthermore, Internet aids network and communication, in particular, connection inside institutions, with international institutions, with regional institutions and with other institutions in Sudan respectively. Moreover, Internet facilitates looking for jobs by allowing searches for job in international institutions, regional institutions, other institutions in Sudan and inside the relevant Sudanese institution. In addition, Internet aids participation in seminars, conferences and workshops by facilitating participation with international institutions, regional institutions, other institutions in Sudan and inside the relevant Sudanese institution. Finally, Internet aids social and work contact by facilitating social contact with friends, work contact with regional institutions, work contact with international institutions, work contact with other institutions in Sudan, social contact with family and work contact with colleagues inside the institution<sup>35</sup> (see Table 16 below).

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<sup>35</sup> As indicated by 100%, 99%, 97%, 73%, 100%, 99%, 97%, 97%, 96%, 95%, 91%, 73%, 70%, 68%, 59%, 71%, 64%, 60%, 57%, 40%, 73%, 75%, 63%, 57%, 62%, 92%, 83%, 81%, 75%, 75%, 69% and 71% of all respondent staff respectively. As indicated by 100%, 98%, 98%, 75%, 100%, 98%, 97%, 97%, 95%, 93%, 100%, 70%, 74%, 68%, 58%, 80%, 69%, 61%, 56%, 38%, 74%, 77%, 61%, 56%, 67%, 92%, 83%, 82%, 75%, 76%, 68% and 67% of all respondent public staff respectively. As indicated by 100%, 100%, 94%, 65%, 100%, 100%, 100%, 100%, 100%, 100%, 67%, 81%, 59%, 71%, 65%, 50%, 47%, 53%, 60%, 50%, 69%, 69%, 69%, 62%, 0%, 93%, 81%, 73%, 75%, 73%, 75% and 100% of all respondent private staff respectively. As indicated by 100%, 100%, 95%, 67%, 100%, 96%, 95%, 91%, 82%, 100%, 50%, 81%, 80%, 86%, 86%, 100%, 57%, 67%, 50%, 35%, 45%, 50%, 55%, 47%, 50%, 64%, 67%, 67%, 76%, 53%, 65% and 50% of all respondent students respectively. As indicated by 80%, 80%, 80%, 60%, 0%, 60%, 80%, 60%, 60%, 60%, 40%, 80%, 60%, 60%, 60%, 0%, 60%, 60%, 40%, 40%, 60%, 60%, 80%, 60%, 40%, 80%, 80%, 60%, 60%, 40%, 80% and 0% of respondent support staff respectively.

Table 16- Assessment of the importance of the use of Internet for fulfilment of personal utility

	All	Public	Private	Students	Support staff
<b>Study</b>					
Facilitate search for books and literature for study purpose	100%	100%	100%	100%	80%
Improve understanding and facilitate search for electronic information	99%	98%	100%	100%	80%
Improve knowledge, training and learning skills	97%	98%	94%	95%	80%
Facilitate search for chances to study abroad	73%	75%	65%	67%	60%
Others	100%	100%	100%	100%	0%
<b>Research</b>					
Facilitate search for books and literature for doing research	99%	98%	100%	96%	60%
Facilitate search for electronic information for doing research	97%	97%	100%	95%	80%
Improve research skills for doing research	97%	97%	100%	91%	60%
Facilitate research collaboration between colleagues for doing research	96%	95%	100%	82%	60%
Facilitate publication of research	95%	93%	100%	100%	60%
Others	91%	100%	67%	50%	40%
<b>Network and communication</b>					
Inside the institution	73%	70%	81%	81%	80%
with international institutions	70%	74%	59%	80%	60%
with regional institutions	68%	68%	71%	86%	60%
with other institutions in Sudan	59%	58%	65%	86%	60%
Others	71%	80%	50%	100%	0%
<b>Looking for job</b>					
in international institutions	64%	69%	47%	57%	60%
in regional institutions	60%	61%	53%	67%	60%
in other institutions in Sudan	57%	56%	60%	50%	40%
inside the institution	40%	38%	50%	35%	40%
<b>Participation in seminars, conferences and workshops</b>					
in regional institutions	73%	74%	69%	45%	60%
in international institutions	75%	77%	69%	50%	60%
in other institutions in Sudan	63%	61%	69%	55%	80%
inside the institution	57%	56%	62%	47%	60%
Others	62%	67%	0%	50%	40%
<b>Social and work contact</b>					
Facilitate social contact with friends	92%	92%	93%	64%	80%
Facilitate work contact with regional institutions	83%	83%	81%	67%	80%
Facilitate work contact with international institutions	81%	82%	73%	67%	60%
Facilitate work contact with other institutions in Sudan	75%	75%	75%	76%	60%
Facilitate social contact with family	75%	76%	73%	53%	40%
Facilitate work contact with colleagues inside the institution	69%	68%	75%	65%	80%
Others	71%	67%	100%	50%	0%

### 5.3 The income and price effects of the use of ICT from the demand perspective

This section provides an indepth analysis from the demand/consumer perspective of the income and price effects of the use of ICT.

Assessment indicates the importance of the effect of the costs of expenditure on ICT on imposing burdens on personal budgets. For instance, from all the staff's perspective, the effect of cost of expenditure on ICT on imposing burdens on personal budgets is more important for mobile (95%), Internet (76%) and computer (64%) and less important for fixed telephone (33%). From the public staff's perspective, the effect of cost of expenditure on ICT on imposing burdens on personal budgets is more important for mobile telephone (95%), Internet (72%) and computer (62%) and less important for fixed telephone (38%). From the private staff's perspective, the effect of cost of expenditure on ICT on imposing burdens on personal budgets is more important for mobile telephone (94%), Internet (88%) and computer (71%) and less important for fixed telephone (14%). From the students' perspective, the effect of cost of expenditure on ICT on imposing burdens on personal budgets is more important for mobile telephone (100%), Internet (88%), computer (83%) and less important for fixed

telephone (29%) respectively. From the support staff's perspective, the effect of cost of expenditure on ICT on imposing burdens on personal budgets is equally important for mobile telephone (60%), Internet (60%) and computer (60%) and less important for fixed telephone (20%) (see Table 17 below). This finding implies that from all the respondents' perspective (except for support staff) the effect of the cost of expenditure on imposing burdens on personal budgets is most important for mobile telephone, which is higher than Internet and computer but less important for fixed telephone.

Assessment indicates the importance of the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets. For instance, from all the staff's perspective, the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is more important for mobile telephone (85%), moderately important for Internet (64%) and computer (55%) and less important for fixed telephone (28%). From the public staff's perspective, the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is more important for mobile telephone (82%) moderately important for Internet (60%) and computer (51%) and less important for fixed telephone (29%). From the private staff's perspective, the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is more important for mobile telephone (94%), followed by Internet (81%) and computer (69%), and less important for fixed telephone (21%). From the students' perspective, the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is more important for mobile telephone (92%), moderately important for Internet (67%) and computer (58%) and less important for fixed telephone (46%) respectively. From the support staff's perspective, the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is more important for Internet (60%) and equally less important for mobile telephone (20%) and computer (20%) and fixed telephone (20%) (see Table 17 below). This result implies that from all the respondents' perspective (except for support staff) the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets, is most important for mobile telephone, which is higher than the moderate importance for Internet, computer and lesser importance for fixed telephone.

Assessment indicates the importance of the effect of the increase in income and impacts on increasing the use of ICT. For instance, from all the staff's perspective, the effect of the increase in income is more important for increasing the use of mobile telephone (82%), followed by Internet (76%) and computer (66%) and less important for fixed telephone (25%). From the public staff's perspective, the effect of the increase in income is more important for increasing the use of mobile telephone (81%), followed by Internet (74%) and computer (66%) and less important for fixed telephone (31%). From the private staff's

perspective, the effect of the increase in income is more important for increasing the use of mobile telephone (88%), followed by Internet (82%) and computer (65%) and is unimportant for fixed telephone (0%). From the students' perspective, the effect of the increase in income is equally more important for increasing the use of Internet (83%) and mobile telephone (83%) followed by computer (75%) and less important for fixed telephone (29%). From the support staff's perspective, the effect of the increase in income is equally important for increasing the use of mobile telephone (40%), Internet (40%) and computer (40%) but is unimportant for fixed telephone (0%) (see Table 17 below). This finding implies that from all the respondents' perspective, the increase in income has an important effect or impact on increasing the use of ICT; the effect is most important for mobile telephone which is higher than Internet and computer and less important for fixed telephone (except for students, as Internet is equally important as mobile and for private staff and support staff as the effect is unimportant for fixed telephone). This implies that from all the staff's perspective, regarding the importance of the effect of increase in income and impact on increasing the use of ICT, the majority indicate that increase in income increases the demand for the use of the various modes of ICT: fixed telephone, mobile telephone and Internet. This finding supports the conventional theoretical view on income effect or the positive correlation between demand and income and the upward sloping relationship in the demand curve; the income effect for mobile telephone is higher than Internet and fixed telephone.

Assessment indicates the importance of the effect of the increase in price and the impact on increasing the use of ICT. For instance, from all the staff's perspective, the effect of the increase in price of fixed telephone is moderately important for increasing the use of mobile (78%) and increasing the use of Internet (71%), and less important for decreasing the use of fixed telephone (60%) and reducing the use of Internet (53%). The effect of the increasing price of mobile is moderately important for decreasing the use of mobile telephone (80%) followed by increasing the use of Internet (73%) and less important for increasing the use of fixed telephone (46%) respectively. The effect of the increasing price of Internet is moderately important for increasing the use of mobile telephone (68%) and for reducing the use of Internet (60%) and is equally less important for decreasing the use of fixed telephone (41%) and increasing the use of fixed telephone (41%).

From the public staff's perspective, the effect of the increase in price of fixed telephone is moderately important for increasing the use of mobile (73%) and increasing the use of Internet (65%), and less important for decreasing the use of fixed telephone (58%) and reducing the use of Internet (53%). The effect of the increasing price of mobile is moderately important for decreasing the use of mobile telephone (74%) followed by increasing the use of Internet (71%) and less important for increasing the use of fixed telephone (43%). The effect of the increasing price of Internet is moderately important for increasing the use of mobile

telephone (65%) and is less important for reducing the use of Internet (53%), increasing the use of fixed telephone (32%) and decreasing the use of fixed telephone (27%).

From the private staff's perspective, the effect of the increase in price of fixed telephone is more important for increasing the use of mobile (94%) and increasing the use of Internet (88%), moderately important for decreasing the use of fixed telephone (64%) and less important for reducing the use of Internet (50%) respectively. The effect of the increasing price of mobile is more important for decreasing the use of mobile telephone (100%) followed by increasing the use of Internet (81%) and moderately important for increasing the use of fixed telephone (53%). The effect of the increasing price of Internet is more important for reducing the use of Internet (86%), followed by decreasing the use of fixed telephone (85%) and moderately important for increasing the use of mobile telephone (77%) and increasing the use of fixed telephone (69%) respectively.

From the students' perspective, the effect of increase in price of fixed telephone is more important for increasing the use of mobile (95%), moderately important for increasing the use of Internet (70%) and reducing the use of Internet (67%) and less important for decreasing the use of fixed telephone (59%). The effect of increasing price of mobile is more important for increasing the use of Internet (95%), moderately important for increasing the use of fixed telephone (71%) and less important for decreasing the use of mobile telephone (57%). The effect of the increasing price of Internet is more important for reducing the use of Internet (95%), moderately important for increasing the use of mobile telephone (79%) and decreasing the use of fixed telephone (75%) and less important for increasing the use of fixed telephone (61%).

From the support staff's perspective, the effect of increase in price of fixed telephone is more important for increasing the use of mobile (100%), but unimportant for decreasing the use of fixed telephone (0%), increasing the use of Internet (0%) and reducing the use of Internet (0%). The effect of the increasing price of mobile is more important for decreasing the use of mobile telephone (80%) and less important for increasing use of fixed telephone (20%), but is unimportant for increasing the use of Internet (0%). The effect of the increasing price of Internet is less important for reducing the use of mobile telephone (40%), but is unimportant for reducing the use of Internet (0%), decreasing the use of fixed telephone (0%) and increasing the use of fixed telephone (0%).

These results imply that from all the staff's perspective, the importance of the effect of the increase in price and its impact on increasing the use of ICT, indicates that the increase in prices reduces the demand for the use of various modes of ICT: fixed telephone, mobile telephone and Internet. This finding supports the conventional theoretical view on price effect or the negative correlation between demand and price, or the downward sloping demand curve; the price effect for mobile telephone is higher than Internet and fixed telephone. The

results also show an interesting substitution effect between the various modes of ICT, i.e. between fixed telephone, mobile telephone and Internet; in particular, somewhat surprising is the substitution effect between mobile telephone and fixed telephone, which is higher than the substitution effect between mobile telephone and Internet. The relationship between fixed telephone and Internet is less clear, some indicates the substitution effect and others indicate the complementary relationship. But the majority are in favour of the complementary relationship, so this is most probably indicating a complementary relationship between fixed telephone and Internet (see Table 17 below).

Assessment indicates the importance of the effect of reduction of the prices of ICT offered by a competing company in transferring to a competing company with cheap prices and in reducing the use from the current company. For instance, from all the respondents' perspective, the majority indicated the decision to transfer to a competing company with cheap prices is important for all staff, public staff, private staff, students and support staff: 79%, 76%, 88%, 74% and 100% respectively. From all the respondents' perspective, the majority indicated that the decision to reduce the use from the current company is important for all staff, public staff, private staff, students and support staff: 83%, 83%, 81%, 83% and 40% respectively (see Table 17 below).

Table 17- Assessment of the effect of expenditure on ICT on imposing burdens on personal budgets and income and price effects

	All	Public	Private	Students	Support staff
<b>a. Assessment of the importance of the effect of the costs of expenditure on ICT on imposing burden in personal budget</b>					
Fixed telephone	33%	38%	14%	29%	20%
Mobile telephone	95%	95%	94%	100%	60%
Computer	64%	62%	71%	83%	60%
Internet	76%	72%	88%	88%	60%
<b>b. Assessment of the importance of the effect of the costs of expenditure on ICT on competing with the expenditures on other goods and services in personal budget</b>					
Fixed telephone	28%	29%	21%	46%	20%
Mobile telephone	85%	82%	94%	92%	20%
Computer	55%	51%	69%	58%	20%
Internet	64%	60%	81%	67%	60%
<b>c. Assessment of the importance of the effect of the increase in income and impacts on increasing the use of ICT</b>					
effect of increase in income on					
increasing the use of Fixed	25%	31%	0%	29%	0%
increasing the use of Mobile	82%	81%	88%	83%	40%
increasing use of Computer	66%	66%	65%	75%	40%
increasing use of Internet	76%	74%	82%	83%	40%
<b>d. Assessment of the importance of the effect of the increase in the prices and impacts on reducing the use of ICT</b>					
effect of increase in the prices of Fixed telephone					
Reduce the use of Fixed	60%	58%	64%	59%	0%
Increase the use of Mobile	78%	73%	94%	95%	100%
Increase the use of Internet	71%	65%	88%	70%	0%
Reduce the use of Internet	53%	53%	50%	67%	0%
effect of increase in the prices of Mobile telephone					
Reduce the use of Mobile	80%	74%	100%	57%	80%
Increase the use of Fixed telephone	46%	43%	53%	71%	20%
Increase the use of Internet	73%	71%	81%	95%	0%
effect of increase in the prices of Internet					
Reduce the use of Internet	60%	53%	86%	95%	0%
Increase the use of Fixed	41%	32%	69%	61%	0%
Decrease the use of Fixed	41%	27%	85%	75%	0%
Increase the use of Mobile	68%	65%	77%	79%	40%
<b>e. Assessment of the importance of the effect of reduction of the prices of ICT offered by the competing company</b>					
	All	Public	Private	Students	Support staff
Transfer to competing company with cheap price	79%	76%	88%	74%	100%
Reduce the use from the current company	83%	83%	81%	83%	40%
N	79	62	17	24	5

Table 18 shows positive significant correlation and complementary correlation between telecommunication (fixed and mobile) expenditure, information technology (IT/computer) expenditure, training (upskilling) and Internet expenditure for academic staff in the public and private universities in Sudan over the period 2005-08. Table 19 shows positive significant and complementary correlation between mobile and fixed telephone for all staff, public staff and students; the complementary correlation for students is higher than for public staff, but for the private staff the correlation coefficient probably indicates substitution rather than a complementary relationship between mobile and fixed telephone. We find positive and significant complementary correlation between IT/computer expenditure and training; (upskilling) expenditure for students is higher and more significant as compared to academic staff, which may not be surprising in view of the urgency and necessity of training for students who are probably more concerned about using IT/computer expenditure for training, as compared to academic staff who may be somewhat more trained. We find positive significant correlation between fixed telephone and Internet for the support staff and positive significant correlation between mobile and Internet for all academic staff and students; the correlation is more significant for the public compared to private and for students compared to public and private staff respectively. We find that the complementary relation between Internet and computer for public staff is higher than students, but between Internet and mobile for student is higher than academic staff. We find that the positive correlation between Internet expenditure and training expenditure is positive and significant and higher for the public staff as compared to private staff and students respectively. Table 20 shows positive significant correlation between the duration of the use of telecommunication (fixed and mobile) expenditure, information technology (IT/computer) expenditure, training (upskilling) and Internet expenditure, income (wage), education and age. Total expenditure over the period 2005-08 is positively correlated with income (wage) and education and is also positively and significantly correlated with age and experience. The use of fixed telephone and Internet are also positively correlated with expenditure; the use of telecommunication (fixed and mobile), information technology (IT/computer), training (upskilling) and Internet are also positively correlated with wage (income) and the expenditure is positively and significantly correlated with wage. Table 21 shows that the correlation between the use of fixed telephone and expenditure is positive and significant and higher for the public staff higher than for the students. The correlation between duration of the use of mobile and education is positive and significant for all staff and higher than for the support staff and students. The correlation between the use of mobile and expenditure on mobile is positive and significant for the support staff and higher than the students and public staff. The correlation between expenditure on mobile and education is positive and significant for students and higher than the academic staff and support staff. The correlation between expenditure and use

of computer is positive and insignificant for all staff. The duration of the use of computer is positive and significant for public staff and higher than for private staff, support staff and students. The correlation between the use of Internet and expenditure on Internet for public staff is lower than the students and both are lower than the support staff. The correlation between education and duration of the use of Internet is positive and significant and higher for the public staff than for private staff, and both are higher than students.

Therefore, apart from the above observed structural change in the demand for ICT, our findings in this chapter verify the third hypothesis in Chapter 1 above that the demand for the four ICT modes amongst public and private university staff in Sudan is determined by income, education attainment level, age, and gender. Our results prove the fourth hypothesis in Chapter 1 above that the demand for or the use of Internet shows positive significant correlations with the use of telephone, the use of/spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training amongst public and private university staff in Sudanese universities. Our results are consistent with the findings in theoretical and empirical endogenous growth literature on the correlation between ICT components and human capital.

Table 18 - Correlation between computers, training, Internet and telecommunications expenditures for academic staff 2005-08

Independent variables	Coefficient(t-value)					Constant	R <sup>2</sup>	N
	Telecommunication expenditure (fixed)	Telecommunication expenditure (mobile)	Computer expenditure	Training expenditure	Internet expenditure			
Dependent variable (ICT expenditures)								
Telecommunication expenditure (fixed)		0.872** <sup>1</sup> (10.702)				0.884 (0.761)	0.804	30
			0.322** (3.211)			6.119 (9.258)	0.158	57
					0.829** <sup>1</sup> (7.842)	2.016 (1.390)	0.703	28
Telecommunication expenditure (mobile)	0.922** <sup>1</sup> (10.702)					1.938 (1.686)	0.804	30
			0.177** (2.914)			10.991 (13.790)	0.081	98
					0.627** <sup>1</sup> (8.248)	5.784 (5.656)	0.558	56
Computer expenditure	0.491** (3.211)					6.738 (3.524)	0.158	57
		0.458** (2.914)				6.920 (3.302)	0.081	98
				0.0529 (0.278)		11.909 (4.829)	0.003	26
					0.736** (5.836)	3.639 (2.277)	0.282	89
Training expenditure				0.315 <sup>1</sup> (1.114)		8.235 (2.024)	0.072	18
			0.061 (0.278)			12.143 (4.398)	0.003	26
Internet expenditure	0.848** <sup>1</sup> (7.842)					2.290 (1.576)	0.703	28
		0.889** <sup>1</sup> (8.248)				0.642 (0.418)	0.558	56
			0.382** (5.836)			7.655 (8.952)	0.282	89

Correlation is significant \* at the 0.05 level (one-tailed) \*\* at the 0.01 level (one-tailed)

Note: (1) log regression for all variables for the period (2005-2008).

Table 19- Correlation between computers, training, Internet and telecommunications expenditures for all sample (defined by occupation and sector) 2005-08

Independent variables	Coefficient(t-value)					Constant	R <sup>2</sup>	N		
	Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure					
Dependent variable (ICT expenditures)										
Telecommunication expenditure (fixed)	All sample		0.410** (4.557)			8.192 (7.210)	0.163	108		
	All staff		0.872** <sup>1</sup> (10.702)			0.884 (0.761)	0.804	30		
	Public staff		0.156* (1.204)			10.364 (6.054)	0.026	56		
	Private staff		-0.725* (-1.470)			23.020 (3.405)	0.119	17		
	Student		0.572** (6.012)			4.885 (3.785)	0.538	32		
	Support staff					0.604** (8.102)	4.002 (4.542)	0.985	2	
	All sample	0.410** (4.557)					8.192 (7.210)	0.163	108	
Telecommunication expenditure (mobile)	All staff	0.922** <sup>1</sup> (10.702)				1.938 (1.686)	0.804	30		
	Public staff	0.165* (1.204)				11.138 (6.545)	0.026	56		
	Private staff	-0.164* (-1.470)				15.854 (10.780)	0.119	17		
	Students	0.941** (6.012)				1.622 (0.819)	0.538	32		
	All staff					0.349** (5.929)	8.955 (11.827)	0.212	102	
	Public staff					0.336** (4.954)	9.053 (10.588)	0.197	101	
	Private staff					0.039 (0.225)	13.393 (5.612)	0.002	30	
Computer expenditure	Students					0.595** (5.331)	6.137 (4.441)	0.448	36	
	All sample			1.052** (6.700)		0.298 (0.148)	0.803	12		
	Public staff					0.273** (3.166)	9.104 (8.045)	0.104	87	
	Students					0.282** (3.271)	8.801 (7.791)	0.129	73	
	All sample				0.964** (3.289)		0.383** (3.258)	7.814 (5.279)	0.307	25
	All staff						611717.2 (1.922)	0.217	40	
	Students						0.360** (4.775)	326423.0 (3.331)	0.352	43
Training expenditure	All staff					0.622** (3.396)	4.837 (2.065)	0.292	29	
	Public staff					0.479** (2.436)	6.568 (2.645)	0.229	21	
	Private staff					1.027** (2.054)	-0.278 (-0.042)	0.413	7	
	Students					0.618* (1.807)	4.515 (1.030)	0.229	12	
	All staff					1.029** (3.003)	217732.1 (0.784)	0.244	29	
	Students					0.936** (10.300)	-42969.6 (3.331)	0.906	12	
	Students			0.306** (8.449)			42175.7 (0.327)	0.866	12	
Internet expenditure	All sample			0.053 (0.278)			11.909 (4.829)	0.003	25	
	Public staff			0.025** (3.629)			12.271 (4.633)	0.001	19	
	Private staff			0.315 (0.457)			8.402 (0.919)	0.050	6	
	Students			0.764** (6.700)			2.273 (1.449)	0.803	12	
	Support staff	1.630** (8.102)					-6.346 (-2.832)	0.985	2	
	All staff		0.607** (5.929)				4.671 (3.393)	0.212	102	
	Public staff		0.587** (4.954)				4.772 (3.026)	0.197	101	
Private staff		0.044** (0.225)				13.003 (4.738)	0.002	30		
Students		0.753** (5.331)				2.180 (1.143)	0.448	36		
All sample			0.383** (3.166)			8.205 (5.334)	0.104	87		
Public staff			0.458** (3.271)			7.281 (4.150)	0.129	73		
Students			0.801** (3.258)			2.393 (0.770)	0.307	25		
All sample				0.976** (4.775)		151466.7 (0.842)	0.352	43		
All staff				0.469** (3.396)		6.755 (3.815)	0.292	30		
Public staff				0.478** (2.436)		6.569 (2.648)	0.229	21		
Private staff				0.402** (2.054)		7.830 (3.006)	0.413	7		
Students				0.371* (1.807)		8.191 (3.200)	0.229	12		

Correlation is significant \* at the 0.05 level (one-tailed) \*\* at the 0.01 level (one-tailed)

Table 20 - Correlation between the duration, cost, expenditures, the use of ICT and income (wage), education, age and experience for academic staff 2005-08

Independent variables		Coefficient(t-value)				Costs	Constant	R <sup>2</sup>	N
		Wage	Education	Age	Experience				
Dependent variable (ICT expenditures)									
Telecommunication expenditure (fixed)	Cost	0.143 (0.861)					9.211 (7.835)	0.029	27
	Length	0.097* (1.636)					1.814 (4.124)	0.047	56
	Length		1.525** (3.024)				-2.253 (-1.477)	0.122	68
	Length			0.281** (3.205)			3.990 (1.157)	0.160	56
	Expenditure	405.7693* (1.435)					635518.0 (0.980)	0.066	31
	Use	0.065 (0.450)					2.100 (1.911)	0.007	31
	Use					352.14 (1.140)	30261.044 (3.067)	0.053	24
Telecommunication expenditure (mobile)	Cost	13886.42* (1.703)					1746.366 (0.029)	0.043	66
	Cost		102881.5* (1.217)				-208090.5 (-0.814)	0.023	66
	Length	0.081* (1.889)					1.319 (4.150)	0.053	66
	Length		0.875** (2.084)				-0.731 (-0.576)	0.064	66
	Length			0.076** (2.712)			4.414 (3.896)	0.103	66
	Expenditure	23005.58 (0.202)					979533.7 (1.160)	0.001	69
	Use	0.078 (0.607)					2.693 (2.803)	0.006	59
Computer expenditure	Cost	39032.08* (1.837)					-222948.3 (-1.436)	0.166	19
	Cost		40587.4 (0.258)				-62009.31 (-0.130)	0.004	19
	Length	0.095* (1.724)					1.667 (4.104)	0.043	68
	Length		1.525** (3.024)				-2.253 (-1.477)	0.122	68
	Length			0.196** (3.038)			4.613 (1.765)	0.123	68
	Expenditure	0.114 (0.526)					12.748 (7.758)	0.009	33
	Expenditure		1082505 (0.275)				-11313635 (-0.135)	0.002	34
	Use	0.084 (0.865)					3.616 (4.999)	0.012	62
	Use			0.715 (0.717)			2.058 (0.678)	0.008	62
	Use						8.654 (6.538)	0.057	57
Internet expenditure	Cost	0.334* (1.824)					319.1945 (0.003)	0.013	57
	Cost		4519.396 (0.859)				1.166 (3.472)	0.110	68
	Length	0.130** (2.857)					-1.035 (-0.771)	0.077	68
	Length		1.041** (2.348)				5.009 (3.278)	0.108	68
	Length			0.107** (2.821)			560092.4 (0.797)	0.001	56
	Expenditure	23153.41 (0.239)					180282.4 (0.260)	0.012	56
	Expenditure		26177.34 (0.795)				3.572052 (5.415)	0.008	66
	Use	0.066 (0.739)					1.948 (0.717)	0.009	66
	Use		0.694 (0.776)				122.76 (0.766)	0.011	53
	Use						84915.105 (4.453)	0.011	53
Total expenditure	Expenditure	1094502 (0.259)					-461360.3 (-0.015)	0.001	70
	Expenditure		903010.2 (0.443)				-11301183 (-0.264)	0.003	70
	Expenditure			803488.6* (1.932)			-24009637 (-1.409)	0.052	70
	Expenditure				949790.5* (1.984)		-6456029 (-0.753)	0.055	70

Correlation is significant \* at the 0.05 level (one-tailed) \*\* at the 0.01 level (one-tailed)

Table 21 - Correlation between the duration, cost, expenditure, the use of ICT and education and age for all sample (defined by occupation and sector) 2005-08

