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Samia Mohamed Nour

Information and Communication Technology in Sudan

An Economic Analysis of Impact and Use in Universities

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UNU-MERIT, Maastricht, The Netherlands Samia Satti Osman Mohamed Nour
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Executive Summary

This research provides an interesting in-depth 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 aim of this research is threefold: 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 and the potential opportunities and challenges that ICT is expected to create for public and private Sudanese universities; and third, 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 the 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 (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 Chap. 1 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 and the importance, structure, trend and income and price effects of the demand for the four ICT modes, fixed telephone, mobile telephones, computer and Internet, seem 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 Chap. 1, 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 towards 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 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 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 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, 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 preferences 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, facilitation of communication with Internet and ease of use in work. The most important advantages of using mobile telephone include ease of carrying and moving from place to place, ease of waiting calls and messages from other people, facilitation of social contact with family, ease of use in work, facilitation of social contact with friends, ease of use of SMS and facilitation of 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 cheap price. In addition, Internet provides advantages such as facilitation of 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 modes 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 give 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 imply 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 shows 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 tends 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 7.2 defines the main characteristics of the supply side of ICT in Sudan. Section 7.3 shows an in-depth analysis from the demand perspective concerning the supply side of ICT, the methods and places of connection to ICT. Section 7.4 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 company, 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 workplace; this is probably because they are offered free of charge in the office or workplace for the respondents in public and private Sudanese universities.

Apart from the above-observed structural change in the demand for ICT, our findings in Chap. 5 verify the third hypothesis in Chap. 1 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 Chap. 1 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.

Our results in Chap. 6 present an overview of the use of ICT and the digital divide in Sudan and highlight the need for bridging the digital divide to enhance equality in the use of ICT in Sudan. Our findings in Chap. 6 are consistent with the findings in the international literature on the incidence and the main reasons for the incidence of the digital divide. We provide significant contribution and fill the gap in the Sudanese literature; a novel element in our analysis is that different from the Sudanese literature we use recent secondary data at the macro level to discuss the use of ICT and the incidence of the digital divide in Sudan and we provide a more comprehensive analysis by investigating and comparing the digital divide for different modes of ICT in Sudan. Our results confirm the seventh hypothesis in Chap. 1 about the relationship between the uses of ICT (mobile, computer and Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. Our results imply that the observed disparities in the use of ICT and digital divide imply that ICT adds a new dimension to the already existing and long-standing challenges of inequalities and disparities in Sudan that has been well documented in the literature as we explained in Chap. 2. We find that the major impediment factors that hindered the use of computer at home and the use of Internet are the lack of electricity that hindered the use of computer and the non-availability of the Internet service that hindered the use of the Internet in rural areas, nearly twice higher than in urban areas. We find that home is the most common place for using the Internet, Arabic is the most widely used language for using the Internet and mobile cellular telephone is the most widely used mean or for using the Internet. The use of mobile cellular telephone is more than 14 times higher than fixed telephone. We find positive relationship between the use of computer and Internet and educational level and negative relationship between the use of computer, Internet and mobile and age. Our findings imply inconclusive relationships between the use of mobile and educational level and between the use of computer, mobile and Internet and professional levels. We find positive correlations between the use of ICT and net enrolment rate in primary education, literacy rate, per capita income and rate of urbanisation and negative correlation between the use of ICT and poverty gap ratio. Our results in this chapter confirm the seventh hypothesis in Chap. 1 about the relationship between the use of ICT and the incidence of the digital divide defined by age and educational level in Sudan. Our results are plausible and consistent with the findings in the literature that imply positive relationship between the uses of ICT and educational level, particularly important for computer, since computer may require substantial levels of education for use, but telephones and the Internet may require very little.

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 Chap. 1 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 and 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, licences 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 and sustainability and improving efficiency of ICT services. The findings in Chap. 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 (Egypt, Kenya, Nigeria, Mozambique, South Africa,Tanzania and Zambia). 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 facilitating 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, 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 licences 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's 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 in ICT and to focus 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 side 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 side 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, encouragement of 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 side include 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 eradication of poverty. Therefore, the major policy implications from our results are 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.

University Survey (2009, April) "The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities," Khartoum.

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Booknotes

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List of Abbreviations

HDR	Human Development Report
GDP	Gross Domestic Product
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

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Part I
Introduction

Chapter 1
General Introduction

1.1 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.

1.2 Research Problem, Importance, Relevance and Method

Information and Communications Technologies (ICT) has been essential for the acceleration and improvement of economic growth and welfare in any society. The crucial role of ICT and its impacts on the global knowledge economy has long received particular recognition and increasing interest in the international literature. The rapid progress in information and communications technologies led to a new economic system characterised by intensive knowledge production and diffusion 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. 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.

It is admitted that ICT like many other forms of technological progress has imposed both the positive and negative impacts (opportunities and challenges) on the world economy. On the one hand, some studies provide robust results showing the various influences of ICT on economic growth and development, productivity, employment, work organisation and skill upgrading (cf. Hitt and Brynjolfsson 1996; Bresnahan et al. 1999; Brynjolfsson and Yang 1996; Jorgenson and Stiroh

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1995; Pohjola 2000, 2001; 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 enhancing knowledge (cf. Smith 2000) and through the complementary relationships between ICT, human capital/skill and skill upgrading (cf. Goldin and Katz 1998; Bresnahan et al. 1999; Autor et al. 1998; Acemoglu 1998; 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 and negative impacts on employment and labour markets (cf. Bound and Johnson 1992; Berman et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor et al. 1998).

It has also been hypothesised that ICT could 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. Several studies in the international literature indicate that measuring the digital divide is important in order to understand development in the information society and to inform ICT policy-makers, analysts and other stakeholders addressing issues of digital equality and ICT for development. (cf. OECD 2001; ITU 2013).

The importance of improving ICT policies appears from the recent literature that indicates the importance of national information policies, as most of the developing 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.

In light of the above background and given the relatively few studies that explain only limited aspects with reference to the use of ICT in the industrial sector in Sudan (Nour 2013), it may be useful in this book 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 knowledge institutions, notably universities in Sudan, and to examine the reasons for the incidence of the digital divide in Sudan. This book therefore will contribute to recent efforts aimed at enhancing the production, creation and transfer of

knowledge and building the information and knowledge society in Sudan and it will fill an important gap in the international literature dealing with enhancing the role of ICT in the production, creation and transfer of knowledge in higher education and universities.[1] In addition, the results discussed in this book will add to the existing studies in the international literature on the incidence and reasons for the incidence of the digital divide (cf. ITU 2013). Our results in this book confirm the relationship between the uses of ICT (the uses of computer at home and outside home, mobile and the Internet) and the incidence of the digital divide defined by age and educational level in Sudan. Our results are consistent with the findings in the international literature that imply positive relationship between the uses of ICT and educational level (cf. ITU 2013).

Hence, based on the above, this book 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 Sudan. By focusing on this theme this book 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 in the Arab literature presented by Nour (2002a, b, 2006), this book 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 Sudanese universities. This book improves understanding, adds to the existing studies in the Arab literature and fills the gap in the Arab literature by focusing on Sudan as a new case study of the Arab countries.

Previous research in the Sudanese literature (cf. Nour 2013) focused on technological change and skill development, the interaction between skill and technology indicators, and provided a macro and micro level empirical investigation of skill development and technological change in Sudan based on new primary data, mainly the "firm survey" and the "macro survey". Different from Nour (2013), this book focuses on the use and impact of ICT in Sudan. A novel element in our analysis is that we use new primary data obtained from "ICT public–privates Sudanese universities survey" undertaken in public–privates universities in Sudan to discuss the use, economic importance and impact of the use of ICT in public and private Sudanese universities. This book provides a new contribution and fills a significant gap in the Sudanese literature (Nour 2013), by examining from demand perspective and from the public–private perspective, the status, pattern, structure and determinants of demand for ICT, the economic impacts of ICT and role of ICT in facilitating production, creation and transfer of knowledge in public and private

[1] See for instance, Durrant (2004); Beebe et al. (2003); Olukoshi and Zeleza (2004); Radwan (2003); Thairu (2003); Oyeyinka and Adeya (2003); Massingue (2003); Adei (2003); Mutagahywa (2003) and Mwenechanya (2003).

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. 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 Sudan. 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 argue that the supply of ICT in Sudan is characterised by structural change, dynamism and rapid development that will facilitate acceleration of the production, creation and transfer of knowledge in Sudan.

In addition, this book presents an overview of the use of ICT and the digital divide in Sudan and highlights the need for bridging the digital divide to enhance equality in the use of ICT in Sudan. We provide significant contribution and fill the gap in the Sudanese literature (Nour 2013), a novel element in our analysis is that different from the Sudanese literature we use recent secondary data at the macro level obtained from Sudan National Telecommunication Corporation "Households and individuals ICT survey 2012," to discuss the use of ICT and the reasons for the incidence of the digital divide in Sudan and we provide a more comprehensive analysis by investigating and comparing the digital divide for different modes of ICT in Sudan. Our results confirm the hypothesis about the relationship between the uses of ICT (mobile, computer and Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. Our results imply that the observed disparities in the use of ICT and digital divide implies that ICT adds a new dimension to the already existing and longstanding challenges of inequalities and disparities in Sudan that has been well-documented in the literature (cf. UNDP 2010). Therefore, from policy perspective; this book provides useful policy implications and recommendations for addressing the problems of the digital divide, regional disparity and gender gap in the use of ICT in Sudan. Our results can be used to improve understanding about the urgent need to stimulate ICT infrastructure development and support new policies that aim at bridging the digital divide by enhancing adequacy and equality of the use and utilization of ICT in Sudan.

To investigate the research problem we focus on Sudan as a case study of Arab 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 University Survey (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. We use recent secondary data on core ICT indicators obtained from Sudan National Telecommunication Corporation "Households and individuals ICT survey 2012," to examine the supply–demand sides at the macro level and to investigate the reasons for the incidence of the digital divide in Sudan.

1.3 Objectives, Hypotheses and Questions of the Research

Hence, based on the above, this book aims to fulfil four objectives; 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, the economic impacts of the uses of ICT: the potential opportunities and challenges that ICT is expected to create for public and private universities in Sudan. Third, 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, namely Sudanese universities. And finally, to examine the occurrence and the main reasons for the occurrence of the digital divide defined by region (geographic location), gender and mode of living in Sudan. In this book 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 (cf. ITU – WDI Database 2005; D'Costa 2003; D'Costa and Sridharan 2003).

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 Sudan, namely universities in Sudan.
7. The use of ICT is closely related to the incidence of the digital divide defined by geographic location (region), mode of living, gender, age and educational level in Sudan.

1.4 Structure of the Research

Considering the research problem, aims, questions and hypotheses presented above, it is convenient in this chapter to set out the structure of the research. This research is composed of four parts and nine chapters structured in the following way. Part I presents the introduction and motivation of the research and includes both Chaps. 1 and 2. Chapter 1 presents an introduction and briefly shows the aims, importance, relevance, hypotheses, questions and the general structure of the research. Chapter 2 presents an overview of Sudanese economy and the trend and status of ICT in Sudan. It explains some stylised facts along with other strategic problems confronting economic development in Sudan, it shows 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 and social and economic development. It explains the trend and status of core ICT indicators in Sudan and provides evidences in support of the incidence of the global digital divide between Sudan, Arab countries and World countries.

Part II presents the conceptual and theoretical framework and includes Chap. 3, which defines the concepts and describes the measures of the digital divide and briefly explains the theoretical and empirical literature on the relationship between ICT, digital divide, economic growth and promotion of knowledge. The purpose of this survey is to provide a background for our study, mainly to highlight the dual positive and negative effects of ICT as confirmed in the endogenous growth literature, in particular, the demand for and positive impacts of the use of ICT in facilitating the production, creation and transfer of knowledge, and the negative impacts of ICT in creating the digital divide as confirmed in the new growth literature. In our view the review of the theoretical and empirical literature is particularly useful to motivate the empirical analysis in the next chapters.

Part III presents the empirical application and includes Chaps. 4, 5, 6 and 7. Chapter 4 defines the methods of data collection; identifies the motives for performing the university survey and selection of a case study; specifies the selection of the sample and the composition, operation, coverage, advantages and limitations of the survey data; and shows the structure and design of the questionnaire. Chapter 5 uses the data and results from the university survey to show from the public–private perspective the public–private differential in the demand for ICT, trend and determinants in Sudanese universities. This chapter examines the

first hypothesis on the presence of significant public–private differential between public and private universities in Sudan in the demand for and impacts of ICT. It investigates the second hypothesis which implies that the demand for the four ICT modes: fixed telephone, mobile telephone and Internet 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. This chapter confirms the incidence of structural change in the demand for ICT by scrutinising the historical use of the four ICT modes. This chapter examines the third hypothesis 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. Chapter 6 extends our analysis in Chap. 5 by providing an overview of the use of ICT and the digital divide in Sudan and highlights the need for bridging the digital divide to enhance equality in the use of ICT in Sudan. This chapter uses recent secondary data at the macro level to discuss the use of ICT and the incidence of the digital divide in Sudan and we provide a more comprehensive analysis by investigating and comparing the digital divide for different modes of ICT in Sudan. This chapter examines the seventh hypothesis in Chap. 1 above about the relationship between the uses of ICT (mobile, computer and Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. This chapter examines the seventh hypothesis about the relationship between the use of ICT and the incidence of the digital divide defined by age and educational level in Sudan. Chapter 7 examines the public–private differential in the supply side of ICT in Sudanese universities. It defines the main characteristics of the supply side of ICT at the macro and micro levels in Sudan and shows an indepth analysis from the demand and consumer perspective of the supply side of ICT, methods and places of connection to ICT. It explains the difficulties on the supply and demand sides and hence provides some suggestions for relevant solutions on the supply and demand sides in Sudan. Our results support the well-investigated argument concerning the structural change in the structure of the supply of ICT market. Our findings show dynamic evolution and structural change in the supplier companies. Chapter 8 illustrates from the demand perspective the 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. This chapter verifies the fifth and sixth hypotheses in Chap. 1 on the importance and impacts of ICT in facilitating the creation and transfer of knowledge in Sudanese universities. This chapter supports 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. It explains briefly the Sudanese national ICT strategy and policy in higher education and the efforts made by the Sudanese Ministry of Higher Education and Scientific Research and then the effort made by some Sudanese universities to enhance the use of ICT for enhancing connection, creation and transfer of knowledge.

Finally Part IV presents the summary, policies, recommendations and conclusions, and includes Chap. 9. Chapter 9 summarises and compares the main findings with the results in the general literature and contributions to the Sudanese literature and concludes with policy recommendations.

References

Acemoglu D (1998) Why do new technologies complement skills? Directed technical change and wage inequality. Q J Econ 113(4):1055–1089

Adei S (2003) Overview of university level education in Africa, Chapter 4. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) "Africa Dot Edu: IT opportunities and higher ED in Africa". Tata McGraw-Hill Publishing Co., New Delhi, pp 90, 108–109. http://www.africadotedu.org/

Aghion P, Howitt P (1998) Endogenous growth theory. MIT Press, Cambridge, MA

Autor DH, Katz LF, Krueger AB (1998) Computing inequality: have computers changed the labour market? Q J Econ 113(4):1169–1213

Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, http://www.africadotedu.org/

Berman E, Bound J, Griliches Z (1994) Change in the demand for skilled labour within U.S. manufacturing industries: evidence from the annual survey of manufacturing. Q J Econ 109(2):367–398

Bound J, Johnson G (1992) Change in the structure of wages in the 1980s: an evaluation of alternative explanations'. Am Econ Rev 82(3):371–392

Bresnahan TF, Brynjolfsson E, Hitt LM (1999) 'Information technology, workplace organization, and the demand for skilled labour: firm level evidence'. National Bureau Of Economic Research NBER working paper no. 7136

Brynjolfsson E, Yang S (1996) Information technology and productivity: a review of the literature'. Adv Comput 43:179–214

D'Costa AP (2003) Uneven and combined development: understanding india's software exports. World Dev 31(1):211–226

D'Costa AP, Sridharan E (eds) (2003) India in the global software industry: innovation, firms strategies, and development'. Palgrave Macmillan, Basingstoke

Durrant S (2004) "Sharing information: African perspectives: bridging the knowledge divide" African Research and Documentation. J Stand Conf Libr Mater Africa 96(2004):63–79

Freeman C, Soete L (1985) Information technology and employment: an assessment. SPRU, Sussex

Freeman C, Soete L (1994) Work for all or mass unemployment? Computerized technical change into the twenty–first century. Printer, London

Freeman C, Soete L (1997) The economic of industrial innovation, 3rd edn. Cassell, London

Goldin C, Katz LF (1998) The origin of technology skill complementarity. Q J Econ 113(3):693–732

Hitt L, Brynjolfsson E (1996) Productivity, business profitability, and consumer surplus: three different measures of information technology value. MIS Q 20:121–142

Hwang GH (2000) Diffusion of information and communication technologies and changes in skills. Electronic working paper series, no. 48. SPRU, Sussex

International Telecommunication Union (ITU) (2013) Measuring the information society. International Telecommunication Union (ITU), Geneva, Switzerland, pp 12, 39–40, 43

Jorgenson DW, Stiroh K (1995) Computers and growth. Econ Innov New Technol 3:295–316

Massingue V (2003) ICT in Mozambique: the role of Eduardo Mondlane University, Chapter 20. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi. http://www.africadotedu.org/.

Mwenechanya J (2003) Pioneering the Internet in Zambia: University role and challenges, Chapter 24. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) "Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi. http://www.africadotedu.org/.

Nour S (2002a) The impact of ICT on economic development in the Arab World: a comparative study of Egypt and the Gulf countries. Economic Research Forum for the Arab Countries, Iran and Turkey, ERF working paper series WP Number: 200237, Cairo 2002

Nour S (2002b) ICT opportunities and challenges for development in the Arab World. UNU-WIDER Discussion paper series DP2002/83. Paper prepared for UNU-WIDER conference on the new economy in development. UNU-WIDER, Helsinki, Finland, 10–11 May 2002

Nour S (2006) ICT opportunities and challenges for development in the Arab Region, Chapter 8. In: D'Costa AP (ed) The new economy in development: ICT challenges and opportunities: series of technology, globalization, and development, vol 2. Palgrave Macmillan's, Basingstoke

Nour S (2013) Technological change and skill development in Sudan. Springer, Berlin, Heidelberg, Germany

Olukoshi A, Zeleza PT (2004) The African Universities in the twenty-first century: future challenges and research agenda" Conclusion. In: Zeleza PT, Olukoshi A (eds) African universities in the twenty-first century. Volume II: Knowledge and society. Council for the Development of Social Science Research in Africa CODERSRIA, p 611

Organisation for Economic Co-operation and Development (OECD) (2001) Understanding the digital divide. OECD Publications: OEC, Organisation for Economic Co-operation and Development, Paris, France, p 5

Oyeyinka BO, Adeya C (2003) Internet access in Nigerian and Kenyan universities, Chapter 22. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa". Tata McGraw-Hill Publishing Co., New Delhi. http://www.africadotedu.org/

Pohjola M (2000) 'Information technology and economic growth: a cross- country analysis. WIDER/UNU Working paper series: WP173

Pohjola M (ed) (2001) Information technology, productivity and economic growth: international evidence and implications for economic growth. Oxford University Press, Oxford

Radwan R (2003) IT and higher education: the case of Egypt, Chapter 18. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, pp 387, 399, 400–401. http://www.africadotedu.org/

Smith K (2000) What is the 'knowledge economy'? Knowledge-intensive industries and distributed knowledge bases. Paper presented to DRUID Summer Conference on The Learning Economy—Firms, Regions and Nation Specific Institutions, June 15–17, 2000

Thairu H (2003) The Kenya Education Network (KENET), Chapter 19. In Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi. http://www.africadotedu.org/.

UNDP (2010) UND-HDR: UN MDGs in Sudan. http://www.sd.undp.org/mdg_sudan.htm. Accessed 1 Jun 2010

University Survey (2009, April) The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities, Khartoum

The World Bank (2005) World Development Indicators database (WDI) (2005): "The Information age (2005)," in the World Bank (2005) World Development Indicators database (WDI) (2005), pp. 310–313. http://data.worldbank.org/sites/default/files/wdi05fulltext.pdf. The World Bank, Washington, 2005

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

2.1 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 2.1 presents introduction. Section 2.2 provides a general overview of the general socio-economic characteristics of the Sudanese economy, Sect. 2.3 explains the status of ICT in Sudan and finally Sect. 2.4 provides the conclusions.

2.2 Socio-economic Characteristics of the Sudanese Economy

Sudan was the largest country in Africa and the Arab world until 2011, when South Sudan separated as an independent country, following an independence referendum. Sudan is now the third-largest country in Africa (after Algeria and the Democratic Republic of Congo) and also the third largest country in the Arab world (after Algeria and Saudi Arabia). According to the World Bank classification, Sudan is classified amongst the lower-medium-income economies. According to the UNDP-HDI classification the average GDP per capita for Sudan is among the world's low-income and low human development group.[1]

[1] The World Bank and United Nations Development Programme (UNDP) Human Development Report classifies world countries differently according to income level. We use the World Bank classification of economies that puts Sudan in the lower middle-income category or group.