Independent variables		Coefficient(t-value)			Constant	R <sup>2</sup>	N	
		Education	Age	Costs				
Dependent variable (ICT expenditures)								
Telecommunication expenditure (fixed)	All sample	Length	1.185** (3.829)			-10.307 (-1.653)	0.173	71
	All sample	Length		0.319** (4.308)		2.108 (0.763)	0.212	70
	All sample	Use			435.704* (1.652)	29310.1 (3.853)	0.074	35
	All staff	Use			352.140 (1.140)	30261.044 (3.067)	0.053	24
	Public staff	Use			693.019* (1.672)	24215.14 (2.190)	0.141	18
	Students	Use			5121.308** (4.257)	-1228.024 (-0.104)	0.721	8
Telecommunication expenditure (mobile)	All sample	Length	0.360** (3.125)			-0.106 (-0.046)	0.101	88
	All sample	Length		0.115** (4.688)		2.911 (3.106)	0.205	86
	All sample	Length	0.993** (2.961)			-1.097 (-1.096)	0.092	88
	All staff	Length	0.875** (2.084)			-0.731 (-0.576)	0.064	66
	Support staff	Length	5.300* (1.794)			-13.019 (-1.563)	0.517	4
	Student	Length	0.748** (0.704)			-0.486 (-0.158)	0.030	17
	All sample	Use			467.138* (2.924)	82443.0 (4.921)	0.105	74
	Public staff	Use			15.187 (0.117)	86653.08 (6.329)	0.000	45
	Support staff	Use			3495.644** (6.493)	27334.890 (2.803)	0.955	3
	Students	Use			1232.236** (2.758)	66133.19 (0.995)	0.409	12
	All staff	Expenditure	0.087 (0.869)			12.924 (17.408)	0.011	66
	Support staff	Expenditure	0.156 (0.308)			11.991 (3.446)	0.045	3
	Students	Expenditure	0.669* (1.421)			9.436 (3.126)	0.155	12
	Computer expenditure	All sample	Use			29.547 (0.243)	49898.132 (2.671)	0.002
All staff		Use			51.723 (0.289)	54922.621 (2.048)	0.005	18
Public staff		Use			72.620 (0.375)	48374.817 (1.733)	0.010	15
All sample		Length		0.259** (4.864)		1.828 (0.884)	0.220	85
All sample		Length	1.648** (3.971)			-2.649 (-2.132)	0.155	87
All staff		Length	1.525** (3.024)			-2.253 (-1.477)	0.122	67
Public staff		Length	1.592** (2.706)			-2.449 (-1.374)	0.126	52
Private staff		Length	1.076 (1.167)			-0.934 (-0.335)	0.095	14
Support staff		Length	4.354* (1.348)			-9.918 (-2.132)	0.377	4
Students		Length	1.538 (1.062)			-2.551 (-0.608)	0.080	14
Internet expenditure	All staff	Use			122.762 (0.766)	84915.105 (4.453)	0.011	53
	Public staff	Use			330.321** (3.281)	51367.777 (4.940)	0.216	40
	Support staff	Use			1733.273** (9.353)	2136.829 (0.166)	0.989	2
	Students	Use			646.490** (8.219)	15240.859 (1.942)	0.860	12
	All sample	Length		0.159** (4.776)		2.594 (2.007)	0.212	86
	All sample	Length	1.486** (3.704)			-2.440 (-2.032)	0.136	88
	Academic staff	Length	1.041** (2.348)			-1.035 (-0.771)	0.077	67
	Public staff	Length	1.262** (2.581)			-1.709 (-1.154)	0.116	52
	Support staff	Length	4.666** (2.193)			-11.053 (-1.842)	0.616	4
	Students	Length	1.499 (0.819)			-2.831 (-0.535)	0.046	15

Correlation is significant \* at the 0.05 level (one-tailed) \*\* at the 0.01 level (one-tailed)

## 5.4 Conclusions

This chapter focuses, discusses and provides the empirical analysis and examines from public-private perspective the research hypotheses on the public-private differential in the demand for ICT, trend and determinants in Sudanese universities. Section 1 defines the main characteristics of the respondents including academic teaching staff, support staff and students in the respondent universities. Section 2 presents from the demand perspective an indepth analysis of the use of ICT, pattern, trend, nature, extent, structural change and comparative advantages of the demand for the use of the different modes of ICT in public and private Sudanese universities. Section 3 explains and examines the income and price effects of the use of ICT in public and private Sudanese universities.

Our findings prove the first hypothesis in Chapter 1 above on the presence of significant public-private differential between public and private universities in Sudan, not only in the general characteristics but also in the demand for and impacts of ICT. For instance, our results show that the reported rapid incidence of the observed structural change in the demand for ICT, knowledge about computer and Internet, the importance, structure, trend, and income and prices effects of the demand for the four ICT modes, fixed telephone, mobile telephones, computer and Internet, seems to be more significant for the private university staff compared to public university staff. This can be interpreted in relation to the observed differences in the general characteristics, which imply that monthly income and skill level are relatively higher for private university staff compared to public university staff.

Our findings prove our second hypothesis in Chapter 1 above which implies that demand for the four ICT modes is characterised by considerable dynamism: it shows a dynamic increasing trend and significant structural change over time amongst public and private university staff in Sudan. For instance, we confirm the incidence of structural change in the demand for ICT by scrutinising the historical use of the four ICT modes, which implies that fixed telephone was used earlier as an old or more traditional and long-standing ICT mode, but then there is a gradual and visible shift towards using other new, more recent ICT modes such as computer, mobile and Internet respectively amongst academic teaching staff, support staff and students.

Our results present interesting evidence in support of the hypothesis on the incidence of structural change in the demand for the four ICT modes from the demand perspective. For instance, we find that important evidence on the incidence of structural change in the demand for ICT can be elaborated from our result, which indicates that for the majority of all respondents the personal use of mobile telephone, Internet and computers show an increasing trend, while the personal use of fixed telephone shows an opposite decreasing trend. For the majority the personal use of mobile telephone is growing faster than Internet, computers and fixed telephone respectively. This result seems consistent with the reported increasing trend

of the use of mobile and Internet at the aggregate macro level in Sudan and also consistent with the observed increasing trend at the regional and international levels.

The interpretation of the above-mentioned evidence on the incidence of structural change in the trend of the demand for the four ICT modes provides further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT, which can be elaborated from the demand perspective along with the respondents' assessment views on the importance of ICT for satisfaction of personal need and utility that highlight the three ICT modes, mobile telephone, Internet and computers, as highly important and value fixed and telephone as moderately important. Our findings on the trend and assessment of the importance of ICT indicate different preferences for the different ICT modes that can be explained in relation to preference of specific characteristics, such as fashion, style and good design, ease of use, cheap price and efficiency and high quality. Our findings indicate that somewhat surprisingly, despite the high poverty rate and low per capita income, the reported concern about cheap prices comes next to the reported concern about efficiency and high quality. We find that for the majority of the respondents the preference of the use of different modes of ICT is most probably related to preference of specific characteristics such as efficiency and high quality. This implies that the respondents are much more concerned with efficiency and high quality, which can be interpreted probably because of high skill level and therefore increasing awareness amongst the respondents in public and private Sudanese universities. We find that from all the respondents' perspectives the most important advantages of using fixed telephone include ease of use for people who are illiterate or have limited electronic knowledge, facilitated communication with Internet and ease of use in work. The most important advantages of using mobile telephone includes ease of carrying and moving from place to place, ease of waiting calls and messages from other people, facilitated social contact with family, ease of use in work, facilitated social contact with friends, ease of use of SMS and facilitated direct contact and reach of the requested person. The most important advantages related to the use of Internet include facilitating training to improve skill for the use of computer and Internet, enhancing learning, training, skill and capacity for all society, long distance learning from international institutions, R&D skill and efforts and offering cheap prices. In addition Internet provides additional advantages such as facilitating study, research, networks and communication, looking for jobs, participation in seminars, conferences and workshops and social and work contact. Our findings imply that because of these multiple advantages for satisfying the needs and utility in an academic setting in Sudanese universities, Internet is followed by mobile as the most important ICT mode, which are both popular and very widely used amongst academic staff. For the majority of the respondents, mobile is preferred because of the characteristics of fashion, style and good design and ease of use, while Internet is preferred because of the characteristics of cheap

prices, efficiency and high quality. These multiple advantages of mobile and Internet gives further justification for the incidence of the structural change in the demand for ICT in Sudanese universities.

Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our finding that the effect of cost of expenditure on imposing burdens on personal budgets is most important for mobile telephone which is higher than Internet, computer, but less important for fixed telephone. Additional evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our result that the effect of cost of expenditure on ICT on competing with expenditure on other goods and services on personal budgets is most important for mobile telephone, which is higher than the moderate important effect for Internet, computer and less important effect for fixed telephone.

Another evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings, which implies that the effect of the increase in income on increasing the use of ICT is most important for mobile telephone, which is higher than Internet and computer and less important for fixed telephone. Somewhat surprisingly, even for both private staff and support staff the increase in income has an unimportant effect on the demand for fixed telephone; this implies that fixed telephone tends to show an inelastic demand with respect to increase in income for both private staff and support staff. Our findings imply that from all the staff's perspective, for the majority the increase in income has an important effect for increasing the demand for the use of various ICT modes: fixed telephone, mobile telephone and Internet. This finding is consistent with the conventional stylised fact in the theoretical literature on the positive income effect or the positive relationship between income and demand, i.e. the increase in income has important positive impacts on increasing the use of ICT.

Additional evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our results, which indicate that the effect of the increase in prices in reducing the demand for the use of ICT is most important for mobile telephone, which is higher than Internet and fixed telephone. Our results indicate that from all the staff's perspective, for the majority the effect of the increase in prices has important impacts on reducing the demand for the use of various modes of ICT: fixed telephone, mobile telephone and Internet. This result is consistent with the conventional stylised fact in the theoretical literature on the downward sloping demand curve or the negative price effect, or the negative relationship between price and demand. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings, which indicate an interesting cross price or substitution effect between the various modes of ICT, i.e. between fixed telephone, mobile telephone and Internet; in

particular, somewhat surprising is that the substitution effect between mobile telephone and fixed telephone is higher than the substitution effect between mobile telephone and the Internet. The relationship between fixed telephone and Internet is somewhat confusing, but for the majority the relationship is in favour or support of the complementary relationship, so this is most probably indicating a complementary relationship between fixed telephone and Internet. Our findings indicate that the interesting substitution effect seems to be observed not only between the demand for the various ICT modes, but also observed between the supplier companies offering ICT services. For instance, our results indicate that the reduction of the prices of ICT offered by competing companies has an important effect in motivating transferring the demand for ICT services offered by competing companies with cheap price and in reducing the demand for ICT services offered by the current company with high prices. This result is consistent with the conventional stylised facts in the theoretical literature concerning the cross price, substitution-complementary effects and rationality of consumers.

Apart from the above-observed structural change in the demand for ICT, our findings verify the third hypothesis in Chapter 1 above that the demand for the four ICT modes amongst public and private university staff in Sudan is determined by income, education attainment level, age, and gender. Our results prove the fourth hypothesis in Chapter 1 above that the demand for or the use of Internet shows positive significant correlations with the use of telephone and the use of/spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training amongst public and private university staff in Sudanese universities. Our results are consistent with the findings in theoretical and empirical endogenous growth literature on the correlation between ICT components and human capital.

## Chapter 6: The Supply Side of ICT

### Introduction

The data from the university survey presented in Chapter 4 above provides us with the required information that is particularly useful for presenting interesting public-private comparative analysis to examine the supply side of ICT in Sudanese universities from public-private perspectives. This chapter discusses the main results from all the universities' academic teaching staff, support staff and students' perspectives. It provides the empirical analysis and examines from public-private perspective, the research hypotheses on the public-private differential in the supply side of ICT in Sudanese universities as a case of African universities.

Before we go into the empirical analysis, it is appropriate to define the main characteristics of the supply side of ICT at the macro and micro levels in Sudan and to show an indepth analysis from the demand and consumer perspective of the supply side of ICT, methods and places of connection to ICT in Section 1. Next, we explain the difficulties on the supply and demand sides in Section 2. We explain the suggestions for relevant solutions on the supply and demand sides in Section 3 and Section 4 provides the conclusions.

### 6.1 Characteristics of the supply side of ICT at macro-micro levels in Sudan

This section is explains the the main characteristics of the supply side of ICT at the macro and micro levels in Sudan. We begin by the characteristics at the macro and then micro levels.

#### *6.1.1 Characteristics of the supply side of ICT at the macro level in Sudan*

This section is based on the paper presented for the National Telecom Corporation (2007) NTC Workshop on Internet Issues 19 July, 2007.

In Sudan, ICT services are mainly supported and provided through the three channels of National Telecommunication Corporation (NTC), Network Operators and Internet Service Providers (ISP). The National Telecommunication Corporation (NTC) is the regulatory authority of Information and Communication Technology in Sudan; it assumes the responsibility of promoting Internet services and regulates the relationships between the operators, service providers and stakeholders. The ISP together with the network operators are the essential providers of the infrastructure upon which the service provision is effected; they assume the genuine role of sector promotion and provision of connectivity to global backbone.<sup>36, 37</sup> In particular, the NTC attempts to enhance the promotion of ICT supply and to

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<sup>36</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

<sup>37</sup> In addition to the NTC, the operators companies and the ISP, other main partners of Internet governance in Sudan are the National Information Center, the Sudanese Internet Society, the Internet clubs, the educational institutions, the public, the Intellectual Property Authority and civil society organisations. See Abu-Al-Fedl Mokhtar (2007) 'Internet Management in Sudan', Ministry of the Cabinet Affairs, National Information Center, NTC Workshop on Internet Issues, 19 July 2007.

support IT as can be seen from its policies including: offering a computer for each family; distributing 50,000 computers as a first stage; supporting E-government projects; focusing on ICT in universities and schools (providing 1,480 computers for universities and 750 computers for Sudanese States. In addition it: provides 7 student housing complexes with 232 computers; is launching Universal Service centres at a rate of 5 centres for each state beside special centres for women and religious schools (khalwas), totalling 100 centres with devices distributed to 47; set up 500 labs in secondary schools, with 300 devices ready to be distributed; increased the capacity of the Council of Ministers' network to 4 mb/s and work is progressing to upgrade universities' networks from 512 kb/s to 1 mb/s (6 universities are ready).<sup>38</sup> According to Zain (2007), there is no doubt that the considerable economic growth and political stability in the country is the result of the peace process and that global development in the field of telecommunications had a positive impact on Sudan. The Sudanese state created the National Center for Information, the E-government project and customs duty exemption for computers and related material in order to comply with the international attention manifest in the United Nations and other international organisations focused on bridging the digital divide and spreading the culture of informatics.<sup>39</sup>

The Sudanese Telecommunication Company Limited (Sudatel) is a public shareholding company and one of the major telecommunications companies in Africa and the Arab world. Sudatel, a network operator and service provider, is offering and developing telecommunication services and information transfer in Sudan. The company was founded in 1993, following the state's decision to privatise the telecommunications sector in Sudan. Sudatel's developed infrastructure in different fields of communications technology is currently considered the backbone of other communications companies. Sudatel's objectives include: spreading information and communication services to all parts of Sudan with the latest technologies and cost-based prices; supporting Sudan's development programme requirements; utilising advanced techniques to increase coverage, upgrade networks operational efficiency and building capable human resources capacities and uphold the company's continual success; fulfil shareholders' objectives and sustain the company's ability to compete globally and to become a regional carrier for Africa and the Arab world. Sudatel offers different types of Internet service including via the fixed network, via the wireless network, Internet Data network, E1 Access, leased lines and Internet broadband services. The technologies used to provide Internet services enable the subscriber to choose any of the following technologies according to the required speed and future need: Frame Relay with speeds from 64 kb/s to 2 Mb/s all over the country; DVB Connection Down link only with speed up to 45 Mb/s, accessed via satellite receiver (this service is presently not available);

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<sup>38</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

<sup>39</sup> See Zain (2007) 'Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR', NTC Workshop on Internet Issues, 19 July 2007.

and ADSL with speeds from 64 kb/s to 1.5 Mb/s. The main characteristics of the Internet service are linking individuals and corporate entities to information centres and performing e-commerce applications through virtual networks (VPN), providing databases of all fields and linking individuals in-home and abroad. The basic infrastructure for information interchange includes major world entertainment sources such as data cloud services that connects local computer networks (LANs) inside Sudan (networks of ministries, government entities, banks, private enterprises, educational institutions and individuals) in order to attain a Wide Area Network (WAN). The service includes nearly all customers with different operating systems. Frame Relay is characterised by low operation costs, compatibility with existing systems, bandwidth efficiency, very high connection speeds, upgradeability and compatibility with newer systems and the up-to-date techniques used in WAN implementation. E1 Access service connects customer location to Sudatel switch with high speed (up to 2 Mb/s); it is characterised by high speed, prompt and guaranteed connectivity, high efficiency and security and connection through the PBX or POTS connectivity (up to 30 lines). Leased Lines is a dedicated connection between two separated points with high speed ranging between 64 kb/s and 2 Mb/s; customer premises' equipment is normally a router that directs traffic to and from the network and it is normally programmed by the company's engineers to be able to interconnect with the other destinations. Asymmetrical Digital Subscriber Line (ADSL) is a broadband access service that reaches about 60-fold the dial-up modem speed; it is a safe service and compatible with data, voice and video traffic. Symmetric High-bit-rate Digital Subscriber Line (SHDSL) provides customers with a permanent Internet service to access information sources via global IP addresses; all broadband customers are connected with speeds from 64 kb/s to 2 Mb/s and supplied with constant access to premium sites including ISP's; the main service characteristics are always-on Internet service plus constant access to premium sites, low initial cost, high connection speed and dedicated bandwidth. Sudani Wireless Internet service via CDMA1x-EVDO and Sudani MDSL technology is an Internet service via fixed wireless terminal FWT technology. Sudani CDMA 1X service is a new NGN application that enables the customer to access Intra and Internet with high speed and free browsing, utilising all Internet applications via EVDO; it is high speed, easy to use and has controllable cost-mode of use trade off. Sudani MDSL service is a new Next Generation Networks (NGN) application that enables the customer to access Internet with high speed, up to 2.4 Mb/s; it is available all over the country with unlimited usage 24 hours a day, unlimited downloads and full geographical coverage. Sudani FWT service is a NGN CDMA network that enables provision of fixed wireless terminal FWT service to handle telephone calls and SMS; FWT allows Internet access via a special connecting cord to the computer.<sup>40</sup> In 2004,

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<sup>40</sup> See Almuneer Taha Elkabashi (2007) 'Introduction and Enhancement of Internet Services in Sudan The Role of Sudatel', NTC Workshop on Internet Issues, 19 July 2007.

Sudatel introduced broadband service via DSL technology over telephone lines. According to the UNDP/NIC e-readiness report in 2005, the Internet broadband users in Sudan were 2,500, which is considered a meagre proportion. Broadband Internet service is normally provided via landlines due to its expandability, reliability and high quality. Nevertheless, telecommunication service in Sudan started lately to forgo landlines and introduce wireless networks.<sup>41</sup>

In addition to Sudatel, during 1997 the Sudanese Company for Internet service (SUDNET) began its work as the first ISP in Sudan via telephone system (Dial-Up Access, 128 kb/s full duplex).<sup>42</sup> As a result of the rising number of subscribers to the service, who numbered 2,283 subscribers in 2000, the company gradually increased the capacities of the Internet available for use. Then the Integrated Services Digital Network (ISDN) for subscriber access was introduced in 2001 to enhance the efficiency of Copper network and thus the common use and speed up of the telephone lines such as telephone (voice + fax + data). In line with the advancing development in communications and information technology, broadband technology was utilised to optimise the use of networks and the frequency spectrum. EVDO and DSL service were then introduced. Then the infrastructure of communications was developed in Sudan to include the Fiber Optic National Backbone Network that covers most of the country's area. In addition to digital exchange networks, there are subscriber access networks via copper cables, wireless and fibre-optic with multi-techniques. Sudan is linked to two global optical cable networks through the international gateways fibre-optic land system to Egypt and via a submarine fibre-optic gateway to Saudi Arabia (SAS) and hence to the international networks via the Red Sea through the Port Sudan - Jeddah (SAS) system; the submarine fibre-optic gateway from Port Sudan then links to the international FLAG cable system. Sudan is also linked to Intelsat satellite via Um Haraz for international communications. As a result of building this infrastructure, the Internet service speed for users in Sudan has developed and is now available via the following technologies: dial-up; frame relay; EVDO; DSL; and Wi-Max (World Interoperability for Microwave Access). After liberation of international gateways there is now more than one source of Internet (Sudatel and Canar) via submarine cables to feed ISP.

The increase in the demand for ICT motivated the recent movement towards privatisation and competition since 2000.<sup>43</sup> For instance, 2005 was marked by the entry of new companies into the telecommunications market in Sudan, such as Areeba and Canar, in addition to the existing companies Mobitel and Sudatel. Sudatel is considered the pioneer in

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<sup>41</sup> See Mohammed Al Bashier Ahmed (2007) 'Development of Internet services in Sudan Challenges and Prospects', Sudanese Internet Society, NTC Workshop on Internet Issues, 19 July 2007.

<sup>42</sup> All ISP in Sudan provide the dial-up service which started in 1997 by Sudanet. The service started in Khartoum then extended piecemeal to other cities. See Mohammed Al Bashier Ahmed (2007) 'Development of Internet services in Sudan Challenges and Prospects', Sudanese Internet Society, NTC Workshop on Internet Issues, 19 July 2007.

<sup>43</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

the modernisation and development of telecommunications in Sudan and deserved approbation of the Council of Ministers and commendation for the results achieved. The cooperation between other ISP with Sudatel has contributed effectively in spreading the technical and scientific awareness and culture of information. Large sums of money had been invested at the beginning, where big investment and strenuous efforts were secured to perform their mission in good faith. That investment was not just for easy return but to educate the citizens and develop the country to gain national advantage and avail opportunities for Sudanese graduates. One of the operating companies in the field is Zinanet, established in October 2000. Zinanet's vision is to introduce new standards of excellence in the computer and data communication domain. Zain (2007) started with the objective of providing developed Internet services and integrated solutions for the corporate market. During the past years the company proved high levels of confidence and dependability. The current services provided by Zinanet beside the Internet include: registration and hosting of websites; website design; short messages service; interactive voice service; network solutions; and security and software solutions.<sup>44</sup>

Since 2000, the NTC encouraged competition in the domain of Internet services by preparing a guidebook for license applications and offering licenses to the public, for instance, in 2007, the number of licensed parties reached 22 ISP, including 18 dial-up and 4 wireless. Monitoring Internet services usage shows that the overall monthly traffic ranges from 30 million minutes to 35 million minutes per month divided among dial-up service providers according to market share of each in the competitive market. To provide Internet service to the subscribers at affordable prices with freedom of choice of ISP, the NTC has reduced the tariff of ISP to 3 Dinars per minute - lower than telephone calls. The NTC secured DSL connectivity to the ISP's through Sudatel network via leased lines.<sup>45</sup>

As a result of the development of the telecommunications market in Sudan and the multi-operator environment, plus the introduction of the mobile telephone service, the number of subscribers in the fixed telephone service has dropped and consequently so has the usage of the system. That reduced further Internet access via the dial-up through ISP. In addition, the advanced technology of wireless Internet such as GPRS and CDMA, in addition to high speed land line technologies ADSL and HDSL, provided multiple options for customers. That led to the reduction of dial-up service uptake due to its inherent demerit. Moreover, the technical problems of underground copper networks, problems such as underground and overhead faults, cable cuts and the weather-induced problems due to storms, heavy rains and very high temperatures, are some of the main reasons that led to the reduction of dial-up usage and the

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<sup>44</sup> See Zain (2007) 'Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR', NTC Workshop on Internet Issues, 19 July 2007.

<sup>45</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

rise of the other advanced alternatives (see Table 22 below).<sup>46</sup> Furthermore, the changing circumstances had influenced the performance of these ICT companies due to high prices of capacities and other basic services with low returns. That was an inevitable result of clients shifting towards ‘broadband DSL and Wireless Technologies’ at lower prices and constituted heavy burden on these companies. As a result, the working ISP companies are decreasing from 17 companies day after day. For those who managed to survive the crunch, they still suffer high expenditure for continuation (cost of survival). Despite their undisputed pioneering role, due to operators’ monopoly of Internet access service and the inadequacy of the wired underground network, customers resorted to wireless access, which led to decrease in dial-up use and a decline in financial returns to beyond 56%<sup>47</sup> (see Table 22 below).

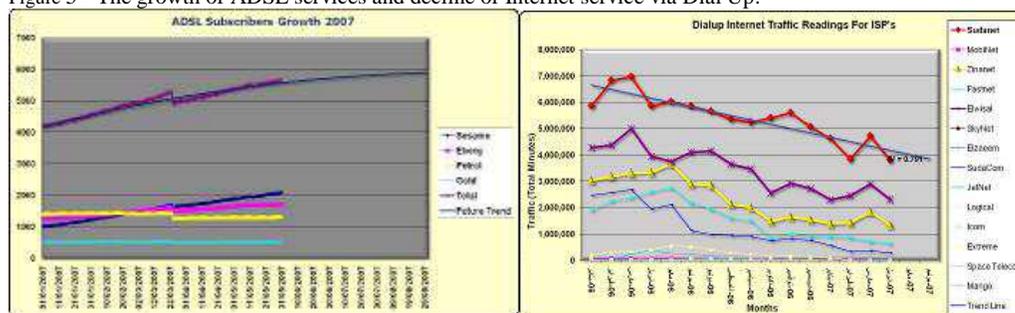
Therefore, the above results imply that in recent years, there is visible structural change in the supply and in preference of means of connection to the Internet as can be seen from the growth in ADSL and decline of dial-up and drop of fixed telephone service subscribers. This structural change can be attributed to the above-mentioned four reasons.

Table 22- The use of ADSL Service Level Agreement (SLA) (defined by level) in Sudan, 2007

Value	Sesame	Ebony	Petroleum	Gold
Shared Capacity	256 Kbps	512 Kbps	1 Mbps	2 Mbps
Rent Per Month (SDG)	100	180	350	650
Upfront Fees (SDG)	250	250	500	500
Renewal / Transfer (SDG)	200	200	200	200
Session Time (Hour)	24H	24H	24H	24H
Bandwidth	UBR	UBR	UBR	UBR

Source: Almuneer Taha Elkabashi (2007) ‘Introduction and Enhancement of Internet Services in Sudan The Role of Sudatel,’ NTC Workshop on Internet Issues 19 July 2007. P. 4.

Figure 5 - The growth of ADSL services and decline of Internet service via Dial Up:



Source: Confidential Document Sudatel ©/ 8/5/2007

Table 23- The Internet users and services providers in Sudan compared to Arab and other world countries 2006

State	Population (million)	Internet Users (million)	Internet service providers
Argentina	37.4	2	33
Australia	19.4	5	718
Austria	8.2	2.7	37
Canada	31.6	14.2	760
Egypt	70	0.455	50
Saudi Arabia	22.8	0.300	42
South Africa	43.6	1.5	44
Sudan	30.6	1.2	3-21
Lebanon	3.6	1.2	22

Source: Zain (2007) ‘Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR’ NTC Workshop on Internet Issues, July 19, 2007

<sup>46</sup> See Almuneer Taha Elkabashi (2007) ‘Introduction and Enhancement of Internet Services in Sudan The Role of Sudatel’, NTC Workshop on Internet Issues, 19 July 2007.

<sup>47</sup> See Zain (2007) ‘Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR’, NTC Workshop on Internet Issues, 19 July 2007.

### *6.1.2 Characteristics of the supply side of ICT at the micro level in Sudan*

Regarding the supplier companies, our results at the micro level are consistent with the macro level. For instance, our results at the micro level indicate that from the demand perspective, the respondents reported different preferences for depending on many sources of ICT supplier companies offering ICT services; this includes for example, Areeba MTN, Canar, Sudani, Sudate and Zain. For instance, from all the respondents' perspective, for all staff the main suppliers companies offering fixed telephone are Sudatel (42%), followed by Canar (23%), Sudani (10%) and Zain (6%). The main supplier companies offering mobile telephone are Zain (68%), followed by Sudani (23%) and Areeba MTN (15%). The main supplier companies offering Internet services are Sudatel (28%), followed by Sudani (25%), Zain (19%), Canar (16%) and other (4%).

From the public staff's perspective, the main supplier companies offering the services fixed telephone are Sudatel (34%), followed by Canar (25%), Sudani (9%) and Zain (8%). The main supplier companies offering mobile telephone are Zain (67%), followed by Sudani (23%), Areeba MTN (16%), Canar (13%) and Sudatel (2%). The main supplier companies offering Internet services are Sudatel (25%), followed by Sudani (25%), Zain (22%), Canar (13%) and other (5%).

From the private staff's perspective, the main supplier companies offering fixed telephone are Sudatel (71%), followed by Zain (24%), Canar (18%) and Sudani (12%). The main supplier companies offering mobile telephone are Zain (71%), followed by Sudani (24%), and Areeba MTN (12%) and Sudatel (12%). The main supplier companies offering the Internet services are Sudatel (41%), followed by Canar (29%), Sudani (24%) and Zain (6%).

From the students' perspective the main supplier companies offering fixed telephone are Sudatel (38%), followed by Canar (38%) and Sudani (19%). The main supplier companies offering mobile telephone are Zain (62%), followed by Canar (23%), Sudani (15%), Sudatel (12%) and Areeba MTN (8%). The main supplier companies offering Internet services are Sudani (38%), followed by Sudatel (19%), Zain (15%), Canar (23%) and other (4%).

From the support staff's perspective the main supplier companies offering fixed telephone are Sudatel (60%), followed by Canar (40%) and Sudani (20%). The main suppliers companies offering mobile telephone are Zain (60%), followed by Sudani (20%) and Areeba MTN (20%). The main supplier companies offering Internet services are Canar (60%), followed by Sudatel (20%), Sudani (20%) and other (4%) (see Table 24 below).

From the demand perspective the selection and preferences of the supplying companies is related to preferences of some specific characteristics characterising the different supplying companies offering ICT services; these include fashion, style, good design, efficiency and high quality, ease of use, cheap price and price discrimination. For instance, from all the respondents' perspective in terms of the characteristics of fashion, style

and good design, the supplier companies are ranked as follows: Zain (28%), followed by Sudani (11%), Sudatel (5%), Canar (4%) and Areeba MTN (1%). In terms of the characteristic of cheap price, Sudani (31%) is followed by Zain (25%), Canar (15%), Sudatel (14%) and Areeba MTN (11%). In terms of the characteristic of ease of use, Zain (30%) is followed by Sudani (21%), Canar (12%), Sudatel (12%) and Areeba MTN (5%). In terms of the characteristics of efficiency and high quality, Zain (57%) is followed by Sudani (21%), Sudatel (16%), Canar (11%) and Areeba MTN (10%). In terms of the characteristic of price discrimination, Zain (37%) is followed by Sudani (28%), Areeba MTN (19%), Canar (12%) and Sudatel (10%).

From the public staff's perspective, in terms of the characteristics of fashion, style, good design, the suppliers companies are ranked as follows: Zain (30%), followed by Sudani (9%), Sudatel (5%), Canar (3%) and Areeba MTN (2%). In terms of the characteristic of cheap price, Sudani (31%) is followed by Zain (25%), Canar (16%), Sudatel (13%) and Areeba MTN (13%). In terms of the characteristic of ease of use, Zain (30%) is followed by Sudani (20%), Sudatel (14%), Canar (11%) and Areeba MTN (5%). In terms of the characteristics of efficiency and high quality, Zain (58%) is followed by Sudani (23%), Sudatel (17%), Canar (13%) and Areeba MTN (13%). In terms of the characteristic of price discrimination, Zain (34%) is followed by Sudani (30%), Areeba MTN (22%), Canar (14%) and Sudatel (9%).

From the private staff's perspective, in terms of the characteristics of fashion, style, good design, the companies are ranked as follows: Zain (24%) followed by Sudani (18%), Sudatel (6%) and Canar (6%). In terms of the characteristic of cheap price, Sudani (29%) is followed by Zain (24%), Sudatel (18%), Canar (12%) and Areeba MTN (0%). In terms of the characteristic of ease of use, Zain (29%) is followed by Sudani (24%), Canar (18%), Sudatel (6%) and Areeba MTN (6%). In terms of the characteristics of efficiency and high quality, Zain (53%) is followed by Sudani (12%), Sudatel (12%) and Canar (6%). In terms of the characteristic of price discrimination, Zain (47%) is followed by Sudani (24%), Sudatel (12%), Canar (6%) and Areeba MTN (6%).

From the students' perspective, in terms of the characteristics of fashion, style, good design, the companies are ranked as follows: Zain (50%) followed by Sudani (15%), Canar (12%) and Areeba MTN (4%). In terms of the characteristic of cheap price, Zain (27%) is followed by Sudani (23%), Canar (23%), Sudatel (8%) and Areeba MTN (8%). In terms of the characteristic of ease of use, Zain (42%) is followed by Canar (12%), Sudatel (12%), Sudani (8%) and Areeba MTN (8%). In terms of the characteristics of efficiency and high quality, Zain (65%) is followed by Sudani (23%), Canar (23%) and Areeba MTN (8%). In terms of the characteristic of price discrimination, Zain (42%) is followed by Sudani (31%), Areeba MTN (15%), Canar (15%) and Sudatel (4%).

From the support staff's perspective in terms of the characteristics of fashion, style, good design, the only preferred company is Canar (20%). In terms of the characteristic of cheap price, Sudani (40%) is followed by Zain (20%), Canar (20%) and Sudatel (40%). In terms of the characteristic of ease of use, Zain (20%) is followed by Canar (20%). In terms of the characteristics of efficiency and high quality, Sudani (60%) is followed by Zain (40%), Sudatel (20%), Canar (20%) and Areeba MTN (20%). In terms of the characteristic of price discrimination, Zain (60%) is followed by Sudani (40%), Canar (40%), Areeba MTN (20%) and Sudatel (20%) (see Table 24 below).

From all the respondents' perspective, Sudatel is preferred because of the specific characteristics of efficiency and high quality (16%), cheap price (14%), ease of use (12%), price discrimination (10%) and fashion, style, good design (5%). Sudani is preferred because of the specific characteristics of cheap price (31%), price discrimination (28%), ease of use (21%), efficiency and high quality (21%), and fashion, style, good design (11%). Areeba MTN is preferred because of the specific characteristics of price discrimination (19%), cheap price (11%), efficiency and high quality (10%), ease of use (5%), and fashion, style, good design (1%). Zain is preferred because of the specific characteristics of efficiency and high quality (57%), price discrimination (37%), ease of use (30%), fashion, style, good design (28%), and cheap price (25%). Canar is preferred because of the specific characteristics of cheap price (15%), price discrimination (12%), ease of use (12%), efficiency and high quality (11%), and fashion, style, good design (4%).

The above findings indicate preference for depending on many sources of ICT supplier companies offering ICT services. From all the respondents' perspective, fixed telephone is mainly supplied by Sudatel and Canar, mobile telephone is mainly supplied by Zain and Sudani, Internet services are mainly offered by Sudatel and Sudani, Zain and Canar. The above results also imply that from all the respondents' perspective, preference amongst ICT suppliers companies indicate that Zain is the most preferred company and ranks first compared to other companies because of its distinguished characteristics in terms of fashion, style, good design, efficiency and high quality, ease of use and price discrimination. Zain is also ranked second next to Sudani in terms of cheap price.

Table 24- Assessment of preferences of specific characteristics related to ICT supplier companies offering ICT services

	Sudatel	Sudani	Areeba MTN	Zain	Canar	Others
<b>a. Preferences of the company offering ICT services: fixed telephone, mobile telephone and internet</b>						
<b>All staff</b>						
Fixed telephone	42%	10%		6%	23%	
Mobile telephone	0%	23%	15%	68%		
Internet	28%	25%		19%	16%	90%
<b>Public staff</b>						
Fixed telephone	34%	9%		8%	25%	
Mobile telephone	2%	23%	16%	67%	13%	88%
Internet	25%	25%		22%		
<b>Private staff</b>						
Fixed telephone	71%	12%		24%	18%	
Mobile telephone	12%	24%	12%	71%		
Internet	41%	24%		6%	29%	100%
<b>Students</b>						
Fixed telephone	38%	19%			38%	
Mobile telephone	12%	15%	8%	62%	23%	
Internet	19%	38%		15%		100%
<b>Support staff</b>						
Fixed telephone	60%	20%			40%	
Mobile telephone		40%	20%	60%		
Internet	20%	20%		38%	60%	100%
<b>b. Assessment of the importance of characteristics related to ICT for satisfaction of personal need/utility</b>						
Distinguished characteristics	Sudatel	Sudani	Areeba MTN	Zain	Canar	Others
<b>All staff</b>						
Fashion, style, good design	5%	11%	1%	28%		4%
Cheap price	14%	31%	11%	25%	15%	1%
Easy for use	12%	21%	5%	30%	12%	1%
Efficiency and high quality	16%	21%	10%	57%	11%	1%
Price discrimination	10%	28%	19%	37%	12%	
<b>Public staff</b>						
Fashion, style, good design	5%	9%	2%	30%		3%
Cheap price	13%	31%	13%	25%	16%	2%
Easy for use	14%	20%	5%	30%	11%	2%
Efficiency and high quality	17%	23%	13%	58%	13%	2%
Price discrimination	9%	30%	22%	34%	14%	
<b>Private staff</b>						
Fashion, style, good design	6%	18%	0%	24%		6%
Cheap price	18%	29%	6%	24%	12%	0%
Easy for use	6%	24%	6%	29%	18%	0%
Efficiency and high quality	12%	12%	0%	53%	6%	0%
Price discrimination	12%	24%	6%	47%	6%	
<b>Students</b>						
Fashion, style, good design	0%	15%	4%	50%	12%	
Cheap price	8%	23%	8%	27%	23%	0%
Easy for use	12%	8%	8%	42%	12%	0%
Efficiency and high quality	0%	23%	8%	65%	23%	0%
Price discrimination	4%	31%	15%	42%	15%	
<b>Support staff</b>						
Fashion, style, good design	0%	0%	0%	0%	20%	0%
Cheap price	0%	40%	0%	20%	20%	0%
Easy for use	0%	0%	0%	20%	0%	0%
Efficiency and high quality	20%	60%	20%	40%	20%	0%
Price discrimination	20%	40%	20%	60%	40%	0%

As for the methods and places of connection to ICT and Internet, our results at the micro level are consistent with the macro level. For instance, our results at the micro level indicate that based on the above findings concerning the importance of the Internet, there are now more than one method for connection to the Internet, and the common ways for connection with the Internet differ according to different means used by different respondents. For instance, from all the staff's perspective, for the majority, the most often widely used and common way for connection with the Internet is through ADSL (78%), followed by connection by wireless (46%), fixed telephone (41%) and others (50%). From the public staff's perspective, for the

majority, the most often widely used and common way for connection with the Internet is through ADSL (74%) this is followed by connection by fixed telephone (48%), wireless (41%), and others (50%). From the private staff's perspective, for the majority, the most often widely used and common way for connection with the Internet is through ADSL (91%), this is followed by connection by wireless (62%), and by fixed telephone (13%). From the students' perspective, for the majority, the most often widely used and common way for connection with the Internet is through ADSL (62%) this is followed by connection by fixed telephone (35%), wireless (28%), and others (17%). From the support staff's perspective, for the majority, the most often widely used and common way for connection with the Internet is through ADSL (40%) followed by connection by wireless (40%) and fixed telephone (40%) (see Table 34 below).

The above findings indicate that there are now more than one method for connection to Internet; from all the staff's perspective, for the majority, the most often widely used and common way for connection with the Internet is through ADSL, which is used by more than three quarters of all respondents, this is followed by connection by wireless, which is used by near to half of all respondents and by fixed telephone which is used by more than one third of all respondents and others.

For the majority of all staff, ADSL is often (78%) or sometimes (12%) used for connection, fixed telephone is sometimes (41%) or often (41%) used for connection, Wireless is often (46%) or sometimes (42%) used for connection and finally others means is often (50%) or sometimes (6%) used for connection. For the majority of public staff, ADSL is often (74%) or sometimes (13%) used for connection, fixed telephone often (48%) or sometimes (33%) used for connection, wireless is often (41%) or sometimes (46%) used for connection and finally others means is often (50%) or sometimes (6%) used for connection. For the majority of private staff, ADSL is often (91%) or sometimes (9%) used for connection, fixed telephone is sometimes (75%) or often (13%) used for connection, wireless is often (62%) or sometimes (31%) used for connection and finally for the majority of private staff, the connection through others means is not reported at all (0%). For the majority of students, ADSL is often (62%) or sometimes (19%) used for connection, fixed telephone is sometimes (45%) or often (35%) used for connection, wireless is sometimes (50%) or often (28%) used for connection, and finally, others means is often (17%) or sometimes (50%) used for connection. For the majority of support staff, ADSL is often (40%) or sometimes (20%) used for connection, fixed telephone is often (40%) used for connection, wireless is often (40%) or sometimes (20%) used for connection, others means is sometimes (20%) used for connection (see Table 25 below).

For all staff, there is now more than one place for using ICT; common locations for the use of ICT include home, office and Internet café and telecommunication office. In the

home fixed telephone is often (47%) or sometimes (22%) used, mobile telephone is often (86%) or sometimes (8%) used, computer is often (74%) or sometimes (24%) used, Internet is often (61%) or sometimes (51%) used. In the office fixed telephone is often (48%) or sometimes (18%) used, mobile telephone is often (86%) or sometimes (14%) used, computer is often (85%) or sometimes (14%) used, Internet is often (80%) or sometimes (20%) used. In Internet café and telecommunication offices fixed telephone is sometimes (26%) or often (3%) used, mobile telephone is often (21%) or sometimes (3%) used, computer is sometimes (24%) or often (22%) used, Internet is sometimes (33%) or often (30%) used.

As for public staff common locations for the use of ICT include home, office and Internet café and telecommunication offices. In the home fixed telephone is often (45%) or sometimes (26%) used, mobile telephone is often (86%) or sometimes (9%) used, computer is often (69%) or sometimes (29%) used, Internet is often (51%) or sometimes (30%) used. In the office fixed telephone is often (39%) or sometimes (14%) used, mobile telephone is often (90%) or sometimes (10%) used, computer is often (84%) or sometimes (14%) used, Internet is often (79%) or sometimes (21%) used. In Internet café and telecommunication offices fixed telephone is sometimes (24%) or often (4%) used, mobile telephone is often (25%) or sometimes (4%) used, computer is often (22%) or sometimes (22%) used, Internet is sometimes (37%) or often (26%) used.

For private staff common locations for the use of ICT include home, office and Internet café and telecommunication offices. In the home fixed telephone is often (55%) or sometimes (9%) used, mobile telephone is often (88%) used, computer is often (92%) or sometimes (8%) used, Internet is often (86%) or sometimes (14%) used. In the office fixed telephone is often (67%) or sometimes (25%) used, mobile telephone is often (63%) or sometimes (38%) used, computer is often (90%) or sometimes (10%) used, Internet is often (85%) or sometimes (15%) used. In Internet café and telecommunication offices fixed telephone is sometimes (33%) used, mobile telephone is not at all (100%) used, computer is sometimes (40%) or often (20%) used, Internet is often (50%) or sometimes (13%) used.

As for students common locations for the use of ICT includes home, office and Internet café and telecommunication offices. In the home fixed telephone is often (63%) or sometimes (16%) used, mobile telephone is often (75%) or sometimes (19%) used, computer is often (61%) or sometimes (39%) used, Internet is often (67%) or sometimes (27%) used. In the office fixed telephone is often (55%) or sometimes (45%) used, mobile telephone is often (53%) or sometimes (33%) used, computer is often (79%) or sometimes (14%) used, Internet is often (67%) or sometimes (33%) used. In Internet café and telecommunication offices fixed telephone is often (47%) or sometimes (7%) used, mobile telephone is often (42%) or sometimes (17%) used, computer is often (50%) or sometimes (17%) used, Internet is often (47%) or sometimes (21%) used.

For support staff common places for the use of ICT include home, office and Internet café and telecommunication offices. In the home fixed telephone is often (20%) or sometimes (20%) used, mobile telephone is often (80%) or sometimes (20%) used, computer is often (60%) or sometimes (40%) used, Internet is often (60%) or sometimes (40%) used. In the office fixed telephone is often (40%) or sometimes (20%) used, mobile telephone is often (60%) or sometimes (20%) used, computer and Internet are often (100%) used. In Internet café and telecommunication offices fixed telephone is sometimes (40%) used, mobile telephone is often (40%) used, computer and Internet are often (20%) used (see Table 26 below).

The above results indicate that there are now more than one location for using ICT; from all the respondents' perspective common locations for the use of ICT include home, office and Internet café and telecommunication offices. From all the respondents' perspective in the home and office mobile telephone, computer and Internet are often widely used, while fixed telephone is less often used. In particular, both computer and Internet are very often used in offices; this is probably because they are offered free of charge in the work place or offices for the respondents in the universities. The Internet café and telecommunication offices are less often widely used compared to both home and offices as common places for the use of ICT.

Table 25- Common ways and methods for connection to the Internet

Connection through using	Often	Sometimes	Not at all
<b>All</b>			
of ADSL	78%	12%	10%
of Fixed telephone	41%	41%	17%
of Wireless	46%	42%	12%
Others (specify)	50%	6%	44%
<b>Public</b>			
of ADSL	74%	13%	13%
of Fixed telephone	48%	33%	18%
of Wireless	41%	46%	14%
Others (specify)	50%	6%	44%
<b>Private</b>			
of ADSL	91%	9%	0%
of Fixed telephone	13%	75%	13%
of Wireless	62%	31%	8%
Others (specify)			
<b>Students</b>			
of ADSL	62%	19%	19%
of Fixed telephone	35%	45%	20%
of Wireless	28%	50%	22%
Others (specify)	17%	50%	33%
<b>Support staff</b>			
of ADSL	40%	20%	20%
of Fixed telephone	40%	0%	0%
of Wireless	40%	20%	0%
Others (specify)	0%	20%	20%

Table 26- Common locations for the use of ICT

		Fixed	Mobile	Computer	Internet
<b>All</b>					
Home	Often	47%	86%	74%	61%
	Sometimes	22%	8%	24%	25%
	Not at all	31%	6%	2%	14%
Office	Often	48%	86%	85%	80%
	Sometimes	18%	14%	14%	20%
	Not at all	35%	0%	2%	0%
Internet café/ telecommunication office	Often	3%	21%	22%	30%
	Sometimes	26%	3%	24%	33%
	Not at all	71%	76%	54%	37%
<b>Public</b>					
Home	Often	45%	86%	69%	51%
	Sometimes	26%	9%	29%	30%
	Not at all	29%	5%	2%	19%
Office	Often	39%	90%	84%	79%
	Sometimes	14%	10%	14%	21%
	Not at all	46%	0%	2%	0%
Internet café/ telecommunication office	Often	4%	25%	22%	26%
	Sometimes	24%	4%	22%	37%
	Not at all	72%	71%	56%	37%
<b>Private</b>					
Home	Often	55%	88%	92%	86%
	Sometimes	9%	0%	8%	14%
	Not at all	36%	13%	0%	0%
Office	Often	67%	63%	90%	85%
	Sometimes	25%	38%	10%	15%
	Not at all	8%	0%	0%	0%
Internet café/ telecommunication office	Often	0%	0%	20%	50%
	Sometimes	33%	0%	40%	13%
	Not at all	67%	100%	40%	38%
<b>Students</b>					
Home	Often	63%	75%	61%	67%
	Sometimes	16%	19%	39%	27%
	Not at all	21%	6%	0%	7%
Office	Often	55%	53%	79%	67%
	Sometimes	45%	33%	14%	33%
	Not at all	0%	13%	7%	0%
Internet café/ telecommunication office	Often	47%	42%	50%	47%
	Sometimes	7%	17%	17%	21%
	Not at all	47%	42%	33%	32%
<b>Support staff</b>					
Home	Often	20%	80%	60%	60%
	Sometimes	20%	20%	40%	20%
	Not at all	0%	0%	0%	0%
Office	Often	40%	60%	100%	100%
	Sometimes	20%	20%	0%	0%
	Not at all	20%	0%	0%	0%
Internet café/ telecommunication office	Often	0%	40%	20%	20%
	Sometimes	40%	0%	0%	0%
	Not at all	0%	0%	20%	20%

## 6.2 Difficulties on the supply and demand sides

At the macro level, several studies show many problems of the Internet. For instance, the above results indicate that access to Internet services in Sudan is made possible through narrow band: broadband, Leased Line, ADSL, Wi-Max and Pre-Wimax, VSAT, Web hosting, Email hosting and Co-location. Although Internet is essential for many businesses and it leads to several gained benefits, Sudan's Internet market is growing rapidly but the Sudanese Internet content is not matching the Sudanese Internet community volume.<sup>48</sup> In Sudan main access to Internet is still via dial-up; study of the use of dial-up service and Internet status in

<sup>48</sup> See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services In Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

Sudan compared to selected countries indicates the low penetration of Internet service in Sudan, while world status show a gradual increase of Internet users. The statistical figure of 2005 in Sudan is improbable, as market facts indicate that users in 2005 were subjected to a slump not an increase (see Table 5 below). Study of the use of the DSL service indicates that DSL service started in Sudan in 2003; the study indicates that penetration of the DSL service in Sudan is very low, due to many reasons such as poor copper outside plants, the investment barrier imposed by Sudatel and the lack of incentive policies. In Sudan, even access to Internet via dial-up service was confronted with some difficulties such as bad copper outside the plant network of Sudatel, the only supplier of this access. Sudatel normally overlooks the Internet service as its profitability is far less than other main services and lack of incentive policies from the regulator (NTC), but Sudatel – the significant market power – normally forestalls smaller ISP from gaining market share. This is manifested in the fact that out of 17 licensed companies, 15 were shut down. In addition to ousting of ISP's co-located equipment in Sudatel premises under the pretence of security measures, there is often a lack of response from Sudatel to ISP's request for connectivity and capacity increase. ISP often suffer from service disconnection due to Sudatel's claim of bill non-payment, though Sudatel suffers seriously from collection problems. In addition there are high costs imposed on capacity price (before the application of revenue-sharing principle) and the revenue-sharing agreement, submitted by Sudatel and approved by the NTC, is disadvantageous and unfair to ISP for the following reasons: unjust revenue-sharing ratio, 60% for Sudatel and 35% for ISP; capacity rent bill is paid to Sudatel from ISP share; ISP pay for substitute locations after Sudatel's revocation of co-location agreement; ISP pay for power consumption and sundry services; and ISP pays dual impost, one within Sudatel's invoice and the other directly to the Taxation Authority. In addition: ISP pays the regular business tax noting that the Taxation Authority does not normally consider the losses inflicted; and ISP do not enjoy any tax exemptions for equipment and facilities as big operators (Sudatel) and the high cost of Sudatel's connection lease for the states.

Broadband service began toward the end of 2004 by Sudatel. By mid-2005 the number of subscribers totalled less than 600 and are now less than 2,000. The meagre number of subscribers is mainly due to Sudatel's monopoly and refusal to the ISP to market the service. For instance, Ashrafcom, after procuring the needed equipment, applied to Sudatel to share provision of the broadband service; after one year, Sudatel compelled Ashrafcom to sell it the equipment. Furthermore, Sudatel mandated that Ashrafcom should not attempt to offer this service in the future. That was tacitly accepted by the NTC. Ashrafcom communicated the matter to NTC to sanction its attained relevant licence but to no avail. Zain, another ISP, suffered from the defectiveness and unreliability of Sudatel's copper cable network where availability is one good line in 100, in addition to the unavailability of the optic fibre network

outside a 5km diameter area centered in the midtown area (Dar el Hatif). Therefore, Sudan is considered a country with no broadband services, as indicated in the ITU year book<sup>49</sup> (see Table 25 below).

The current situation of the ISP indicates that rent of Internet capacities fell by 88.5% in 2005 after the operation of submarine cable (SAS); the number of ISP decreased from 22 companies to 9 companies offering dial-up access and 2 companies wireless access. The reasons for the shrinking number of service providers are due to losses resulting from weak revenues, the inability of providers to innovate, high administrative and general expenses (often more than 100% of the total revenue and provision of the service by main operators). The Internet services in Sudan suffered from many disadvantageous factors that rendered it a poor service, not up to the expected standard and unable to develop the Internet applications. The factors of poor service performance are due to low speed to customers, limitation of the associated services and poor quality, poor roll-out of the service to cover other regions in Sudan and weak competitive attitudes due to failure to provide multiple choices for customers (note: a licensed company has applied creative and innovative method of marketing the Internet service and was rewarded substantial profits).<sup>50</sup> Technical issues affect Internet business, including availability, bandwidth, access coverage, bandwidth per subscriber, add-on services, quality staff and operation. The presence of many obstacles are mainly related to factors such as Internet access (majority over dial-up), landline, use of telephone declining, new technologies (3G services, WLL, etc.), high cost of hosting services in Sudan, reliability and service availability and business relationship with the operators<sup>51</sup> (see Table 27 below).

According to Mobitel the problems that restrain Internet use in Sudan include the common prevailing culture and knowledge faculty (as the ordinary citizen is not yet qualified), academic qualifications, material qualifications as the fact that Internet services are unaffordable to the public and high access cost (including PCs and laptops, net cafés), scant proliferation, unaffordable prices, low standards (which do not encourage users) and high operational cost forcing ISP to raise prices. In addition both private and public institutions do not admit the Internet as a mean to handle transactions, which has led to it being regarded by some as of no importance and by others as means of communication only. Moreover, the titular bodies have not used enough promotion to invite users for their websites<sup>52</sup> (see Table 28 below). The problems of Internet service in Sudan include capacity, as the estimated Internet capacity in Sudan ranges between 300 to 450 Mb. Though it is more than those of some neighbouring countries (Ethiopia, Eritrea and Chad) it is still well below other regional

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<sup>49</sup> See Ashraf Communication Company (2007) 'The Importance of Internet Services', NTC Workshop on Internet Issues, 19 July 2007.

<sup>50</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

<sup>51</sup> See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services in Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

<sup>52</sup> See Mobitel (2007) 'Internet Issues', NTC Workshop on Internet Issues, 19 July 2007.

countries (Egypt, 2.1 gb, UAE 5.1 gb). There is no definite assessment of capacity need, neither of the market nor those required to meet the ISP's demand to meet the requirements of additional services, local contents and other applications. The second problem is related to quality of service and technical support; despite the paucity of Internet users, there is inefficiency in the technical support, installation and follow-up and the technical faults demand a relatively long time to recover. The third problem is related to website hosting as some websites are hosted locally in Sudan but at high prices compared with hosting abroad. As a result optional values (such as e-mail) are still fewer than abroad. Dedicated Internet Bandwidth 'CIR' prices offered by Telco's are higher than abroad and considered a barrier to local hosting. That will add to the restriction of the Internet market in Sudan. Website owners have genuine desire to host their web pages locally due to the trouble of fund transfers abroad and the impossibility of direct technical support. Moreover, the language barrier is an added complication. The United States' embargo is another standing threat; any web service is subjected to shut down hereupon. However, due to the strategic importance of the matter, the ISP's problems should be considered and resolved. The state's e-government project necessitates local hosting and collocation services and the establishment of data centres, which must be hosted locally for security and confidentiality. Presently, the high cost of engineering works and setting up of data centres may deter the investment in the field. Unfortunately, Telco's have not managed to create their own data centres up to international standards that could offer hosting of websites for the local market, (moreover, enriching the local content is hindered by the high bandwidth prices for ISP's). Such prices will reflect negatively on customer use. The fourth problem is related to IP addresses and software licensing; the present policy of IP address assignment restrains users from developing Internet applications. To have an IP address, Telco's stipulate paying for a dedicated leased circuit. In addition, IP addresses are not offered for broadband applicants against nominal prices. University students, for example, cannot post their graduation projects on the Internet due to the unavailability of IP addresses and the difficulty of securing bandwidth. ICANN and African Network Information Center (AfriNIC) (the body responsible for IP-address assignment in Africa) recommend free-of-charge assignment or a nominal charge. ISP and other corporate entities must be encouraged to join AfriNIC to increase the numbers of Local Internet Registry agents in order to mitigate the rigmarole of obtaining Internet addresses for users. The dependence of programmers and developers on banned foreign software imposes difficulties on applications based thereon, which inflict high costs. So, it is advisable to encourage the use of open source to develop Internet applications.<sup>53</sup>

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<sup>53</sup> See Mohammed Al Bashier Ahmed (2007) 'Development of Internet services in Sudan Challenges and Prospects Sudanese Internet Society, NTC Workshop on Issues, 19 July 2007.