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Data from Sudan's Central Bureau of Statistics and Central Bank of Sudan (2013) about the structure of Sudan's economy indicates the dominance of the services (49 %, 46.7 %) and agricultural (30.6 %, 30.6 %) sectors and low share of the industrial sector (20.4 %, 21.1 %) in GDP in 2012 and 2013 respectively (See Central Bank of Sudan, 2013, p. 120). 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). The structure of Sudan economy is characterised by rent-seeking, shifting from agricultural-based economy to oil-based (or oil-dependent) economy that appears from high dependency on oil for exports and revenues, with oil contributing over 95 % of exports and about 50 % of government revenues. The heavy reliance on oil implies that Sudan's economy turned from low to lower- medium-income economy, but suffers from uncertainty and high fluctuation in economic growth.[2] 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 poor and highly indebted economies, but following the exploitation of oil and 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. The increasing dependence on oil has led to sound economic growth. Consequently, Sudan's real economic growth averaged about 9 % during 2005–2007, putting Sudan among the fastest growing economies in Africa (The World Bank WB-DTS2008). In 2010, Sudan was considered as the 17th—fastest—growing economy in the world given the rapid development of the country -largely from oil profits, despite international sanctions.[3] However, the secession of the South in 2011, had gravely affected the economy as more than 80 % of Sudan's oil fields existed in the southern part of the country. This decline in oil revenues caused a major adjustment to the Sudan's fiscal situation and prompting financial austerity measures. The situation was further exacerbated by the continuing tensions between Sudan and South Sudan and their inability to reach an agreement over transit fees for oil from South Sudan.[4] The independence of the

[2] See the World Bank (2008).

[3] See http://www.sd.undp.org/content/sudan/en/home/countryinfo/, accessed on September 2014.

[4] See http://www.sd.undp.org/content/sudan/en/home/countryinfo/, accessed on September 2014.

South has had immediate negative fiscal and balance of payments implications for North Sudan [because of the loss of the bulk of the oil production and export revenues, because about 75 % of Sudan's oil revenues generated from southern oil production].[5]

Concerning the general socio-economic characteristics and economic development context in Sudan, Table 2.1 illustrates the substantial gap between Sudan and the world regions in economic development, as measured by GDP per capita and the human development index (HDI). In general, Sudan is characterized by low standards of economic development together with high population. For instance, Table 2.1 shows the low GDP per capita income in Sudan which is in excess of only the least developing countries, low human development, and Sub- Saharan Africa (SSA) countries, but less than all other world regions. Despite the fact that in 2005–2007 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-HDR (2014) Sudan is still classified amongst the low human development countries and the bottom of developing countries in terms of HDI (0.473), as it ranked 166 out of 187 countries.[6] Sudan's performance in terms of the estimated HDI (0.473), falling behind all other groups, even the least developed, low human development, and SSA countries. Sudan's performance in terms of life expectancy (62.1) and GDP per capita (3,428) is above only the least developed and low human development, and SSA countries, and lags behind all other groups including the Arab states, East Asia and the Pacific, Latin America and the Caribbean, South Asia, Europe and Central Asia, high human development and medium human development. Adult literacy rate in Sudan accounted for 71.9, which lies below all other groups except the least developed and medium and low human development, South Asia, and SSA countries. Moreover, the share of population with at least some secondary education and gross enrolment ratios for primary (73), secondary (39) and tertiary (6.1) education for Sudan fall behind the standard rate of the world countries and fall behind all other groups, even the least developed, low human development, and SSA countries (See Table 2.1).

[5] See International Monetary Fund IMF (2013) "Sudan Interim Poverty Reduction Strategy Paper" IMF Country report no. 13/318, October 2013. http://www.imf.org/external/pubs/ft/scr/2013/cr13318.pdf. Accessed 04 September 2014, p. 6.

[6] 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 (2014), pp. 238–286.

Table 2.1 Socio-economic human development and education indicators in Sudan and other regions in the World 2014

Human development index and its components						Education					
						Literacy rates			Gross enrolment ratios		
HDI rank	Human Development Index (HDI)	Life expectancy at birth	Mean years of schooling	Expected years of schooling	Gross national income (GNI) per capita	Adult	Youth	Population with at least some secondary education	Primary	Secondary	Tertiary
	Value	(years)	(years)	(years)	(2011 PPP $)	(% aged 15 and above)	(% aged 15–24)	(% aged 25 and above)	(% of primary school-age population)	(% of secondary school-age population)	(% of tertiary school-age population)
	2013	2013	2012	2012	2013	2005–2012	2005–2012	2005–2012	2003–2012	2003–2012	2003–2012
Sudan	0.473	62.1	3.1	7.3	3,428	71.9	87.3	15.5	73[a]	39[a]	6.1[a]
Human development index groups											
Very high human development	0.890[b]	80.2[b]	11.7[b]	16.3[b]	40,046[b]	. . .[b]	. . .[b]	86.9[b]	103[b]	101[b]	76[b]
High human development	0.735[b]	74.5[b]	8.1[b]	13.4[b]	13,231[b]	94.2[b]	98.9[b]	64.9[b]	118[b]	87[b]	35[b]
Medium human development	0.614[b]	67.9[b]	5.5[b]	11.7[b]	5,960[b]	71.7[b]	85.9[b]	47.5[b]	111[b]	70[b]	23[b]
Low human development	0.493[b]	59.4[b]	4.2[b]	9.0[b]	2,904[b]	58.2[b]	70.2[b]	22.1[b]	98[b]	39[b]	8[b]

Regions											
Arab States	0.682[b]	70.2[b]	6.3[b]	11.8[b]	15,817[b]	77.0[b]	89.9[b]	41.1[b]	105[b]	76[b]	28[b]
East Asia and the Pacific	0.703[b]	74.0[b]	7.4[b]	12.5[b]	10,499[b]	94.4[b]	98.8[b]	. . .[b]	120[b]	84[b]	. . .[b]
Europe and Central Asia	0.738[b]	71.3[b]	9.6[b]	13.6[b]	12,415[b]	97.7[b]	99.4[b]	75.6[b]	101[b]	95[b]	50[b]
Latin America and the Caribbean	0.740[b]	74.9[b]	7.9[b]	13.7[b]	13,767[b]	91.5[b]	97.1[b]	54.7[b]	106[b]	85[b]	44[b]
South Asia	0.588[b]	67.2[b]	4.7[b]	11.2[b]	5,195[b]	62.9[b]	80.6[b]	38.4[b]	110[b]	64[b]	22[b]
Sub-Saharan Africa	0.502[b]	56.8[b]	4.8[b]	9.7[b]	3,152[b]	58.9[b]	69.2[b]	28.1[b]	100[b]	43[b]	8[b]
Least developed countries	0.487[b]	61.5[b]	3.9[b]	9.4[b]	2,126[b]	59.3[b]	71.5[b]	. . .[b]	105[b]	42[b]	9[b]
World	0.702[b]	70.8[b]	7.7[b]	12.2[b]	13,723[b]	81.2[b]	87.9[b]	63.6[b]	108[b]	74[b]	31[b]

Source UNDP Human Development Report (2013, 2014), pp. 146–147, 173, 196–197
Note PPP refers to purchasing power parity. Gross enrolment ratios for Sudan refers to 2002–2011
[a]UNDP-HDR (2013)
[b]UNDP-HDR (2014)

In addition, the little progress in social indicators in Sudan also apparent from high poverty rates, where about 46.5 % in northern Sudan are estimated to be living below the poverty line of less than US$ 1 a day.[7] While progress has been made toward several of the Millennium Development Goals (MDGs), such as in the areas of education (MDG 2), infant and child mortality (MDGs 5 and 5), access to water and sanitation (MDG 7). However, Sudan's performance against the MDG indicators demonstrates large inequalities with respect to gender (MDG 3), rural–urban residence (MDG 7), and at the regional and sub-regional level.[8] Data from UNDP-HDR (2014) shows evidences on inequalities with respect to gender in terms of GNI per capita in 2011 (male (US$5153)—female (US$1692)) and in terms of mean years of schooling [male (3.8) and female (2.5)] over the period 2002–2012. The significant regional disparities between regions contributed to growing inequalities and unbalanced development in Sudan (see Tables 2.2 and 2.3). Sudan suffers from disparities in development; Sudan's growth process has been unbalanced, with the majority of its manufacturing firms and irrigated land concentrated in the center with a huge disparity in development indicators between the best and worst performing regions in Sudan. Outcomes from the NBHS 2009 for a number of individual MDG-related indicators confirm that the major challenge facing Sudan's progress towards the MDGs is the massive inequality in outcomes and access to services (Table 2.3). Overall, there appears to be little evidence of aggregate improvements in social indicators such as poverty and educational enrolment. The significant development disparities between urban and rural areas and between regions contributed to growing inequalities and an increasing urban informal sector accounting for more than 60 % of GDP. This state of affairs has aggravated migration from rural to urban centers that is believed to have weakened agricultural productivity.[9] Furthermore, Sudan suffers from high unemployment rates (20.7 %) and, particularly, high youth unemployment rates (32.8 %). Over the period (2000–2010) the unemployment rate increased from 15.5 % in 2000 to 20.3 % in 2010; i.e. increased by 4.8 %.[10]

[7] Sudan Central Bureau of Statistics Household Survey Report (2009).

[8] The Millennium Declaration and adoption of the UN MDG in September 2000 implies commitment toward achievement of the eight MDG by 2015. The MDG are: (1) Eradicate extreme poverty and hunger: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day, and halve, between 1990 and 2015, the proportion of people who suffer from hunger. (2) Achieve universal primary education: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling. (3) Promote gender equality and empower women: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015. (4) Reduce child mortality: Reduce by two thirds, between 1990 and 2015, the under-five mortality rate. (5) Improve maternal health: Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio. (6) Combat HIV/AIDS, malaria and other diseases. (7) Ensure environmental sustainability and (8) Develop a global partnership for development. See UND-HDR 'UN MDGs in Sudan': http://www.sd.undp.org/mdg_sudan.htm, accessed June 1, 2010.

[9] See International Monetary Fund IMF (2013) "Sudan Interim Poverty Reduction Strategy Paper" IMF Country Report No. 13/318, October 2013. http://www.imf.org/external/pubs/ft/scr/2013/cr13318.pdf. Accessed 04, September 2014, pp. 7–8.

[10] See Sudan Ministry of Labour and Human Resources (MoLHR) (unpublished data and statistics).

Table 2.2 The status of MDGs in Northern Sudan in 2008

MDGs/indicators	Indicators	Status in 2004[a]	Current level[b]	Reference year	2015 target
MDG 1 eradicate extreme poverty and hunger	Estimated poverty incidence (% of total population)*	50 %[c]	46.5 %	2009	45 %
	Prevalence of child malnutrition (underweight for age; % under 5) *	35 %[c]	31.8 %	2006	16 %
	Prevalence of acute child malnutrition* (underweight for weight; % under 5)	16 %[c]			8 %
MDG 2 achieve universal primary education	Gross primary enrolment ratio***	62 %	71.1 %	2009	100 %
	Percentage of cohort completing primary school***	21 %			100 %
	Adult literacy rate**	65.1 %[(b)]	77.5 %	2009	25 % 1
MDG 3 promote gender equality and empower women	Ratio girls to boys in primary education***	88 %	53.9–46.1 %	2007	100 %
	Women's literacy rate	62 %	86 %	2009	–
	Percentage of women in National Assembly/Council of States	19 %	25 %	2010	–
MDG 4 reduce child mortality	Under-5 mortality rate (per 1,000)*	105[c]	102	2008	35
	Infant mortality rate (per 1,000 live births)*	70[c]	71	2006	–
	One-year-olds immunized against measles***	78 %	85 %	2009	–
MDG 5 improve maternal health	Maternal mortality ratio (per 100,000 live births)	638[c]	534	2006	127
	Birth attended by skilled health staff*	57 %[c]	57 %	2006	90 %
MDG 6 combat HIV AIDS, malaria and other diseases	Contraceptive prevalence (% of women ages 15–49)***	7 %	7.6 %	2006	–
	HIV Prevalence (% adults ages 15–49)*	1.6 %[c]	0.5–1.24[d]	2009	–
	Incidence of TB (per 100,000 per year)***	90	120		–
	Children under 5 with fever treated with antimalarials (%)	54.2 %[c]			–

(continued)

Table 2.2 (continued)

MDGs/indicators	Indicators		Status in 2004[a]	Current level[b]	Reference year	2015 target
MDG 7 integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources	Access to improved drinking water source (% of population)*		58.7 %[c]	65 %	2010	85 %
	Access to improved sanitation (% of population)*		39.9 %[c]	42 %	2009	67 %
MDG 8 develop a global partnership for development	In cooperation with the private sector, make available the benefit of new technologies, especially information and communications	Telephone line per 100 population (% of population)	2 % (2005)	0.9 %	2009	
		Cellular subscribers per 100 population (% of population)	9 % (2005)	28 %	2009	
		Internet users per 100 population (% of population)	8.2 % (2009)	10.4 %	2010	

Sources

[a]Sudan Millennium Development Goals Interim Unified Report, 2004 prepared by the UN Resident Coordinator's Support Office, Khartoum, Sudan: http://www.sd.undp.org/mdg_fact.htm, accessed on 1 June 2010

[b]SPHS-2010, NBHS-2009, SHHS-2006 and administrative data from concerned institutions cited in pp. Sudan MDGs Progress Report 2011, Sudan National Population council, Khartoum, Sudan, 9–10

[c]Sudan Health and Household Survey 2006

[d]0.5 for males and 1.24 for females

[*]Sudan Health and Household Survey 2006

[**]EFA Global Summary Report 2008 p. 17

[***]Sudan Millennium Development Goals. Interim Unified Report, 2004

Table 2.3 Regional disparity in demographic and economic structure and achievements in MDGs in Northern Sudan 2005–2009

Region			Northern	Khartoum	Central	Kordufan	Darfur	Eastern	Total
Demographic and economic structure (2005–2008)									
Population[a]	2008	Total	1,819	5,274	7,423	4,327	7,516	4,534	30,893
		Share (%)	5	13	19	11	19	12	100
Revenues[b]	2005	Total	14,853	15,678	19,267	9,546	10,628	25,382	95,354
		Share (%)	16	16	20	10	11	27	100
Actual per capita federal Allocation[b]	2005	Total	9,068	8,497	4,872	3,765	2,732	2,553	5,248
Urbanization[b]	2005	Total	27	88	29	29	20	43	39
MDGs[c] (2009)									
Poverty gap ratio	MDG 1.2	Total	9.4	6.4	13.8	23.1	24.6	17.7	16.2
Net enrolment rate in primary education	MDG 2.1	Total	83	85	67	60	62	57	67
Literacy rate of 15–24-year olds	MDG 2.3.1	Total	88	94	77	69	74	63	77
Literacy rate of 15–24-year olds	MDG 2.3.2	Men	91	96	84	79	85	68	84
Literacy rate of 15–24-year olds	MDG 2.3.3	Women	86	92	70	61	64	57	71
Share of women in wage employment in nonagricultural sector	MDG 3.2	Total	15	19	13	19	22	12	17
Employment ratio to population 15 years old and above	MDG 1.5	Total	35.9	37	41.3	48.5	45.3	39	41.4
Proportion of employed population below poverty line	MDG 1.6	Total	30.1	21	41.5	55.5	58.8	39.2	42.5
Proportion of own account and contributing family workers to total employed	MDG 1.7	Total	39.2	25.3	36	39.8	50	46.7	45

[a]Adapted from Sudan Central Bureau of Statistics Population Census Data (2010), in thousands: The Fifth Sudan Population and Housing Census (2008)
[b]Elbadawi and Suleiman (2008, p. 107)
[c]Sudan Central Bureau of Statistics (2011, p. 12)

2.3 Background on the Importance and Diffusion of Core ICT Indicators in Sudan, Arab Countries and World Regions, (2000–2013)

This section examines the status and trend of core ICT indicators on access to, and use of ICT in Sudan compared to Arab countries and World regions, using the latest available data for the period (2000–2013) (see Tables 2.4, 2.5, 2.6, and 2.7).[11]

The historical use of ICT in Sudan, according to the WDI database (2005) implies that before 2000 the number of users of both mobile-cellular telephones 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. In recent years, the diffusion of ICT in Sudan has increased significantly. Tables 2.4, 2.5, 2.6, and 2.7 below present recent indicators from International Telecommunication Union (ITU) (2014) and illustrate that despite recent slowdown in terms of fixed telephone, the recent average growth rate of the total online population, Internet, fixed (wired)-broadband and mobile-cellular subscribers in Sudan during the period 2000–2013 has been significant. In Sudan over the period (2000–2013) the growth rate of mobile-cellular telephone (1,039.71) is faster than Internet (755.67), fixed (wired)-broadband (59) and fixed telephone (−0.04) respectively (see Tables 2.4, 2.5, 2.6, and 2.7).

The status and trend of ICT indicators in Sudan appears from the status and trend of fixed-telephone, mobile-cellular telephone and fixed (wired)-broadband subscriptions and the percentage of individuals using the Internet in Sudan over the period (2000–2013). For instance, fixed-telephone subscriptions (in millions) increased from 386,775 in 2000 to 570,000 in 2005 but then declined to 544,984 and to 415,571 in 2010 and 2013 respectively. Moreover, fixed-telephone subscriptions per 100 inhabitants over the period (2000–2013) increased from 1.13 in 2000 to 1.48 in 2005 but then declined to 1.25 and to 1.09 in 2010 and 2013 respectively (see Table 2.4 and Fig. 2.1). In addition, mobile-cellular telephone subscriptions (in millions) increased from 23,000 in 2000 to 1,827,940, 18,093,231 and to 27,657,875 in 2005, 2010 and 2013 respectively. Moreover, mobile-cellular telephone subscriptions per 100 inhabitants over the period (2000–2013) increased from 0.07 in 2000 to 4.76, 41.54 and to 72.85 in 2005, 2010 and 2013 respectively (see Table 2.5 and Fig. 2.1). In addition, fixed (wired)-broadband subscriptions (in millions) increased from 793 in 2004 to 1269, 13,500 and to 44,662 in 2005, 2010 and 2013 respectively. Moreover, fixed (wired)-broadband subscriptions per 100 inhabitants over the period (2000–2013) increased from 0.002 in 2004 to 0.003, 0.03 and to 0.12 in 2005, 2010 and 2013 respectively (see Table 2.6 and Figs. 2.2 and 2.3). Furthermore, the percentage of individuals using the Internet increased

[11] Regions in Tables 2.4, 2.5, 2.6, and 2.7 are based on ITU BDT Regions, see:http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Table 2.4 Fixed-telephone subscriptions per 100 inhabitants in Sudan compared to Arab Countries and World Regions 2000–2013

	Fixed-telephone subscriptions per 100 inhabitants													
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Arab countries														
Algeria	5.55	5.85	5.99	6.30	7.43	7.57	8.23	8.74	8.59	7.08	7.89	8.10	8.40	7.98
Bahrain	25.59	24.88	23.95	24.06	23.35	22.00	20.42	19.72	19.75	19.97	18.22	21.39	22.72	21.78
Comoros	1.28	1.64	1.84	2.32	2.58	2.82	3.09	4.11	4.44	4.62	3.11	3.31	3.34	3.13
Djibouti	1.34	1.35	1.36	1.35	1.45	1.36	1.43	1.77	1.84	2.05	2.22	2.18	2.32	2.37
Egypt	8.29	9.96	11.41	12.58	13.41	14.48	14.81	15.13	15.70	13.43	12.32	10.98	10.60	8.31
Iraq	2.84	2.75	4.47	4.56	3.88	4.07	4.45	4.75	3.68	5.47	5.56	5.63	5.71	5.63
Jordan	13.00	13.65	13.76	12.49	12.53	11.99	11.31	9.88	8.78	8.11	7.52	6.91	6.20	5.20
Kuwait	24.50	23.85	23.53	23.01	22.63	21.98	21.39	21.07	19.24	18.54	17.36	16.47	15.69	15.08
Lebanon	17.80	18.64	19.31	18.97	16.35	15.92	16.70	16.85	17.92	18.93	19.30	19.09	18.66	18.04
Libya	11.69	12.55	13.48	13.83	14.52	15.23	15.99	16.76	15.66	17.83	20.33	16.38	13.23	12.72
Morocco	4.96	4.11	3.85	4.12	4.38	4.45	4.17	7.81	9.66	11.24	11.85	11.12	10.08	8.86
Oman	10.12	10.29	9.86	9.89	9.85	10.52	10.56	11.48	11.61	11.27	10.13	9.50	9.19	9.67
Palestinian Authority	8.49	7.75	7.19	7.11	7.78	9.47	8.85	9.36	9.29	9.41	8.98	9.30	9.34	9.29
Qatar	26.98	27.37	28.03	27.95	26.50	25.01	23.60	20.60	19.56	18.41	15.43	16.17	19.23	19.02
Saudi Arabia	14.72	15.47	15.66	15.33	15.50	15.57	15.57	15.42	15.55	15.57	15.28	16.69	16.97	16.37
Somalia	0.34	0.46	0.45	1.24	1.21	1.18	1.15	1.12	1.09	1.07	1.04	0.91	0.69	0.61
Sudan	1.13	1.28	1.88	2.56	2.74	1.48	1.27	0.85	0.88	0.87	1.25	1.33	1.14	1.09
Syria	10.23	10.88	12.33	13.94	15.04	15.98	17.25	17.65	17.86	18.41	18.90	19.67	19.43	20.22
Tunisia	10.00	10.94	11.78	11.82	12.10	12.51	12.48	12.39	11.92	12.16	12.13	11.32	10.10	9.29
United Arab Emirates	33.71	33.62	33.92	33.71	32.46	29.81	26.86	23.90	23.48	20.47	17.53	20.45	21.37	22.32
Yemen	1.98	2.34	2.92	3.64	4.07	4.48	4.69	4.82	4.43	4.49	4.60	4.61	4.63	4.68

(continued)

Table 2.4 (continued)