Table 27 – The Internet users, Personal Computer (PC) owners, the use of DSL Services and International Internet Band Width in Sudan and selected countries 2001-05

(a)Internet user/100 inhabit & Pc owner /100(a)												
	2002 Pc 100	Internet 100	2001 Pc 100	Internet 100	2002 Pc 100	Internet 100	2003 Pc 100	Internet 100	2004 Pc 100	Internet 100	2005 Pc 100	Internet 100
Sudan	0.097	0.321	0.47	0.36	0.91	0.60	2.82	1.10	33.30	1.76	7.98	9.3
Algeria	0.49	0.66	0.65	0.71	1.69	0.77	2.20	0.83	4.63	0.9	5.83	10.06
Egypt	0.71	1.26	0.93	1.55	2.82	1.66	4.37	2.91	5.57	3.29	6.75	3.65
Lebanon	9.12	5.32	7.76	7.46	11.72	8.78	14.29	10.00	16.90	11.27	19.57	11.45
K.S.A	2.14	6.05	4.6	8.09	6.25	13.22	6.43	21.62	6.62	35.39	-	-
Kenya	0.33	0.49	0.64	0.56	1.27	0.65	3.15	0.95	3.22	-	3.24	-
South Africa	5.26	6.39	6.27	6.72	6.66	7.09	7.09	7.94	7.55	7.29	10.75	8.36
Argentina	7.06	6.96	9.82	7.80	10.93	8.00	11.96	8.19	16.10	8.37	17.79	9.07
Canada	41.13	41.90	44.96	45.61	48.30	48.62	55.39	-	62.33	-	67.89	-
Germany	30.15	33.60	31.54	38.00	33.92	43.13	39.99	48.47	42.67	54.55	43.17	60.47
(b)DSL Services					(c)International Internet Band Width (Mbp)							
	2002 DSL	2003 DSL	2004 DSL	2005 DSL	2001	2002	2003	2004	2005			
Sudan	00.00	00.00	1,400	1,900	12	24	90	202	202			
Algeria	00.00	00.00	36,000	195,000	86.30	156.0	156.3	156.3	156.3			
Egypt	937	4,850	29,307	91,111	274.60	735	559	1412	3,784			
Lebanon	00.00	00.00	00.00	00.00	40.0	60.0	60.0	200	290			
K.S.A	2,287	8,400	19,700	52,000	-	340	390	750	1,200			
Kenya	00.00	00.00	00.00	00.00	26.0	26.0	26.0	34.0	1.134			
South Africa	2,669	20,313	60,000	95,290	4,750	5,645	6,255	8,815	-			
Argentina	85,904	140,620	352,130	592,090	4,172	5,476	7,358	12,248	12,248			
Canada	1,471,000	1,958,000	2,400,000	2,839,000	55,623	89,273	172,530	217,520	-			
Germany	3,160,000	4,400,000	6,770,000	10,380,000	207,670	260,670	384,850	566,060	566,060			

Source: Ashraf Communication Company(2007) "The Importance of Internet Services," NTC Workshop on Internet Issues, 2007

Table 28- The Tariff for Internet Capacity Rent in Sudatel and Canar companies (SDG/month), 2007

Sudatel Tariff for Internet Capacity Rent (SDG/month)				Canar Tariff for Internet Capacity Rent (SDG/month)			
2000	2005	2006	2007	capacities	2006	2007	capacities
2,891	500	500	500	64 k/bit	380	380	64 k/bit
5,782	850	850	850	128 k/bit	710	710	128 k/bit
11,564	1,450	1,450	1,450	256 k/bit	1,310	1,310	256 k/bit
17,340	2,170	2,170	2,170	348 k/bit	1,850	1,850	348 k/bit
23,128	3,250	3,250	3,250	512 k/bit	2,460	2,460	512 k/bit
43,365	5,000	5,000	5,000	1 Mbit	4,460	4,460	1 Mbit
86,730	10,000	10,000	10,000	2 Mbit	8,240	8,240	2 Mbit

Source: National Telecom Corporation (2007) NTC Workshop on Internet Issues 19 July 2007

Table 29- The Internet Tariff in Sudan (SDG/hour), Internet Tariff via EVDO for Subscriber, Monthly Tariff of Dedicated Bandwidth, Tariff of Broadband ADSL Internet and Tariff of Dial-up Internet in Sudan and Selected Countries, 2000-07

a. Tariff of usage (SDG/hour),					
2000	2004	2005	2007		
DIAL UP 3	DIAL UP 2.40	DIAL UP 2.40	5HOURS DAILY	DIAL UP 360	DSL100 256 KBPS Shared
b. Internet Tariff via EVDO for Subscriber:					
SERVICE		SUDATEL		CANAR	
Subscription Fees		2,500 Device + Laptop		GO2	
Monthly Usage		Fees 1,800		GO5	
				30	
				60	
				132	
c. Monthly Tariff of Dedicated Bandwidth: Tariff of Broadband ADSL Internet and Tariff of Dial-up Internet in Selected Countries:					
Company	Value in dollar				Capacities
Africa On Line	2,266				1/Mbps
Blue Broadband	2,453				1/Mbps
Sudatel	2,560				1/Mbps
Canartel	2,230				1/Mbps
d. Tariff of Broadband ADSL Internet and Tariff of Dial-up Internet in Selected Countries:					
Country	Tariff of Broadband ADSL Internet			Tariff of Dial-up Internet	
	Value in dollar	Capacities		Value in dollar	Usage (Hours)
Jordan	17	1Mbps Down 2kbps Up		25	60
Kenya	1,237	256kbps Down 64kbps Up			
Nepal	1,169	1Mbps Up/Down		14	50
Egypt	88	128kbps Down 64kbps Up			
Bahrain	504	1Mbps Up/Down			
Sudan	175	1Mbps Up/Down		54	60

Sources: (a) National Telecom Corporation (2007) NTC Workshop on Internet Issues 19 July 2007 and (b) Ashraf Communication Company (2007) "The Importance of Internet Services," NTC Workshop on Internet Issues, 2007

Table 30- Internet accessibility in Sudan - E-readiness report: in 2005

Service	Speed	Total subscribers
ISDN	64 kb/s	1360
Analog leased lines	64 kb/s -2048 kb/s	123
Digital leased lines	30 x 2 Mb/s	344
ADSL	256 Kb/S	2560

Source: Mohammed Al Bashier Ahmed (2007) "Development of Internet services in Sudan Challenges and Prospects," Sudanese Internet Society, NTC Workshop on Internet Issues, 19 July 2007

At the micro level our findings indicate the importance of the difficulties in the supply and demand sides in hindering the personal usage of ICT. For instance, from all the respondents' perspective, the difficulties in the supply side include high costs of offering the services, lack of networks, interruption/disconnection of services, lack of R&D, low quality/ efficiency of services, lack of government spending on ICT, inadequate capacity of the services, lack of/inadequate investment, slow speed of services, lack of infrastructure, interruption of electricity supply, uncertainty related to investment in ICT, lack of technical skills and others respectively.<sup>54</sup> In addition, from all the respondents' perspective, difficulties on the demand side include: high spread of electronic illiteracy, high cost for offering the services, lack of awareness of the importance of ICT in the new economy, high spread of poverty and others respectively<sup>55</sup> (see Table 31 below). Moreover, our results show that assessment indicates the importance of the lack of fluency in English language in hindering the personal usage of ICT. For instance, from all the respondents' perspective, the majority of all staff indicated that for mobile telephone it is unimportant (63%), followed by those who indicated it as slightly (25%), extremely (7%) and moderately (6%) important. For computer it is unimportant (43%), followed by those who indicated it as slightly (21%), moderately (20%), and extremely (16%) important. For Internet it is unimportant (38%), followed by those who indicated it as extremely (22%), moderately (22%), and slightly (17%) important.

From the public staff's perspective, the majority indicated that for mobile telephone it is unimportant (60%), followed by those who indicated it as slightly (29%), extremely (7%), and moderately (4%) important. For computer it is unimportant (40%), followed by those who indicated it as slightly (19%), moderately (21%) and extremely (19%) important. For Internet it is unimportant (34%), followed by those who indicated it as extremely (25%), moderately (22%), and slightly (19%) important.

From the private staff's perspective, the majority indicated that for mobile telephone it is unimportant (71%), followed by those who indicated it as moderately (12%), slightly (12%), and extremely (6%) important. For computer it is unimportant (53%), followed by those who indicated it as slightly (24%), moderately (18%), and extremely (6%) important. For Internet it is unimportant (53%), followed by those who indicated it as moderately (24%), slightly (12%), and extremely (12%) important.

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<sup>54</sup> As indicated by 93%, 93%, 93%, 93%, 92%, 92%, 90%, 89%, 89%, 88%, 86%, 84%, 79% and 92% of all respondents respectively. As indicated by 93%, 93%, 93%, 94%, 93%, 91%, 89%, 89%, 89%, 86%, 86%, 82%, 80% and 90% of public respondents respectively. As indicated by 94%, 94%, 93%, 88%, 88%, 94%, 94%, 88%, 88%, 94%, 82%, 88%, 76% and 100% of private respondents respectively. As indicated by 90%, 90%, 71%, 95%, 90%, 100%, 81%, 95%, 86%, 81%, 52%, 67%, 76% and 67% of student respondents respectively. As indicated by 60%, 40%, 40%, 60%, 40%, 40%, 60%, 60%, 60%, 40%, 60%, 40%, 40% and 0% of support staff respondents respectively.

<sup>55</sup> As indicated by 92%, 92%, 90%, 88% and 88% of all respondents respectively. As indicated by 91%, 91%, 91%, 88% and 100% of public respondents respectively. As indicated by 94%, 94%, 88%, 88% and 75% of private respondents respectively. As indicated by 95%, 100%, 90%, 95% and 100% of student respondents respectively. As indicated by 60%, 60%, 60%, 60% and 0% of support staff respondents respectively.

From the students' perspective, the majority indicated that for mobile telephone it is slightly (33%) important, this is followed by those who indicated it as moderately (29%), unimportant (25%) and extremely (13%). For computer it is moderately (44%) important, followed by those who indicated it as extremely (39%), slightly (13%), and unimportant (4%). For Internet it is extremely (61%) important, followed by those who indicated it as moderately (34%), slightly (4%), and unimportant (0%).

From the support staff's perspective, the majority indicated that for mobile telephone it is unimportant (40%), followed by those who indicated it as moderately (40%), slightly (20%), and extremely (0%) important. For computer it is moderately (40%) important, followed by those who indicated it as extremely (20%), slightly (20%), and unimportant (20%). For Internet it is moderately (40%) important, followed by those who indicated it as extremely (20%), slightly (20%), and unimportant (20%) (see Table 32 below).

Table 31- Assessment of the importance of the effect of the difficulties in the supply and demand sides in hindering personal use of ICT

Supply sides	All	Public	Private	Students	Support staff
High costs of offering services	93%	93%	94%	90%	60%
Lack of networks	93%	93%	94%	90%	40%
Interrupt/disconnection services	93%	93%	93%	71%	40%
Lack of R&D	93%	94%	88%	95%	60%
Low quality/ efficiency of the services	92%	93%	88%	90%	40%
Lack of govt. spending on ICT	92%	91%	94%	100%	40%
Inadequate capacity of services	90%	89%	94%	81%	60%
Lack of / inadequate investment	89%	89%	88%	95%	60%
Slow speed of the services	89%	89%	88%	86%	60%
Lack of infrastructure	88%	86%	94%	81%	40%
Interrupt of electricity supply	86%	86%	82%	52%	60%
Uncertainty related to investment in ICT	84%	82%	88%	67%	40%
Lack of technical skills	79%	80%	76%	76%	40%
Others	92%	90%	100%	67%	0%
Demand side:					
High spread of electronic illiteracy	92%	91%	94%	95%	60%
High cost for offering the services	92%	91%	94%	100%	60%
Lack of awareness of the importance of ICT in the new economy	90%	91%	88%	90%	60%
High spread of poverty	88%	88%	88%	95%	60%
Others	88%	100%	75%	100%	0%

Table 32- Assessment of the importance of the effect of the lack of fluency in English language in hindering the personal usage of ICT

All	Extremely	Moderately	Slightly	Unimportant	N
Mobile telephone	7%	6%	25%	63%	76
Computer	16%	20%	21%	43%	
Internet	22%	22%	17%	38%	
Public					59
Mobile telephone	7%	4%	29%	60%	
Computer	19%	21%	21%	40%	
Internet	25%	22%	19%	34%	
Private					17
Mobile telephone	6%	12%	12%	71%	
Computer	6%	18%	24%	53%	
Internet	12%	24%	12%	53%	
Students					24
Mobile telephone	13%	29%	33%	25%	
Computer	39%	44%	13%	4%	
Internet	61%	35%	4%	0%	
Support staff					5
Mobile telephone	0%	40%	20%	40%	
Computer	20%	40%	20%	20%	
Internet	20%	40%	20%	20%	

### 6.3 Suggestion for solutions on the supply and demand sides

At the macro level, several studies provide many suggestions for solutions of the above-mentioned problems. For instance, it is mandatory to strengthen the ISP trade environment and modify their business approach through: increased investment capital and consideration of mergers with each other to establish a solid investment base; diversifying and enriching the offered services to enhance competitiveness; commitment to quality of service; providing optional access methods to improve affordability; consideration of geographical expansion outside the capital; consideration of inter-connectivity to improve storage and hosting capacity of frequent sites (peer-to-peer operation) and encourage investment in e-applications. To contribute to the proliferation of Internet services and substantiate the role of service providers, the operators should consider secure Internet capacities to the providers all over Sudan and separating uplink and downlink capacities according to providers' requirements, provide direct connection circuits with preferential prices to make use of the infrastructure and provide Reference Interconnection Offer for data service. In addition, they should enable the ISP to undertake retail selling; operators should sell Internet capacities and connection lines at wholesale prices, diversify the parties with direct links to the Internet network to ensure the continuity and stability of the service; gradually withdraw from the service provision competitive market to enable ISPs' role and meet Next Generation Networks and services convergence (an agreement between the NTC and the SIS upon the management of the Internet Top-Level Domain of Sudan and doling out the subsequent domains). In order to accomplish the information society and optimise the Internet service, the NTC should contribute to: achieving a clear policy for the Internet; implementing a realistic pricing policy to differentiate between the wholesale and retail prices; encouraging fair competition between service providers and the elimination of the unified tariff system; realising the roll-out of service to other regions in Sudan through promotional advantage; obliging operators and service providers to adhere to the adopted quality standards; advising operators to remain as network and capacity providers and abandon the Internet service provision and supervising the service performance and drafting market statistical data.<sup>56</sup>

In conclusion, refreshing Internet related business requires application service provisioning, enhancement of the existing services (availability, quality, coverage, etc.), getting engaged in the content market (Farouq Telecom), co-operation with the operators to generate new business opportunities, monitoring the technology directions towards the Internet and Internet services, prolonging the business cycle and setting quality standards.<sup>57</sup> Mobitel Road Map includes that Mobitel provides multi-technology Internet access through

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<sup>56</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

<sup>57</sup> See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services in Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

MobiNet, which started in 1999 to cover all subscribed customers via fixed or mobile networks with speeds 56 kb/s for fixed service and 9.6 kb/s for mobile service, and through GPRS which started in 2005 for Mobitel customers with telephone sets supporting this service. In addition to provision of an advanced GSM data transmission technology in 2007 and provision of maximum speed services that was planned to be introduced in 2007 to meet the aspiration of business and corporate sector. Moreover, as an Internet Service Promoter Mobitel utilises all media resources to acquaint the public and raise their level of awareness of its services, supports all educational institutions to uphold academic qualification, and offers incentives to customers to urge them to use the Internet (free credit and session hours and others). Furthermore, Mobitel offers various gifts to customers as PCs, laptops and mobile phone sets as motivation to elevate their “technological value”. This has helped to develop the overall stance.<sup>58</sup> The main recommendations include developing the ISP services offered by introducing new packages like web, e-mail and hosting and designing websites, offering the value-added services of the fixed telephone network such as games, multi-choice television, videophone and video-on-demand. This comes in addition to offering the value-added services of the mobile telephone network such as SMS (news, sports, banks, etc.) and new technologies (Wi-Fi, WiMax).<sup>59</sup> To adopt a broad vision of the Internet governance based on the five cases (technical, economic, cultural, and social aspects and developmental issues), it is mandatory to form a work group to study how to develop mechanisms and lay foundations for Internet governance in Sudan, taking into account achieving active Sudanese presence on the Internet, coordination between stakeholders in the field to ensure suitable environment to deploy the Internet to greater community sectors and coordination with the UN and relevant concerned international organisations to develop optimal vision for Internet Governance.<sup>60</sup> Prospects and solutions includes development of the Internet service and making optimal use of the telecommunications infrastructure at hand, which is considered the best in Africa; this implies that it is mandatory to maintain a cooperative partnership between Telco’s and ISP to enable the latter to offer broadband services to the widest targeted Sudanese sectors possible. In this way, Telco’s can assume their role as carriers utilising their infrastructure. As the ISPs in a position to offer other value-added services, there will be a competitive market activity that will render Internet prices more affordable. Moreover, broadband service via landlines should be resumed and not to be abandoned. There must be an opportunity offered for Telco’s/ISP partnership. The Egyptian case is a good example; Telecom Egypt, the main Telco-extended revenue-sharing partnership with the ISP to disseminate the Internet service

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<sup>58</sup> See Mobitel (2007) ‘Internet Issues’, NTC Workshop on Internet Issues, 19 July 2007.

<sup>59</sup> See Almuneer Taha Elkabashi (2007) ‘Introduction and Enhancement of Internet Services in Sudan The Role of Sudatel’, NTC Workshop on Internet Issues, 19 July 2007.

<sup>60</sup> See Abu-Al-Fedl Mokhtar (2007) ‘Internet Management in Sudan’, Ministry of the Cabinet Affairs, National Information Center, NTC Workshop on Internet Issues, 19 July 2007.

via Telecom Egypt. That enabled the ISP greater expansion in offering broadband services at token prices. That partnership instigated positive competition in the market. As for Internet capacities, the Internet bandwidth dedicated to corporate bodies should be reduced. A special rate must be worked out for universities and educational institutions so they can avail the Internet adequately to their students. That should indeed unleash progress and development of scientific research. In addition to Internet Added Services, as a contribution to the development of Internet local services including website hosting, it is advisable to sponsor value-added and additional services via Telco's and ISPs. The establishment of data centres by the state or private sector is a strategic issue to develop the Internet applications service. A government data centre is a pressing need; Sudan has now its own address on the Internet global map. That will no doubt enhance all services including the contents. Still, there is a big need to develop the DNS infrastructure to bolster Internet development.<sup>61</sup> Proposals for upgrading Internet services imply that most Sudanese cities are covered with state-of-the-art telecommunications infrastructure.<sup>62</sup>

At the micro level, our findings show the importance of the implementation of the following selected policies in the supply and demand sides in encouraging and supporting the use of ICT. For instance, from all the respondents' perspective, policies in the supply sides include improving and increasing R&D, improving and increasing infrastructure, encouraging the use of preferential tariff or free access to electronic publications for academic purpose in developing countries, improving and increasing efficiency and capacity of the services, improving and increasing speed of the services, increasing government spending and investment on ICT and improving and increasing networks offering the services. In addition: introduction of policies to increase collaboration in the field of research and publication and free access to electronic publications for academic purpose in developing countries, introduction of policies to reduce the digital and scientific gap between Sudan and advanced countries in the world, encouragement and support of private investment, improving and treating the problem of interruption or disconnection in the supply of the services, treating the provision of electricity supply and others respectively. Moreover, from all the respondents' perspective, policies on the demand side include improving and increasing quality of education and electronic knowledge and eradication of electronic illiteracy, reducing the costs for offering the services, improving and increasing awareness of the importance of ICT in the new economy, improving and increasing income, eradicating poverty and others respectively<sup>63</sup> (see Table 33 below).

<sup>61</sup> See Mohammed Al Bashier Ahmed (2007) 'Development of Internet services in Sudan Challenges and Prospects', Sudanese Internet Society, NTC Workshop on Internet Issues, 19 July 2007.

<sup>62</sup> See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

<sup>63</sup> As indicated by 99%, 96%, 96%, 95%, 95%, 95%, 94%, 93%, 93%, 93%, 93%, 92%, 80%, 97%, 97%, 95%, 91% and 80% of all respondent staff respectively. As indicated by 100%, 96%, 96%, 95%, 95%, 95%, 96%, 95%, 93%, 91%, 91%, 95%,

Table 33- Assessment of the importance of implementation of selected policies in the supply and demand sides in encouraging and supporting the use of ICT

	All	Public	Private	Students	Support staff
Policies in the Supply sides					
Improve and increase R&D	99%	100%	94%	100%	40%
Improve and increase infrastructure	96%	96%	94%	96%	80%
Encourage the use of preferential tariff or free access to electronic publications for academic purpose in developing countries	96%	96%	94%	100%	40%
Improve and increase efficiency and capacity of services	95%	95%	94%	100%	40%
Improve and increase speed of the services	95%	95%	94%	96%	40%
Improve and increase govt. spending and investment on ICT	95%	95%	94%	100%	40%
Improve and increase networks offering the services	94%	96%	87%	100%	80%
Introduction of policies to increase collaboration in the field of research and publication and free access to electronic publications for academic purpose in developing countries	93%	95%	88%	95%	40%
Introduction of policies to reduce digital and scientific gap between Sudan and advanced countries in the world.	93%	93%	94%	100%	40%
Treatment of problem of Interrupt/disconnection services	93%	91%	100%	92%	40%
Encourage and support private investment to offering services	93%	91%	100%	96%	40%
Treatment of Interrupt of electricity supply	92%	95%	82%	87%	40%
Others	80%	75%	100%	100%	0%
Policies on the Demand side:					
Improve and increase quality of education and electronic knowledge and eradication of electronic illiteracy	97%	96%	100%	92%	80%
reduce cost for offering the services	97%	98%	94%	96%	80%
Improve and increase awareness of the importance of ICT in the new economy	95%	95%	94%	100%	40%
Improve and increase income and eradicate poverty	91%	91%	88%	91%	40%
Others	80%	80%	0%	100%	0%

## 6.4 Conclusions

This chapter discusses and provides empirical analysis and examines from the public-private perspective the research hypotheses on the public-private differential in the supply side of ICT in Sudanese universities as a case of African universities. Section 1 defines the main characteristics of the supply side of ICT in Sudan. Section 2 shows an indepth analysis from the demand perspective of the supply side of ICT, methods and places of connection to ICT. Section 3 explains the difficulties on the supply and demand sides and suggestions for relevant solutions.

Our findings in this chapter provide further evidence in support of the second hypothesis in Chapter 1 above on the incidence of structural change in the demand for ICT. In particular, in this chapter we complement our discussion in Chapter 5 above and we elaborate the incidence of structural change in the demand for ICT from the supply side. For instance, next to the well-investigated structural change in the structure of the supply of ICT market from monopoly to monopolistic competition with more than one operating companies, we explain further structural change from the demand perspective. We find that the increasing number of operating companies has been in favour of consumers not only by increasing availability of ICT services but also by offering consumers wider options for selection from the different ICT supplier companies. For instance, our results indicate that from all the

75%, 96%, 98%, 95%, 91% and 80% of respondent public staff respectively. As indicated by 94%, 94%, 94%, 94%, 94%, 94%, 87%, 88%, 94%, 100%, 100%, 82%, 100%, 100%, 94%, 94%, 88%, and 0% respondent private staff respectively. As indicated by 100%, 96%, 100%, 100%, 96%, 100%, 100%, 95%, 100%, 92%, 96%, 87%, 100%, 92%, 96%, 100%, 91% and 100% of respondent students respectively. As indicated by 40%, 80%, 40%, 40%, 40%, 40%, 80%, 40%, 40%, 40%, 40%, 40%, 0%, 80%, 80%, 40%, 40% and 0% of respondent support staff respectively.

respondents' perspective fixed telephone is mainly supplied by Sudatel and Canar, mobile telephone is mainly supplied by Zain and Sudani and Internet services are mainly offered by Sudatel and Sudani. Our findings indicate that the above observed structural change in the supply side from monopoly by Sudatel to monopolistic competition with many operating companies has been in favour of consumers, not only by increasing availability of ICT services, but also by increasing competition between different ICT supplier companies to attract more consumers by offering ICT services with high or improved efficiency, low or cheap prices and also introduction of price discrimination mechanism. Our results indicate further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT from the demand perspective in relation to the supply side; for instance our findings imply shift from Sudatel as ICT pioneer company to Zain as new recent ICT supplier company. Our results imply that the justification of this shift or structural change is related to preference of certain characteristics of the supplier company. For instance, our findings imply that from all the respondents' perspective, the preference of the company offering ICT services indicates that Zain is the most preferred company and ranks first compared to other companies because of its distinguished characteristics in terms of fashion, style, good design, efficiency and high quality, ease of use and price discrimination. Zain is also ranked second next to Sudani in terms of cheap price. This result is also consistent with the conventional stylised fact in the theoretical literature concerning the rationality of consumers.

Another piece of evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings on the methods of connection to the Internet, which indicates a significant shift from connection via dial-up by telephone to connection by ADSL. For instance, our results indicate that from all the staff's perspective, for the majority, the most widely used and common way for connection with the Internet is through ADSL, which is used by near to half of all respondents, this is followed by connection by wireless, which is used by near to one third of all respondents and finally by fixed telephone which is used by near to one fifth of all respondents. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings, which imply that from all the staff's perspective, for the majority, in both the home and office, mobile telephone, computer and Internet are often widely used, while fixed telephone is less often used. Our results indicate that from all the respondents' perspective ICT is often and widely accessed in both the home and office, while Internet café and telecommunication offices are less often widely used compared to both home and offices as common locations for the use of ICT. In particular, both computer and Internet are very often used in the office or work place, this is probably because they are offered free of charge for the respondents in public and private Sudanese universities.

## **Chapter 7: The Effect of ICT in Knowledge in Sudanese Universities and the Labour Market**

### **Introduction**

The data from the university survey presented in Chapter 4 above provides us with the required information that is particularly useful for presenting interesting public-private comparative analysis to examine elaborate the role of ICT to enhance the creation and transfer of knowledge in Sudanese universities from public-private perspectives. This chapter discusses the main results from all the universities' academic teaching staff, support staff and students' perspectives. It provides the empirical analysis and examines from the demand perspective and from the public-private perspective, the research hypotheses on the public-private differential and impacts of the use of ICT in labour market and investigates the opportunities and challenges that ICT is expected to create for the production, creation and transfer of knowledge in Sudanese universities as a case study of African universities.

Before we go into the empirical analysis, it is appropriate to explain briefly the Sudanese national ICT strategy and policy in higher education in Section 1. Next, we show explain the efforts made by the Sudanese Ministry of Higher Education and Scientific Research and then the effort made by some Sudanese universities, notably, universities in Khartoum, Sudan, Juba, Ahfad and Computerman to enhance the use of ICT to meet the multiple needs for enhancing connection, creation and transfer of knowledge in Section 2. And we explain from the demand perspective the effect of ICT and opportunities and challenges for the creation and transfer of knowledge in Sudanese universities in Section 3. Section 4 provides the conclusions.