	Fixed-telephone subscriptions per 100 inhabitants													
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
World regions														
Developed						47.2	46.6	44.8	44.3	45.5	44.6	43.4	42.2	41.2
Developing						12.7	13.0	13.0	12.8	12.4	11.9	11.5	11.2	10.9
World						19.1	19.2	18.8	18.5	18.4	17.8	17.2	16.7	16.2
Africa						1.5	1.5	1.5	1.5	1.6	1.5	1.4	1.3	1.3
Arab States						9.4	9.6	10.1	10.3	9.9	9.8	9.8	9.6	8.9
Asia & Pacific						15.1	15.5	15.3	14.9	14.9	14.2	13.7	13.3	12.9
CIS						23.0	24.7	25.8	26.0	26.1	26.2	26.1	25.7	25.0
Europe						45.5	45.3	43.7	42.7	43.6	42.8	41.6	40.3	39.6
The Americas						33.0	31.9	30.9	31.2	29.9	29.2	28.3	27.6	27.0

Source International Telecommunication Union (ITU) (2014) World Telecommunication (ITU)/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Table 2.5 Mobile-cellular telephone subscriptions per 100 inhabitants 2000–2013

	Mobile-cellular telephone subscriptions per 100 inhabitants													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Arab countries														
Algeria	0.27	0.31	1.38	4.38	14.59	40.23	60.85	78.53	75.66	89.96	88.44	94.31	97.52	102.01
Bahrain	30.79	42.87	53.10	57.39	79.19	87.22	95.42	108.10	129.10	117.66	125.21	131.01	161.17	165.91
Comoros	0.00	0.00	0.00	0.35	1.43	2.58	5.98	9.82	14.13	18.41	24.20	30.91	39.51	47.28
Djibouti	0.03	0.41	2.01	3.05	4.50	5.67	5.69	8.71	13.93	15.67	19.86	22.80	24.72	27.97
Egypt	2.06	4.16	6.58	8.35	10.83	18.99	24.66	40.54	54.69	72.10	90.50	105.08	119.92	121.51
Iraq	0.00	0.00	0.08	0.31	2.15	5.60	33.30	48.79	59.56	66.69	75.14	80.16	81.63	96.10
Jordan	8.16	17.90	24.87	26.59	31.89	59.89	80.00	84.37	89.89	97.30	102.56	111.16	128.17	141.80
Kuwait	24.97	44.33	59.91	67.10	80.79	60.19	48.79	55.83	55.51	91.87	133.01	157.91	156.90	190.29
Lebanon	22.96	22.84	22.05	21.56	22.95	24.92	27.12	30.44	34.09	56.28	65.97	77.19	80.81	80.56
Libya	0.77	0.95	1.31	2.34	9.08	35.75	69.07	77.83	125.56	159.85	180.45	163.85	155.77	165.04
Mauritania	0.56	3.96	8.59	11.83	17.10	23.70	32.74	42.46	61.12	62.06	76.91	89.52	106.04	102.53
Morocco	8.16	16.44	21.15	24.88	31.27	41.14	52.66	65.31	73.71	80.93	101.07	114.02	119.97	128.53
Oman	7.39	14.43	20.06	24.86	32.72	52.86	71.16	97.29	124.13	149.09	164.34	159.00	159.25	154.65
Palestinian Authority	0.22	5.35	7.48	7.71	12.51	15.94	22.58	27.42	34.43	45.99	64.88	70.12	74.30	73.74
Qatar	20.36	29.08	42.35	57.03	68.07	87.29	95.06	109.70	105.18	124.60	124.96	120.48	126.86	152.64
Saudi Arabia	6.83	12.10	22.95	31.67	38.49	57.37	77.64	109.59	136.54	167.43	189.17	193.45	187.40	176.50
Somalia	1.08	1.12	1.28	2.49	6.06	5.91	6.33	6.73	6.86	6.83	6.73	18.17	22.56	49.38
Sudan	0.07	0.30	0.53	1.44	2.80	4.76	11.90	20.36	28.95	36.11	41.54	68.78	74.36	72.85
Sweden	71.82	80.76	89.20	98.43	97.81	100.82	105.69	110.46	108.44	112.13	117.16	121.22	124.57	124.40
Syria	0.18	1.20	2.35	6.85	13.27	16.24	24.86	31.87	34.68	47.65	54.32	59.24	59.30	55.97
Tunisia	1.25	4.03	5.89	19.47	37.55	56.52	72.23	76.34	82.78	93.21	104.54	115.20	118.11	115.60

(continued)

Table 2.5 (continued)

	Mobile-cellular telephone subscriptions per 100 inhabitants													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
United Arab Emirates	47.19	60.96	75.31	88.22	100.67	109.29	113.20	133.36	137.64	138.27	129.43	131.40	149.64	171.87
Yemen	0.18	0.82	2.62	3.54	7.53	11.31	14.41	20.53	29.70	37.40	48.70	50.07	58.28	69.01
World regions														
Developed						82.1	92.9	102.0	107.8	112.1	113.3	113.5	116.0	119.2
Developing						22.9	30.1	39.1	49.0	58.2	68.5	77.4	82.1	87.6
World						33.9	41.7	50.6	59.7	68.0	76.6	83.8	88.1	93.1
Africa						12.4	17.8	23.5	32.2	38.0	45.4	52.3	58.9	65.9
Arab States						26.8	38.8	52.6	63.2	76.5	87.9	99.1	105.4	108.8
Asia & Pacific						22.6	28.8	37.1	46.6	56.3	67.3	76.5	80.9	86.4
CIS						59.7	81.8	96.1	111.6	126.8	134.2	127.2	130.5	137.0
Europe						91.7	101.2	111.7	117.0	116.8	115.0	117.9	119.6	122.8
The Americas						52.1	62.0	72.1	80.8	87.3	94.0	100.6	103.9	107.2

Source International Telecommunication Union (ITU) (2014) World Telecommunication (ITU)/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Table 2.6 Fixed (wired) broadband subscriptions per 100 inhabitants 2000–2013

	Fixed (wired)-broadband subscriptions per 100 inhabitants													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Arab countries														
Algeria		0.00	0.00	0.05	0.11	0.40	0.49	0.82	1.36	2.25	2.43	2.60	3.00	3.26
Bahrain	0.00	0.17	0.68	1.26	1.82	2.44	4.06	6.46	6.89	6.38	5.40	14.16	13.20	13.15
Comoros		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.05	0.06	0.17	0.18
Djibouti	0.00	0.00	0.00			0.01	0.02	0.14	0.30	0.64	0.97	1.33	1.73	2.03
Egypt		0.00	0.07	0.08	0.11	0.20	0.35	0.64	1.02	1.36	1.86	2.32	2.83	3.26
Jordan		0.01	0.06	0.10	0.20	0.45	0.90	1.57	2.32	3.29	3.03	2.97	2.81	2.83
Kuwait		0.25	0.51	0.61	0.91	1.09	1.24	1.37	1.48	1.58	1.54	1.50	1.45	1.40
Lebanon		0.00	1.00	1.90	2.08	3.26	4.66	4.64	4.66	4.64	6.98	8.28	9.71	9.95
Libya			0.00	0.00	0.00				0.79	1.06	1.21	1.15	1.09	1.04
Mauritania		0.00	0.00	0.00	0.00	0.01	0.03	0.12	0.17	0.19	0.16	0.17	0.18	0.19
Morocco		0.00	0.01	0.01	0.22	0.83	1.29	1.56	1.56	1.52	1.58	1.84	2.10	2.53
Oman		0.00	0.00	0.01	0.03	0.52	0.79	0.79	1.25	1.54	1.83	1.74	2.15	2.62
Palestinian Authority		0.00	0.00	0.00	0.00	0.21	0.75	1.49				3.79	4.42	4.71
Qatar	0.00	0.00	0.04	0.45	1.52	3.12	4.83	7.55	7.67	9.04	8.23	8.53	8.96	9.94
Saudi Arabia		0.07	0.16	0.20	0.29	0.27	0.86	2.40	3.98	5.01	5.49	5.68	6.95	7.33
Somalia		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				0.39	0.57
Sudan		0.00	0.00	0.00	0.00	0.00	0.01	0.11	0.11		0.03	0.05	0.07	0.12
Syria		0.00	0.00	0.00	0.00	0.01	0.03	0.04	0.05	0.16	0.32	0.56	1.11	1.58
Tunisia	0.00	0.00	0.00	0.00	0.03	0.17	0.43	0.93	2.19	3.55	4.53	5.20	4.85	4.77
United Arab Emirates	0.07	0.27	0.52	0.90	1.53	3.12	4.94	6.55	8.20	8.91	9.32	9.71	10.34	11.11
Yemen		0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.12	0.24	0.37	0.47	0.70	1.05

(continued)

Table 2.6 (continued)

	Fixed (wired)-broadband subscriptions per 100 inhabitants													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
World regions														
Developed						12.3	15.5	18.0	20.4	22.0	23.5	24.6	25.7	26.6
Developing						1.3	1.8	2.3	2.9	3.5	4.2	4.9	5.4	5.8
World						3.4	4.3	5.2	6.1	6.9	7.6	8.4	9.0	9.4
Africa						0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3
Arab States						0.3	0.5	0.9	1.3	1.6	1.9	2.2	2.6	2.8
Asia & Pacific						2.2	2.8	3.2	4.0	4.7	5.5	6.4	7.0	7.4
CIS						0.6	1.3	2.3	4.3	6.1	8.0	9.2	11.0	12.6
Europe						10.9	14.8	18.4	20.4	22.1	23.6	24.8	25.7	26.6
The Americas						7.5	9.0	10.9	12.3	13.0	14.0	15.0	15.8	16.3

Source International Telecommunication Union (ITU) (2014) World Telecommunication (ITU)/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Table 2.7 Percentage of individuals using the internet and proportion of households with internet access at home and with computer 2000–2013

	Percentage of individuals using the internet														Proportion of households with	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Internet access at home	Computer
Arab countries																
Algeria	0.49	0.65	1.59	2.20	4.63	5.84	7.38	9.45	10.18	11.23	12.50	14.00	15.23	16.50	10.0	18.1
Bahrain	6.15	15.04	18.05	21.55	21.46	21.30	28.24	32.91	51.95	53.00	55.00	77.00	88.00	90.00	79.0	92.7
Comoros	0.27	0.44	0.55	0.85	1.33	2.00	2.20	2.50	3.00	3.50	5.10	5.50	5.98	6.50	2.4	...
Djibouti	0.19	0.34	0.49	0.63	0.78	0.95	1.27	1.62	2.26	4.00	6.50	7.00	8.27	9.50	1.7	12.1
Egypt	0.64	0.84	2.72	4.04	11.92	12.75	13.66	16.03	18.01	25.69	31.42	39.83	44.00	49.56	34.5	43.1
Iraq		0.10	0.50	0.60	0.90	0.90	0.95	0.93	1.00	1.06	2.50	5.00	7.10	9.20	...	...
Jordan	2.62	4.71	6.03	8.47	11.66	12.93	13.87	20.00	23.00	26.00	27.20	34.90	41.00	44.20	35.4	50.8
Kuwait	6.73	8.55	10.25	22.40	22.93	25.93	28.79	34.80	42.00	50.80	61.40	65.77	70.45	75.46	62.0	66.9
Lebanon	7.95	6.78	7.00	8.00	9.00	10.14	15.00	18.74	22.53	30.14	43.68	52.00	61.25	70.50	61.8	71.5
Libya	0.19	0.37	2.24	2.81	3.53	3.92	4.30	4.72	9.00	10.80	14.00	14.00		16.50	...	...
Mauritania	0.19	0.26	0.36	0.42	0.48	0.67	0.98	1.43	1.87	2.28	4.00	4.50	5.37	6.20	...	...
Morocco	0.69	1.37	2.37	3.35	11.61	15.08	19.77	21.50	33.10	41.30	52.00	46.11	55.42	56.00	46.0	47.0
Oman	3.52	5.89	6.87	7.26	6.76	6.68	8.30	16.68	20.00	26.80	35.83	48.00	60.00	66.45	77.6	82.9
Palestinian Authority	1.11	1.84	3.10	4.13	4.40	16.01	18.41	21.18	24.36	32.23	37.40	41.08	43.40	46.60		
Qatar	4.86	6.17	10.23	19.24	20.70	24.73	28.97	37.00	44.30	53.10	69.00	69.00	69.30	85.30	96.4	97.1
Saudi Arabia	2.21	4.68	6.38	8.00	10.23	12.71	19.46	30.00	36.00	38.00	41.00	47.50	54.00	60.50	54.4	...
Somalia	0.02	0.08	0.12	0.38	1.05	1.08	1.10	1.12	1.14	1.16		1.25	1.38	1.50	...	...
Sudan	0.03	0.14	0.44	0.54	0.79	1.29		8.66			16.70	17.30	21.00	22.70	29.3	14.0
Syria	0.18	0.35	2.09	3.40	4.32	5.65	7.83	11.50	14.00	17.30	20.70	22.50	24.30	26.20	35.2	...

(continued)

Table 2.7 (continued)

	Percentage of individuals using the internet														Proportion of households with	
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Internet access at home	Computer
Tunisia	2.75	4.30	5.25	6.49	8.53	9.66	12.99	17.10	27.53	34.07	36.80	39.10	41.44	43.80	17.1	23.2
United Arab Emirates	23.63	26.27	28.32	29.48	30.13	40.00	52.00	61.00	63.00	64.00	68.00	78.00	85.00	88.00	72.0	85.2
Yemen	0.08	0.09	0.52	0.60	0.88	1.05	1.25	5.01	6.89	9.96	12.35	14.91	17.45	20.00	2.9	. . .
World regions																
Developed						50.9	53.5	59.0	61.3	62.9	67.1	70.5	73.1	75.7	72.6	75.5
Developing						7.8	9.4	11.9	14.6	17.4	21.2	24.3	27.4	29.9	24.2	27.6
World						15.8	17.6	20.6	23.1	25.6	29.4	32.5	35.5	37.9	37.1	40.7
Africa						2.4	3.3	3.9	5.9	7.3	9.8	12.6	14.6	16.8	7.5	7.8
Arab States						8.3	11.1	13.4	16.2	19.1	23.0	26.6	33.8	37.4	31.2	34.0
Asia & Pacific						9.4	10.6	13.4	16.2	18.9	22.5	25.2	28.1	30.1	28.0	31.0
CIS						10.3	12.6	16.8	19.5	23.8	34.0	40.8	45.5	50.8	43.4	50.4
Europe						46.3	49.7	56.0	60.2	63.2	66.6	69.2	71.4	73.1	74.0	76.2
The Americas						35.9	38.8	42.7	44.1	46.1	50.5	54.8	58.1	61.8	51.8	58.4

Source International Telecommunication Union (ITU) (2014) World Telecommunication (ITU)/ICT Indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

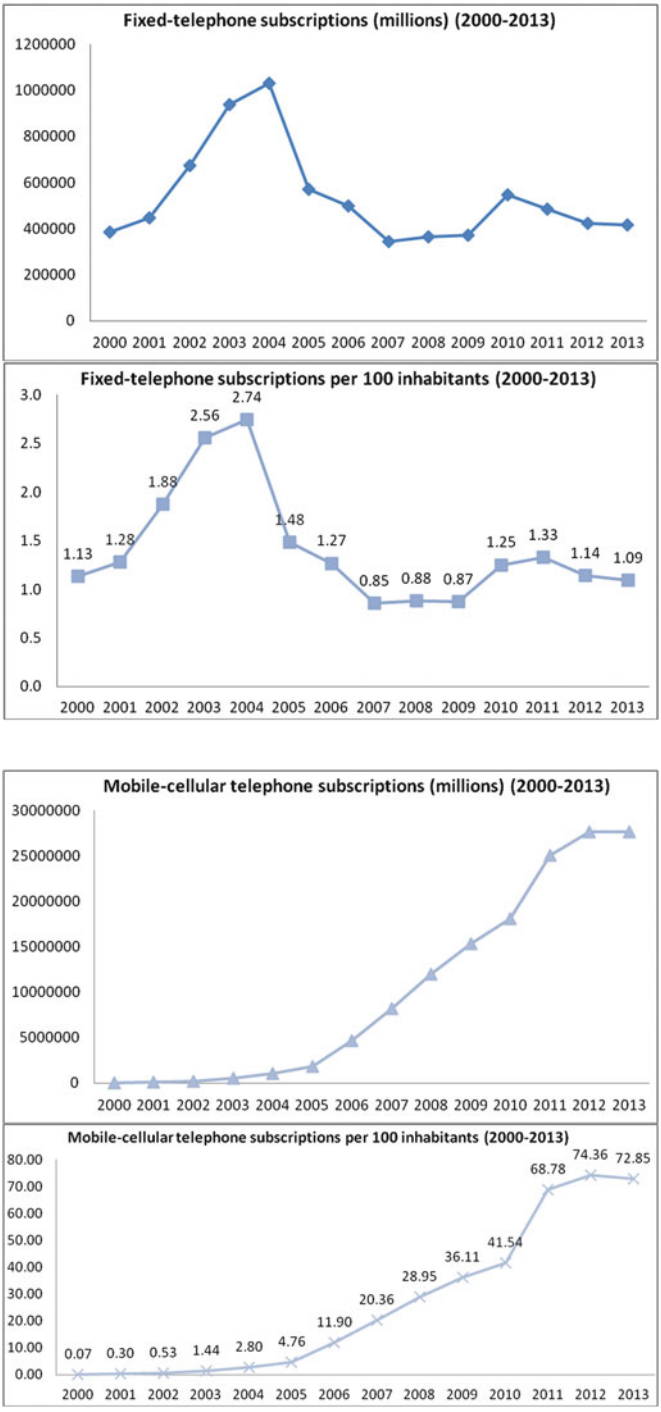
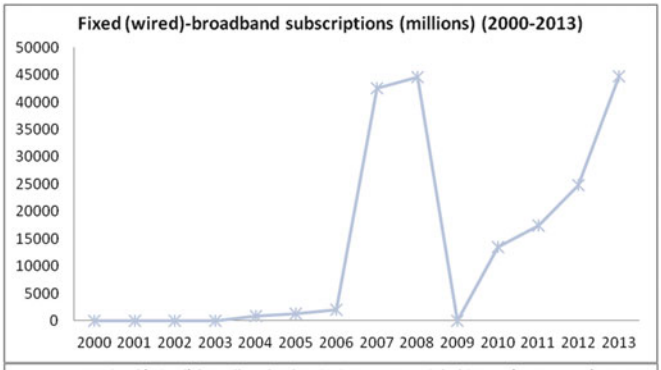
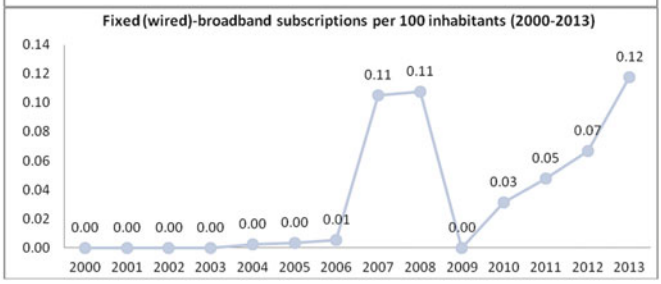
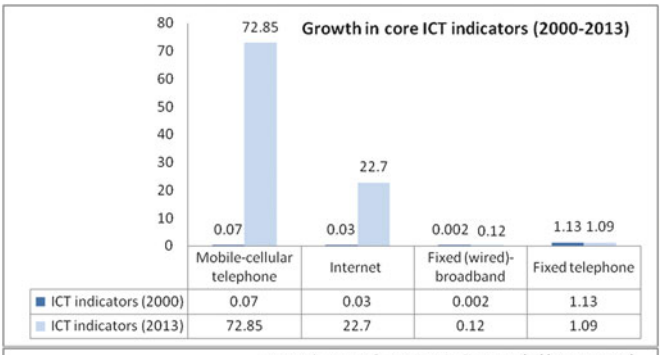


Fig. 2.1 (continued)







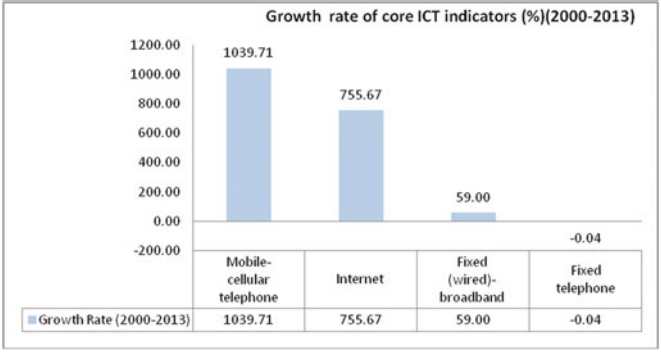


Fig. 2.1 (continued)

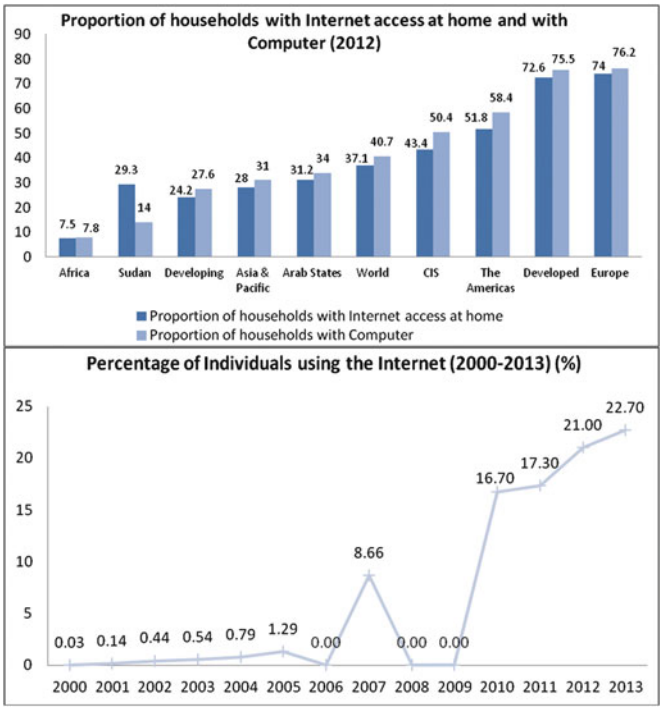


Fig. 2.1 Fixed-telephone, mobile cellular telephone, Fixed (wired) broadband subscriptions per 100 inhabitants and use of Internet in Sudan 2000–2013 (*Source* Adapted from ITU World Telecommunication/ICT Indicators database)