### **7.1 The Sudanese national ICT strategy and policy in higher education**

In June 1999, the Sudanese national ICT strategy and policy was formulated and a high-level ministerial committee was formed to oversee its implementation. The strategy focuses on five major areas: technology (infrastructure), human resource development, software industry development, content (Arabic reservoir) and geo-information. Based on the knowledge and recognition of the importance of public-private partnerships in enhancing any development process, the Sudanese government is constantly seeking partners to implement the national strategy, including e-government projects, the development of an electronic smart city, distance learning, and telemedicine. The General Ministry of Education Information Centre is the entity responsible for the development of a strong ICT infrastructure. The national policy encourages the use of ICT in developing local policies to ensure the complete integration of ICT in education and training at all levels, including the development of school curricula, teacher training, managing and organising educational institutions and supporting the idea of

lifelong learning by designing ICT training programmes to satisfy the educational needs of employees working in the field. The ICT policy for education was launched in 2002. The Information Directorate and Curriculum Centre and Training Directorate are the entities managing the implementation. In 2004, ICT was introduced in secondary education curricula. A number of computers were installed in schools (around 50% of secondary schools), at an average of ten computers per school. In schools the connectivity is mainly through dial-up and ADSL. However, in higher education systems, it is through ADSL only. The country is planning to have computers available at all education levels by the year 2015 as agreed at the ICT summit in Geneva. The ICT curriculum has been introduced at Grade 4 and the teachers have been trained on the basics of ICT. Both the government and the private sector provide access to the Internet as a learning resource. In the last two decades Sudan has built and capitalised on ICT, and the government has opened up competitive investments in telecommunication. Licensing has been granted for newcomers employing advanced technologies, which are hoped to increase the spread of and access to ICT and make products affordable. Development in ICT in Sudan is evident in a substantial expansion of infrastructure and capital investment including management systems and human capital: Table 34 provides a quantitative perspective of some selected system indicators.<sup>64</sup>

Table 34: Selected Education Data

Institution	Total
Public schools	11,752
Private schools	1,035
Technical schools	81
Others	5,808
Number of school students for all levels	4.6 million
Public universities/higher institutions	27
Private universities/higher institutions	47
Technical	6
Number of university students	446,998
Public schools with computer labs	4,363
Private schools with computer labs	647
Technical schools with computer labs	20
Schools with Internet connection	20
Public universities with computer labs	27
Private universities with computer labs	47
Public universities with Internet connection	20
Private universities with Internet connection	47

Source: Amr Hamdy (2007) "ICT in Education in Sudan: Survey of ICT and Education in Africa: Sudan Country Report," June 2007, p. 3. [www.infodev.org](http://www.infodev.org). see also Ministry of Education. *Education Statistic Yearbook 2004-2005, 2002-2003*; Khartoum.

## 7.2 ICT and Knowledge Production Institutions in Sudanese universities

Based on the literature on ICT and knowledge production, notably in African universities presented in Chapter 2 above, this section explains first the efforts made by the Sudanese Ministry of Higher Education and Scientific Research and then the effort made by some

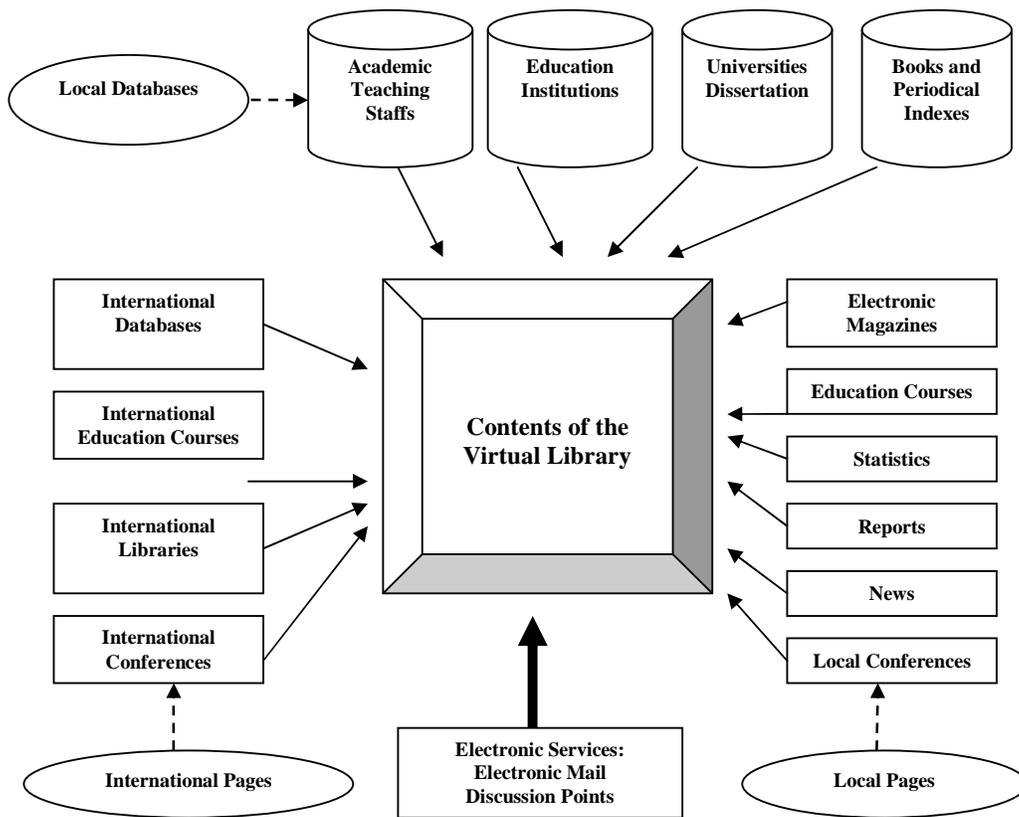
<sup>64</sup> See Amr Hamdy (2007) "ICT in Education in Sudan: Survey of ICT and Education in Africa: Sudan Country Report" (June 2007), pp. 3-5. [www.infodev.org](http://www.infodev.org). Accessed: 11 May 2009. See also Ministry of Education. *Education Statistic Yearbook 2004-2005, 2002-2003*, Khartoum, Sudan; United Nations Economic Commission for Africa (UNECA): <http://www.uneca.org/aisi/nici/Sudan/sudan.htm>. Accessed: 11 May 2009. ; Sudan. Internet World Stats: <http://www.Internetworldstats.com/africa.htm#sd>. Accessed: May 2009; Elamin Abdelgadir, K. Promoting ICT for Human Development in Sudan. 2004. ICS Portal for Technology Transfer. <http://www.ics.trieste.it/Documents/Downloads/df2124.doc>. Accessed: 11 May 2009.

Sudanese universities, notably, universities in Khartoum, Sudan, Juba, Ahfad and Computerman to enhance the use of ICT to meet the multiple needs for enhancing connection, creation and transfer of knowledge.

For instance, the Sudanese Ministry of Higher Education and Scientific Research decided to use ICT to establish the Sudanese Universities Virtual Library (SUVL) to offer academic teaching staff and students 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 within the context of the project of the Sudanese Universities Networks (SUN), which aims to support scientific research and educational activities, improve the acquisition of knowledge, support the restructuring of administration and modernisation of Sudanese universities and facilitate offer and direct access to electronic books, references, magazines research, courses, lectures and information available online by using ICT techniques. The SUVL aims to fulfil the following objectives: to improve the ways of offering education and research and make information available in all fields of knowledge in order to help improve the capacity 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 Government of Sudan's strategic plans in the field of ICT to encourage Sudanese universities and higher education institutions to achieve their objectives. Mainly, by using ICT to help introduction of change and improvement in education and restructure of education system, modernisation, reorganisation and digitalisation of information to facilitate easy access to and rapid expansion in the diffusion of information and knowledge and support production and contents of local knowledge. The main tasks of the project include improvement and modernisation of the ways of collection, storage and organisation of information and knowledge in a digital format and to offer easy accessible ways for all to access the information at any time and from any place. The SUVL works to achieve these tasks by the following: link Sudanese universities and higher education institutions in Sudan by information networks, establish the virtual library to offer database and sources of knowledge in different fields for all universities, offer access to these information depending on the use of ICT, offer ways of electronic contact between Sudanese universities by use of electronic mail (e-mail) and other electronic techniques, contribute to easy access to information for different purposes for students, academic teaching staff, researchers, administrative and other support staff in all higher education institutions in Sudan and support access to long distance education and scientific research by direct free access to online lectures. The plan for the implementation of the SUVL library includes three stages or phases: collection and analysis of data, design and implementation of data, testing and verification. The first stage or phase was implemented in December 2004, whereas the second stage of design and implementation

started in January 2005 and in February 2005 respectively; this second stage completed in January 2006, when it witnessed the establishment of the Internet and websites, and now the library includes about 200,000 files. The third and last stage of testing and verification is still on going. To facilitate the implementation process the Ministry conducted training programmes on network administration for 70 trainers from different Sudanese universities to train them in the different fields related to management and administration of the networks in their universities. The electronic information networks and connection was implemented by DATANET Company; the first stage enables 30 universities and higher education institutions in Sudan to be electronically connected to the central network in Khartoum University. The design of the networks not only allows direct exchange of information between Sudanese universities through the Internet, but also offers special contact addresses (IP numbers) for each university to enable them to host their own website and offer the electronic services of e-mail and electronic publications. For more details about SUVL see Figure 6 below.

**Figure 6- Sudanese Universities Virtual Library (SUVL) Process Diagram**



Source: Sudan Ministry of Higher Education and Scientific Research<sup>65</sup>

<sup>65</sup> See Sudanese Universities Virtual Library (SUVL): [http://www.suvl.edu.sd/content\\_1/about.htm](http://www.suvl.edu.sd/content_1/about.htm)

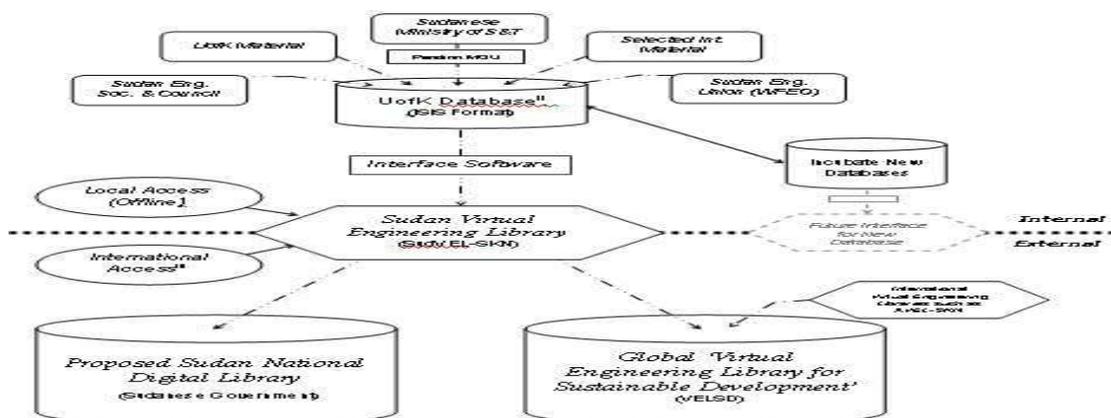
In addition to the Sudan Ministry of Higher Education's efforts, the Sudanese universities in Khartoum, Sudan, Juba, Ahfad and Computerman have established ICT or computer and network centres to meet the multiple ICT needs for their universities. For example, Khartoum University established the computer and information centre that was recently named Information Technology and Network Administration (ITNA) to meet the institution's multiple ICT needs; it implemented several initiatives using ICT to promote knowledge and academic work in the university. For instance, the use of ICT enables Khartoum University to offer free access to Internet that not only facilitates building internal networks inside the university and facilitates internal connections between staff, but also facilitates external connections with other institutions in Sudan and with other regional and international institutions. Moreover, more recently, the use of ICT enabled the ITNA in Khartoum University to offer a website for the University of Khartoum's online publications and documents. The University Electronic Collections (UEC) includes the electronic theses, dissertations and electronic books in different disciplines; both these services are available only from within the university campuses. Moreover, the use of ICT enables the staff members from different faculties in Khartoum University to use the ICT facility to register and to offer new courses to include many different disciplines. Now, the university online course categories include not only scientific disciplines such as Medicine, Medical Laboratory Services, Animal Production, Agriculture, Sciences (Chemistry and Physics), Mathematics (Computer and Mathematics) and Engineering (Chemical and Electrical), but also include other disciplines such as Arts (Arabic Language), Education and University Requirements.

In addition the use of ICT enables Khartoum University to offer online courses on Intellectual Property Rights (IPR) in collaboration with the Distance Learning Program, WIPO Academy, World Intellectual Property Organization (WIPO). It enables the provision of distance learning education and training programmes in intellectual property and creates awareness to promote and disseminate knowledge in intellectual property. By using ICT Khartoum University has embarked on an ambitious online distance learning programme of 'Training of Trainers' to train 40 academic staff members drawn from various faculties of the university; for instance, 24 staff members were trained on diverse issues pertaining to intellectual property for an intensive six month course to serve as trainers of Intellectual Property in their respective faculties, upon the successful completion of the course and certification by the WIPO Academy. The course conducted in both online and face-to-face classes, indicates successful use of ICT in Khartoum University to conduct a distance-online course in cooperation with international institutions (WIPO).

Moreover, the use of ICT has enabled the University of Khartoum, Faculty of Engineering and Architecture, to establish the Sudan Virtual Engineering Library Sustainability Knowledge Network (SudVEL-SKN). It is a pilot project supported by

UNESCO in partnership with many international institutes and organisations including the Australian Virtual Engineering Library (AVEL-SKN), World Federation of Engineering Organisations (WFEO), Sustainable Alternatives Network (SANet) and the Foundation Ecole d'Ingenieurs (EPF) through the International Institute of Women in Engineering (IIWE). The objective of this project is preparing and establishing a website on 'Virtual Library on Engineering for Sustainable Development' as a pilot project. The existing data and information in the field of engineering and sustainable development is transformed into a digital form and stored in this virtual library. This digital library is intended to be part of the learning environment for the Faculty of Engineering; the library aims to develop as part of the information network of the University of Khartoum, to provide both easy and efficient online access and international online access to information and knowledge by students, researchers and academic staff. The SudVEL-SKN also aims to provide Sudanese contributions to the UNESCO/WFEO Virtual Engineering Library for Sustainable Development and contribute to the Proposed Sudan National Digital Library. The library aims to be a part of the learning environment for the Faculty of Engineering and Architecture containing both internal sources and a selection of international materials. The project was conducted and implemented in two phases from December 2003 to February 2004. The first phase of the project involved the development of a 'Bibliographic Level' prototype version 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, development of the web-interface and usability testing. The second phase of the project focused on the increased digitisation to 'Full Text' of the extensive library of hardcopy research material and thesis reports held by the Faculty of Engineering and Architecture. For more details about SudVEL see Figure 7 below.<sup>66</sup>

**Figure7- Sudan Virtual Engineering Library (SudVEL) Process Diagram**



Source: Sudan Virtual Engineering Library Sustainability Knowledge Network.

<sup>66</sup>. See Sudan Virtual Engineering Library Sustainability Knowledge Network: <http://www2.uofk.edu/SudVEL/Contents/reports.htm>, Accessed: 11 May 2009.

Furthermore, more recently, the use of ICT enabled the ITNA in Khartoum University to start the implementation of online or electronic registration of students. A questionnaire aiming to examine from the students' perspective the visibility, value and effectiveness of the new system of online or electronic registration that has been implemented in some of faculties in Khartoum University was distributed amongst 1,000 male and female students in the Faculty of Engineering. The results of the questionnaire indicate that about 30.2% of the students praised the new online or electronic registration system and indicated that the new system is good and effective because it offers many facilities and it is relatively easy to use compared to the old and traditional registration system. The findings of the questionnaire indicate that about 26.1% of the students indicated that the new online or electronic registration system is satisfactory, but it needs some improvements in the future to remove and deal with all errors and mistakes that accompanied its application in its first year. The results of the questionnaire indicate that about 43.7% of the students indicate that the new online or electronic registration system is unsatisfactory mainly because of the technical errors and mistakes that accompanied its application and the delay it caused for the registration process for many of them.<sup>67</sup> This implies that ICT facilitates connection, transformation and transfer of knowledge in Khartoum University, as a case study of Sudanese universities.

Moreover, the Sudan University of Science and Technology (SUST) established its Computer Centre in 1992 to provide excellent and reliable services to satisfy the need for ICT, which had evolved and applied to all university activities. The Computer Centre contributes to improve the performance of SUST by automating the university systems and providing outstanding services to all the departments and units of SUST by providing suitable hardware equipment and networks, developing software applications, training the staff and providing innovative technical solutions. During the last decade the Centre built a suitable and solid ICT foundation by introducing the challenging infrastructure, and by training the ICT staff to manage ICT activities. The Centre uses these staff along with the academic staff members of SUST to provide solutions and consultancies and to build strategic relations with the governmental and non-governmental organisations. The Centre offers the university a computerised environment that enables it to achieve its mission, i.e. to enable a good environment for scientific production and innovation. Its main objectives include promoting IT inside the university, rendering computer and IT services for the university, taking into consideration the technological development which is manifested in training and networks and promoting atmosphere of IT in the university, supplying the university with computer sets and IT in addition to assembling and maintaining them, providing consultancies and preparing feasibility studies for the technological projects inside and outside the country, rendering

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<sup>67</sup> See Khartoum University Engineering Association Scientific Secretariat Magazine (April, 2009), p. 3

software services and unique database processing, rendering typing and computer design services for the university and other institutions and producing identification cards for both the university employees and students. Moreover, the Centre has extended its activities in the fields of IT through cementing relations with institutions and ministries. The Centre includes a number of technical, developing and administrative departments. For example, the software department plays a pioneering role in promoting work because software helps access, keeping and confidentiality of information. Consequently, the department is establishing specialised systems and programmers for bodies inside and outside the university besides preparing a database. The networks and technical support department includes the technical support unit, which provides both the university and the Centre with computer sets as well as assembling and maintaining these computers for the university, the teaching staff and the contractual bodies. The networks unit is assigned to internal and external networks by connecting the different campuses of the university because networks are considered to be the real infrastructure for technology applications, furthermore, the unit is designing and developing websites, in addition to providing feasibility studies for projects related to networks. The training department is one of the most important units of the Centre because it trains and qualifies people, who are considered the dynamic force for all activities. The unit is responsible for awarding International Computer Driving License (ICDL) for qualified individuals as well as eliminating computer illiteracy for the university leaders. The research and development department unit is responsible for feasibility studies related to the IT projects prepared by the Centre for the different institutions and ministries.<sup>68</sup>

Moreover, the University of Juba has established the College of Computer Science and Information Technology; although comparatively young, computer science has had a major impact on daily life during the last decades and its impact has perhaps been more significant and more pervasive than that of many other disciplines. The University of Juba aims to contribute to the increasing and dominating awareness amongst the government and private sector in Sudan of the importance of computer studies as a strategic contribution towards the promotion of human resources, through training on modern technologies linked to computer application, whether in hardware or software. The University established its Computer Studies Centre (CSC) in July 1996, which was opened with the latest technical specifications. Its main aim was to meet the practical requirements for short and intermediate training courses for government and private institutions as well as individual applicants. Since then, the CSC has developed courses which aim to produce graduates with expertise in programming and indepth knowledge of the methods involved in performing computations and processing data with computers. Following the increase in the demand for computer

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<sup>68</sup> See the Sudan University of Science and Technology (SUST) website: <http://www.sustech.edu/>, Accessed: 12 May 2009.

graduates, the College of Computer Science and Information Technology has been established as an extension of the already existing programme of the CSC. The main objectives are: to meet the need of labour market in the areas of software and hardware; to provide students with the knowledge and skills in computers to enable them to succeed in their future life no matter in what field of work they enter; and to keep up with the tremendous development in the area of computers and information technology.<sup>69</sup>

In addition, the Ahfad University for Women (AUW) established its Computer Sciences Unit (CSU) to promote the role of ICT in the production of knowledge in the university. The first computer experience within Ahfad was in 1985, when a training network was donated by the French government. After that some computers were donated to Ahfad by various organizations, including IBM, WHO and UNDP. They were used mainly for word processing and training students. This early start, relative to the rest of Sudan, gave Ahfad University some experience with computers and their uses. The university realised that soon computer experience would be important for its graduates and give them a better chance to find work if they have computer skills. The need for IT arises because of many reasons, for example, university staff studying abroad found it difficult to match research requirements without computer skills and often had to undergo training programmes. In addition, many administrative duties within the university were done manually resulting in errors and data losses. Moreover, data was kept in paper files and each staff member had their own way of recording information. Exchange and retrieval of older information took a very long time. For these reasons, the CSU was approved by the academic board in December, 1994. Its main objectives could be summarised as follows: to train both staff and students on various computer applications; to create, operate and develop the university databases; to promote, develop and maintain computer ability of the university both in software and hardware; and to help in the university press. Regarding activities and services, the CSU provides services for all the university schools and units on various aspects of computer application. This range includes the initial installing of a new computer, helping in presentations and other computer-assisted activities. In fact CSU services sometimes extend to other educational and non-educational institutions outside the university. In addition the CSU contribute to training of staff and students of the university. As for staff training, most if not all of the university staff members, have been trained at the CSU, regular training programs are held each year to update trained staff and initiate newly appointed ones. The training programme is divided into three stages, the first stage takes about 20 hours, the second stage 15 hours and the third stage takes 6 hours. The training programme includes the following stages and topics: Stage One includes introduction to the computer; word processing software; and spreadsheets. Stage

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<sup>69</sup> See Juba University website: <http://www.juba.edu.sd/>, Accessed: 12 May 2009.

Two includes: statistical software packages (SPSS and others); and Internet techniques. Stage Three includes: scanning techniques; presentation software (PowerPoint and others); and computer-aided education. As for student training, the programme began in 1996 for the third year of the School of Organizational Management. In 1997 the CSU started to offer courses to the Ahfad Primary School. The School of Health Sciences was included in the training programme in 1998. Currently all the university students have the chance for training according to the timetable set by the Staff and Student Training Lab (SSTL) tutor and the head of the unit. The SSTL trains more than 500 students from various schools of the university and students from Ahfad Primary School (APS) annually. Both undergraduate and postgraduate students are included in the training programs. The training programme includes the following topics: introduction to computers; using Windows; word processing software; spreadsheets; and Internet techniques. In addition, the CSU provides computer instruction to its staff members on different computer techniques in cooperation with other institutions, local and international. The CSU also helps with the organisation of the university databases, which now include the academic, the financial, the library, the digital images and the slides databases. For example, the academic database includes all information concerning academic results of the university students. It is centralised in the main server and accessed by staff members from all schools. The financial database includes financial information concerning students, staff and university bodies. The library database currently includes information about all the books in English held by the AlHafeed Library. The digital images database was established in the academic year 1998/99. It includes scanned photos and documents from various sources. These digital photos are used for presentations as well as made available to the use of staff and students in the university intranet. The slides database project was launched during the academic year 1999/2000, there are now more than 200 slides in the database and processing is still on going. The CSU is also responsible for the promotion of computer capacity of the university, developing the CSU infrastructure and maintenance of the university hardware and software. This part concerns response of the CSU workshop to various complaints, troubleshooting for photocopiers and consumables, computers and their accessories, spare parts and telephone repairs. Providing technical support for university academic and administrative staff; in this respect the CSU, is continuously advising university bodies, staff and students about their computer problems. These include network problems, software problems and hardware problems and operating the telecommunication system; the CSU has the obligation to maintain all telecommunication problems including installing new lines and repairing old ones. This was not originally part of the CSU main objectives. It came into the CSU's responsibility because the CSU was the initiator and the supervisor for the installation and operation of the telecommunication network system. The CSU also uses the telecommunication network to expand its computer network. As for the work groups the CSU

has five full-time staff members divided into four committees or work groups including: the Network and Systems Committee that is responsible for assembling, following up and maintaining the network; the Integrated Systems Committee that is responsible for all the university databases, financial, academic, library; the Maintenance and Supply Committee that works for the maintenance of the programmes and systems and the supply of all the needed spare parts for all the university; and the Training and Information Committee that is responsible for training of staff and students to use the Internet and CDs effectively. As for the facilities offered, the CSU has four offices and three labs. These consist of: the CSU head office, which also includes the main servers; the CSU workshop; the CSU store; and the telephone switchboard office. The three labs consist of the following: The staff and students training lab (16 workstations) located at the building of the School of Organizational Management; the Information Centre (15 workstations) located in the basement of AlHafeed Library; and the Computer Skills Training Lab (12 workstations) located at the building of School of Medicine. Plans for development includes developing the capacity for additional training of the staff and students of the university; introducing academic staff to available software and hardware; acquiring and introducing existing teaching software in various academic fields related to AUW; encouraging academic staff to develop, in cooperation with the CSU, computer based course contents that can be available to student through university intranet; training in the library system; develop training programmes for schools; and introducing the students to available computer based courses in the university. IT also facilitates inquiries about suitability of manuscripts and communication for publication of suitable manuscripts on topics affecting women in developing countries or contributions of women to rural and national development. Articles can be submitted in electronic form for review and publication at Ahfad Journal, Women and Change.<sup>70</sup>

Since its inception in 1991, the ComputerMan University (CMC) heralded a new era of technological studies at the higher education level in Sudan. The university established itself as a prime source of skilled ICT students and as a prime source of skilled computer scientists, information technologists and computer engineers, all of whom are timely needed by the country, to cope with the tremendous growth in communication and information technology as well as the global trend of specialisation and development in the ICT technologies. CMC strives to maintain its pioneering role and excellence in the dissemination of quality education through both traditional and online computer and ICT-based learning and teaching methods. CMC e-learning core strategies and policies include the following: provide high-quality e-learning opportunities for students and establish a reputation for the provision of excellent, varied and innovative e-learning and teaching methods; develop and disseminate

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<sup>70</sup> See Ahfad University website: [http://www.ahfad.org/computer\\_unit.html](http://www.ahfad.org/computer_unit.html), Accessed :10 May 2009.

relevant best practice in e-learning and teaching to meet challenging standards; continue to develop processes for monitoring and evaluating the effectiveness of e-learning in all subject areas to achieve consistency of standards; encourage research into e-learning and teaching so as to ensure that the learning strategies employed by the university are apposite and effective; provide a forum through university and faculty learning and teaching committees, to monitor and promote e-learning and teaching techniques and technologies, to ensure effective dissemination of these across all disciplines, and to set measurable targets for improvement; identify and support the effective use of information technologies and digital resources to aid the process of e-learning and teaching. The facilities offered by CMC includes an e-learning unit and library; the library offers remote access to information resources that are not limited to the in-house collection since the library has access to wider resources, e.g. Encyclopedia of Life Science and Support System (EOLSS), which is an electronic database of UNESCO. Internet is available for all patrons for use free of charge. In addition the library is using a Library Information System (LIS) known as WINISIS, which is a UNESCO product. WINISIS is an arabised and integrated system that accommodates all library operations. The library offers an On-line Public Access Catalogue (OPAC): all the library holdings are entered in the LIS as a bibliographic database. Searching and browsing is accessible from within the campus or remotely since the LIS is web-based.<sup>71</sup>

### **7.3 The effect of ICT on knowledge: ICT opportunities and challenges for connection and knowledge**

The results of the university survey indicate that Internet facilitates connections, networks and communication inside the institutions, with other institutions in Sudan, with regional institutions and with international institutions. The importance of the effect with regards to connections varies from all public and private universities academic teaching staff, support staff and students' perspectives, as we explain below (see also Table 35 below).

For example, from all the universities' academic teaching staff's perspective, Internet facilitates connections, networks and communication inside the institution, this is followed by equivalent effect in facilitating connections with international and with regional institutions and finally, the effect in facilitating connections with other institutions in Sudan is also mentioned, but somewhat surprisingly with somewhat less importance.<sup>72</sup> From the public universities' academic teaching staff's perspective, Internet facilitates connections with international institutions, and similarly connections, networks and communication inside the institution, this is followed by connections with regional institutions and finally with other institutions in Sudan respectively.<sup>73</sup> Whereas from the private universities' academic teaching

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<sup>71</sup> See Computerman university website: <http://www.computerman.edu/>. Accessed: 10 May 2009.

<sup>72</sup> As indicated by 73%, 70%, 68% and 59% of the respondent all universities academic staff respectively.

<sup>73</sup> As indicated by 74%, 70%, 68% and 58% of respondent public university academic staff respectively.

staff's perspective, Internet facilitates connections, networks and communication inside the institution, this is followed by connections with regional institutions, connections with other institutions in Sudan, and finally connections with international institutions respectively.<sup>74</sup> From the support staff's perspective, Internet highly facilitates connections, networks and communication inside the institution, which is higher than the equivalent effects in facilitating connections with other institutions in Sudan and connections with regional and with international institutions.<sup>75</sup> From the students' perspective, Internet facilitates connections, networks and communication inside the institution and connections with international institutions, but somewhat surprisingly it is with somewhat less importance than the higher equivalent effects in facilitating connections with other institutions in Sudan and connections with regional institution.<sup>76</sup>

One interesting observation from our findings is that both public and private universities agree on the important value of Internet for facilitating connections and internal networks inside the institutions. The importance and value of Internet for facilitating connections 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 own more favourable ICT infrastructure and manage to provide more facilities and therefore a more conducive environment for promoting good connections and internal networks. Another interpretation is that promotion of internal connections and networks is probably used by private universities to compete with other universities to attract more qualified academic teaching staff, 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 the Internet in facilitating external networks 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 connections and networks higher than the external networks, whereas, students present an opposite point of view and value the effect of Internet in facilitating external connections 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 connections inside their institutions, whereas students most probably are more interested in broadening their connections, namely external connections with other international, regional and local institutions in Sudan. From the students' perspective strong connections and networks with external institutions are probably required for increasing and enhancing educational, learning and research skills for students.

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<sup>74</sup> As reported by 81%, 71%, 65%, 59% of respondent private university academic staff respectively.

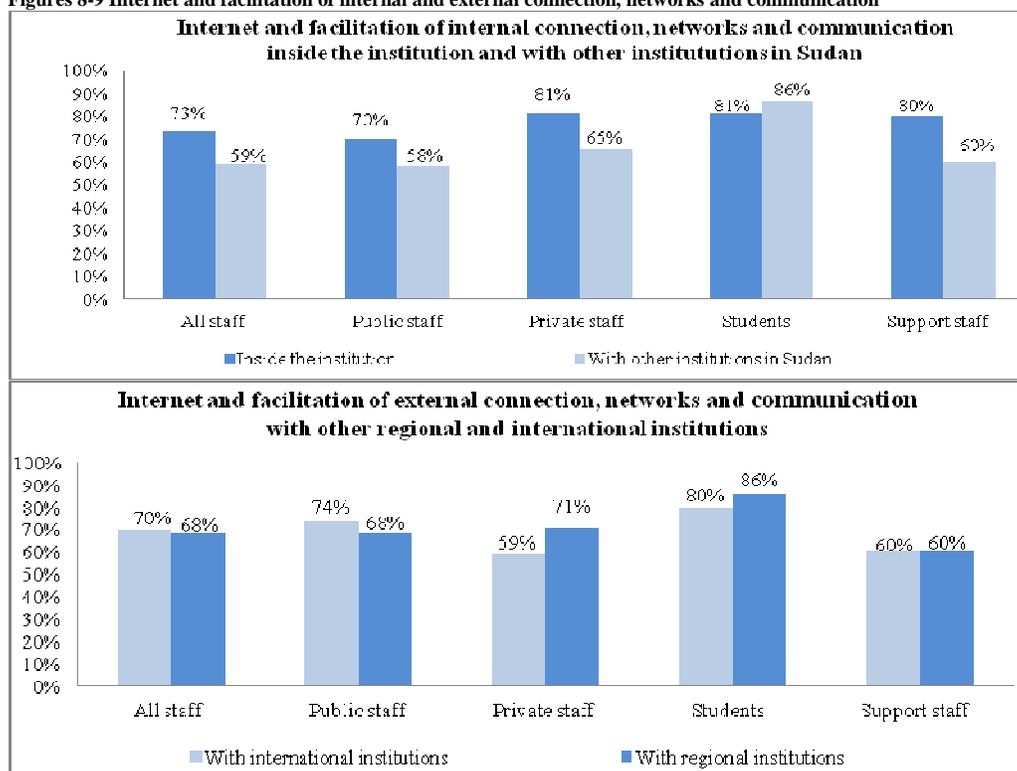
<sup>75</sup> As indicated by 80%, 60%, 60%, 60% of the respondent support staff respectively.

<sup>76</sup> As reported by 65%, 69%, 69%, 69% of the respondent students respectively.

**Table 35- The effect of Internet in facilitating connection, networks and communication**

	All	Public	Private	Students	Support staff
Inside the institution	73%	70%	81%	81%	80%
with international institutions	70%	74%	59%	80%	60%
with regional institutions	68%	68%	71%	86%	60%
with other institutions in Sudan	59%	58%	65%	86%	60%

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

**Figures 8-9 Internet and facilitation of internal and external connection, networks and communication**

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

### 7.3 ICT (Internet) impacts: opportunities and challenges

The results of the university survey indicate that from all the 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 difficulties. This section explains first the opportunities and advantages and then the challenges and difficulties (see also Tables 36-37 below).

#### 7.3.1 ICT (Internet) opportunities and advantages

From all the universities' academic teaching staff, support staff and students' perspectives Internet leads to many positive impacts, opportunities and advantages. The most important advantage is related to the use of Internet for facilitating connection and transformation and enhancing the production, creation and transfer of knowledge and includes increasing digital knowledge for academics and researchers by finding information that was earlier not available or accessible, a rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information. In addition, development of a new model for disseminating and distributing electronic information, where the information moved towards

the user, increasing creation and transfer of knowledge and increasing free access to electronic publications for academic purposes. Other opportunities and advantages are viewed differently by different groups, as we explain below (see Table 36 below).

From all the universities academic teaching staff's perspective the Internet provides many opportunities and advantages for facilitating connections and transforming and enhancing the production, creation and transfer of knowledge. For instance, the top opportunities and advantages include increasing digital knowledge for academics and researchers by finding information that was earlier neither available nor accessible, rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information, increased possibility of introduction of research outside academic fields, creation of linkages and contact between people with common interests in different activities related to increase of knowledge and development of a new model for disseminating and distributing electronic information, where the information moved towards the user.<sup>77</sup> In addition to increased creation and transfer of knowledge, encouragement and increased process of integration in world and international knowledge and increased free access to electronic publications for academic purposes.<sup>78</sup> Other advantages are 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 preservation of heritage for future generations, development of social capability and so acquisition of knowledge and learning new skills from others, saving of time and easy performance of work related to production and transfer of knowledge and facilitated preparation of unlimited copies with cheap prices in the Internet instantaneously without affecting the quality with the possibility of rapid transferring copies to any place in the world.<sup>79</sup> In addition to improved intellectual capacity that was earlier not available, introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advise users for the use of electronic data, information and documents, encouraged knowledge about other cultures and increased integration of higher education and research sector in implementation, assessment and regulation of ICT sector.<sup>80</sup> In addition to increased use of long distance learning, training and education, facilitated introduction of the world for production of knowledge and academic works conducted by Sudanese, 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.<sup>81</sup> In

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<sup>77</sup> As indicated by 100%, 100%, 99%, 99% and 99% of the respondent all universities academic staff respectively.

<sup>78</sup> As reported by 97%, 97%, and 96% of the respondent all universities academic staff.

<sup>79</sup> As indicated by 96% of the respondent all university academic staff.

<sup>80</sup> As reported by 95% of the respondent all university academic staff.

<sup>81</sup> As indicated by 93% of the respondent all university academic staff.

addition to introduction of change in the role of libraries by the use of the digital documents, facilitated contact between academic teaching staff colleagues and students in academic institutions and increased possibility of electronic dissemination of academic documents and for commercial benefits.<sup>82</sup> Furthermore, facilitated transfer of protected materials in the Internet and facilitated digital networks and the use of materials across borders and reduced monopoly in creation of knowledge earlier dominated by universities and researchers.<sup>83</sup> In addition to introduction of change by reducing the use of written paper, reduced need for the users to go to a library or documentation centre to have direct access to information/data and facilitated management of Intellectual Properties Rights (IPRs) and preventing piracy.<sup>84</sup>

From the support staff's 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, improved intellectual capacity that was earlier not available. In addition to the development of a new model for disseminating and distributing electronic information, where the information moved towards the user, increase creation and transfer of knowledge, increased the use of long distance learning, training and education, reduced monopoly in creation of knowledge earlier dominated by universities and researchers, increased possibility of electronic dissemination of academic documents and for commercial benefits and increased free access to electronic publications for academic purposes. Beside introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally, introduction of change in the role of libraries by the use of the digital documents and introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advise users for the use of electronic data, information and documents. Created linkage and contact between people with common interests in different activities related to increase of knowledge and saving of time and easy performance of work related to production and transfer of knowledge. Encouraged knowledge about other cultures, developed social capability and so acquisition of knowledge and learning new skills from others and reduced the need for the users to use the services of information professional to have direct access to information/data. In addition, it facilitated management of Intellectual Properties Rights (IPRs) and preventing piracy, facilitated 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 and facilitated transfer of protected materials in the Internet and digital networks and

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<sup>82</sup> As indicated by 93% of the respondent all university academic staff.

<sup>83</sup> As reported by 92% and 91% of academic staff in all the respondent universities.

<sup>84</sup> As reported by 86%, 83%, 83% of the respondent all universities academic staff respectively.

the use of materials across boarders.<sup>85</sup> This is followed by introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research and increase integration of higher education and research sector in implementation, assessment and regulation of ICT sector. Increased possibility of introduction of research outside academic fields and 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. In addition it facilitated introduction of the world for production of knowledge and academic works conducted by Sudanese, encouraged and increased process of integration in world and international knowledge, facilitated contact between academic teaching staff colleagues and students in academic institutions and reduced the need for the users to go to a library or documentation centre to have direct access to information/data.<sup>86</sup> And finally to a lesser extent facilitated introduction of change by reducing the use of written paper.<sup>87</sup>

From the students' perspectives the top advantages and opportunities include rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information, improved intellectual capacity that was earlier not available, increased digital knowledge for academic and researchers by finding information that was earlier not available or accessible and introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research.<sup>88</sup> In addition to increased creation and transfer of knowledge, increased integration of higher education and research sector in implementation, assessment and regulation of ICT sector and increased possibility of introduction of research outside academic fields, introduction of change in the role of libraries by the use of the digital documents and increased possibility of electronic dissemination of academic documents and for commercial benefits.<sup>89</sup> This is followed by development of social capability and so acquisition of knowledge and learning new skills from others, reduced monopoly in creation of knowledge earlier dominated by universities and researchers, introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally, increased free access to electronic publications for academic purposes and facilitated introduction of the world for production of knowledge and academic works conducted by Sudanese.<sup>90</sup> In addition to encouragement and increased process of integration in world and international knowledge institutions, encouraged knowledge about other cultures, creation of linkage and contact between people with common interests in different activities related to

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<sup>85</sup> As indicated by 80% of the respondent support staff.

<sup>86</sup> As reported by 60% of the respondent support staff.

<sup>87</sup> As indicated by 40% of the respondent support staff.

<sup>88</sup> As reported by 100% of the respondent students.

<sup>89</sup> As indicated by 100% of the respondent students.

<sup>90</sup> As reported by 96%, 95%, 95% 95% and 95% of the respondent students.

increase of knowledge and facilitated contact between academic teaching staff colleagues and students in academic institutions.<sup>91</sup> In addition to increased use of long distance learning, training and education, development of a new model for disseminating and distributing electronic information, where the information moved towards the user, 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 preservation of heritage for future generations.<sup>92</sup> In addition to introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advise users for the use of electronic data, information and documents, saving of time and easy performance of work related to production and transfer of knowledge.<sup>93</sup> Moreover, it also facilitated 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 and facilitated transfer of protected materials in the Internet and digital networks and the use of materials across borders.<sup>94</sup> In addition, it also reduces the need for the users to go to a library or documentation centre to have direct access to information/data, facilitates management of Intellectual Properties Rights (IPR) and preventing piracy and introduction of change by reducing the use of written paper.<sup>95</sup>

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 advantages for facilitating creation and transfer of knowledge in the Sudanese universities. The importance and value of Internet for providing many opportunities and advantages 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 environments for providing many opportunities and advantages for facilitating creation and transfer of knowledge. Another interpretation is that promotion of opportunities and advantages of Internet for facilitating creation and transfer of knowledge is probably used by private universities to compete with other universities in attracting more qualified academic teaching and support staff and qualified students. The only exception is that the importance of the Internet in improving intellectual capacity that was previously not available, is indicated as higher from the public universities' perspective compared to the private universities' perspective. Somewhat surprisingly regarding the importance of Internet in increasing

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<sup>91</sup> As indicated by 95% 95%, 95% and 95% of the respondent students.

<sup>92</sup> As indicated by 91% of the respondent students.

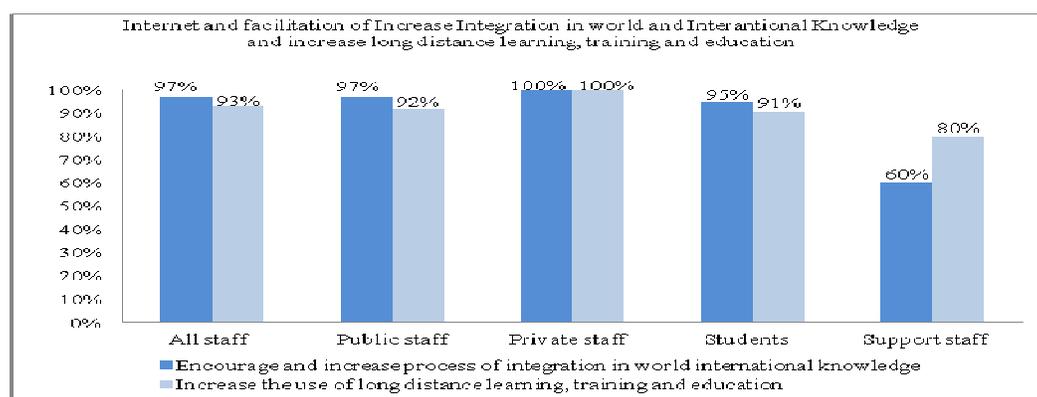
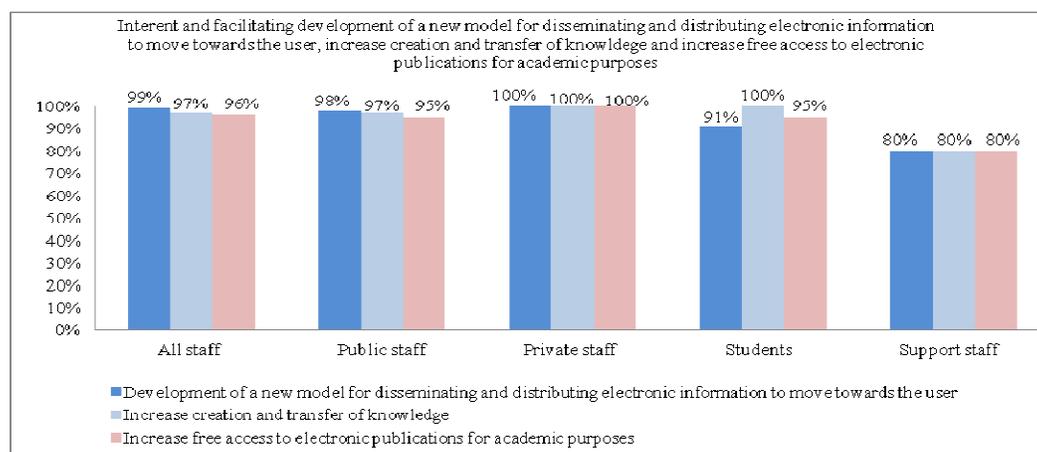
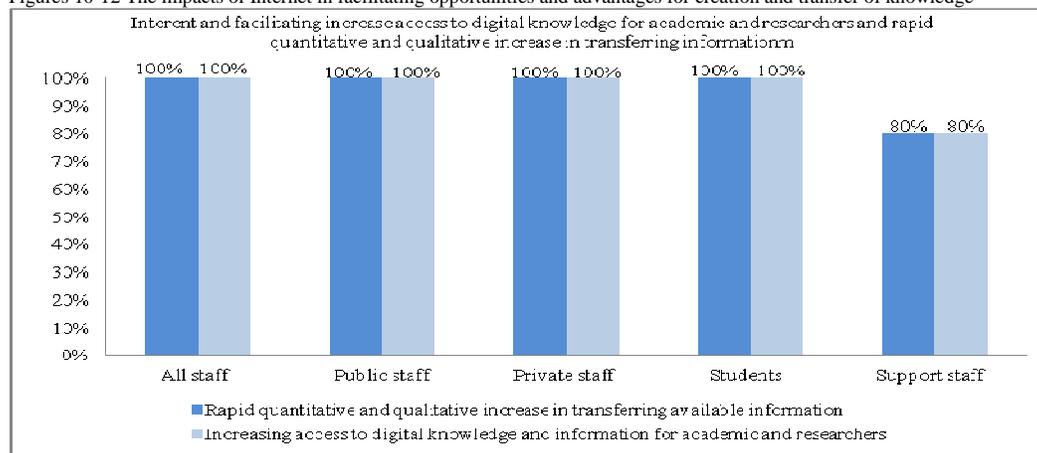
<sup>93</sup> As indicated by 91% of the respondent students.

<sup>94</sup> As reported by 91% of the respondent students.

<sup>95</sup> As reported by 86%, 82% and 65% of the respondent students respectively.

integration in the world and international knowledge institutions is that the private universities value it higher than the public universities. This is surprising probably because the majority of the public universities are older and have already established good repetitions and relationships with the world and international knowledge institutions, whereas the majority of the private universities –probably except Ahfad - are relatively young and only recently started to build repetitions and relationships with the world and international knowledge institutions.

Figures 10-12 The impacts of Internet in facilitating opportunities and advantages for creation and transfer of knowledge



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

Table 36- The impacts, opportunities and advantages of the use of Internet in facilitating creation and transfer of knowledge

Internet opportunities/ advantages	All staff	Public staff	Private staff	Students	Support staff
Rapid quantitative (in number) and qualitative (efficiency and speed) increase in transferring available information	100%	100%	100%	100%	80%
Increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible	100%	100%	100%	100%	80%
Increase possibility of introduction of research outside academic fields	99%	98%	100%	100%	60%
Create linkage and contact between people with common interests in different activities related to increase of knowledge	99%	98%	100%	95%	80%
The development of a new model for disseminating and distributing electronic information, where the information moved towards the user	99%	98%	100%	91%	80%
Increase creation and transfer of knowledge	97%	97%	100%	100%	80%
Encourage and increase process of integration in world international knowledge	97%	97%	100%	95%	60%
Save of time and easy performance of work related to production and transfer of knowledge	96%	95%	100%	91%	80%
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	96%	95%	100%	91%	60%
Increase free access to electronic publications for academic purposes	96%	95%	100%	95%	80%
Develop social capability and so acquisition of knowledge and learning new skills from others	96%	95%	100%	96%	80%
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	96%	95%	100%	91%	80%
Encourage knowledge about other cultures	95%	93%	100%	95%	80%
Improve intellectual capacity that was earlier not available	95%	97%	88%	100%	80%
Introduction of change in the role of workers in the libraries from the traditional roles in the traditional system to the new role to advise users for the use electronic data, information and documents	95%	93%	100%	91%	80%
Increase integration of higher education and research sector in implementation, assessment and regulation of ICT sector	95%	93%	100%	100%	60%
Introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research	93%	92%	100%	100%	60%
Reduce the need for the users to use the services of an information professional to have direct access to information/data	93%	93%	94%	91%	80%
Introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally	93%	91%	100%	95%	80%
Increase the use of long distance learning, training and education	93%	92%	100%	91%	80%
Increase possibility of electronic dissemination of academic documents and for commercial benefits	93%	91%	100%	100%	80%
Introduction of change in the role of libraries by the use of the digital documents.	93%	91%	100%	100%	80%
Facilitate introduction of the world for production of knowledge and academic works conducted by Sudanese	93%	93%	94%	95%	60%
Facilitate contact between academic teaching staff colleagues and students in academic institutions	93%	93%	94%	95%	60%
Facilitate transfer of protected materials in the Internet and digital networks and the use of materials across borders	92%	91%	94%	91%	80%
Reduce monopoly in creation of knowledge earlier dominated by universities and researchers	91%	88%	100%	95%	80%
Introduction of change by reducing the use of written paper	86%	84%	94%	65%	40%
Reduce the need for the users to go to a library or documentation centre to have direct access to information/data.	83%	81%	88%	86%	60%
Facilitate management of Intellectual Properties Rights (IPR) and preventing piracy	83%	82%	88%	82%	80%
Others	71%	71%	100%	75%	0%
N	80	63	17	26	5

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

### 7.3.2 ICT (Internet) challenges, problems and difficulties

From all the universities' academic teaching staff, support staff and students' perspectives, Internet leads to some other negative impacts, challenges and difficulties. From all universities' academic teaching and support staff's 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 licenses or subscriptions. Other problems are viewed differently by different groups as we explain in Table 37 below.

From all the universities' academic teaching staff's perspectives the top problem related to the use of Internet is the lack of or inadequate regular budget adequate for university libraries to pay for access to scientific and technical information, author's rights and have licenses or subscriptions.<sup>96</sup> This is followed by inadequate or lack of required technical skills, increased demand for technical and engineering education related to ICT and the problem, lack of assessment policies and evaluation programmes, increased training and knowledge for users to ensure relevant use of the electronic information and increased 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.<sup>97</sup> Other difficulties include difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information and 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 IPR and preventing piracy for academic documents when transferring adjusted unoriginal documents for users.<sup>98</sup> In addition to the problem of lack of clear objectives and strategic planning, increased worry of families regarding children's time wasted on Internet, SMS, video, welfare and entertainment facilities, increased worry of institutions regarding waste of working time on Internet, personal e-mail and use for personal purposes.<sup>99</sup> In addition to the difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries and the problem of creating gaps (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology.<sup>100</sup> In addition to the difficulties of high costs of acquiring licenses for access to electronic libraries for individuals and institutions, difficulty of access to scientific and technical information for creation and transfer of knowledge, difficulty of regular access to Internet, problem of creation of isolation for illiterate people who do not know how to use the Internet.<sup>101</sup> In addition to the limited and lack of modern available references, poor availability or lack of services offered to users, difficulties of preventing spy programmes and spread of viruses, difficulty of overcoming the problem of high costs paid for using information, difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources.<sup>102</sup> Other problems include lack of enthusiasm for the use of Internet to improve and increase efficiency and promotion of

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<sup>96</sup> As indicated by 96% of the respondent all universities academic staff.

<sup>97</sup> As indicated by 94%, 94%, 93%, 93%, 93% of the respondent all universities academic staff.

<sup>98</sup> As reported by 92% of the respondent all universities academic staff.

<sup>99</sup> As reported by 92% of the respondent all universities academic staff.

<sup>100</sup> As reported by 90% of the respondent all universities academic staff.

<sup>101</sup> As indicated by 89% of the respondent all universities academic staff.

<sup>102</sup> As indicated by 88%, 87%, 86%, 86%, 85% of the respondent all universities academic staff.

institutions of higher education and scientific research due to limited electronic knowledge and widespread electronic illiteracy, risk of spread of electronic piracy, lack of access to credit cards and lack of security in their use, lack of enthusiasm for electronic publications and inadequate electronic capacity.<sup>103</sup>

From the support staff's perspective, the top problems related to the use of Internet include lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, author's rights and have licenses 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 widespread electronic illiteracy and lack of access to credit cards and lack of security in their use. In addition to the difficulty of increased 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 and the increased demand for technical and engineering education related to ICT and difficulties of preventing spy programmes and the spread of viruses.<sup>104</sup> Other problems include lack of enthusiasm for electronic publications, risk of spread of electronic piracy, difficulty of overcoming the problem of high costs paid for using information and lack of assessment policies and evaluation programmes. In addition to difficulty of regular access to Internet, limited and lack of modern available references, difficulty of overcoming the problem of copyrights and obstacles to dissemination and use of these sources, high costs of acquiring licenses for access to electronic libraries for individuals and institutions, creation of isolation for illiterate people who do not know how to use the Internet and increased worry of institutions on waste of working time of their workers on Internet, personal e-mail and use for personal purposes. In addition to the difficulty of increased training and knowledge for users to ensure relevant use of the electronic information, difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information and easy change and adjustment of original documents and impacts on author's moral and financial rights and impacts on hindering management of IPR and preventing piracy for academic documents when transferring adjusted unoriginal documents for users.<sup>105</sup> Other problems include, poor or lack of services offered to users, inadequate or lack of the required technical skills, inadequate electronic capacity, difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries, creating gaps (related to training and financial ability to

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<sup>103</sup> As reported by 82%, 81%, 81%, 79%, 73% of the respondent all universities academic staff respectively.

<sup>104</sup> As indicated by 80% of the respondent support staff.

<sup>105</sup> As reported by 60% of the respondent support staff.

communicate) between those who own and those who do not own the Internet technology and increase worry of families regarding children's wasted time on Internet, SMS, video, welfare and entertainments facilities.<sup>106</sup>

From the students' perspective, the top problem related to the use of Internet is lack of or inadequate regular budget for universities libraries to pay for access to scientific and technical information, author's rights and have licenses or subscriptions.<sup>107</sup> In addition to the problem of access to scientific and technical information for creation and transfer of knowledge, increased demand for technical and engineering education related to ICT, inadequate and lack of the required technical skills and difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information.<sup>108</sup> In addition to increased 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, creating gaps (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology, increase worry of families regarding children's wasted time on Internet, SMS, video, welfare and entertainments facilities.<sup>109</sup> Other problems are the 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 widespread electronic illiteracy and 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.<sup>110</sup> In addition to the lack of assessment policies and evaluation programmes, difficulty of overcoming the problem of high costs paid for using information, increased training and knowledge for users to ensure relevant use of the electronic information, and increased worry of institutions regarding waste of working time of their workers on Internet, personal e-mail and use for personal purposes.<sup>111</sup> Other problems include lack of access to credit cards and lack of security in their use, creation of isolation for illiterate people who do not know how to use the Internet and difficulties of preventing programmes of spy and spread of viruses.<sup>112</sup> In addition to the difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources, high costs of acquiring licenses for access to electronic libraries for individuals and institutions, difficulty of regular access to Internet and limited and lack of modern available references.<sup>113</sup> Other

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<sup>106</sup> As indicated by 40% of the respondent support staff.

<sup>107</sup> As reported by 100% of the respondent students.

<sup>108</sup> As reported by 96%, 95%, 95% and 95% of the respondent students respectively.

<sup>109</sup> As indicated by 95% of the respondent students.

<sup>110</sup> As indicated by 91% and 90% of the respondent students respectively.

<sup>111</sup> As indicated by 90% of the respondent students.

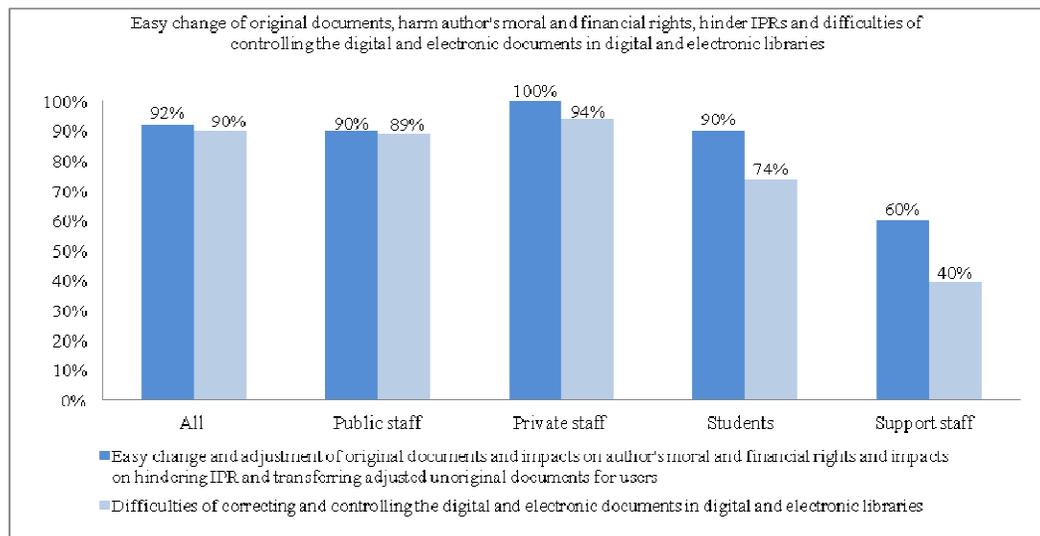
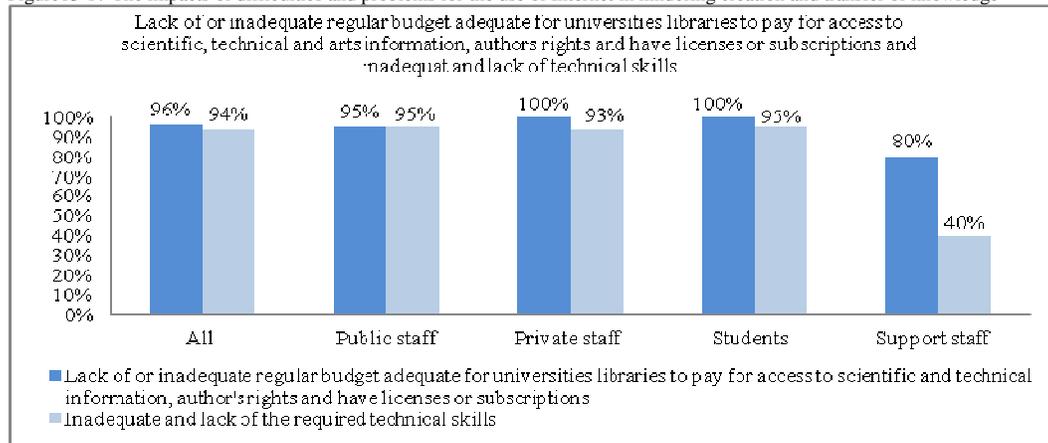
<sup>112</sup> As indicated by 89% of the respondent students.