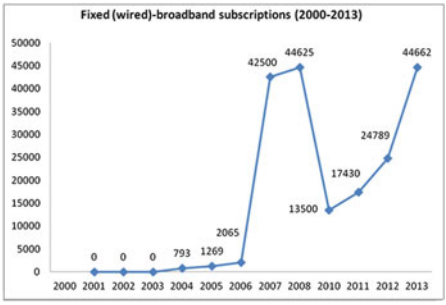


Fig. 2.2 Fixed (wired) broadband subscriptions per 100 inhabitants in Sudan 2000–2013. According to the ITU database (2014) before 2004 the fixed (wired)-broadband subscriptions (and per 100 inhabitants) were zero. Fixed (wired)-broadband subscriptions over the period (2004–2013) increased from 793 in 2004 to 1,269; 2065; 43,500 and to 44,662 in 2005; 2006; 2007 and 2008 respectively, but decreased substantially from 44,625 in 2008 to 13,500 in 2010, then increased to 17,430; 24,789 and to 44,662 in 2011; 2012 and 2013 respectively (see Table 2.6 and Figs. 2.5 and 2.6). (*Source* Adapted from ITU World Telecommunication/ICT Indicators database)

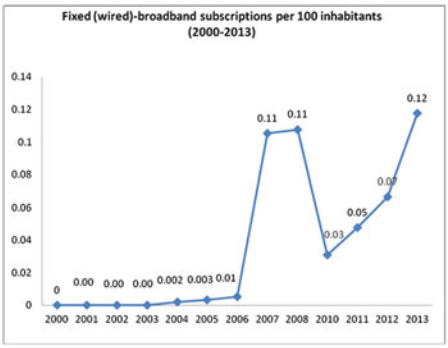


Fig. 2.3 Fixed (wired) broadband subscriptions per 100 inhabitants in Sudan 2000–2013. According to the ITU database (2014) fixed (wired)-broadband subscriptions per 100 inhabitants over the period (2004–2013) increased from 0.002 in 2004 to 0.003; 0.01; 0.11 and to 0.11 in 2005; 2006; 2007 and 2008 respectively, but decreased substantially from 0.11 in 2008 to 0.03 in 2010 then increased to 0.05; 0.07 and to 0.12 in 2011; 2012 and 2013 respectively (see Table 2.6 and Figs. 2.5 and 2.6). (*Source* Adapted from ITU World Telecommunication/ICT Indicators database)

from 0.03 in 2000 to 1.29, 16.7 and to 22.7 in 2005, 2010 and 2013 respectively (see Table 2.7 and Fig. 2.1).

The rapid increase in ICT indicators in Sudan that appear from the increasing use of Internet and mobile-cellular telephone in Sudan over the period (2000–2013), are above that of Africa but below Arab region and World region, whereas the use of fixed-telephone in Sudan is less than Africa, Arab region and World region. This implies that by regional and international standards, ICT indicators in Sudan are below compared to Arab countries and World regions. The status of ICT indicators in Sudan in 2013 can be explained by regional and international standards compared to Arab countries and world regions respectively. We find that by regional standard compared to Arab countries fixed-telephone subscriptions per 100 in Sudan (1.09 in 2013) ranked in the second bottom place in the Arab countries after Somalia, the top performance in the Arab region that reported in the United Arab Emirates (22.32) is equivalent to 20.48 times that of Sudan. By international standard, compared to world region, fixed-telephone subscriptions per 100 in Sudan is below the level of all World regions: developed countries, developing countries, World, Africa, Arab States, Asia and Pacific, CIS, Europe and the Americas (see Table 2.4 and Fig. 2.4). We find that by regional standard compared to Arab countries, mobile-cellular telephone subscriptions per 100 in Sudan (72.85 in 2013) ranked in the sixth bottom place in the Arab countries after Djibouti, Comoros, Somalia, Syria and Yemen respectively, the top performance in the Arab region that reported in Kuwait (190.29), is equivalent to 2.61 times that of Sudan. By international standard compared to world region, mobile-cellular telephone subscriptions per 100 inhabitants in 2013 in Sudan is only above the level of Africa, but below the level of developed countries, developing countries, World, Arab States, Asia and Pacific, CIS, Europe and the Americas (see Table 2.5 and

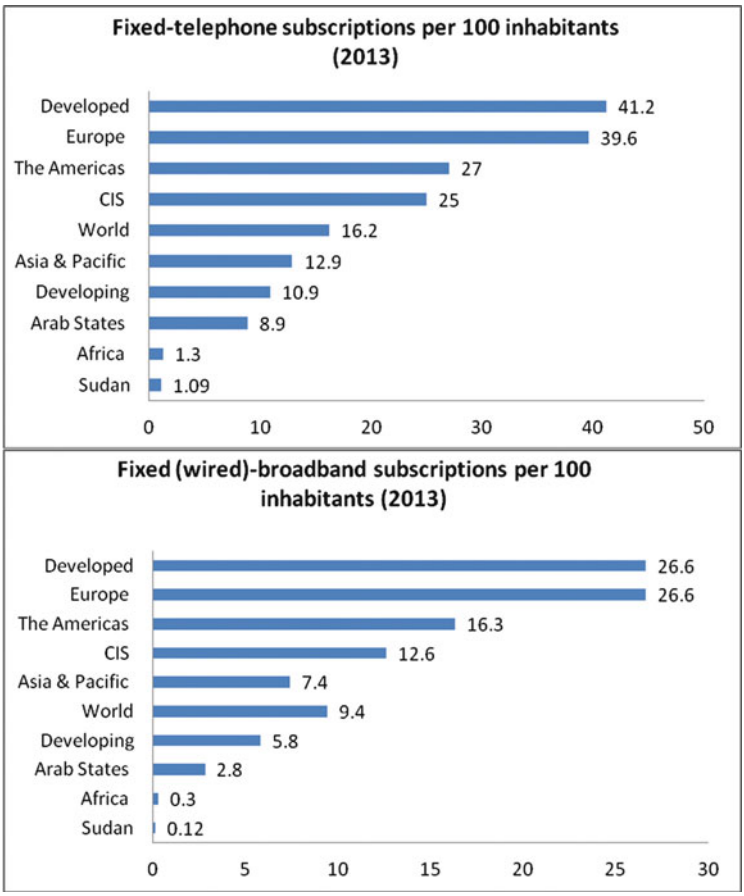


Fig. 2.4 (continued)

Fig. 2.4). We find that by regional standard compared to Arab countries, fixed (wired)-broadband subscriptions per 100 in Sudan (0.12 in 2013) ranked in the bottom place in the Arab countries, the top performance in the Arab region that reported in Bahrain (13.15) is equivalent to 109.58 times that of Sudan. By international standard compared to world region, fixed (wired)-broadband subscriptions per 100 inhabitants in 2013 in Sudan is below the level of all World regions: developed countries, developing countries, World, Africa, Arab States, Asia and Pacific, CIS, Europe and the Americas (see Table 2.6 and Fig. 2.4). We find that by regional standard compared to Arab countries, the percentage of individuals using the Internet in Sudan (22.7 in 2013) ranked in the ninth bottom place in the Arab countries after Somalia, Mauritania, Comoros, Djibouti, Iraq, Libya, Algeria and Yemen respectively, the top performance in the Arab region that reported in Bahrain (90), is equivalent to 3.96 times that of Sudan. By international standard compared to world region, the percentage of individuals using the Internet

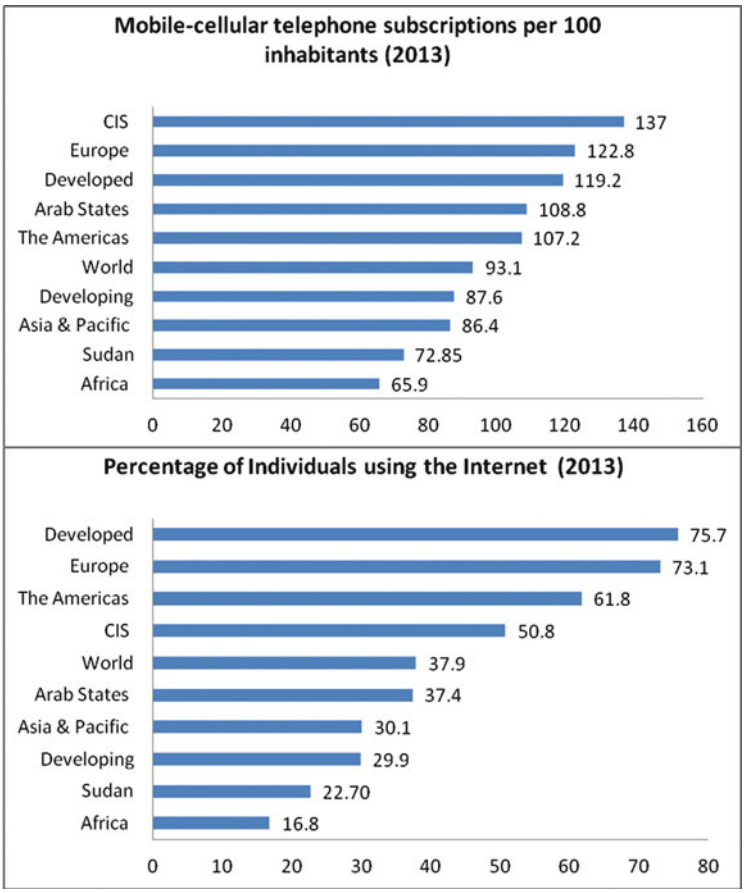


Fig. 2.4 Fixed telephone, mobile cellular telephone and Fixed (wired)-broadband subscriptions and percentage of individuals using the Internet in Sudan compared to World Regions (2013) (*Source* Adapted from ITU World Telecommunication/ICT Indicators database)

Table 2.8 ICT development index (IDI), access sub-index, use sub-index and skills sub-index in Sudan 2011–2012

	Rank	Access	Rank	Access	Change in rank	Change in access
	2012	2012	2011	2011	2011–2012	2011–2012
ICT development index (IDI)	119	2.33	118	2.19	−1	0.14
IDI access sub-index	115	2.62	120	2.37	5	0.25
IDI use sub-index	104	1.26	101	1.16	−3	0.10
IDI skills sub-index	130	3.88	129	3.88	−1	0

Source ITU (2013), pp. 24, 40, 46, 50, 54

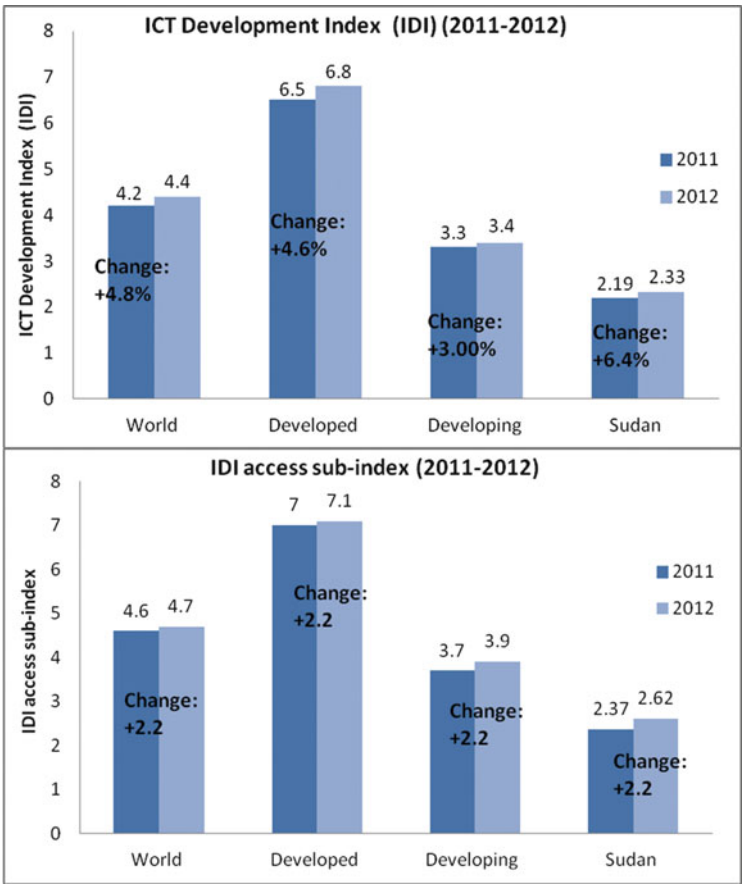


Fig. 2.5 (continued)

in 2013 in Sudan is only above the level of Africa, but below the level of developed countries, developing countries, World, Arab States, Asia and Pacific, CIS, Europe and the Americas (see Table 2.7 and Fig. 2.4). We find that by regional standard compared to Arab countries, the proportion of households with Internet access at home in Sudan (29.3 in 2013), ranked in the fifth bottom place in the Arab region after Djibouti, Yemen, Algeria and Tunisia respectively, the top performance in the Arab region that reported in Qatar (96.4) is equivalent to 3.29 times that of Sudan. By international standard compared to world region, the proportion of households with Internet access at home in Sudan is above only the level of developing countries, Africa, Asia and Pacific, but below the level of developed countries, World, Arab States, CIS, Europe and the Americas. We find that by regional standard compared to Arab countries, the proportion of households with computer in Sudan (14), ranked in the second bottom place in the Arab countries after Djibouti,

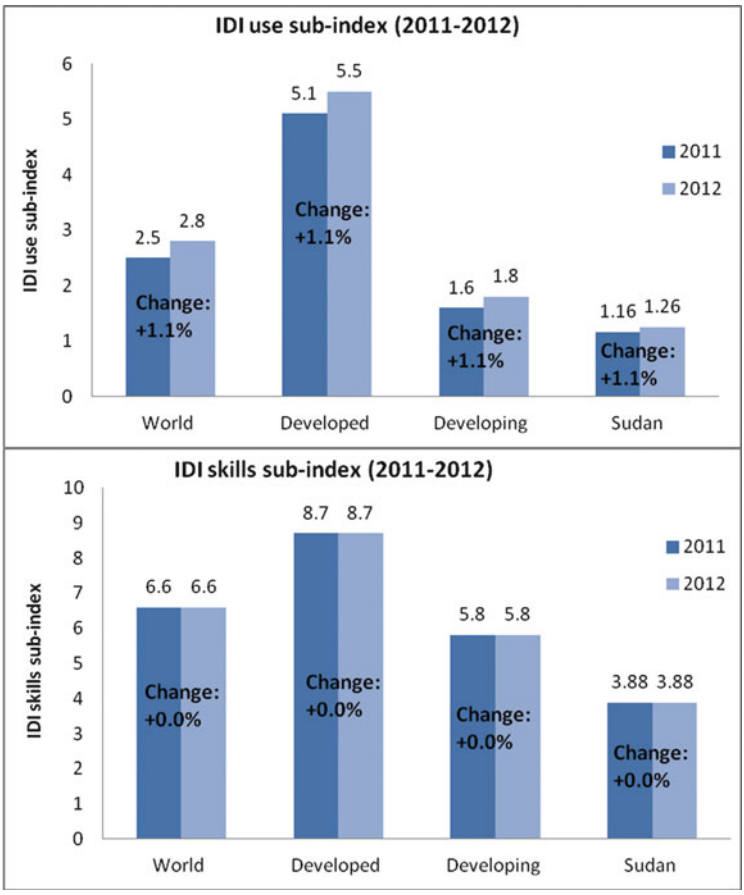


Fig. 2.5 ICT Development Index (IDI), and access sub-index, use sub-index and skills sub-index in Sudan 2011–2012 (*Source* Adapted from ITU (2013), p. 40)

the top performance in the Arab region that reported in Qatar (97.1) is equivalent to 6.94 times that of Sudan. By international standard compared to world region, the proportion of households with computer in Sudan is above only the level of Africa, but below the level of developed countries, developing countries, World, Arab States, Asia and Pacific, CIS, Europe and the Americas (see Table 2.7 and Fig. 2.4).

The performance in terms of ICT Development Index (IDI) implies slight improvement in Sudan's score value from 2.19 in 2011 to 2.33 in 2012, but in terms of global IDI ranking, Sudan fell in the rankings between 2011 and 2012, Sudan is ranked at 119 place globally in 2012 compared to 118 place globally in 2011 out of 157 countries in the World. In the Arab region, Sudan is ranked at 13 place regionally out of 17 countries in the Arab region, it is ranked at fifth bottom place in Arab region in 2012 (see Table 2.8, Fig. 2.5). The status and trend of ICT indicators in Sudan appears from the status and trend of ICT Development Index

(IDI), access sub-index, use sub-index and skills sub-index over the period (2011–2012). For instance, ICT Development Index (IDI) increased from 2.19 in 2011 to 2.33 in 2012; access sub-index increased from 2.37 in 2011 to 2.62 in 2012; use sub-index increased from 1.16 in 2011 to 1.26 in 2012 and skills sub-index remained unchanged 3.88 in 2011 and 2012 (see Table 2.8, Fig. 2.5). We find that evidences in support of the incidence of the global digital divide between Sudan and the World countries, developed countries and developing countries appear from ICT Development Index (IDI), access sub-index, use sub-index and skills sub-index over the period (2011–2012) (see Fig. 2.5) (See ITU 2013, p. 40).

2.4 Conclusions

This chapter presents an overview of Sudanese economy and the trend and status of ICT in Sudan. Section 2.2 explains some stylised facts along with other strategic problems confronting economic development in Sudan. Section 2.2 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 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. However, the secession of the South in 2011 had seriously and critically affected the Sudan economy (UNDP-HDR 2014), particularly, because of the loss of greater part of Sudan's oil production and export revenues.

Section 2.3 explains the trend and status of core ICT indicators in Sudan. We show that in the recent years, Sudan has shown growing telecommunication networks and Internet services and the diffusion of ICT in Sudan has increased significantly. We explain that recent indicators from International Telecommunication Union (ITU) (2014) show the trend of core ICT indicators and illustrate that despite recent slowdown in terms of fixed telephone, the recent average growth rate of the total online population, Internet, fixed (wired)-broadband and mobile-cellular subscribers in Sudan during the period 2000–2013 has been significant. ITU (2014) data for 2000–2013 indicates that in Sudan the growth rate of mobile-cellular telephone (1,039.71) is faster than Internet (755.67), fixed (wired)-broadband (59) and fixed telephone (−0.04) respectively (see Tables 2.4, 2.5, 2.6, and 2.7). We show that the status of ICT indicators in Sudan in 2013 can be explained by regional and international standards compared to Arab countries and world regions respectively. We find that ITU (2014) data for 2000–2013 indicates that by regional and international standards the rapid increase in ICT indicators in Sudan that appear from the increasing use of Internet and mobile-cellular telephone and the increasing proportion of households with Internet and proportion of households with computer are above that of Africa but below Arab region and World region, whereas the use of fixed-telephone in Sudan is less than Africa, Arab region and World region. This

implies that by regional and international standards, ICT indicators in Sudan are below compared to Arab countries and World regions. 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. We find evidences in support of the incidence of the global digital divide between Sudan and the World countries, developed countries and developing countries that appear from ICT Development Index (IDI), access sub-index, use sub-index and skills sub-index over the period (2011–2012). Our results indicate that the reported digital gap in core ICT indicators at the aggregate macro level in Sudan compared to world regions seems consistent with the observed development gap in social, economic, human development and education indicators in Sudan compared to world regions.

References

Elbadawi I, Suleiman K (2008) Toward an equitable inter-governmental transfer system for the Sudan, chapter 3. In: Abd El Rhman S (ed) Generating growth and making fiscal decentralization work in post-conflict Sudan. Ministry of Finance and National Economy, Khartoum, p 107, Table 3

International Telecommunication Union (ITU) (2013) Measuring the information society. ITU, Geneva, pp 24, 39–40, 43

International Telecommunication Union (ITU) (2014) World telecommunication (ITU)/ICT indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Sudan Central Bureau of Statistics Population Census Data (2010) Fifth Sudan population and housing census (2008). Sudan Central Bureau of Statistics, Khartoum

The Sudan Central Bureau of Statistics (2011) Sudan national baseline household survey 2009. Sudan Central Bureau of Statistics, North Sudan, p 12

The World Bank (WB-DTS) (2008) "Revitalizing Sudan's non-oil exports: a Diagnostic Trade Integration Study (DTIS)" prepared for the integrated framework program (December 2008). A revised version of "Sudan Diagnostic Trade Integration Study (DTS), poverty reduction and economic management 2—Africa region, draft: 2 May 2008, decision meeting: 13 May 2008", pp 8–9; 1–7. http://www.integratedframework.org/files/english/Sudan%20DTIS%20final.pdf. Accessed 10 June 2010

The World Development Indicators (WDI)/IMF/World Bank Staff Estimate (2008) Revitalizing Sudan's non-oil exports: a diagnostic trade integration study (DTIS) prepared for the integrated framework program (December 2008). A revised version of "Sudan Diagnostic Trade Integration Study (DTS), poverty reduction and economic management 2—Africa region, draft: 2 May 2008, decision meeting: 13 May 2008", pp 8–9; 1–7

UNDP-HDR (2014) Human development report 2014: sustaining human progress: reducing vulnerabilities and building resilience. UNDP, New York

World Development Indicator (WDI) database (2005)

The Central Bank of Sudan (2013) The Central Bank of Sudan Annual Report (2013), p. 120, Khartoum, Sudan

Part II
Conceptual and Theoretical Framework

Chapter 3
Conceptual Framework and Reviews of Theoretical and Empirical Literature

3.1 Introduction

Information and Communications Technologies (ICT) has been essential for the acceleration and improvement of economic growth and welfare in any society. The crucial role of ICT and its impacts on the global knowledge economy has long received particular recognition and increasing interest in the international literature. The rapid progress in information and communications technologies led to a new economic system characterised by intensive knowledge production and diffusion 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. 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.