<sup>113</sup> As reported by 85%, 85%, 85% and 83% of the respondent students.

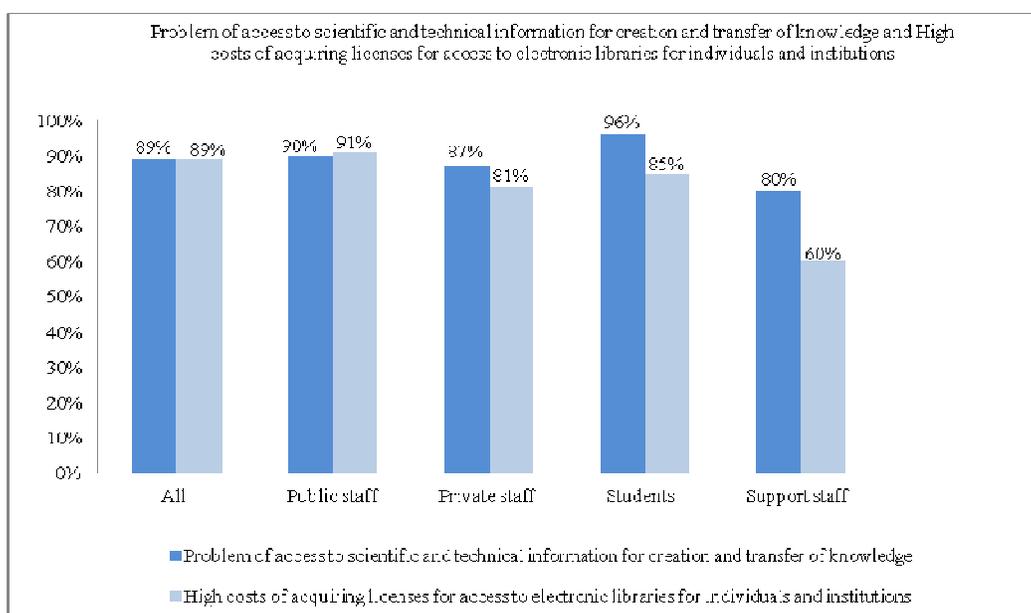
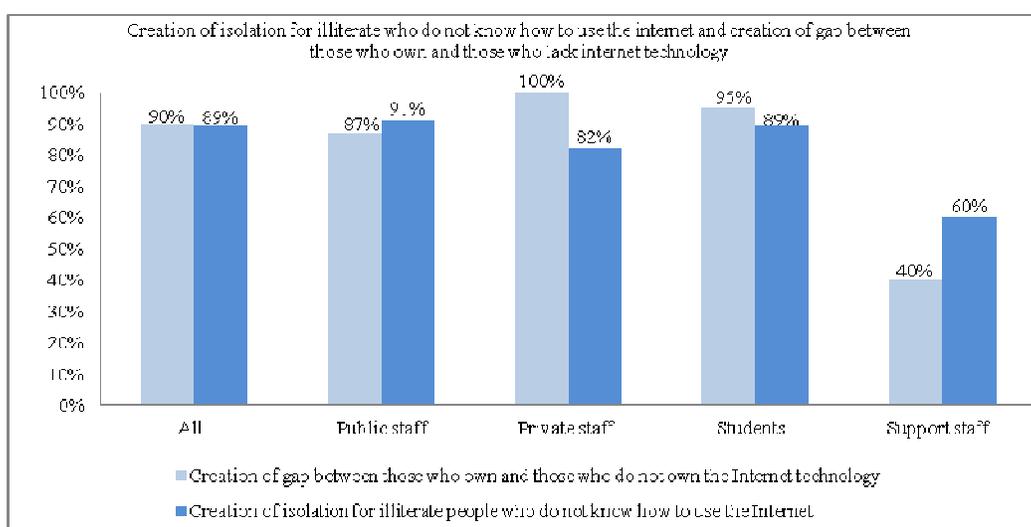
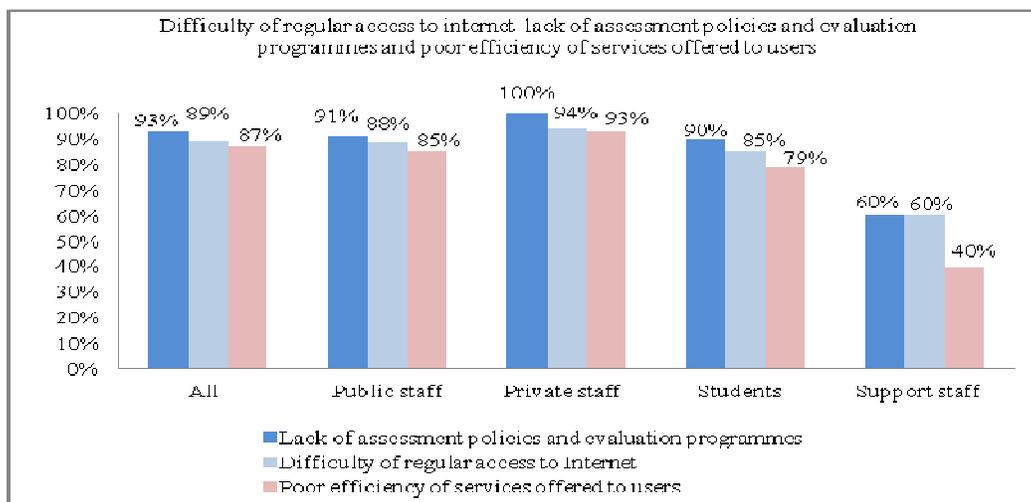
difficulties are lack of clear objectives and strategic planning, poor or lack of services offered to users, the risk of spread of electronic piracy, inadequate electronic capacity, difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries and lack of enthusiasm for electronic publications.<sup>114</sup>

One interesting observation from our findings is that both public and private universities agree on several problems and challenges related to the use of Internet that are hindering the creation and transfer of knowledge in Sudanese universities. The complaint about most of these problems and difficulties and their corresponding implications 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 environments for meeting the challenges, solving the problems and difficulties hindering the creation and transfer of knowledge.

Figure 13-17 The impacts of difficulties and problems for the use of Internet in hindering creation and transfer of knowledge



<sup>114</sup> As indicated by 79%, 79%, 77%, 75%, 74%, 73% of the respondent students.



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

**Table 37- The impacts of difficulties and problems for the use of Internet in hindering creation and transfer of knowledge**

Internet challenges/ difficulties	All	Public staff	Private staff	Students	Support staff
Lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific and technical information, author's rights and have licenses or subscriptions	96%	95%	100%	100%	80%
Increase demand for technical and engineering education related to ICT	94%	92%	100%	95%	80%
Inadequate and lack of the required technical skills	94%	95%	93%	95%	40%
Lack of assessment policies and evaluation programmes	93%	91%	100%	90%	60%
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	93%	93%	94%	95%	80%
Increase training and knowledge for users to ensure relevant use of the electronic information	93%	91%	100%	90%	60%
Lack of clear objectives and strategic planning	92%	93%	88%	79%	80%
Increase worry of families regarding children's time wasted on Internet, SMS, video, welfare and entertainments facilities	92%	93%	88%	95%	40%
Increase worry of institutions regarding waste of working time on Internet, personal e-mail and use for personal purposes	92%	91%	94%	90%	60%
Difficulty of distinction between original and unoriginal documents and risk for users to use wrong unreliable information	92%	93%	88%	95%	60%
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 (IPR) and preventing piracy for academic documents when transferring adjusted unoriginal documents for users	92%	90%	100%	90%	60%
Difficulties of correcting and controlling the digital and electronic documents in digital and electronic libraries	90%	89%	94%	74%	40%
Creating gap (related to training and financial ability to communicate) between those who own and those who do not own the Internet technology	90%	87%	100%	95%	40%
Problem of access to scientific and technical information for creation and transfer of knowledge	89%	90%	87%	96%	80%
Difficulty of regular access to Internet	89%	88%	94%	85%	60%
High costs of acquiring licenses for access to electronic libraries for individuals and institutions	89%	91%	81%	85%	60%
Creation of isolation for illiterate people who do not know how to use the Internet	89%	91%	82%	89%	60%
Limited and lack of modern available references	88%	86%	94%	83%	60%
Poor or lack of services offered to users	87%	85%	93%	79%	40%
Difficulties of preventing programmes of spy programmes and spread of viruses	86%	87%	81%	89%	80%
Difficulty of overcoming the problem of high costs paid for using information	86%	88%	82%	90%	60%
Difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources	85%	88%	75%	85%	60%
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 widespread electronic illiteracy	82%	78%	94%	91%	80%
Risk of spread of electronic piracy	81%	82%	76%	77%	60%
Lack of access to credit cards and lack of security in their use	81%	82%	75%	89%	80%
Lack of enthusiasm for electronic publications	79%	76%	88%	73%	60%
Inadequate electronic capacity	73%	75%	65%	75%	40%
Others	100%	100%	100%	0%	0%
N	80	63	17	26	5

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

### 7.3.3 The effect of ICT in the labour market and on knowledge

Assessment indicates the importance effect of the use of ICT in the labour market. For instance, from all the respondents' perspective, the effects of ICT in the labour market include increased competition in production and cost especially the cost of labour and their quality, besides the impact on the type and structure of jobs through both creating new jobs in the labour market and destroying old jobs in the labour market. In addition to the impacts on the ways of doing jobs through the use of IT in doing jobs and managing projects, cancelling and reducing the concept of distance and changing the concept of work place (possibility of doing

work in home). In addition to the impacts on education courses (that lead to jobs with changing contents) ways, patterns, techniques and times through increasing demand for practical education at different levels, increasing importance of training before and within the job, increasing the role of IT-distance learning and the possibility of re-qualifying in accordance to changing needs in the labour market and the rising unemployment problem. In addition to the necessity of education after acquiring the minimum level of basic knowledge and the role of technology to respond to needs of special categories (people with disabilities and underdeveloped education) respectively<sup>115</sup> (see Table 38 below).

Table 38- Assessment of the importance of the effect of the use of ICT in labour market

	All	Public	Private	Students	Support staff
Increase competition in production and costs especially the cost of labour factor and their quality	97%	96%	100%	100%	80%
Impact on the type and structure of jobs through:					
Creating new jobs in labour market	96%	95%	100%	95%	80%
Destruction of old jobs in labour market	86%	88%	81%	86%	80%
Impacts on ways of doing jobs through:					
Use of IT in doing jobs and managing projects	97%	98%	94%	100%	80%
Cancelling and reduce concept of distance	95%	95%	94%	100%	80%
Change concept of work place (possibility of doing work in home)	88%	86%	94%	74%	0%
Impacts on education courses (that lead to jobs with changing contents) ways, patterns, techniques and times through:					
Increase demand for practical education at different levels	97%	98%	94%	96%	40%
Increase importance of training before and within the job	96%	95%	100%	95%	80%
increasing role of IT-Distance Learning	94%	92%	100%	100%	80%
Possibility of requalifying in accordance to changing needs in the labour market and facing the rising unemployment problem	94%	92%	100%	95%	40%
Role of technology to respond to needs of special categories (people with disabilities and underdeveloped education)	93%	93%	94%	100%	80%
Necessity of education during all life after acquiring minimum level of basic knowledge	93%	93%	94%	95%	40%

## 7.4 Conclusions

This chapter focuses on the impacts of ICT in the connection, transformation, creation and transfer of knowledge in Sudan as a case study of African countries. Section 1 presents an introduction. Section 2 reviews the theoretical and empirical literature discussing the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the role of ICT in connections, transformation and production of knowledge. Section 3 explains the status and properties of ICT diffusion in the knowledge production institutions, notably universities in the African region in general and in the Sudan in particular, we show the importance of the use of ICT in the Sudanese universities. Section 4 explains the data and methodology to examine the impacts of ICT diffusion in introducing transformation and production of knowledge in Sudan as a case study of the African region.

<sup>115</sup> As indicated by 97%, 96%, 86%, 97%, 95%, 88%, 97%, 96%, 94%, 94%, 93% and 93% of all respondent staff respectively. As indicated by 96%, 95%, 88%, 98%, 95%, 86%, 98%, 95%, 92%, 92%, 93% and 93% of respondent public staff respectively. As indicated by 100%, 100%, 81%, 94%, 94%, 94%, 94%, 100%, 100%, 100%, 94% and 94% of respondent private staff respectively. As indicated by 100%, 95%, 86%, 100%, 100%, 74%, 96%, 95%, 100%, 95%, 100% and 95% of respondent students respectively. As indicated by 80%, 80%, 80%, 80%, 80%, 0%, 40%, 80%, 80%, 40%, 80% and 40% of respondent support staff respectively.

Section 5 discusses the results on the impacts of the use of ICT in transformation, production creation and transfer of knowledge across universities in Sudan as a case study of the African countries. Our findings in this chapter are consistent, agree with and add a new African case study to contribute to the African literature on ICT, higher education institutions and universities in Africa as we explain in Chapter 3 above. Our results in this chapter verify the fifth and sixth hypotheses in Chapter 1 above on the importance and impacts of ICT in facilitating the creation and transfer of knowledge in Sudanese universities. Our results are consistent with the results in theoretical and empirical literature. We show that the use of ICT, namely Internet, facilitates connections, networks and communication inside knowledge institutions, namely Sudanese universities, facilitates connections with other institutions in Sudan, with regional and international institutions, collaboration between Sudanese universities and international universities, northern institutions and integration of Sudanese universities in the system of global knowledge production. Our findings support the hypothesis that the use of ICT introduces 'positive-negative' effects by providing opportunities for the production, creation and transfer of knowledge, but simultaneously also creating hazards to production, creation and transfer of knowledge in African, namely Sudanese universities: the positive effect is enhancing access, production and dissemination of knowledge, building connections and organisational changes; the negative transformation is building disconnections for those who do not share the knowledge and do not know how to use ICT. Our results show that the most important advantage related to the use of Internet for facilitating connection and transformation and enhancing the production, creation and transfer of knowledge includes 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. In addition to development of a new model for disseminating and distributing electronic information, where the information moved towards the user and not the other way around, increased creation and transfer of knowledge and increased free access to electronic publications for academic purposes. Our findings indicate that the top problem related to the use of Internet is the lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, licenses and subscriptions.

From all the universities' academic teaching staff, support staff and students' perspectives the most important advantage related to the use of the Internet for facilitating connection and transformation and enhancing the production, creation and transfer of knowledge includes 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. In addition to development of a new model for disseminating and distributing electronic information, where

the information moved towards the user, increased creation and transfer of knowledge and increased free access to electronic publications for academic purposes. From all the universities' academic teaching and support staff's perspectives the top problem related to the use of the Internet is the lack of or inadequate regular budget adequate for university libraries to pay for access to scientific and technical information, author's rights and have licenses or subscriptions.

Finally we show the rapid growth in the use of ICT in Sudan; the use of ICT facilitates transformation and connections in Sudanese universities, enhances access to and transfer of knowledge in Sudanese universities, facilitates integration into the global knowledge and collaboration between international universities and Sudanese universities and introduces some opportunities and challenges for connections and transformations in Sudanese universities. The major policy implication from our findings is that it is essential for policy making in Sudan and Sudanese universities to enhance the use and impacts of ICT, mainly by motivating the effective use of ICT for creation and transfer of knowledge, enhancing quality and accumulation of human capital and skill and offering adequate budget for enhancing ICT in Sudanese universities.

## Chapter 8: Summary and Conclusions

This research provides an interesting indepth pioneering analysis of demand for and economic impact of ICT from the demand perspective and from public-private perspectives in public and private Sudanese universities. The aims of this research is three fold: first, to examine the status, pattern, structure, trend and determinants of the demand for ICT in public and private Sudanese universities; second to investigate the economic impacts of the uses of ICT, the potential opportunities and challenges that ICT is expected to create for public and private Sudanese universities; and finally to explain the role of ICT in facilitating the production, creation and transfer of knowledge in Sudanese universities.

We fill the gap in the literature, since we examine the demand for ICT from public-private perspective in Sudanese universities. Different from earlier studies in the literature that focuses on ICT from the supply perspective, we provide a new and perhaps the first study focused on ICT from the demand perspective, since we examine both the uses and impacts of ICT in public and private Sudanese universities. One advantage and interesting element in our analysis is that we present a more comprehensive analysis from the demand perspective concerning the use and impacts of ICT at the micro level and we compare between public and private universities. Another advantage is that we examine from the demand perspective, the use and economic impacts of ICT after integrating three different perspectives of academic teaching staff, support staff and students. A novel element in our analysis is that we use a new primary survey data at the micro level, which we obtained from the university survey of Nour (2009) which we distributed randomly amongst 131 individuals in 10 public and private Sudanese universities located in Khartoum.

Chapter 1 gives a background and a brief general overview of the research problem and briefly shows the importance, relevance, objectives, hypotheses, and the general structure of the research project. Chapter two presents an introduction and background to motivate the research and explains some stylised facts, the research problem along with other strategic problems confronting economic development in Sudan. Section 1 explains that Sudan's economy has been characterised by low GDP per capita income, presence of high rates of poverty, unemployment and inequalities in resources sharing. But in recent years following the increasing dependence on oil structural change in the economy improvement in the economic performance and leads to sound economic growth, Sudan turned from a low income economy into a lower medium income economy according to the World Bank classification putting Sudan among the fastest growing economies in Africa (World Bank, 2008). Section 2 explains the status of ICT in Sudan; we show that in the recent years, Sudan has shown growing telecommunication networks and Internet services but still has the most expensive Internet service compared to other African and developing countries. We show that UNDP-

HDR (2007) data for 1990-2005 indicates the rapid diffusion of ICT: Internet is faster than mobile and fixed telephone, the use of Internet and telephone landlines in Sudan are higher than Sub-Saharan Africa (SSA) and less than world, but the use of mobile in Sudan is less than SSA and the world. Moreover, World Bank-World Development Indicators database (2009) data for 2000-07 indicates the fast growth in mobile (21%) which is more than twice the fast growth in Internet (9.1%) in Sudan; the fast growth in mobile in Sudan is below SSA, but the fast growth in Internet in Sudan is above SSA. Our findings indicate that the reported increasing trend of the use of mobile and Internet at the aggregate macro level in Sudan seems consistent with the observed increasing trend at the regional and international levels.

Chapter 2 reviews the theoretical and empirical literature discussing the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the demand for and impacts of the use of ICT in facilitating the production, creation and transfer of knowledge, as confirmed in the new growth literature. Chapter 3 provides a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature on the use and impact of ICT. In Section 1 we review the theoretical and empirical literature and emphasise the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the demand for and impacts of the use of ICT in facilitating the production, creation and transfer of knowledge, as confirmed in the new growth literature. In Section 2 we explain the literature on the use and impact of ICT in higher education institutions in Africa; in particular, we show the significance and impacts of ICT for enhancing knowledge production in higher education institutions and universities in Africa. This chapter discusses the theoretical and empirical endogenous growth literature on the demand for ICT and relationship between ICT, creation and transfer of knowledge and economic growth, which we considered as a useful background for the empirical investigation that follows in the next chapters.

Chapter 4 explains the research methodology and methods of data collection and illustrates the composition and operation of the survey in this chapter. Section 1 explains the motives for performing the university survey and selection of a case study. Section 2 shows the selection of the sample and composition of the survey. Section 3 explains the structure and design of the questionnaire and Section 4 provides the conclusions, advantages and limitations of the survey.

Chapter 5 provides the empirical analysis and examines from public-private perspective the research hypotheses on the public-private differential in the demand for ICT, trend, determinants in Sudanese universities. Section 1 defines the main characteristics of the respondent including academic teaching staff, support staff and students in the respondent universities. Section 2 presents from the demand perspective an indepth analysis of the use of ICT, pattern, trend, nature, extent, structural change and comparative advantages of the

demand for the use of the different modes of ICT in public and private Sudanese universities. Section 3 explains and examines the income and price effects of the use of ICT in public and private Sudanese universities. Chapter five presents our findings and proves the first hypothesis in Chapter 1 above on the presence of significant public-private differential between public and private universities in Sudan not only in the general characteristics but also in the demand for and impacts of ICT. For instance, our results show that the reported rapid incidence of the observed structural change in the demand for ICT, knowledge about computer and Internet, the importance, structure, trend, and income and prices effects of the demand for the four ICT modes, fixed telephone, mobile telephones, computer and Internet, seems to be more significant for private university staff compared to public university staff. This can be interpreted in relation to the observed differences in the general characteristics, which imply that monthly income and skill level are relatively higher for private university staff compared to public university staff.

Our findings prove our second hypothesis in Chapter 1 above which implies that demand for the four ICT modes is characterised by considerable dynamism: it shows a dynamic increasing trend and significant structural change over time amongst public and private university staff in Sudan. For instance, we confirm the incidence of structural change in the demand for ICT by scrutinising the historical use of the four ICT modes which implies that fixed telephone was used earlier as old or more traditional and a long-standing ICT mode, but then there is a gradual and visible shift toward using of other new more recent ICT modes such as computer, mobile and Internet respectively amongst academic teaching staff, support staff and students.

Our results present several interesting pieces of evidences in support of the hypothesis on the incidence of structural change in the demand for the four ICT modes from the demand perspective. For instance, we find that one important piece of evidence on the incidence of structural change in the demand for ICT can be elaborated from our result which indicates that for the majority of all respondents the personal use of mobile telephone, Internet and computer shows an increasing trends, while the personal use of fixed telephone shows an opposite decreasing trend. For the majority the personal use of mobile telephone is growing faster than Internet, computer and fixed telephone respectively. This result seems consistent with the reported increasing trend of the use of mobile and Internet at the aggregate macro level in Sudan and also consistent with the observed increasing trend at the regional and international levels.

The interpretation of the above-mentioned evidence on the incidence of structural change in the trend of the demand for the four ICT modes provides another piece of evidence in support of the hypothesis on the incidence of structural change in the demand for ICT, which can be elaborated from the demand perspective along with the respondents' assessment

views on the importance of ICT for satisfaction of personal need and utility that highlight the three ICT modes, mobile telephone, Internet and computer, as highly important and value fixed telephone as moderately important. Our findings on the trend and assessment of the importance of ICT indicate different preference of the different ICT modes that can be explained in relation to preference of specific characteristics such as fashion, style and good design, ease of use, cheap price and efficiency and high quality. Our findings indicate that somewhat surprisingly despite the high poverty rate and low per capita income, the reported concern about cheap price comes next to the reported concern about efficiency and high quality. We find that for the majority of the respondents the preference of the use of different modes of ICT is most probably related to preference of specific characteristics such as efficiency and high quality. This implies that the respondents are much more concerned with efficiency and high quality, which can be interpreted probably because of high skill level and therefore increasing awareness amongst the respondents in public and private Sudanese universities. We find that from all the respondents' perspectives, the most important advantages of using fixed telephone include ease of use for people who are illiterate or have limited electronic knowledge, facilitated communication with Internet and ease of use in work. The most important advantages of using mobile telephone includes easy to carry and move from place to place, easy for waiting calls and messages from other people, facilitated social contact with family, ease of use in work, facilitated social contact with friends, ease of use of SMS and facilitated direct contact and reach of the requested person. The most important advantages related to the use of Internet include facilitated training to improve skill for the use of computer and Internet, enhanced learning, training, skill and capacity for all society, long distance learning from international institutions, R&D skill and efforts and cheap price. In addition, Internet provides advantages such as facilitated study, research, networks and communication, job listings, participation in seminars, conferences and workshops and social and work contact. Our findings imply that because of these multiple advantages for satisfying the needs and utility in an academic setting in Sudanese universities, Internet is followed by mobile as the most important ICT mode that are popular and very widely used amongst academic staff. For the majority of the respondents mobile is preferred because of the characteristics of fashion, style and good design and ease of use, while Internet is preferred because of the characteristics of cheap price and efficiency and high quality. These multiple advantages of mobile and Internet gives further justification for the incidence of the structural change in the demand for ICT in Sudanese universities.

Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our finding that the effect of the costs of expenditure on imposing burden in personal budget is most important for mobile telephone, which is higher than Internet and computer, but less important for fixed telephone. Additional

evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our result that the effect of the costs of expenditure on ICT on competing with the expenditures on other goods and services in personal budget is most important for mobile telephone, which is higher than the moderate important effect for Internet and computer and less important effect for fixed telephone. Another piece of evidence in support of our hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings which implies that the effect of the increase in income on increasing the use of ICT is most important for mobile telephone, which is higher than Internet and computer and less important for fixed telephone. Somewhat surprisingly, even for both private staff and support staff the increase in income has an unimportant effect for the demand for fixed telephone; this implies that fixed telephone tends to be an inferior good and show an inelastic demand with respect to increase in income for both private staff and support staff. Our findings imply that from all the staff's perspective, for the majority the increase in income has an important effect on increasing the demand for the use of various ICT modes, fixed telephone, mobile telephone and Internet, and that the use of various ICT modes tend to be normal goods and their demand varies in the same direction as income. This finding is consistent with the conventional stylised fact on the theoretical literature on the positive income effect or the positive relationship between income and demand, i.e. that increase in income has important positive impacts on increasing the use of ICT. Additional evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our results, which indicate that the effect of the increase in prices in reducing the demand for the use of ICT is most important for mobile telephone, which is higher than Internet and fixed telephone. Our results indicate that from all the staff's perspective, for the majority the effect of the increase in prices has important impacts on reducing the demand for the use of various modes of ICT: fixed telephone, mobile telephone and Internet. This result is consistent with the conventional stylised fact in the theoretical literature on the downward sloping demand curve or the negative price effect or the negative relationship between price and demand. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings which indicate an interesting cross price or substitution effect between the various modes of ICT, i.e. between fixed telephone, mobile telephone and Internet, in particular, somewhat surprising is the substitution effect between mobile telephone and fixed telephone, which is higher than the substitution effect between mobile telephone and the Internet. The relationship between fixed telephone and Internet is somewhat confusing, but for the majority the relationship is in favour or support of the complementary relationship, so this most probably indicates a complementary relationship between fixed telephone and Internet. Our findings indicate that the interesting substitution effect seems to be observed not only between the

demand for the various ICT modes, but also between the supplier companies offering ICT services. For instance, our results indicate that the reduction of the prices of ICT offered by ICT competing companies has an important effect in motivating transference of the demand for ICT services offered by ICT competing companies with cheap prices and in reducing the demand for ICT services offered by the current company with high prices. This result is consistent with the conventional stylised facts in theoretical literature concerning the cross price, substitution-complementary effects and rationality of consumers.