It is admitted that ICT like many other forms of technological progress has imposed both the positive and negative impacts (opportunities and challenges) on the world economy. On the one hand, some studies provide robust results showing the various influences of ICT on economic growth and development (cf. Jorgenson and Stiroh 1995; Pohjola 2000, 2001), productivity (cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organisation (cf. Bresnahan et al. 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 enhancing knowledge (cf. Smith 2000) and through the complementary relationships between ICT, human capital/skill and skill upgrading (cf. Goldin and Katz 1998; Bresnahan et al. 1999; Autor et al. 1998; Acemoglu 1998; 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

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creative destruction process that creates opportunities for development, while also imposing certain restrictions to development and negative impacts on employment and labour markets (cf. Bound and Johnson 1992; Berman et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor et al. 1998).

It has also been hypothesised that ICT could 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 (cf. OECD 2001; ITU 2013).

In light of this background and the findings in Chap. 2 above, it is therefore reasonable to highlight the need for improvement of investment in ICT to alleviate the digital divide, enhance production, creation and transfer of knowledge in higher education institutions and to enhance economic growth and sustainable development in Sudan. Before starting the empirical analysis, it is useful in this chapter to briefly explain the concepts, measures and theoretical and empirical literature in relation to ICT, knowledge, economic growth and digital divide. We provide a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature that emphasizes the positive effects of ICT in enhancing knowledge and economic growth and the negative effects of ICT through exacerbating the digital divide, the digital divide continues to cause intense debate.

The rest of this chapter is organized as follows: in Sect. 3.2 we define the concepts of "information and communications technology (ICT)", "digital divide", "global digital divide" and "gender digital divide"; the theoretical and empirical literature on the relationship between ICT, knowledge and digital divide are presented in Sect. 3.3. Section 3.3.2 describes the relationship between ICT and economic growth; Sect. 3.3.4 discusses relations between ICT and knowledge production and higher education institutions, and finally, Sect. 3.4 concludes.

3.2 Conceptual Framework: Definition of Information and Communications Technology, Digital Divide, Global Digital Divide, and Gender Digital Divide

Before presenting the theoretical and empirical literature, it is useful to begin with the definition of the concepts of "information and communications technology (ICT)", "digital divide", "global digital divide" and "gender digital divide".

3.2.1 Information and Communications Technology

The term Information and communications technology (ICT) is often used as an extended synonym for information technology (IT), but is a more specific term that stresses the role of unified communication and the integration of telecommunication (telephone lines and wireless signals), computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information. The term *ICT* is also used to refer to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system.[1]

3.2.2 Digital Divide

This section explains the distinction that has been made between the term "digital divide", "global digital divide" and "gender digital divide".

3.2.2.1 Digital Divide

We start with the concept digital divide, according to the definition of Oxford dictionaries: "*the digital divide is the gulf between those who have ready access to computers and the Internet, and those who do not*".[2] According to the definition provided in other dictionary "*the digital divide is the socioeconomic and other disparities between those people who have opportunities and skills enabling them to benefit from digital resources, especially the Internet, and those who do not have these opportunities or skills*".[3] According to OECD (2001) "*the term "digital*

[1] See http://en.wikipedia.org/wiki/Information_and_communications_technology.

[2] See Oxford dictionaries: http://www.oxforddictionaries.com/definition/english/digital-divide, accessed on September 08, 2014.

[3] See http://dictionary.reference.com/browse/digital+divide, accessed on September 08, 2014.

divide" refers to the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access information and communication technologies (ICTs) and to their use of the Internet for a wide variety of activities, the digital divide reflects various differences among and within countries" (OECD 2001).[4] The U.S. Department of Commerce—National Telecommunications and Information Administration (NTIA) (1999) defines the "digital divide" as "*the divide between those with access to new technologies and those without*".[5] More broadly, the term digital divide is used to describe a gap between those who have ready access to information and communication technology and the skills to make use of those technology and those who do not have the access or skills to use those same technologies within a geographic area, society or community. Based on this, a digital divide is an economic and social inequality between groups of persons, according to categories of persons in a given population in their access to, use of, or knowledge of information and communication technologies (ICT) (NTIA 1995; Chinn and Fairlie 2004). It may refer to inequalities between individuals, households, businesses, or geographic areas, usually at different socioeconomic levels or other demographic categories.[6] The term digital divide also refers to "*an inequality in the power to communicate and to process information digitally*" (cf. NTIA 1995, 1999; OECD 2001; Hilbert 2011a, b), it is considered as "*a new form of inequality added to all the existing forms of discrimination*" (cf. Hilbert 2011a, b). Based on this definition some studies argue for shifting attention from the "digital divide"—inequality between "haves" and "have-nots" differentiated by dichotomous measures of access to or use of the new technologies—to digital inequality, which refers not just to differences in access, but also to inequality among persons with formal access to the Internet (cf. DiMaggio and Hargittai 2001). Data on Internet penetration show five dimensions of digital inequality in equipment, autonomy of use, skill, social support, and the purposes for which the technology is employed, this suggests the need to study institutional issues in order to understand patterns of inequality as evolving consequences of interactions among firms' strategic choices, consumers' responses, and government policies (cf. DiMaggio and Hargittai 2001).[7] The concept is widely used to describe the divide within countries (such as the digital divide in the United States), it was originally popularized in regard to the disparity in Internet access between rural and urban areas of the United States of America.[8] However, research shows that the digital divide is more than just an access issue and cannot be alleviated merely by providing the necessary equipment. There are at least three factors at play: information accessibility, information utilization and information receptiveness. More than just accessibility, individuals

[4] See OECD (2001), p.5.

[5] See (NTIA) (1999), p. xiii.

[6] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

[7] See DiMaggio and Hargittai (2001).

[8] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

need to know how to make use of the information and communication tools once they exist within a community (Mun-cho and Jong-Kil2001). Information professionals have the ability to help bridge the gap by providing reference and information services to help individuals learn and utilize the technologies to which they do have access, regardless of the economic status of the individual seeking help (Aqili and Moghaddam 2008). Conceptualization of the digital divide has been described as follows: (Buente and Robbin 2008; Hilbert 2011a, b): subjects (who have connectivity, or who connects: individuals, organizations, enterprises, schools, hospitals, countries, etc.); characteristics of connectivity (or which attributes: demographic and socio-economic variables, such as income, education, age, geographic location, etc.); means of connectivity (or connectivity to what: fixed or mobile, Internet or telephony, digital TV, etc.); intensity of connectivity (or how sophisticated the usage: mere access, retrieval, interactivity, innovative contributions.); purpose of connectivity, or why individuals and their cohorts are (not) connecting: reasons individuals are and are not online and uses of the Internet and information and communication technologies ("ICTs"); and dynamics or evolution, (whether the gap of concern will increase or decrease in the future, when the gap of concern would be maximized) (Huang and Chen 2010). Based on different answers to the questions of who, with which kinds of characteristics, connects how and why, to what there are hundreds of alternatives ways to define the digital divide (Hilbert 2011a, b). "The new consensus recognizes that the key question is not how to connect people to a specific network through a specific device, but how to extend the expected gains from new ICTs" (Galperin 2010). In short, the desired impact and "the end justifies the definition" of the digital divide (Hilbert 2011a, b).

3.2.2.2 Global Digital Divide

Distinction has been made between the term digital divided and global digital divide. The term "global digital divide" refers to *the divide between differing countries or regions of the world* (NTIA 1995; Norris 2001); it examines the technological gap between developing and developed countries on an international scale (Chinn and Fairlie 2004). The global digital divide describes global disparities, primarily between developed and developing countries, in regards to access to computing and information resources such as the Internet and the opportunities derived from such access (Ming-te 2001). The global digital divide describes an inequality that exists, referencing a global scale, it is a special case of the digital divide, the focus is set on the fact that "Internet has developed unevenly throughout the world" (Guillen, and Suárez 2005) causing some countries to fall behind in technology, education, labor, democracy, and tourism; the global digital divide mirrors this disparity on an international scale. The global digital divide also contributes to the inequality of access to goods and services available through technology. Computers and the Internet provide users with improved education, which can lead to higher wages; the people living in nations with limited access are

therefore disadvantaged (Krueger 1993; Attewell and Battle 1999). This global divide is often characterized as falling along what is sometimes called the north–south of "northern" wealthier nations and "southern" poorer ones.[9] "The digital divide can be measured using the ratio in penetration rates between different groups of economies: for example, "developed" and "developing" economies"[10] (ITU and World Information Society Report 2007). According to ITU and World Information Society Report (2013) "*the digital divide can be understood as the difference in ICT access and use between countries, between regions, or between other groupings that share common characteristics*." "at the global level, a common way of identifying differences between countries is to look at national ICT levels in relation to the world average, or to group the world into developed and developing countries and compare their respective performance. The ICT Developments Index (IDI) is an especially useful tool (for assessing and tracking the global digital divide and) for comparing differences in ICT developments since, as a composite index, it consolidates several ICT indicators into one single value"[11] (ITU and World Information Society Report 2013).

3.2.2.3 Gender Digital Divide

Distinction has been made between the term digital divided and gender digital divide. The gender digital divide describes an inequality that exists defined by gender, it is a special case of the digital divide, the focus is set on the fact that the gender gap between men and women implies that women fall behind men in terms of access to and use of ICT. The term gender digital divide refers to the gap in ICT access rates between men and women (cf. Seybert 2007; Hilbert 2011a, b; ITU 2013). It adds to the longstanding challenges of gender inequalities in developing countries, in access to employment, income, education and health services.[12]

3.3 Theoretical Framework and Reviews of Empirical Literature

Based on the above conceptual framework, in this section we show the theoretical and empirical literature on the relationship between ICT and digital divide, ICT and economic growth, and ICT and education and knowledge production in knowledge institutions.

[9] See: http://en.wikipedia.org/wiki/Digital_divide, accessed September 09, 2014.

[10] See ITU (2007) "Bridging the digital divide," chapter two in "World Information Society Report 2007," p. 21.

[11] See ITU (2013), pp. 39–40.

[12] See Hilbert (2011a, b).

3.3.1 ICT and Digital Divide: Theoretical Framework and Empirical Literature

In this section, we show that the interaction between ICT and digital divide motivates theoretical and empirical literature to postulate several explanations of the incidence of the digital divide and the main reasons for the incidence of the digital divide.

3.3.1.1 ICT and Digital Divide: Theoretical Framework

The theoretical framework discussed in several studies in the international literature illustrates the debate concerning the incidence and the main reasons for the digital divide. From existing research on the digital divide we may surmise two plausible theoretical interpretations of the incidence and the main reasons for the incidence of the digital divide, which are closely related to Internet *diffusion* and theories of *Social Stratification in the Networked World*. These theoretical interpretations provide the proponents and opponents arguments concerning the incidence of the digital divide. On the one hand, the more optimistic '*normalization*' hypothesis predicts that, at least in affluent post industrial societies, the social profile of the online community will gradually broaden over time, like the early audience for radio or television, until eventually it comes to mirror society as a whole (see Resnick 1998). In countries at the forefront of the information revolution, like the United States, Australia and Britain, Internet use has rippled out within the last decade from an information source networking scholars and scientists at elite research institutions to become a medium of mass communications for the delivery of news, music, video and audio programming, as well as e-commerce and home shopping. The *normalization* thesis suggests that in developed societies the Internet could eventually become as popular as TV today, so that we can expect penetration levels to reach 90–95 % of the population, encouraged by falling costs for hardware, software and services, and the growth of online home entertainment. Surrounded at home and work by easy access to all Internet, all the time, often assume that eventually most will succumb to the digital onslaught. Competition in the marketplace, some assume, will eventually take care of any residual major disparities, removing the need for government intervention or regulation for the provision of universal service, beyond the minimal prevention of monopolistic practices. In contrast the more pessimistic diffusion theory developed by Everett Rogers provides an alternative interpretation of social stratification in technological adaptation (see Rogers 1995). Case studies implies that compared with laggards, early adopters of new innovations are characteristically drawn from groups with higher socioeconomic status. Education, literacy, and social status provide access to the essential financial and information resources required to adapt flexibly to innovative technologies. Moreover, diffusion theory suggests that the adoption of successful new technologies often reinforces economic advantages, like the greater

productivity facilitated in agriculture by mechanized tractors, artificial fertilizers and specialist seed-corn, so that the rich get richer, and the less well- off sectors fall further behind. Everett Rogers emphasizes that this pattern is far from inevitable, since the conditions under which an innovation is implemented determines, in part, their social consequences. Active initiatives to level the playing field by the state and non-profit sectors can broaden technological access. The existing social structure also plays a role; innovations in highly stratified societies will usually reinforce existing socioeconomic disparities. The type of technology can also influence this process, for example the initial resources required for access, including both financial investments and educational skills. Nevertheless diffusion theory predicts that without successful state intervention, if the spread of the Internet follows the conventional trajectory established by many previous technologies, then the initial adoption of wired computers can be expected to exacerbate existing social divisions, at least in the early-to- middle stages of the 'S' shaped diffusion curve, and perhaps in the longer—term as well if the new technology produces substantial productivity gains and continuing access barriers (Norris 2001).[13]

3.3.1.2 ICT and Digital Divide: Empirical Literature

Based on the above theoretical framework, since long, there is increasing debate around the incidence, measurement and reasons of the incidence of the digital divide; recently the topic has received increasing interest in the international and empirical literature.

ICT and Digital Divide

Several studies in the empirical literature indicate that measuring the digital divide is important in order to understand development in the information society and to inform ICT policy-makers, analysts and other stakeholders addressing issues of digital equality and ICT for development. Traditionally the nature of the divide has been measured in terms of the existing number of subscriptions and digital devices. Given the increasing number of such devices, the conclusion has been that the digital divide among individuals has increasingly been closing as the result of a natural and almost automatic process (Compaine 2001; Dutton et al. 2004). According to OECD (2001) for measuring the digital divide important indicators appear to be communications infrastructures, computer availability—and potentially the availability of alternative access through TVs or mobile phones—and Internet access (these are "readiness" indicators). Recent studies have measured the digital divide not in terms of technological devices, but in terms of the existing bandwidth per individual (in kbit/s per capita) (Hilbert 2013). The term "digital

[13] For all this part see Norris, P. (2001) "Social inequalities" Chapter 4 in Norris, P. (2001) "Digital Divide," Chapter 4, pp. 1– 4.

divide" doesn't necessarily mean that someone doesn't have technology; it could mean that there is simply a difference in technology. These differences can refer to, for example, high-quality computers, fast Internet, technical assistance, or telephone services. The difference between all of these is also considered a gap. Despite the differences in the focus and methodological approach of studies on the digital divide, all of them answer (part of) the following questions: who (individuals vs. organizations/communities, vs. societies/countries/world regions, etc.), with which attributes (income, education, geography, age, gender, or type of ownership, size, profitability, sector, etc.), connect how (pain access vs. usage vs. real impact), to what kind of technology (phone, Internet, computer, digital TV, etc.) (see Hilbert 2011a, b).

Some studies in the empirical literature provide explanation of the incidence of the digital divide and indicate that the gap in a digital divide may exist for a number of reasons and determinants. Previous research has shown that ICT adoption patterns are characterized by the same long established determinants of inequality as other aspects of social life, such as those related to income, education, skills, employment, geography, age and ethnicity, and gender, among others (e.g. Cullen 2001; Compaine 2001; OECD 2002; Warschauer 2003; Mossberger et al. 2003; van Dijk 2005; OSILAC 2007; Hilbert 2010).[14]

One important reason to explain the incidence of the digital divide is income, "as income rises so does Internet use, strongly suggesting that the digital divide persists at least in part due to income disparities" (Rubin 2010). Obtaining access to ICTs and using them actively has been linked to a number of demographic and socio-economic characteristics: among them income, education, race, gender, and geographic location (urban–rural), age, skills, awareness, political and cultural and psychological attitudes (Mossberger et al. 2006; Lawton 2012; Wensheng 2001; Guillen and Suárez 2005; Wilson 2004; Deborah 2007; Kenneth et al. 2003; Hilbert 2010). Previous studies across countries has shown that income levels and educational attainment are identified as providing the most powerful explanatory variables for ICT access and usage (Hilbert 2010). As for geographic location, people living in urban centers have more access and show more usage of computer services than those in rural areas. Gender was previously thought to provide an explanation for the digital divide, many thinking ICT were male gendered, but controlled statistical analysis has shown that income, education and employment act as cofounding variables and that women with the same level of income, education and employment actually embrace ICT more than men (see Women and ICT4D) (Hilbert 2011a, b).

The U.S. Department of Commerce has drawn attention to these disparities in successive studies since 1993. Falling through the Net emphasizes the lack of access to computers and the Internet commonly found in America among poorer households, those with only high-school education, the black and Hispanic populations, rural communities and women. Pew surveys in Spring 2000 confirm

[14] See Hilbert (2011a, b).

the familiar pattern found in many American studies, with sharp inequalities of Internet access by age, education, race and ethnicity, plus the more modest gender gap. Three-quarters of all American college graduates use the Internet compared with less than a fifth of those who failed to graduate from high school. One half of all whites are online compared with one third of all blacks. And two-thirds of the younger generation is online compared with one in ten senior citizens. The OECD has documented similar patterns of stratification among the Internet population in Canada, Australia and Finland. The chief concern about the digital divide is that the underclass of info-poor may become further marginalized in societies where basic computer skills are becoming essential for economic success and personal advancement, entry to good career and educational opportunities, full access to social networks, and opportunities for civic engagement (See Norris 2001).[15]

According to OECD (2001) "the ability of individuals and businesses to take advantage of the Internet varies significantly across the OECD area as well as between OECD and non-member countries. Access to basic telecommunications infrastructures is fundamental to any consideration of the issue, as it precedes and is more widely available than access to and use of the Internet. The digital divide among households appears to depend primarily on two variables, income and education. Other variables, such as household size and type, age, gender, racial and linguistic backgrounds and location also play an important role. The differences in PC and Internet access by household income are very large and increasing, but access in lower income groups is rising. Largely through its effects on income, the higher the level of education, the more likely individuals are to have access to ICTs. Other important indicators concern differences in the profiles of countries, individuals and businesses that use, and make the most use of, the possibilities offered by the new information technologies and the Internet" (OECD 2001).[16]

ICT and Global Digital Divide

Several studies in the international literature examine the incidence of the global digital divide. For instance, ITU World Information Society Report (2013) provides monitoring of the global digital divide between developed, developing and least connected countries. ITU (2013) uses the ICT Developments Index (IDI) as a useful tool for assessing and tracking the global digital divide and for comparing differences in ICT developments.[17] On the basis of the 2012 and 2011 data presented in ITU (2013), measures the magnitude of the current (2012) divide and also the increasing or decreasing divide over the past year. An analysis of the IDI points to a significant divide between the developed and developing world. In 2012, the

[15] See Norris (2001) "Digital Divide" Chap. 4, pp. 1–4.

[16] See OECD (2001), p. 5.

[17] ICT Development Index (IDI) is a composite index, it consolidates several ICT indicators into one single value.

average developed-country IDI value was exactly twice as high as the developing-country average. At the same time, the developing-country average IDI value is growing faster, at a rate of 5.8 %, as against 3.5 % for developed countries. While developed countries are starting to reach saturation levels, in particular in terms of mobile-cellular subscriptions and household ICT access, developing countries, where penetration levels remain much lower, continue to have ample potential for growth. The difference in the access sub-index, which measures ICT infrastructure and readiness, is smaller than the difference in the use sub-index, thus confirming that developing countries have been able to make greater progress in providing basic ICT access. Progress has been achieved particularly through mobile-cellular technology, but also through an increase in household access to ICTs and increased availability of international Internet bandwidth. Between 2011 and 2012, the access sub-index in the developing countries grew three times as fast as in the developed world. The divide, which is measured as the difference in IDI values between groups, is largest in terms of the use sub-index, which measures the uptake and intensity of ICT use. Here, developed countries have reached over three times the average 2012 IDI value of developing countries. This gap points to the considerable differences that exist between the developed and developing world in terms of Internet users and fixed (wired)-broadband and wireless-broadband subscriptions, in many developing countries, broadband access remains very limited. At the same time, the use sub-index is growing at twice the speed in developing countries. This is a positive development, suggesting that developing countries are catching up. The smallest differences between developed and developing countries and smallest change between 2011 and 2012 are found in the skills sub-index, where changes take time to come into effect. While developed countries have reached very high levels of literacy and school enrolment, developing countries need to ensure that all citizens are equipped with basic skills to enable them to participate in the information society. This is particularly—and increasingly—important as infrastructure barriers are being overcome and ICTs are made available to an increasingly large proportion of the world's population.[18]

Some studies provide explanation for the occurrence of the global digital divide. For instance ITU (2013) show that there are many reasons why some countries lag behind in terms of ICTs. There is a strong link between ICT uptake (and other development issues) and income levels. A regression analysis of IDI values and GNI per capita confirms the strong relationship that exists between how wealthy countries are and how advanced their information societies are. Despite the strong link between income and ICT development variables, some countries are faring comparatively better (or worse) than their income levels would predict. Countries such as the Republic of Korea, Estonia and Moldova, for example, lie well above the regression curve and have relatively high IDI values in relation to their gross national income (GNI) level. The Republic of Korea and Estonia, in particular, have made ICTs a national priority and showcased clear leadership in developing and

[18] For all this part see ITU (2013), pp. 39–40.

using ICTs and formulating targeted ICT policies that have driven ICT growth and uptake. Countries with relatively high income levels but comparatively lower IDI values include the United Arab Emirates, Brunei Darussalam, Angola, Gabon and Botswana. The comparison suggests that, in these countries, focused policies and government action could quickly lead to higher ICT levels. ITU highlighted the link between the uptake of ICTs and the price of telecommunication services, [differences in prices explains] differences between countries. A comparison of the IDI with the ICT Price Basket, and comparison of the affordability of ICT services in more than 160 countries worldwide, confirms the link between ICT uptake and affordability. [The result] substantiates the claim that relatively high prices tend to hamper the spread of ICTs, while affordable services foster their uptake and use. Countries with very high ICT prices and very low ICT levels, in particular, must address pricing policies to allow more people to join the information society.[19]

A number of studies confirm the occurrence of the global digital divide, indicating that many developing countries have computer and Internet penetration rates that are 1/100th of the rates found in North America and Europe. For example, there are less than 6 personal computers per 1,000 people in India, whereas more than 6 out of 10 people in the United States own a computer (ITU 2003). Although these differences in technology diffusion may have substantial economic consequences, the empirical literature aimed at identifying the causes is limited. A few factors have been identified as being important, such as differentials in income, human capital, regulatory effectiveness, and telecommunications infrastructure. The income per capita differential accounts for the single most important component (see for example Quibria, et al. 2002; OECD 2001; U.S. Department of Commerce 2002), but it is not by any means the only component. Differences of the digital divide in the telecommunications infrastructure and the role to human capital (see Dasgupta, et al. 2001; Barro 1991; Wallsten 2003) and institutional factors (see Hall and Jones 1999) are also important. According to Dasgupta, et al. (2001) computers may require substantial levels of education for use, but telephones and the Internet may require very little. Additional results include a large (positive) impact of regulatory quality or property rights on the Internet digital divide, which suggests that the diffusion of the Internet may be particularly dependent upon the quality of institutions prevailing in an economy. Finally, the results for demographic controls suggest that the global digital divide would be even larger if developing countries had an age composition that was more similar to the United States.[20]

Other studies provide explanations and identify the determinants of cross-country disparities in personal computer and Internet penetration. For instance, Chinn and Fairlie (2004) examine cross-country disparities using a panel of 161 countries over the 1999–2001 period and use the economic variables (income per capita, years of schooling, illiteracy, trade openness), demographic variables (youth and aged dependency ratios, urbanization rate), infrastructure indicators

[19] See ITU (2013), p. 43.

[20] See Chinn and Fairlie (2004).

(telephone density, electricity consumption), telecommunications pricing measures, and regulatory quality. With the exception of trade openness and the telecom pricing measures, these variables enter in as statistically significant in most specifications for computer use. A similar pattern holds true for Internet use, except that telephone density and aged dependency matter less. Their results imply that the global digital divide is mainly—but by no means entirely—accounted for by income differentials. For computers, telephone density and regulatory quality are of second and third importance, while for the Internet, this ordering is reversed. Their results suggest that public investment in human capital, telecommunications infrastructure, and the regulatory infrastructure can mitigate the gap in PC and Internet use[21] (See Chinn and Fairlie 2004).

ICT and Gender Digital Divide

Several studies in the international literature examine the incidence of the gender digital divide. For instance, ITU (2013) monitoring the ICT gender gap and indicating that data show that there is a gender gap in the use of computers, mobile phones and Internet, and that the gap is more prevalent in developing than developed countries. For example, by end 2013, ITU estimates that the gender gap in Internet usage will be 11 % globally, 2 % in developed countries and 16 % in developing countries. Indeed, there is a close relationship between Internet access differences by gender and other variables, such as level of income and level of education (Deen-Swarray et al. 2013). Gender differences can also be observed when it comes to the location of Internet use, activities carried out over the Internet and frequency of Internet use. For example, available data suggest that women tend to use the Internet more than men for educational activities; that men access the Internet more than women in commercial Internet access facilities (such as cybercafés); and that men tend to be online more frequently than women. Another area where critical gender-relevant information is in high demand is the participation of women in the ICT workforce.[22]

Several studies in the international literature on the digital gender divide examine the differences between men's and women's access to and use of ICT in developed countries (cf. World Internet Project 2009) and in developing countries (cf. Hilbert 2011a, b). In nearly all European countries and in all age groups, however, men are more regular users of both computers and the internet than women and many more men than women are employed in computing jobs throughout the EU (Seybert 2007).[23] Other studies find similar results in Latin American and African countries from 2005 to 2008, indicating that the reason why fewer women access and use ICT is a direct result of their unfavorable conditions with

[21] See Chinn and Fairlie (2004).
[22] See ITU (2013), p. 12.
[23] See Seybert (2007).

respect to employment, education and income (Hilbert 2011a, b).[24] In the international literature there are two arguments concerning the differences between men's and women's access to and use of ICT. The first argument considers ICT as an opportunity for empowering women [especially, in developing countries], and considers ICT and digital technologies as tools for women to overcome longstanding inequalities. ICT can help women to gain employment (for example through telework or newly created information jobs), obtain cost-effective health services and education (such as through online courses or software-based literacy programs) and to increase their income (such as through e-business channels and online transactions). In contrary to this first optimistic argument, the second pervasive and persistent counterargument believes that women are at a natural disadvantage to benefit from the digital revolution because they are less tech savvy, and more technophobic, and because the technology is not built for their needs and intuition. [Hence,] the increasing socio-economic importance of ICT would add a new dimension to the already existing vicious circle between discrimination and women's backwardness, which can be expected to be particularly severe in developing countries. A well-known stylize facts in the literature indicate the lack of employment, income and education affect ICT usage negatively (e.g. NTIA 1999; Cullen 2001; Warschauer 2003; Mossberger et al. 2003; OSILAC 2007), and the digital revolution would pose a severe threat to women (cf. Hilbert 2011a, b).

Bimber (2000) finds that the gap in ICT usage between women and men is the product of both socioeconomic differences and some combination of underlying, gender-specific effects. Women remained less frequent and less intense users of the Internet (Ono and Zavodny 2003; Wasserman and Richmond-Abbott 2005). The focus of attention started to shift towards differences in how men and women use ICT (Bonfadelli 2002). For example, it was found that girls use the Internet for instant messaging and chat-rooms, whereas boys downloaded games and music, engaged in online trading, and created Web pages (Lenhart et al. 2001; Roberts et al. 2004). According to Fallows (2005) men like the internet for the experiences it offers, while women like it for the human connections it promotes. Statistical data from the USC led World Internet Project (2009) reconfirm these findings. In Canada, 79 % of men and 75 % of women were online in 2007. The study also confirms differences in usage. In 2004, Canadian men spent on average more time online than women (14.3–12.0 h per week). This difference increased from 2.3 to 3.5 h in 2007 (18.8–15.3 h). As the main reasons for non-usage, Australian women state lack of interest (35 %), not having a computer or Internet connection (26 %) or lack of skills (16 %). The percentage of men to women who use the Internet is reported for the following developed countries: Australia: 74–71 %. Czech Republic: 55–46 %; Hungary: 45–39 %; New Zealand: 78–77 %; Singapore: 69–54 %; United Kingdom: 68–65 %. The two exceptions to this trend seem to be Sweden (with 75 % of men online and 78 % of women) and the United States (71–73 %).

[24] See Hilbert (2011a, b).

However, even in these countries, men are more frequent and more intense users. In 2008, men from the U.S. are more likely than women to surf the web—at least daily (54–41 %) and men spend 1.5 h more than women at their monitors reading. In short, differences have become smaller in developed countries, but still remain, especially in usage. Similar to the above-cited data from developed countries (World Internet Project 2009); existing data from developing countries show that women are less likely than men to use ICT, this divide applies to access and to the frequency and intensity of usage (Park 2009). Looking for reasons, researchers found that women face barriers that include lack of access and training, and that they were confronted with software and hardware applications that did not reflect their female interests and needs (Arun and Arun 2002; Ng and Mitter 2005; Best and Maier 2007).[25]

3.3.2 ICT and Economic Growth: Empirical Literature

Apart from the above debate in the empirical and international literature concerning the digital divide, empirical literature examine the interaction between ICT and economic growth. 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; Pohjola 2000, 2001), productivity

[25] See Hilbert (2011a, b).

(cf. Hitt and Brynjolfsson 1996; Brynjolfsson and Yang 1996), employment, work organisation (cf. Bresnahan et al. 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 et al. 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 et al. 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 et al. 1994; Freeman and Soete 1985, 1994, 1997; Acemoglu 1998; Aghion and Howitt 1998; Autor et al. 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.[26] 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,

[26] See for instance, Quah (2001), Pohjola (2001) and Smith (2000).

since innovation in computing and communications changes both physical constraints and costs in the collection and dissemination of information. So for some, the rise of ICT technologies and the complex of ICT industries is coterminous with the move to a knowledge society." [27] 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." [28] "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."[29]

[27] See for instance, Smith (2000), p. 4. See Smith (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.

[28] 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.

[29] 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.

3.3.3 ICT and Education: Empirical Literature

Along with the above debate in the empirical and international literature concerning the interaction between ICT and economic growth, the empirical literatures examine the interaction between ICT and education. For instance, Asian Development Bank (ADB) (2009) explains the importance of investment in ICT for Education. ADB (2009) argues that ICT has the potential to "bridge the knowledge gap" in terms of improving quality of education, increasing the quantity of quality educational opportunities, making knowledge building possible through borderless and boundless accessibility to resources and people, and reaching populations in remote areas to satisfy their basic right to education. As various ICTs become increasingly affordable, accessible, and interactive, their role at all levels of education is likely to be all the more significant in making educational outcomes relevant to the labor market, in revolutionizing educational content and delivery, and in fostering "information literacy." Information literacy is the sustaining force of a knowledge society. Information literacy is recognized as "a basic human right in the digital world" as it empowers individuals "in all walks of life to seek, evaluate, use, and create information effectively to achieve their personal, social, occupational, and educational goals" (UNESCO 2008). The digital divide is much more than a "technology access" divide; without the skills to use the technologies, an even greater divide emerges—the information literacy divide. This divide is not a "north–south, developed–developing" issue; it applies to all countries and is more a reflection of the extent to which education systems are—or are not—keeping up in the development of knowledge societies (UNESCO 2008). It is increasingly clear that a principal factor in stimulating economic growth is improvement in cognitive competencies and skills (ADB 2008). Good practice in information and communication technology for education to date; many initiatives in ICT for education in developing countries have been limited to increasing information access for educational institutions in general and specifically for teacher training, aimed at using ICT-based resources and tools in the classroom. Evidence that the use of ICT leads to higher student achievement or other positive effects is limited to pilots that have yet to be implemented on a larger scale in developing countries. However, ICTs enable access to and use of information that may not be commonly available in certain contexts, thus providing teachers with content they would not have had otherwise to engage their students. In addition, teacher training in ICT for education parallels training in teaching methodology that supports student-centered learning. Hence, investments in ICT for education are likely to lead developing countries toward educational reforms that are necessary for fostering an information-literate citizenry, which is the key to competing in the global economy. Investments in ICT for education at the basic and secondary levels support information literacy as a foundation for subsequent learning, as well as supporting teacher training in student-centered methodologies that foster critical and analytical thinking during the early years of the education cycle. ICTs have the potential to improve the teaching and learning process by enabling students to access information and

engage in interactive learning experiences that would not otherwise be available to them. Such ICT-enhanced classroom experiences have the potential for encouraging student-centered learning, allowing students to be active learners who construct knowledge rather than passively receiving information. As a further pedagogical development, ICT can support evolution from the student-centered approach and the use of interactive technology to team-centered pedagogy and the use of collaborative technology. In this context, the focus is evolving from ensuring appropriate learning styles to ensuring an appropriate learning environment. Investments in ICT for education at the higher educational level support the development of a skilled, "ICT-capable" labor force that may attract direct foreign investment, as well as research and development activities and university–private sector links that are important drivers of innovation and growth in advanced economies (ADB 2008). ICT capability involves technical and cognitive proficiency to access, use, develop, create, and communicate information appropriately, using ICT tools. Along with having the potential to enhance teaching and learning in the classroom, ICTs in higher education have the potential to encourage open communication between and among students, faculty, and others that supports active learning and knowledge construction; make available information and resources supporting academic research that would not be accessible otherwise; and foster development of learning materials, presentations, and lectures in an interactive manner that allows faculty to deliver them to and share them with students directly. The flexibility and accessibility enabled by ICT have led to the emergence of open distance learning (ODL), wherein the teacher is removed in space and/or time from the student, and most communication is through an electronic medium (e.g., internet, radio, television) (UNESCO 2002). ODL has taken the form of open universities that have adopted a student-centered approach in higher education systems in a number of countries. Open universities have been established to meet the increasing demand for higher and/or tertiary education while providing opportunities to working adults and others who face constraints in accessing such education in its traditional form. Investments in ICT for education in the area of technical and vocational education and training (TVET) further support the demand for a skilled, "ICT-capable" labor force, which is the hallmark of a country transitioning to a knowledge economy. ODL holds promise for addressing critical problems facing TVET, namely, the lack of qualified instructors, the need to greatly increase the delivery of skills training on a wide scale, and the need to deliver training at much lower unit costs (UNESCO 2003). ODL can be used in TVET to empower disadvantaged populations, such as women and ethnic minorities, and to allow greater participation by working adults who cannot afford to take time off from their jobs and who are interested in improving various aspects of their work and/or their general professional knowledge (UNESCO 2003). Additionally, ICT in TVET has the potential to provide such persons with real-life learning experiences that are applicable to their immediate work situations (e.g., ICT-based simulations that model best practices). In a number of developing member countries of the Asian Development Bank (ADB), TVET students are often from the working class or are minority students having limited access to ICT. The integration of ICT in TVET would provide equality of

opportunity for these students (UNESCO 2003). In alternative settings (e.g., programs for out-of-school youth, adult literacy, students in remote areas), ICTs have the potential to deliver education to those unable to participate in the mainstream education system.[30]

Some studies examine the role of information and communications technology in education and raises some fundamental issues and questions whether ICT is suited to transmitting knowledge, particularly to students who are not already highly motivated to learn or well versed in the art of using and interpreting information (cf. Carnoy 2004). One study takes as a point of reference the world of business and offers a brief look at the changes brought to the sector by ICT. To date, the main application of ICT in the business sector has focused on aiding access and processing of large quantities of information for employees and management with the principal aim of increasing productivity. In the case of education, however, little or no information is being used to improve student performance, mainly because education managers are largely illiterate in information management tools. Like-wise, despite schools having more and more access to ICT, new technologies are still scarcely used as part of the teaching methodology. Once again, it is the lack of training that creates difficulties: many teachers do not have the necessary IT skills and feel uncomfortable, nor do they have the specific training needed to be able to use the new resources in the classroom. In the university sector, ICT has already made an important impact, whether in terms of teaching, research or administration; however, despite some exceptions, there are few real examples with educational models that are based on this technology and there is still an important social preference for traditional educational models (cf. Carnoy 2004).[31]

Other studies indicate that across the past 20 years the use of ICT has fundamentally changed the practices and procedures of nearly all forms of endeavour within business and governance, within education, ICT has begun to have a presence but the impact has not been as extensive as in other fields (cf. Oliver 2002). A number of people have attempted to explore this lack of activity and influence (e.g. Soloway and Pryor 1996; Collis 2002). There have been a number of factors impeding the wholesale uptake of ICT in education across all sectors. These have included such factors as a lack of funding to support the purchase of the technology, a lack of training among established teaching practitioners, a lack of motivation and need among teachers to adopt ICT as teaching tools (Starr 2001). Education is a very socially oriented activity and quality education has traditionally been associated with strong teachers having high degrees of personal contact with learners. The use of ICT in education lends itself to more student-centred learning settings and often this creates some tensions for some teachers and students. But with the world moving rapidly into digital media and information, the role of ICT in education is becoming more and more important and this importance will continue to grow and develop in the twenty-first century. In recent times, factors have

[30] See Asian Development Bank (2009).

[31] See Carnoy (2004).

emerged which have strengthened and encouraged moves to adopt ICTs into classrooms and learning settings. These have included a growing need to explore efficiencies in terms of program delivery, the opportunities for flexible delivery provided by ICTs; the capacity of technology to provide support for customized educational programs to meet the needs of individual learners (e.g. Kennedy and McNaught 1997); and the growing use of the Internet as a tool for information access and communication (e.g. Oliver and Towers 2000). One study highlights the various impacts of ICT on contemporary higher education and explores potential future developments and argues the role of ICT in transforming teaching and learning and seeks to explore how this will impact on the way programs will be offered and delivered in the universities and colleges of the future (cf. Oliver 2002).[32]

3.3.4 ICT and Enhancing Knowledge 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 Africa.[33] 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.

[32] See Oliver (2002).

[33] 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.

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. [34]

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 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'.[35]

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

[34] See Ahwireng-Obeng (2000), pp. 3–9.

[35] See Unwin (2004), pp. 150–160.

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.[36]

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 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.[37]

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.[38]

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 enrols 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

[36] See Durrant (2004), pp. 63–79.

[37] See Olukoshi and Zeleza (2004), p. 611.

[38] See Beebe et al. (2003).

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.[39]

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 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 plat form, 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 info-structure company Nile on line, supported by the Ministry of Higher Education. It helps creates 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.[40]

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.[41]

[39] See Adei (2003), pp. 90, 108–109.

[40] See Radwan (2003), pp. 387, 399, 400–401.

[41] See Thairu (2003).

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 CIEUM 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 extends to wider Mozambican society. [42]

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 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. [43]

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.[44]

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.[45]

[42] See Massingue (2003).

[43] See Oyeyinka and Adeya (2003).

[44] See Mutagahywa (2003).

[45] See Mwenechanya (2003).

3.4 Conclusions

In this chapter we provide a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature that emphasizes the positive effects of ICT in enhancing knowledge and economic growth and the negative effects of ICT through exacerbating the digital divide. In Sect. 3.2 we define the conceptual framework. The theoretical and empirical literature on the relationship between ICT, knowledge and the digital divide are presented in Sect. 3.3 Section 3.3.2 describes the relationship between ICT and economic growth; Sect. 3.3.4 discusses the relationship between ICT, education and knowledge. We explain the 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. We illustrate that on the one hand, some studies provide robust results showing the various influences of ICT on enhancing economic growth and development, not only directly, but also indirectly through enhancing knowledge and through the complementary relationships between ICT, human capital and skill upgrading. We explain that on the other hand, several studies discuss the hazards ICT creates for economic development. In particular, the rapid progress in ICT will make it harder for the developing countries to bridge the already existing and widening gap and digital divide between the developed and developing countries. Based on our findings from the existing studies in the literature we highlight the need for improvement of investment in ICT to alleviate the digital divide, enhance production, creation and transfer of knowledge in higher education institutions and to enhance economic growth and sustainable development in Sudan.