Chapter 6 provides the empirical analysis and examines from the public-private perspective the research hypotheses on the public-private differential in the supply side of ICT in Sudanese universities. Section 1 defines the main characteristics of the supply side of ICT in Sudan. Section 2 shows an indepth analysis from the demand perspective the supply side of ICT, methods and places of connection to ICT. Section 3 explains the difficulties on the supply and demand sides and suggestions for relevant solutions. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from the supply side. For instance, next to the well investigated structural change in the structure of the supply of ICT market from monopoly to monopolistic competition with more than one operating companies, we explain further structural change from the demand perspective. We find that the increasing number of operating companies has been in favour of consumers not only by increasing availability of ICT services but also by offering consumers wider options for selection from the different ICT supplier companies. For instance, our results indicate that from all the respondents' perspective, fixed telephone is mainly supplied by Sudatel and Canar, mobile telephone is mainly supplied by Zain and Sudani and Internet services are mainly offered by Sudatel and Sudani. Our findings indicate that the above-observed structural change in the supply side from monopoly by Sudatel to monopolistic competition with many operating companies has been in favour of consumers not only by increasing availability of ICT services, but also by increasing competition between different ICT supplier companies to attract more consumers by offering ICT services with high or improved efficiency, low or cheap prices and also the introduction of price discrimination mechanisms. Our results indicate further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT from the demand perspective in relation to the supply side, for instance our findings imply shift from Sudatel as ICT pioneer company to Zain as new recent ICT supplier company. Our results imply that the justification of this shift or structural change is related to preference of certain characteristics of the supplier company. For instance, our findings imply that from all the respondents' perspective, the preference of the company offering ICT services indicates that Zain is the most preferred company and ranks first compared to other companies because of its distinguished characteristics in terms of fashion, style, good design, efficiency and high quality, ease of use

and price discrimination; Zain is also ranked second next to Sudani in terms of cheap price. This result is also consistent with the conventional stylised fact in the theoretical literature concerning the rationality of consumers. Another piece of evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings on the methods of connection to the Internet, which indicate significant shift from connection via dial-up by telephone to connection by ADSL. For instance, our results indicate that from all the staff's perspective, for the majority, the most widely used and common way for connection with the Internet is through ADSL, which is used by near to half of all respondents, followed by connection by wireless, which is used by near to one third of all respondents and finally by fixed telephone which is used by near to one fifth of all respondents. Further evidence in support of the hypothesis on the incidence of structural change in the demand for ICT can be elaborated from our findings, which imply that from all the staff's perspective, for the majority, in both the home and office mobile telephone, computer and Internet are widely used, while fixed telephone is less often used. Our results indicate that from all the respondents' perspective ICT is often and widely accessed in both the home and office, while Internet café and telecommunication offices are less often widely used compared to both home and offices as common locations for the use of ICT. In particular, both computer and Internet are very often used in office or work place; this is probably because they are offered free of charge in the office or work place for the respondents in public and private Sudanese universities.

Apart from the above observed structural change in the demand for ICT, our findings in Chapter 5 verify the third hypothesis in Chapter 1 above that the demand for the four ICT modes amongst public and private university staff in Sudan is determined by income, education attainment level, age, and gender. Our results prove the fourth hypothesis in Chapter 1 above that the demand for or the use of Internet shows positive significant correlations with the use of telephone; the use of/spending on IT (computer) shows positive significant correlations (complementary relationships) with both telecommunication and ICT training amongst public and private university staff in Sudanese universities. Our results are consistent with the findings in the theoretical and empirical endogenous growth literature on the correlation between ICT components and human capital.

Chapter 7 focuses on the impacts of ICT in connection, transformation, creation and transfer of knowledge in Sudanese universities. Section 1 presents an introduction on Sudanese national ICT strategy and policy in higher education, Section 2 examines ICT and knowledge production institutions in Sudanese universities, reviews the theoretical and empirical literature discussing the significance and impacts of ICT as confirmed in the endogenous growth literature, in particular, the role of ICT in connections, transformation and production of knowledge. Section 3 explains the effect of ICT in knowledge: ICT

opportunities and challenge for connection and knowledge in knowledge production institutions, notably Sudanese universities. Finally, Section 4 provides the conclusions. Our results discussed in Chapter 7 verify the fifth and sixth hypotheses in Chapter 1 above on the importance and impacts of ICT in facilitating the creation and transfer of knowledge in Sudanese universities. Our results are consistent with the results in the theoretical and empirical literature. We show that the use of ICT, namely Internet, facilitates connections, networks and communication inside knowledge institutions, namely Sudanese universities, facilitates connections with other institutions in Sudan, with regional and international institutions, collaboration between Sudanese universities and international universities, northern institutions and integration of Sudanese universities into the system of global knowledge production. Our findings support the hypothesis that the use of ICT introduces 'positive-negative' effects by providing opportunities for the production, creation and transfer of knowledge, but simultaneously also creating hazards to production, creation and transfer of knowledge in Sudanese universities: the positive effect is enhancing access, production and dissemination of knowledge, building connections and organisational changes; the negative transformation is building disconnections for those who do not share the knowledge and do not know how to use ICT. Our results show that the most important advantages related to the use of Internet for facilitating connections and transformations and enhancing the production, creation and transfer of knowledge, 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. In addition to development of a new model for disseminating and distributing electronic information, where the information moved towards the user and not the other way around, increased creation and transfer of knowledge and increased free access to electronic publications for academic purposes. Our findings indicate that the top problem related to the use of Internet is the lack of or inadequate regular budget for university libraries to pay for access to scientific and technical information, licenses and subscriptions. Finally, the general conclusion of this chapter is that the advantages of using ICT in Sudanese universities are more than the challenges or difficulties. We explain that ICT introduces opportunities and challenges for the creation and transfer of knowledge. One of these challenges or difficulties is that ICT has the capacity to lead to disconnection and to marginalisation of some people. By disconnection we mean the difficulties of getting connected due to the difficulties on both the supply and demand sides. On the supply side disconnection is probably caused by poor availability, inefficiency and interruption or irregular supply of ICT services. On the demand side, disconnection means lack of ability to connect that is probably due to both poverty and therefore, inability to have access to ICT and the lack of adequate skill and knowledge to use ICT, particularly for the poor. This implies

that disconnection leads to creating gaps and marginalisation of some people who are poor and lacking access and other people who are lacking skill and knowledge to use ICT. The major ethical and political implications are that ICT, by causing disconnection, has the potential to add a new form of marginalisation and therefore add to the already existing inequalities between the different social groups in Sudan. The major policy recommendation on the demand side is increasing subsidies for the poor to facilitate their access to ICT and increase literacy, skill and knowledge about ICT to improve access to ICT. The major suggestion on the supply side is increasing availability, sustainability and improving efficiency of ICT services. The findings in Chapter 7 are consistent, agree with and add a new case study to contribute to the literature on ICT, higher education institutions and universities in Africa (cf. Durrant, 2004; Beebe, et al., 2003; Olukosh and Zeleza, 2004), universities in Egypt (cf. (Radwan, 2003: Cairo University and other Egyptian universities), Kenya (Thairu, 2003: Kenya Education Network), Kenya and Nigeria (Oyeyinka and 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 are useful to improve understanding of the role of ICT in production, creation and transfer of knowledge in Sudan as a new case study in the literature. In addition in this research we fill the gap in the literature by focusing only in Sudan as a new case study in the literature; mainly we explain the importance of the use of ICT for facilitating connection within knowledge institutions and for introducing opportunities and challenges for the creation and transfer of knowledge.

The findings in Chapter 7 suggest that ICT is leading to significant transformation by facilitating connection, creation and transfer of knowledge in Sudanese universities. The introduction of ICT has the potential to support scientific research activities, improve the ways of acquisition of knowledge, support the restructuring of administration and modernisation of Sudanese universities and facilitate access to electronic publications and online courses and distance learning, help solve the problematic access to limited members in enrolment through distance education, help bridge the knowledge divide by improving accessibility to scientific and technical information, facilitate internal and external connections, improve collaboration between south-south and south-north and create and transfer knowledge. In the future ICT has the potential to continue playing an important role and facilitate connection, creation and transfer of knowledge in Sudanese universities provided that they manage to overcome the difficulties on the supply and demand sides, in particular, improve skill, training and knowledge about ICT and improve availability, sustainability and efficiency of ICT infrastructure (cf. Durrant, 2004). In addition to increasing government spending for the development of ICT infrastructure in higher education and for provision of subsidies to offer adequate regular budgets for university

libraries to pay for having licenses or subscriptions and access to scientific and technical information. However, there are both political and ethical issues related to government spending on ICT. As for the political issue, the justification of the commitment of the Sudanese government spending on the development of ICT for the universities, is probably because the universities relate to the elite and their power-position; therefore, when the Sudanese government spends money on ICT it is then 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 the universities, thereby reducing the amount of money it has available for addressing important issues such as poverty and health. This probably implies a disadvantage of ICT, as government spending on ICT draws money away from other urgent targets (the poor). The major implication here is that more spending on ICT, probably implies less spending on social development such as health and poverty reduction, consequently, poverty will continue to increase and the poor will suffer more. Therefore, probably, the challenge would be how to make the right balance and trade off between allocations of government funds to different priorities. The major policy recommendation is to encourage private sector involvement on ICT and to focusing government spending on ICT more towards the beneficiaries of the poor by upgrading their skills, offering more education and employment opportunities for the poor that will also contribute towards achieving the UN Millennium Development Goal of halving the share of people living in poverty by 2015.

Our findings show that the main problems on the supply sides are the lack of government spending on ICT, lack of or inadequate investment, high costs of offering services, low quality/efficiency of the services, lack of networks, interruption/disconnection of the services, lack of R&D, slow speed of the services, interruption of electricity supply, inadequate capacity of services, lack of infrastructure, uncertainty related to investment in ICT and lack of technical skills. Whereas, the main problems on the demand side are high spread of electronic illiteracy, high cost for offering the services, lack of awareness of the importance of ICT in the new economy and high spread of poverty. Based on these results, our findings indicate that the major recommendations and policies on the supply sides include improvement and increase in R&D, improvement and increase in infrastructure, improvement and increase in efficiency and capacity of services, improvement and increase in speed of the services, introduction of policies to increase collaboration in the field of research and publication and free access to electronic publications for academic purpose in developing countries, introduction of policies to reduce the digital and scientific gap between Sudan and advanced countries in the world, improvement and increase in government spending and investment on ICT, encourage the use of preferential tariff or free access to electronic publications for academic purpose in developing countries, treatment of problem of

interruption/disconnection of services, improvement and increase in networks offering the services, treatment of interruption of electricity supply and encouragement and support of private investment to offering services. Whereas, the main recommendations and policy on the demand sides includes, improvement and increase in quality of education and electronic knowledge and eradication of electronic illiteracy, reduced cost for offering the services, improvement and increase in awareness of the importance of ICT in the new economy, improvement and increase in income and eradicate poverty. Therefore, the major policy implications from our results is that it is essential for policy making in Sudan and Sudanese universities to enhance the use and impacts of ICT, mainly by motivating the effective use of ICT for creation and transfer of knowledge, enhancing quality and accumulation of human capital and skill and offering adequate budget for enhancing ICT in Sudanese universities.

Our findings from the ICT survey indicate that the use of ICT has grown and increased in Sudan, despite many obstacles that are represented in the high cost. For instance, the academic staff confirm the importance of ICT, mobile phone, computers and the Internet, for their personal use, but the high cost of mobile negatively affects their expenses because of their high and widespread personal use of mobile. We find that the ICT technology has qualitatively affected and eased the burden of long-distance for the branches of institutions within and outside Sudan. Although, the impact of high technology may be effective over the long term, the benefit and advantages from the use of Internet services, especially in scientific research depends on the capabilities of the user and knowledge of the English language and mastery of specialisation and cooperation with international institutions to provide access to specialised sites. We find that certainly the impact of information technology is very useful if properly employed for the purposes of scientific research. But it may have negative effects if not employed properly. Our findings from the ICT survey imply several recommendations for the use of ICT in Sudan. We recommend the government to seriously address the problems hindering access and use of ICT and to facilitate the provision of ICT modes at reduced costs and free of charge provision of fixed telephone and exemption of the input related to the transfer of information technology. In view of the problem of low standard of living in Sudan that is reflected in all aspects of life, including ICT, the government needs to address technological illiteracy, the limited ability of most people even educated people to acquire computers at home, the limited access to ICT service to certain segments of society, notably, the financially able and highly educated and lack of access to ICT to poor people due to the high cost that constitutes a burden for the poor. We appeal to the responsible authorities to facilitate free of charge provision, connections and access or facilitating subsidised provision of ICT services for all members of the community in every place (school, home, workplace, etc.), especially, the poor and rural areas, in order to contribute to increasing education and raising awareness. Since the use of ICT is related to the level of development, income and

knowledge, we recommend increasing income and living conditions and skill and knowledge for all Sudanese to improve their access to ICT. In addition we recommend improving the literacy and knowledge about the English language and research strategies for information retrieval on the Internet. Moreover, we recommend reducing the official control over access to Internet and removing all obstacles in the flow of information, and easy provision of ICT in accordance with the state's general policy, principle, moral values, general regulations and sound measures. We recommend avoiding the negative impact and treatment of the problem of the seizure of the information and blocking and controlling of important academic programmes and websites, without any objective justification to withhold important useful websites that may be due to limited cultural attitudes. We recommend improving use of electronic publications. Moreover, we recommend maximising the productive use of ICT and minimising other currently widespread misuse of ICT for unproductive, unimportant and unnecessary purposes, for example, leisure, entertainment, to follow up the news of celebrities, songs, movies, etc. In addition, we recommend enhancing the direction of the use of ICT for all purposes of production and development and dissemination of knowledge in Sudan. We recommend increasing sufficient awareness of the importance of ICT and its impact on development and scientific knowledge amongst all Sudanese, not only among the highly educated people. We recommend reforming the laws and legislations for the protection of IPR related to the use of ICT. In addition, we recommend implementing other important policies in the demand side by focusing on the import of equipment with high efficiency and design, reducing the tariff imposed on it, facilitating acquisition by consumers, in addition to ensuring quality (total quality assurance (TQA)). Moreover, we recommend improving government policy towards the use of ICT and linking that to the various government strategies and provision of all necessary infrastructure and human development. In addition, we recommend the government encourage increasing investment and accelerating the diffusion of ICT, as more investment in the information technology is needed, especially given the Internet is not accessible to about 60% of the population of Sudan, notably the rural population. In addition, we recommend the government encourage the introduction of the use of ICT at all education levels; we recommend the provision of training for all public people interested in the use of ICT means. We recommend increasing the use of ICT and its direct impacts on increasing production, by reducing the cost and increasing the efficiency and speed of the Internet and reducing the burden imposed on many families in the Sudan as a result of ICT use. Moreover, we recommend that the expansion in the use of ICT must be well thought out so that it adds to the positive development of human, social, cultural and economic development in Sudan.

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19. Please determine the approximate costs of expenditure on the use of ICT over the past four years (in Sudanese pounds)

	2005	2006	2007	2008
expenditure on the use of Fixed telephone including maintaining services				
expenditure on the use of Mobile telephone including maintaining services				
expenditure on the use of Computer including maintaining services				
expenditure on the use of Internet including maintaining services				
expenditure on the ICT training				

20. Please give an approximate assessment of the length (history) and costs of expenditure on ICT (in Sudanese pounds)

	Fixed telephone	Mobile telephone	Computer	Internet
History: how long				
Monthly usage: How long per month				
Monthly cost of usage: how much expenditure per month				

21. Please give assessment of the importance of the effect of the costs of expenditure on ICT on imposing burden in personal budget?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Fixed telephone				
Mobile telephone				
Computer				
Internet				

22. Please give an assessment of the importance of the effect of the costs of expenditure on ICT on competing with the expenditures on other goods and services in personal budget?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Fixed telephone				
Mobile telephone				
Computer				
Internet				

23. Please give an assessment of the importance of the effect of the increase in income and impacts on increasing the use of ICT?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
effect of increase in income on increasing the use of Fixed telephone				
effect of increase in income on increasing the use of Mobile telephone				
effect of increase in income on increasing the use of Computer				
effect of increase in income on increasing the use of Internet				

24. Please give an assessment of the importance of the effect of the increase in the prices and impacts on reducing the use of ICT?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
effect of increase in the prices of Fixed telephone				
Reduce the use of Fixed telephone				
Increase the use of Mobile telephone				
Increase the use of Internet				
Reduce the use of Internet				
effect of increase in the prices of Mobile telephone				
Reduce the use of Mobile telephone				
Increase the use of Fixed telephone				
Increase the use of Internet				
effect of increase in the prices of Internet				
Reduce the use of Internet				
Increase the use of Fixed telephone				
Increase the use of Mobile telephone				

25 Please give an assessment of the importance of the effect of reduction of the prices of ICT offered by the competing company?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Transfer to competing company with cheap price				
Reduce the use from the current company				

**d. Difficulties on the supply and demand side on the use of ICT**

26. Please assess the importance of the effect of the lack of fluency in English language in hindering the personal usage of ICT?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Mobile telephone				
Computer				
Internet				

27. Please give an assessment of the importance of the effect of the difficulties in the supply and demand sides in hindering the personal usage of ICT?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Supply sides				
Lack of govt. spending on ICT				
Lack of / inadequate investment				
Lack of infrastructure				
Lack of R&D				
Inadequate capacity of services				
Slow speed of the services				
Interrupt/disconnection services				
High costs of offering services				
Lack of networks				
Uncertainty related to investment in ICT				
Interrupt of electricity supply				
Low quality/ efficiency of the services				
Lack of technical skills				
Others				
Demand side:				
Lack of awareness of the importance of ICT in the new economy				
High cost for offering the services				
High spread of electronic illiteracy				
High spread of poverty				
Others				

**e. Characteristics of the use of ICT**

28. Please give an assessment of the importance of the use of fixed telephone compared to mobile and internet in facilitating fulfillment of personal utility?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Cheap price and low usage cost				
Easy for use with people who are illiterate or have limited electronic knowledge				
Facilitate communication with internet				
Preserve/ keep personal privacy				
Easy for use in work				
Facilitate social contact with family				
Facilitate social contact with friends				
Facilitate work contact with colleagues inside the institution				
Facilitate work contact with other institutions in Sudan				
Facilitate work contact with regional institutions				
Facilitate work contact with international institutions				
Others				

29. Please give an assessment of the importance of the use of mobile compared to fixed telephone and internet in facilitating fulfillment of personal utility?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Reduce spending				
Control spending through prepaid services				
Facilitate communication with internet				
Facilitate direct contact and reach of the requested person				
Easy for carry and move from place to place				
Easy for transfer of account from place to place				
Easy for use of SMS				
Easy for waiting call and messages from other people				
Easy for use in work				
Facilitate social contact with family				
Facilitate social contact with friends				
Facilitate work contact with colleagues inside the institution				
Facilitate work contact with other institutions in Sudan				
Facilitate work contact with regional institutions				

Facilitate work contact with international institutions				
Others				

30. Please give an assessment of the importance of the use of internet for facilitating fulfillment of personal utility?

		Degree of importance			
		Unimportant	Slightly important	Moderately important	Extremely important
Study	Facilitate search for books and literature for study purpose				
	Improve understanding and facilitate search for electronic information				
	Improve knowledge, training and learning skills				
	Facilitate search for chances to study abroad				
	Others				
Research	Facilitate search for books and literature for doing research				
	Facilitate search for electronic information for doing research				
	Improve research skills for doing research				
	Facilitate research collaboration between colleagues for doing research				
	Facilitate publication of research				
	Others				
Network and communication	Inside the institution				
	with other institutions in Sudan				
	with regional institutions				
	with international institutions				
Look for job	inside the institution				
	in other institutions in Sudan				
	in regional institutions				
	in international institutions				
Participation in seminars, conferences and workshops	inside the institution				
	in other institutions in Sudan				
	in regional institutions				
	in international institutions				
Social and work contact	Facilitate social contact with family				
	Facilitate social contact with friends				
	Facilitate work contact with colleagues inside the institution				
	Facilitate work contact with other institutions in Sudan				
	Facilitate work contact with regional institutions				
	Facilitate work contact with international institutions				
	Others				

31. Please give an assessment of the importance of the use of internet compared to fixed telephone and mobile in facilitating fulfillment of personal utility for creating the following opportunities and challenges?

Opportunities:	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Cheap price and low costs				
Enhancing production, creating investment opportunities and encourage electronic commerce				
Creating employment opportunities for poor				
Creating employment opportunities for youth				
Creating employment opportunities for women				
Enhancing learning, training, skill and capacity for all society				
Enhancing learning, training, skill and capacity for women				
Enhancing long distance learning, from international institutions				
Enhancing R&D skill and efforts				
Facilitate training to improve skill for the use of computer and internet				
Offer welfare and entertainments facilities				
<b>Challenges:</b>				
Increase competition and competitiveness				
Create burden for allocation and distribution of limited govt. resources between poor regions				
Increase inequality between rich and poor (those who own and those who do not own technology)				
Exclusion and reduction of unskilled labours jobs				
Increase employability of only high skilled labour				
Increase demand for technical and engineering education related to ICT				
Increase inequality and disparity and imbalanced development between				

states in Sudan				
Increase underdevelopment and digital gap Sudan and advanced world countries				
Difficult for use with people who are illiterate or have limited electronic knowledge				
Create other side effects for health				
Others				

**f. Policies for encouraging and supporting the use of ICT**

32. Please give an assessment of the importance of the effect of the importance of implementation of the following policies in the supply and demand sides in encouraging and supporting the use of ICT?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
<b>Policies in the Supply sides</b>				
Improve and increase govt. spending and investment on ICT				
Improve and increase infrastructure				
Improve and increase R&D				
Improve and increase efficiency and capacity of services				
Improve and increase speed of the services				
Treatment of problem of Interrupt/disconnection services				
Improve and increase networks offering the services				
Encourage and support private investment to offering services				
Treatment of Interrupt of electricity supply				
Introduction of policies to reduce digital and scientific gap between Sudan and advanced countries in the world.				
Introduction of policies to increase collaboration in the field of research and publication and free access to electronic publications for academic purpose in developing countries				
Encourage the use of preferential tariff or free access to electronic publications for academic purpose in developing countries				
Others				
<b>Policies on the Demand side:</b>				
Improve and increase awareness of the importance of ICT in the new economy				
reduce cost for offering the services				
Improve and increase quality of education and electronic knowledge and eradication of electronic illiteracy				
Improve and increase income and eradicate poverty				
Others				

**h. The impacts and advantages of the use of Internet in facilitating creation and transfer of knowledge**

33. Please give an assessment of the importance of the use of internet in facilitating fulfillment of the following opportunities and advantages for creation and transfer of knowledge?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
<b>Internet opportunities/ advantages</b>				
Rapid increase in number (quantity) and quality (efficiency and speed) in transferring available information				
Increasing digital knowledge for academic and researchers by finding information that was earlier not available or accessible.				
Improve intellectual capacity that was earlier not available				
Introduction of the use of new ways and modern techniques for improving quality and efficiency of education and scientific research				
Increase integration of higher education and research sector in implementation, assessment and regulation of ICT sector				
Increase creation and transfer of knowledge				
Increase the use of long distance learning, training and education				
Reduce monopoly in creation of knowledge earlier dominated by universities and researchers				
Increase possibility of introduction of research outside academic fields				
Increase possibility of electronic dissemination of academic documents and for commercial benefits				
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				
Increase free access to electronic publications for academic purposes				
Introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally.				
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 electronic data, information and documents.				
Facilitate introduction of the world for production of knowledge and academic works conducted by Sudanese				
Encourage and increase process of integration in world international knowledge				
Create linkage and contact between people with common interests in different activities related to increase of knowledge				
Save of time and easy performance of work related to production and transfer of knowledge				
Introduction of change by reducing the use of written paper				
Encourage knowledge about other cultures				
Develop social capability and so acquisition of knowledge and learning new skills from others				
The development of a new model for disseminating and distributing electronic information, where the information moved towards the user (Push) and not the other way round (Pull).				
Reduce the need for the users to use the services of an information professional to have direct access to information/data.				
Reduce the need for the users to go to a library or documentation centre to have direct access to information/data.				
Facilitate contact between teaching staffs colleagues and students in academic institution				
Facilitate management of Intellectual Properties Rights and preventing piracy.				
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				
Facilitate transfer of protected in the internet and digital networks and the use of materials across boarders.				
Others				

**i. The impacts of difficulties and problems for the use of Internet in creation and transfer of knowledge**

34. Please give an assessment of the importance of the following challenges/difficulties facing the use of internet and hindering facilitating for creation and transfer of knowledge?

Internet challenges/ difficulties	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Problem of access to scientific and technical information for creation and transfer of knowledge.				
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				
Lack of enthusiasm for electronic publications				
Risk of spread of electronic piracy				
Difficulty of overcoming the problem of high costs paid for using information.				
Lack of access to credit cards and lack of security in their use				
Lack of or inadequate regular budget adequate for universities libraries to pay for access to scientific, technical and arts information, authors rights and have licenses or subscription. distance learning, training and education				
Creating gap (related to training and financial ability to communicate) between those who own and those who do not own the internet technology				
Lack of clear objectives and strategic planning				
Lack of assessment policies and evaluation programmes				
Difficulty of regular access to internet				
Limited and lack of modern available references				
Poor or lack of services offered to users				
Difficulty of overcoming the problem of copyrights and obstacle to dissemination and use of these sources.				
High costs of acquiring licenses for access to electronic libraries for individuals and institutions.				
Creation of isolation for illiterate who do not know how to use the internet.				
Difficulties of preventing programmes of spy and spread of viruses				
Increase worry of families of waste of time of their children on internet, SMS, video, welfare and entertainments facilities				
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				
Inadequate electronic capacity				
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				
Increase training and knowledge for users to ensure relevant use of the electronic information.				
Increase demand for technical and engineering education related to ICT				
Inadequate and lack of the required technical skills				
Difficulty of distinction between original and not original documents and risk for users to use wrong unreliable information.				
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 and preventing piracy for academic documents when transferring adjusted non original documents for users.				
Others				

**g. The impacts of ICT on labour market**

35. Please give an assessment of the importance of the effect of the use of ICT in labour market?

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
Increase competition in production and costs especially human being factor and their quality				
Impact on jobs contents and structure in labour markets through:				
Creating new jobs in labour market				
Hide old jobs in labour market				
Impacts on ways of doing jobs through:				
Use of IT in doing jobs and managing projects				
Canceling and reduce concept of distance				
Change concept of work place (possibility of doing work in home)				
Impacts on education courses (that lead to jobs with changing contents) ways, patterns, techniques and times through:				
Increase demand for practical education at different levels				
Necessity of education during all life after acquiring minimum level of basic knowledge				
Increase importance of training before and within the job				
Possibility of requalifying in accordance to changing needs in the labour market and facing the rising unemployment problem				
Role of technology to respond to needs of special categories (people with disabilities and underdeveloped education)				

36 Do you want to add any other general comments regarding the impacts of ICT to improve gender equality in Sudan?

.....  
 .....  
 .....

We would like to extend to you sincere thanks for your kind cooperation and for finding the time in completing this questionnaire.

Name of the person completing the survey:

Name of institution:

Position in the institution:

Telephone number:

Fax number:

E-mail:

Date:

### ABOUT THE AUTHOR

Dr Samia Satti Osman Mohamed Nour obtained her first degree (BSc Hons.) and second degree (MSc) in Economics from the University of Khartoum (Sudan) in 1994 and 1999 respectively, and her doctorate (PhD) in Economics from the University of Maastricht (the Netherlands) in 2005. Currently, she is a Visiting Research Fellow (and former Ph.D. Fellow) at UNU-MERIT, School of Business and Economics, Maastricht University, the Netherlands. She is an Assistant Professor of Economics at the Department of Economics, Faculty of Economic and Social Studies, Khartoum University, Sudan (currently on sabbatical leave). At the Department of Economics, Khartoum University, she teaches Macroeconomics, Labour Economics, Development Economics and Industrial Economics for the B.SC. (undergraduate class) and Microeconomics for the M.Sc. (postgraduate class). She was employed as the coordinator of the Ph.D. programme in Economics (2006-2009) and as a teaching assistant (1995-2005) at the Department of Economics, Faculty of Economic and Social Studies, Khartoum University. She received five different best student faculty prizes during her undergraduate studies and several research awards and grants during her postgraduate studies. She completed several research projects supported by several regional and international institutions. Dr Samia stayed as a Ph.D. Fellow at Maastricht University and UNU-INTECH, now UNU-MERIT, Maastricht, the Netherlands from September 1999 to November 2005; as a Ph.D. Intern at UNU-WIDER, Helsinki, Finland from May to July 2002; as a visiting research fellow at ASC, Leiden University, Leiden, the Netherlands from May to July 2009 and as a visiting research fellow at UNU-MERIT, Maastricht, the Netherlands from October 2010 to November 2011. Dr Samia's main research interests are in the fields of Economics, Economics of Technical Change, Macroeconomics, Microeconomics, Labour Economics, Development Economics, Human Capital Development, Endogenous Growth and Knowledge Economy. Dr Samia has published several discussion and working papers and has contributed to four articles published in international refereed journals.

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