References

Acemoglu D (1998) Why do new technologies complement skills? Directed technical change and wage inequality. Q J Econ 113(4):1055–1089

Adei S (2003) Overview of university level education in Africa, chapter 4. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, pp 90, 108–109, http://www.africadotedu.org/

Aghion P, Howitt P (1998) Endogenous growth theory. The MIT, Cambridge, MA, 1998

Ahwireng-Obeng F (2000) The knowledge revolution and African development. Afr Insights 30(3–4):3–9

Aqili S, Moghaddam A (2008) Bridging the digital divide: the role of librarians and information professionals in the third millennium. Electron Libr 26(2):226–237. doi:10.1108/02640470810864118

Arun S, Arun T (2002) ICTs, gender and development: women in software production in Kerala. J Int Dev 14(1):39–50

Asian Development Bank (ADB) (2008) Education and skills. Strategies for accelerated development in Asia and the Pacific. ADB, Manila. Available at: www.adb.org/Documents/Studies/Education-Skills-Strategies-Development/Education-Skills-Strategies-Development.pdf

Asian Development Bank (ADB) (2009) Good practice in information and communication technology for education. Asian Development Bank, Philippines. http://www.adb.org/sites/default/files/pub/2009/Good-Practice-in-ICT-for-Education.pdf. Accessed on 11 Sept 2014
Attewell P, Battle J (1999) Home computers and school performance. Inf Soc 15:1–10
Autor DH, Katz LF, Krueger AB (1998) Computing inequality: have computers changed the labour market? Q J Econ 113(4):1169–1213
Bailey MN, Gordon R (1988) The productivity slowdown, measurement issues and the explosion of computer power. Brook Pap Econ Act 2:347–423
Barro RJ (1991) Economic growth in a cross section of countries. Q J Econ 106(2):407–443
Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, India. http://www.africadotedu.org/
Berman E, Bound J, Griliches Z (1994) Change in the demand for skilled labour within U.S. manufacturing industries: evidence from the annual survey of manufacturing. Q J Econ 109(2):367–398
Best ML, Maier SG (2007) Gender, culture and ICT use in rural South India. Gend Technol Dev 11(2):137–155
Bimber B (2000) Measuring the gender gap on the internet. Soc Sci Q 81(3):868–876
Bonfadelli H (2002) The internet and knowledge gaps: a theoretical and empirical investigation. Eur J Commun 17(1):65–84
Bound J, Johnson G (1992) Change in the structure of wages in the 1980s: an evaluation of alternative explanations. Am Econ Rev 82(3):371–392
Bresnahan TF (1999) Computerization and wage dispersion an analytical interpretation. Econ J 109(456):390–415
Bresnahan TF, Brynjolfsson E, Hitt LM (1999) Information technology, workplace organization, and the demand for skilled labour: firm level evidence. National Bureau of Economic Research NBER working paper no. 7136
Brynjolfsson E, Yang S (1996) Information technology and productivity: a review of the literature. Adv Comput 43:179–214
Buente W, Robbin A (2008) Trends in internet information behavior, 2000–2004. J Am Soc Inf Sci Technol 59(11):1743–1760, www.interscience.wiley.com
Carnoy M (2004) ICT in education: possibilities and challenges. Inaugural lecture of the UOC 2004–2005 academic year, Barcelona [online]. UOC. http://www.uoc.edu/inaugural04/dt/eng/carnoy1004.pdf. Accessed on 11 Sept 2014
Carr D (2007) The global digital divide. Contexts 6(3):58–58
Chinn MD, Fairlie RW (2004) The determinants of the global digital divide: a cross-country analysis of computer and internet penetration. Economic Growth Center, Yale University, Center discussion paper no. 881. http://www.econ.yale.edu/growth_pdf/cdp881.pdf
Collis B (2002) Information technologies for education and training. In: Adelsberger H, Collis B, Pawlowski J (eds) Handbook on technologies for information and training. Springer, Berlin
Compaine BM (2001) The digital divide: facing a crisis or creating a myth? illustratedth edn. The MIT, Cambridge, MA
Cullen R (2001) Addressing the digital divide. Online Inf Rev 25(5):311–320
Dasgupta S, Lall S, Wheeler D (2001) Policy reform, economic growth and the digital divide: an econometric analysis. World Bank working paper no. 2567 (March)
Deen-Swarray M, Gillwald A, Morrell A (2013) Lifting the veil on ICT gender indicators. Evidence for ICT policy action. Policy paper no. 13. Available at: http://www.researchICTafrica.net
DiMaggio P, Hargittai E (2001) From the 'digital divide' to 'digital inequality': studying internet use as penetration increases. Working paper #15, summer 2001, working paper series, 15. Center for Arts and Cultural Policy Studies, Princeton University
Durrant S (2004) Sharing Information: African perspectives: bridging the knowledge divide. African research and documentation. J Stand Conf Libr Mater Africa 96:63–79

Dutton WH, Gillett SE, McKnight LW, Peltu M (2004) Bridging broadband internet divides. J Inf Technol 19(1):28–38

Fallows D (2005) How women and men use the internet pew internet & American life project. Pew internet and American life project. Retrieved 16 Aug 2009, from http://www.pewinternet.org/Reports/2005/How-Women-and-Men-Use-the-Internet.aspx

Freeman C, Soete L (1985) Information technology and employment: an assessment. SPRU, Sussex

Freeman C, Soete L (1994) Work for all or mass unemployment? Computerized technical change into the twenty–first century. Printer, London

Freeman C, Soete L (1997) The economic of industrial innovation, 3rd edn. Cassell, London

Galperin H (2010) Goodbye digital divide, Hello digital confusion? A critical embrace of the emerging ICT4D consensus. Inf Technol Int Dev 6(Special Edition):53–55

Goldin C, Katz LF (1998) The origin of technology skill complementarity. Q J Econ 113(3): 693–732

Guillen MF, Suárez SL (2005) Explaining the global digital divide: economic, political and sociological drivers of cross-national internet use. Soc Forces 84(2):681–708

Hall R, Jones CI (1999) Why do some countries produce so much more output per worker than others? Q J Econ 114(1):83–116

Hilbert M (2010) When is cheap, cheap enough to bridge the digital divide? Modeling income related structural challenges of technology diffusion in Latin America. World Dev 38(5): 756–770. Free access to the study here: http://martinhilbert.net/CheapEnoughWD_Hilbert_pre-print.pdf

Hilbert M (2011a) Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics. Women's Stud Int Forum 34(6): 79–489. doi:10.1016/j.wsif.2011.07.001. www.martinhilbert.net/DigitalGenderDivide.pdf

Hilbert M (2011b) The end justifies the definition: the manifold outlooks on the digital divide and their practical usefulness for policy-making. Telecommun Policy 35(8):715–736

Hilbert M (2013) Technological information inequality as an incessantly moving target: the redistribution of information and communication capacities between 1986 and 2010. J Am Soc Inf Sci Technol. Free access to the article through this link: www.martinhilbert.net/TechInfoInequality.pdf

Hitt L, Brynjolfsson E (1996) Productivity, business profitability, and consumer surplus: three different measures of information technology value. MIS Q 20:121–142

http://en.wikipedia.org/wiki/Information_and_communications_technology

http://dictionary.reference.com/browse/digital+divide. Accessed on 08 Sept 2014

http://en.wikipedia.org/wiki/Digital_divide. Accessed 09 Sept 2014

Huang C-Y, Chen H-N (2010) Global digital divide: a dynamic analysis based on the bass model. J Public Policy Market 29(2):248–264. doi:10.1509/jppm.29.2.248

Hwang G-H (2000) Diffusion of information and communication technologies and changes in skills. Electronic working paper series, no. 48. SPRU, Sussex. Oct 2000

International Telecommunications Union (ITU) (2003) Cited in Chinn MD, Fairlie RW (2004) "The Determinants of the Global Digital Divide: A Cross-Country Analysis of Computer and Internet Penetration," Economic Growth Center, Yale University, Center Discussion Paper No. 881. http://www.econ.yale.edu/growth_pdf/cdp881.pdf. March 2004, p 1

International Telecommunication Union (ITU) (2007) Bridging the digital divide, chapter 2. In: World information society report 2007, p 21. http://www.itu.int/osg/spu/publications/worldinformationsociety/2007/WISR07-chapter2.pdf

International Telecommunication Union (ITU) (2013) Measuring the information society 2013. Geneva, Switzerland, pp 12, 24, 39–40, 43

Jorgensen D, Stiroh K (1999) Information technology and growth. Am Econ Rev 89:109–116

Jorgenson DW, Stiroh K (1995) Computers and Growth. Econ Innov New Technol 3:295–316

Kennedy D, McNaught C (1997) Design elements for interactive multimedia. Aust J Educ Technol 13(1):1–22

Kenny C (2002) The Internet and economic growth in least developed countries. UNU- WIDER discussion paper series DP2002/75. UNU-WIDER, Helsinki, Finland
Krueger AB (1993) How computers have changed the wage structure: evidence from micro data. Q J Econ 108:33–60
Lawton T (2012) Pretty graphs on Chinese internet user demographics. Jan, 2012
Lenhart A, Lewis O, Rainie L (2001) Teenage life online. Pew Internet & American Life Project. Retrieved 16 Aug 2009, from http://www.pewinternet.org/Reports/2001/Teenage-Life-Online.aspx
Lundvall B-Å, Foray D (1996) The knowledge-based economy: from the economics of knowledge to the learning economy. In: OECD employment and growth in the knowledge-based economy. OECD, Paris, p 14
Massingue V (2003) ICT in Mozambique: the role of Eduardo Mondlane University, chapter 20. In Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, India. http://www.africadotedu.org/
Ming-te L (2001) Digital divide in developing countries. J Glob Inf Technol Manag 4(3):1–4
Mossberger K, Tolbert CJ, Stansbury M (2003) Virtual inequality: beyond the digital divide, 1st edn. Georgetown University Press, Washington, DC
Mossberger K, Tolbert CJ, Gilbert M (2006) Race, place, and information technology (IT). Urban Aff Rev 41:583–620. Retrieved from http://uar.sagepub.com/content/41/5/583
Mun-cho K, Jong-Kil K (2001) Digital divide: conceptual discussions and prospect. In: Kim W, Wang Ling T, Lee YJ, Park SS (eds) The human society and the Internet: Internet related socio-economic issues. First international conference, Seoul, Korea: proceedings. Springer, New York
Mutagahywa B (2003) Information and communication technology in Tanzania: the role of the university of Dar es Salaam. In: Beebe M, Kouakou K, Oyeyinka B, Rao M (eds) Africa dot edu; IT opportunities and higher education in Africa. Tata McGraw-Hill, New Delhi
Mwenechanya J (2003) Pioneering the Internet in Zambia: university role and challenges. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi
Ng C, Mitter MS (2005) Gender and the digital economy: perspectives from the developing world. Sage, London
Norris P (2001) "Social Inequalities" Chapter 4 in Norris, P. (2001). Digital divide: civic engagement, information poverty and the internet worldwide. Cambridge University Press, Cambridge
OECD (Organisation for Economic Co-operation and Development) (2001) Understanding the digital divide. OECD Publications: OECD, Organisation for Economic Co-operation and Development, Paris, France, p 5
OECD (Organization for Economic Co-operation and Development) (2002) Measuring the information economy 2002. OECD (Organization for Economic Co-operation and Development), Paris, France, p 94
Oliver R (2002) The role of ICT in higher education for the 21st century: ICT as a change agent for education. Edith Cowan University, Perth, Western Australia: http://www.academia.edu/467397/The_role_of_ICT_in_higher_education_for_the_21st_century_ICT_as_a_change_agent_for_education. Accessed on 11 Sept 2014
Oliver R, Towers S (2000) Benchmarking ICT literacy in tertiary learning settings. In: Sims R, O'Reilly M, Sawkins S (eds) Learning to choose: choosing to learn, Proceedings of the 17th annual ASCILITE conference. Southern Cross University Press, Lismore, pp 381–390
Olukoshi A, Zeleza PT (2004) The African universities in the twenty-first century: future challenges and research agenda, conclusion. In: Zeleza PT, Olukoshi A (eds) African universities in the twenty-first century. Volume II: knowledge and society, council for the development of social science research in Africa CODERSRIA, p 611
Ono H, Zavodny M (2003) Gender and the Internet. Soc Sci Q 84(1):111–121

OSILAC (Observatory for the Information Society in Latin America and the Caribbean) (2007) Monitoring eLAC2007: progress and current state of development of Latin American and Caribbean information societies. United Nations, Santiago Chile: United Nations ECLAC, Information Society Programme, OSILAC. Retrieved August 6, 2009, from http://www.cepal.org/SocInfo/publicaciones

Oyeyinka BO, Adeya C (2003) Internet access in Nigerian and Kenyan universities, chapter 22. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, India. http://www.africadotedu.org/

Park S (2009) Concentration of Internet usage and its relation to exposure to negative content: does the gender gap differ among adults and adolescents? Women's Stud Int Forum 32(2):98–107

Pohjola M (2000) Information technology and economic growth: a cross- country analysis. WIDER/UNU working paper series: WP173, Jan 2000

Pohjola M (ed) (2001) Information technology, productivity and economic growth: international evidence and implications for economic growth. Oxford University Press, Oxford

Pohjola M (2002) New economy in growth and development. UNU- WIDER discussion paper series no. DP2002/67

Quah D (2001) The weightless economy in economic development, chapter 4. In: Pohjola M (ed) Information technology, productivity and economic growth: international evidence and implications for economic growth. Oxford University Press, Oxford, pp 72–99

Quibria MG, Ahmed SN, Tschang T, Reyes-Macasaquit M-L (2002) Digital divide: determinants and policies with special reference to Asia. Economics and research department working paper no. 27. Asia Development Bank, Manila

Radwan R (2003) IT and higher education: the case of Egypt, chapter 18. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, India, pp 387, 399, 400–401. http://www.africadotedu.org/

Resnick D (1998) Politics on the Internet: the normalization of cyberspace. In: Chris T, Luke TW (eds) The politics of cyberspace. Routledge, New York

Roberts DF, Foehr UG, Henry J. Kaiser Family Foundation (2004) Kids and media in America. Cambridge University Press, Cambridge, p 380

Rogers EM (1995) Diffusion of innovations, 4th edn. Free Press, New York, pp 269, 435–442

Rubin RE (2010) Foundations of library and information science. Neal-Schuman, New York, pp 178–179

Seybert H (2007) Gender differences in the use of computers and the Internet. Statistics in focus, population and social conditions, no 119/2007

Sichel D (1997) Computer revolution. An economic perspective. Brookings Institution, Washington, DC

Smith K (2000) What is the 'knowledge economy'? Knowledge-intensive industries and distributed knowledge bases. Paper presented to DRUID summer conference on the learning economy—firms, regions and nation specific institutions, 15–17 June 2000

Soloway E, Pryor A (1996) The next generation in human-computer interaction. Commun ACM 39(4):16–18

Starr L (2001) Same time this year [on-line]. Available at http://www.education-world.com/a_tech/tech075.shtml. Accessed Jul 2002

Thairu H (2003) The Kenya education network (KENET), chapter 19. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill, New Delhi, India. http://www.africadotedu.org/

The U.S. Department of Commerce—National Telecommunications and Information Administration (NTIA) (1995) Falling through the Net: a survey of the "Have Nots" in rural and Urban America. Retrieved 2 Aug 2009, from http://www.ntia.doc.gov/ntiahome/fallingthru.html

The U.S. Department of Commerce—National Telecommunications and Information Administration (NTIA) (1999) Falling through the Net: defining the digital divide, chapter 4. A report on the telecommunications and information technology gap in America, p xiii, Jul 1999

The U.S. Department of Commerce—National Telecommunications and Information Administration (NTIA) (2002) A nation online: how Americans are expanding their use of the Internet. U.S. GPO, Washington, DC

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2002) Open and distance learning. Trends, policy and strategy considerations. UNESCO, Paris. Available at: http://unesdoc.unesco.org/images/0012/001284/128463e.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2003) Analytical survey. The use of ICTs in technical and vocational education and training. UNESCO, Paris. Available at: http://unesdoc.unesco.org/images/0013/001330/133024eo.pdf

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2008) Towards information literacy indicators. UNESCO, Paris. Available at: http://unesdoc.unesco.org/images/0015/001587/158723e.pdf

Unwin T (2004) ICT and education in Africa: partnership, practices and knowledge sharing. In: Cline-Cole R, Powell M (eds) ICTs,'Virtual Colonisation and Political Economy'. Review of African political economy, vol 31(99). Carfax; Taylor and Francis, Basingstoke, pp 150– 160

Oxford dictionaries: US, British and World English dictionary: http://www.oxforddictionaries.com/definition/american_english/digital-divide; http://www.oxforddictionaries.com/definition/english/digital-divide. Accessed on 08 Sept 2014

Van Dijk JA (2005) The deepening divide: inequality in the information society, 1st edn. Sage, London

Wallsten S (2003) Regulation and internet use in developing countries. AEI-Brookings joint center for regulatory studies related publication 03–8. AEI and Brookings Institution, Washington, DC, May 2003

Warschauer M (2003) Technology and social inclusion: rethinking the digital divide. The MIT, Cambridge

Wasserman IM, Richmond-Abbott M (2005) Gender and the Internet: causes of variation in access, level, and scope of use. Soc Sci Q 86(1):252–270

Wensheng, W (2001) Impact of ICTs on farm households in China. ZEF of University Bonn

World Internet Project (2009) World Internet international Report 2009. USC Annenberg School Center for the Digital Future. Retrieved 18 Aug 2009, from http://store.digitalcenter.org/world-internet-report.html

Wilson EJ III (2004) The information revolution and developing countries. The MIT Press, Cambridge, MA

Wilson K, Wallin J, Reiser C (2003) Social science computer review. Social Sci Comput Rev 21.2:133–143. http://ssc.sagepub.com/content/21/2/133.full.pdfhtml. Accessed 7 Nov 2012

Part III
Empirical Application

Chapter 4
Research Methodology and Methods of Data Collection

4.1 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. Section 4.1 presents introduction. In Sect. 4.2 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 Sect. 4.3 and show structure and design of the questionnaire in Sect. 4.4. Section 4.5 provides the conclusions, advantages and limitations of the survey.

4.2 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

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discusses the implications of this in the production, creation and transfer of knowledge in the ten selected Sudanese universities.[1] 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 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 Chap. 1, 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 4 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

[1] 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.

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 et al. 1994; Freeman and Soete 1994; Autor et al. 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.[2] To test the sixth hypotheses we use qualitative data on the 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 (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 Arab countries—see Chap. 3. 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.[3]

[2] See for example, ITU-WDI Database (2005), D'Costa (2003) and D'Costa and Sridharan 2003). 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 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 et al. 1994; Freeman and Soete 1994; Autor et al. 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.

[3] For the implementation of the university survey, a team of part-time researchers from the Department of Economics, the 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

In addition to primary data we use recent secondary data at the macro level obtained from Sudan National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012," to discuss the interaction between the use of ICT and the reasons for the incidence of the digital divide in Sudan in Chap. 6.

4.3 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.[4] 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 selected ten (five public and five private) Sudanese universities located in Khartoum.[5] The selection of the individuals was based on a random basis; the coverage of individual in the survey is more comprehensive and includes both males (50 %) and females (50 %) whose ages are between 20 and 70 years 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).[6] The survey aimed to collect

response rates. The university survey was distributed after translation of the English version into the Arabic language in order to increase the response rate.

[4] 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.

[5] 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.

[6] 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

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 4.1 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.

4.4 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 (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.[7] Each of the nine sections in the university survey aimed to request

that accounted for 10 per 1,000 and 20 per 1,000 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.

[7] 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.

Table 4.1 Composition of the ICT University Survey in Sudan (2009)

Representation	Institutions			Individuals								
				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 (%)	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)

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 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.

4.5 Conclusions

To investigate the research problem this book uses a combination of primary and secondary data. We use new primary data obtained from "ICT public-privates Sudanese universities survey" undertaken in public-privates universities in Sudan to discuss the use, economic importance and impact of the use of ICT in public and private Sudanese universities. In addition to primary data we use recent secondary data at the macro level obtained from Sudan National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012," to discuss the use of ICT and the reasons for the incidence of the digital divide in Sudan in Chap. 6. 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 Chaps. 5–8 and also for the policy analysis and recommendations in Chap. 9.

References

Autor DH, Katz LF, Krueger AB (1998) Computing inequality: have computers changed the labour market? Q J Econ 113(4):1169–1213

Berman E, Bound J, Griliches Z (1994) Change in the demand for skilled labour within U.S. manufacturing industries: evidence from the annual survey of manufacturing. Q J Econ 109(2):367–398

Bound J, Johnson G (1992) Change in the structure of wages in the 1980s: an evaluation of alternative explanations. Am Econ Rev 82(3):371–392
D'Costa AP (2003) Uneven and combined development: understanding India's software exports. World Dev 31(1):211–226
D'Costa AP, Sridharan E (eds) (2003) India in the global software industry: innovation, firms strategies, and development. Palgrave Macmillan, Basingstoke
Freeman C, Soete L (1994) Work for all or mass unemployment? Computerized technical change into the twenty-first century. Printer, London
International Telecommunication Union (ITU) (2005) WDI Database
National Telecommunication Corporation "Households and individuals ICT survey 2012", Khartoum, Sudan
University Survey (2009, April) "The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities," Khartoum
World Information Technology and Services Alliance (WITSA) (2002) 'Digital Planet 2002', The Global Information Economy, WITSA, Vienna

Chapter 5
The Demand Side of ICT

5.1 Introduction

The data from the University Survey (2009) presented in Chap. 4 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.

This chapter uses the results from University Survey (2009) to examine the demand for ICT in Sudanese universities. Section 5.1 present introduction. Before we go into the empirical analysis, it is appropriate to define the main characteristics of the respondent to the University Survey (2009), including academic teaching staff, support staff and students in the universities mentioned in Sect. 5.2. 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 Sect. 5.3. We explain and examine the income and price effects of the use of ICT in Sect. 5.4. Section 5.5 provides the conclusions.

5.2 Main Characteristics of the Sample

Before we go into the empirical analysis, it is appropriate to define the main characteristics of the respondent to the University Survery (2009), including academic teaching staff, support staff and students in the universities in this section.

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For instance, Table 5.1 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 Chap. 1 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

Table 5.1 Main characteristics of the ICT university survey in Sudan 2009

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 %		
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	0.0158730	0	0	0
	Associate professor	0.26	0	0	0	0	0.5	0	0	0	0	0.185	0.2063492	0.1176471	0	0
	Assistant professor	0.36	0	0.2	0	1	0.5	0	0.5	0.2	0.667	0.32	0.3174603	0.3529412	0	0
	Lecturer	0.18	0	0	1		0	0.33		0.8	0.33	0.2099	0.1746032	0.3529412	0	0
	Teaching assistant	0.18	1	0.2	0	0	0	0.667	0.5	0		0.235	0.2539683	0.1764706		0.308
Education	Ph.D.	0.66	0	0.2		1	1	0	0.5	0.2	0.667	0.531	0.5555556	0.4705882	0	0
	M.Sc.	0.2	0.5		1	0	0	0.667		0.8	0.33	0.272	0.2380952	0.4117647	0.2	0.308
	B.Sc.	0.14	0.5	0.2	0	0	0	0.33	0.5	0	0	0.161	0.1746032	0.1176471	0.6	0.577
	Diploma	0	0	0	0	0	0	0	0	0	0	0			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	200–3,500	50–1,000	675–unknown	500–1,000	1,900	2,000–6,000	450–1,000	600–4,000	1,150–4,500	1,385–2,500	50–4,500	50–3,500	450–4,500	150–220	200–1,800
	Average	1,705.68	558.333	675	750	1,900	3,666.667	816.667	2,300	2,000	2,128.333	1,650.068	1,117.8	2,182.3	1,270	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 %
Residence	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
	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

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.

5.3 The Demand Perspective of the Use of ICT

This section uses the results from the University Survey (2009) to provide 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.

5.3.1 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 5.2).

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 5.3 and Fig. 5.1).

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 4 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

Table 5.2 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

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 5.4).

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. The World Bank 2009; UNDP 2007/2008) as we explained in Chap. 2.

The above findings prove our second hypothesis in Chap. 1 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

Table 5.3 The demand for ICT from historical perspective

	Fixed		Mobile		Computer		Internet	
	Early start	Late start	Early start	Late start	Early start	Late start	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

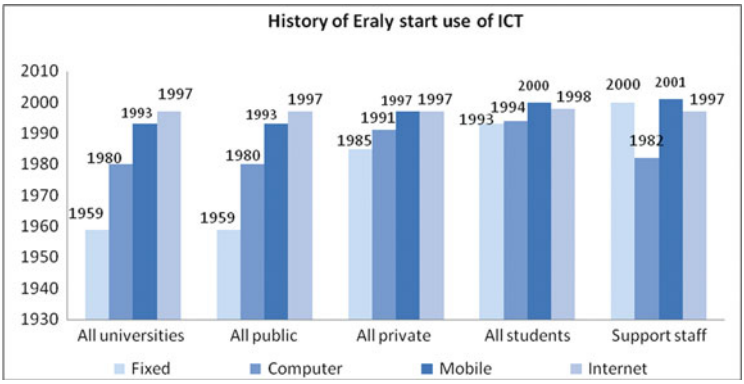

Fig. 5.1 The demand for ICT from historical perspective

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

Table 5.4 The trends of personal use of the different modes of ICT 2005–2008

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

(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 5.5).

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

Table 5.5 Assessment of the importance of ICT for satisfaction of personal need and utility

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

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 5.6).

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 5.6).

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.

Table 5.6 Assessment of preference of specific characteristics related to different modes of ICT

	Fixed (%)	Mobile (%)	Computer (%)	Internet (%)
All staff				
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
Public staff				
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
Private staff				
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
Students				
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
Support staff				
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

5.3.2 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[1] (see Table 5.7).

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 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[2] (see Table 5.8).

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

[1] 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 %, 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.

[2] 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.

Table 5.7 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

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 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[3] (see Table 5.9).

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[4] (see Table 5.10).

[3] 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.

[4] 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 %,

Table 5.8 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

5.4 The Income and Price Effects of the Use of ICT from the Demand Perspective

This section uses the results from the University Survey (2009) to provide 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

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 5.9 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 (%)
Opportunities					
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
Challenges					
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

Table 5.10 Assessment of the importance of the use of Internet for fulfilment of personal utility

	All (%)	Public (%)	Private (%)	Students (%)	Support staff (%)
Study					
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
Research					
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
Network and communication					
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
Looking for job					
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
Participation in seminars, conferences and workshops					
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
Social and work contact					
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

(continued)

Table 5.10 (continued)

	All (%)	Public (%)	Private (%)	Students (%)	Support staff (%)
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

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 5.11). 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 5.11). 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). 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 5.11).

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 5.11).

Table 5.12 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 2005–2008. Table 5.13 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

Table 5.11 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 (%)
a. Assessment of the importance of the effect of the costs of expenditure on ICT on imposing burden in personal budget					
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. 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					
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
c. Assessment of the importance of the effect of the increase in income and impacts on increasing the use of ICT					
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
d. Assessment of the importance of the effect of the increase in the prices and impacts on reducing the use of ICT					
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
e. Assessment of the importance of the effect of reduction of the prices of ICT offered by the competing company					
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

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 5.14 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 2005–2008 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 5.15 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 Chap. 1 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 Chap. 1 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 5.12 Correlation between computers, training, Internet and telecommunications expenditures for academic staff 2005–2008

Independent variables	Coefficient (t-value)							
	Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure	Constant	R^2	N
Dependent variable (ICT expenditures)								
Telecommunication expenditure (fixed)		0.872**, a (10.702)				0.884 (0.761)	0.804	30
			0.322** (3.211)			6.119 (9.258)	0.158	57
					0.829**, a (7.842)	2.016 (1.390)	0.703	28
Telecommunication expenditure (mobile)	0.922**, a (10.702)					1.938 (1.686)	0.804	30
			0.177** (2.914)			10.991 (13.790)	0.081	98
					0.627**, a (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				0.315a (1.114)		8.235 (2.024)	0.072	18
			0.061 (0.278)			12.143 (4.398)	0.003	26

Internet expenditure	0.848**, a (7.842)					2.290 (1.576)	0.703	28
		0.889**, a (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)
[a]Log regression for all variables for the period (2005–2008)

Table 5.13 Correlation between computers, training, Internet and telecommunications expenditures for all sample (defined by occupation and sector) 2005–2008

Independent variables		Coefficient (t-value)							
		Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure	Constant	R^2	N
Dependent variable (ICT expenditures)									
Telecommunication expenditure (fixed)	All sample		0.410** (4.557)				8.192 (7.210)	0.163	108
	All staff		0.872**, a (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
Telecommunication expenditure (mobile)	All sample	0.410** (4.557)					8.192 (7.210)	0.163	108
	All staff	0.922**, 1 (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
	Students					0.595** (5.331)	6.137 (4.441)	0.448	36

Computer expenditure	Students				1.052** (6.700)		0.298 (0.148)	0.803	12
	All sample					0.273** (3.166)	9.104 (8.045)	0.104	87
	Public staff					0.282** (3.271)	8.801 (7.791)	0.129	73
	Students					0.383** (3.258)	7.814 (5.279)	0.307	25
	All sample				0.964** (3.289)		611,717.2 (1.922)	0.217	40
Training expenditure	All sample					0.360** (4.775)	326,423.0 (3.331)	0.352	43
	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)	217,732.1 (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
	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

(continued)

Table 5.13 (continued)

Independent variables		Coefficient (t-value)							
		Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure	Constant	R^2	N
Internet expenditure	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)

[1] Log regression for all variables for the period (2005–2008).

Table 5.14 Correlation between the duration, cost, expenditures, the use of ICT and income (wage), education, age and experience for academic staff 2005–2008

Independent variables		Coefficient (t-value)							
		Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure	Constant	R^2	N
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

(continued)

Table 5.14 (continued)

Independent variables		Coefficient (t-value)							
		Telecommunication (fixed) expenditure	Telecommunication (mobile) expenditure	Computer expenditure	Training expenditure	Internet expenditure	Constant	R^2	N
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
Internet expenditure	Cost	0.334* (1.824)					8.654 (6.538)	0.057	57
	Cost		4519.396 (0.859)				319.1945 (0.003)	0.013	57
	Length	0.130** (2.857)					1.166 (3.472)	0.110	68
	Length		1.041** (2.348)				−1.035 (−0.771)	0.077	68
	Length			0.107** (2.821)			5.009 (3.278)	0.108	68
	Expenditure	23153.41 (0.239)					560092.4 (0.797)	0.001	56
	Expenditure		26177.34 (0.795)				180282.4 (0.260)	0.012	56
	Use	0.066 (0.739)					3.572052 (5.415)	0.008	66

	Use		0.694 (0.776)				1.948 (0.717)	0.009	66
	Use					122.76 (0.766)	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
					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 5.15 Correlation between the duration, cost, expenditure, the use of ICT and education and age for all sample (defined by occupation and sector) 2005–2008

		Coefficient (t-value)						
Independent variables			Education	Age	Costs	Constant	R^2	N
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	26
	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

(continued)

Table 5.15 (continued)

		Coefficient (t-value)						
Independent variables			Education	Age	Costs	Constant	R^2	N
	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)

5.5 Conclusions

This chapter uses the results from the University Survey (2009) to discuss and provide the empirical analysis and examine from public-private perspective the research hypotheses on the public-private differential in the demand for ICT, trend and determinants in Sudanese universities. Section 5.1 presents introduction. Section 5.2 defines the main characteristics of the respondents to the University Survey (2009), including academic teaching staff, support staff and students in the respondent universities. Section 5.3 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 5.4 explains and examines the income and price effects of the use of ICT in public and private Sudanese universities.

Our findings from the University Survey (2009) prove the first hypothesis in Chap. 1 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 from the University Survey (2009) prove our second hypothesis in Chap. 1 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 from the University Survey (2009) 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 from the University Survey (2009) verify the third hypothesis in Chap. 1 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 from the University Survey (2009) prove the fourth hypothesis in Chap. 1 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.

References

University Survey (2009) The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities, Khartoum

The World Bank (2009) World Bank world development indicators database 2009. Accessed 15 June 2009

UNDP (United Nations Development Programme) (2007/2008) Human development report 2007/2008: fighting climate change: human solidarity in a divided world. Palgrave Macmillan, New York

Chapter 6
Overview of the Use of ICT and the Digital Divide in Sudan

6.1 Introduction

Chapter 5 uses the data and results of the university set out in Chap. 4 to examine from public-private perspective the research hypotheses on the public-private differential in the demand for ICT, trend and determinants in Sudanese universities. To complete our earlier analysis in Chap. 5, in this chapter we present an overview of the use of ICT and the digital divide in Sudan and we highlight the need for bridging the digital divide to enhance equality in the use of ICT in Sudan. This chapter uses the conceptual and theoretical frameworks presented in Chap. 3 and uses the most recent secondary data to discuss the use of ICT indicators (mobile, computer and Internet) at the macro level and the incidence of the digital divide in Sudan. Our analysis in this chapter differs in several ways from the several studies in the literature, which provides an interesting analysis of ICT indicators and performance in the Arab countries and Sudan.

Our findings are consistent with the findings in the international literature on the incidence and the main reasons for the incidence of the digital divide. First, different from the studies in the Arab literature (Nour 2002a, b, 2006) we provide significant contribution and a more in depth, comprehensive and up to date assessment of ICT indicator by focusing only on Sudan as a new case of the Arab countries. Secondly, we add to the existing studies in the international literature on the incidence and reasons for the incidence of the digital divide, we provide significant contribution and we extend our analysis to compare the digital divide for different modes of ICT in Sudan. Finally, different from the studies in the Sudanese literature (Nour 2013), a novel element in our analysis is that we fill the gap in the Sudanese literature we use recent secondary data at the macro level to discuss the use of ICT and the incidence of the digital divide in Sudan and we provide a more comprehensive analysis by investigating and comparing the digital divide for different modes of ICT in Sudan. Our results confirm the seventh hypothesis in Chap. 1 about the relationship between the uses of ICT (mobile, computer and

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Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. Our results imply that the observed disparities in the use of ICT and digital divide implies that ICT adds a new dimension to the already existing and longstanding challenges of inequalities and disparities in Sudan that has been well-documented in the literature as we explained in Chap. 2. We investigate the use of ICT and occurrence of the digital divide according to the conceptual framework: subjects of connectivity (defined by households and individuals); characteristics or attributes of connectivity (defined by geographic location, mode of living, gender, education and age); means of connectivity (fixed telephone, mobile telephone, Internet, DSL/mDSL); and purposes of connectivity (connecting or not connecting) using (or not using) the Internet and ICT; and locations of connectivity. We are aware of the fact that it may be particularly important and interesting to explain the two interesting issues related to both the intensity of connectivity, or how sophisticated the usage and the dynamics or evolution, whether the gap increased or decreased in the past and whether the gap will increase or decrease in the future, but due to practical problems related to availability of adequate and reliable data, unfortunately it will not be possible to discuss these issues in this chapter, so we leave that for a more in depth analysis in our future research.

This chapter uses new secondary data at the macro level based on the National Telecommunication Corporation (2012) "Households and individuals ICT survey 2012" to test the seventh hypothesis in Chap. 1 about the relationship between the uses of ICT (mobile, computer and Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. This is so we can help to improve understanding about the urgent need and necessity to stimulate ICT infrastructure development and support new policies that aim to enhance adequacy and equality of the use and utilization of ICT in Sudan and poor countries.

The rest of this chapter is organised as follows: Sect. 6.2 shows the use of mobile and digital divide in Sudan. Section 6.3 discusses the use of computer and digital divide in Sudan. Section 6.4 investigates the use of Internet and digital divide in Sudan. Section 6.5 examines the determinants of the digital divide that appears from the relationships between the use of ICT (mobile, computer and Internet) and age, educational and professional levels, and the use of ICT and per capita income, poverty and urbanization. Finally, Sect. 6.6 draws conclusions and proposes policies to bridge the digital divide and enhance adequacy and equality of the use and utilization of ICT in Sudan.

6.2 The Use of Mobile and Digital Divide in Sudan

This Sect. 6.2 examines the use of mobile and digital divide in Sudan and shows evidences on the incidence of the digital divide for households and individuals in terms of ownership, use, spending and purposes of use of mobile defined by mode of living, gender and region.

6.2.1 Ownership and Use of Mobile by Households

Concerning households' ownership and use of mobile, Table 6.1 and Fig. 6.1 explain households' ownership and use of mobile defined by region and mode of living. The regional disparities in ICT indicators appear from proportions of households' ownership of mobile defined by region and mode of living in Sudan. That implies that the proportions of households' ownership of mobile in urban (95.4 %) are higher than rural (88.5 %) and total Sudan (92.2 %). The regional distribution implies that the highest proportions of households ownership of mobile is reported in Northern region followed by Khartoum, Southern, Western, Central, all Sudan, and Eastern regions respectively.[1]

The regional disparities in ICT indicators appear from proportions of households' use of mobile defined by region and mode of living in Sudan. That implies that the proportions of households' use of mobile in urban (96.9 %) are higher than rural (93.5 %) and total Sudan (95.2 %). The regional distribution implies that the highest proportions of households use of mobile is reported in Southern region followed by Khartoum, Northern, Central, Western, all Sudan, and Eastern regions respectively.

6.2.2 Spending on Mobile Services and Fixed Telephone

Average spending of households on mobile services per month defined by region, mode of living and gender in Sudan implies that the average spending in urban (30 %) is equivalent to rural (30 %) and total Sudan (30 %), but the average spending for males (30 %) is higher than females (20 %). The regional use implies similar and equivalent average spending of households on mobile for all Sudan, Khartoum, Western, Eastern, Central and Southern regions, which are all higher than the Northern region[2] (see Table 6.2 and Fig. 6.2).[3]

The regional disparities in ICT indicators appear from households' average spending on fixed telephone per month defined by region and mode of living in

[1] As indicated by 98.6 %, 97.6 %, 95 %, 93.4 %, 92.7 %, 92.2 % and 79.5 % respectively.

[2] As indicated by 30 %, 30 %, 30 %, 30 %, 30 %, 30 % and 20 % respectively.

[3] As reported by 98.3 %, 98.1 %, 97.1 %, 95.7 %, 95.5 %, 95.2 % and 88.8 % respectively.

Table 6.1 The proportions of households owned or used mobile (% of the total population) defined by region and mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Proportions of households	Owned a mobile	Urban	100	82.5	97.9	97	97.6	95.6	95.4
		Rural	98.1	78	96.7	91.8	91	78.4	88.5
		Region	98.6	79.5	97.6	93.4	95	92.7	92.2
	Used a mobile	Urban	98.1	89.6	98.8	97.6	99.1	96.7	96.9
		Rural	96.8	88.4	97.5	95	97.2	89	93.5
		Region	97.1	88.8	98.1	95.7	98.3	95.5	95.2

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012," See Household of individuals ICT survey 2012, accessed on August 09, 2014: http://www.ntc.gov.sd/index.php/en/publications-eng/research-studies-eng/tech-stu-eng/14-ntc-departments/research-a-studies/248-communicationsurvey1

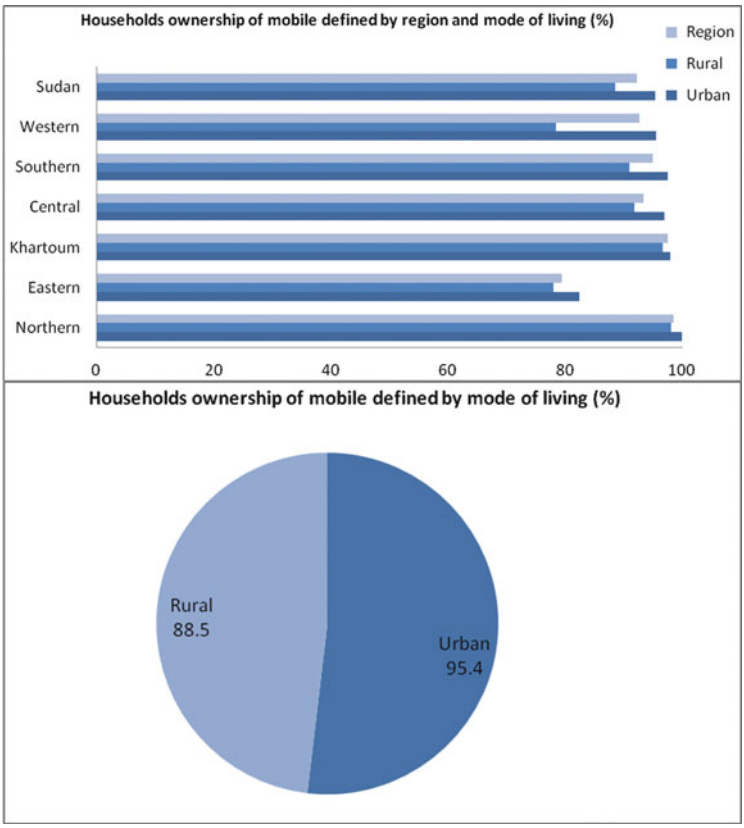

Fig. 6.1 Households use of ICT: mobile, computer and Internet defined by region and by mode of living in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

Sudan. That implies that average spending on fixed telephone per month in urban areas (20 %) is twice average spending in rural areas (10 %). The regional distribution implies that the highest households' average spending on fixed telephone per month is reported in Southern region followed by Central, Western, all Sudan, Khartoum, Eastern, and Northern regions respectively (see Table 6.2 and Fig. 6.2).[4]

[4] As indicated by 35.5 %, 25 %, 25 %, 20 %, 20.4 % and 20 % respectively.

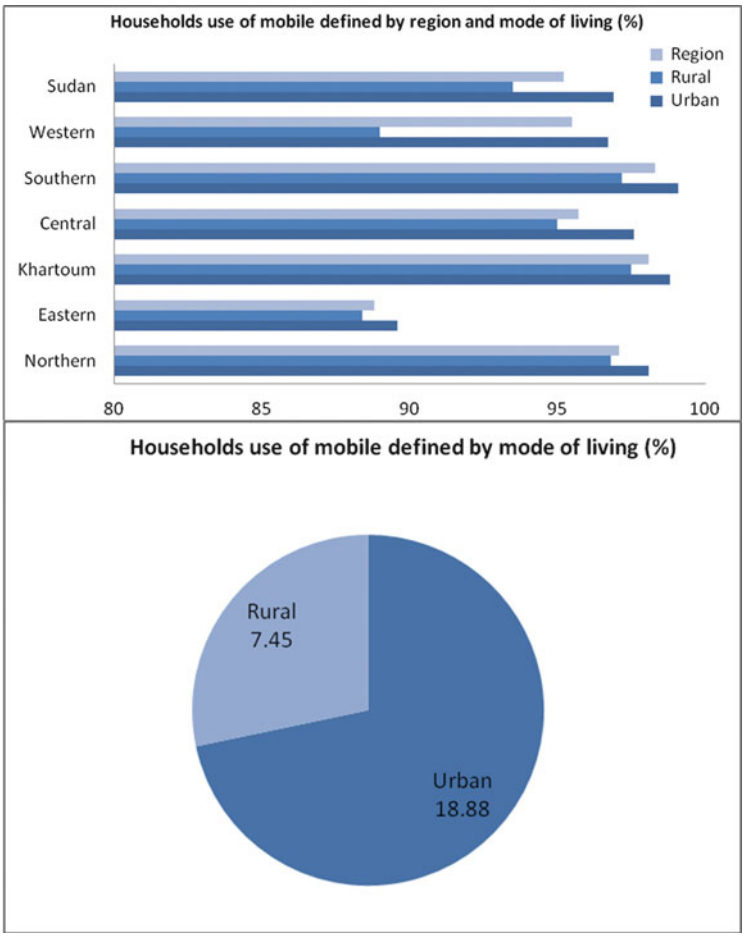

Fig. 6.1 (continued)

6.2.3 Ownership and Use of Mobile by Individuals

Concerning individual use of mobile, Tables 6.3 and 6.4 explains the discrepancies in terms of the proportions of individuals used mobile at least once during 2011 and purposes of the use of mobile, average number of Subscriber Identity Module or Subscriber Identification Module (SIM), or SIM card individuals owned, bought from companies or their agents or received from other sources, proportions of individuals with knowledge of mobile services prices, sources of knowledge of mobile services prices and cost of using mobile from the viewpoint of individuals defined by region, mode of living and gender.

The regional disparities in ICT indicators appear from proportions of individuals' ownership of mobile defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' ownership of mobile in urban

Table 6.2 Households average monthly spending on fixed telephone and mobile (in pounds) defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Average spending on fixed telephone		Urban	10.5	20	17.5	30	20	25	20
		Rural	0	60	20	17.5	50	10	10
		Region	0	20	20	25	35.5	25	20
Average spending on mobile	Mode of living	Urban	20	30	30	30	30	30	30
		Rural	20	30	30	30	30	30	30
	Gender	Males	25	35	40	30	40	30	30
		Females	15	20	30	20	20	24	20
	Region		20	30	30	30	30	30	30

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

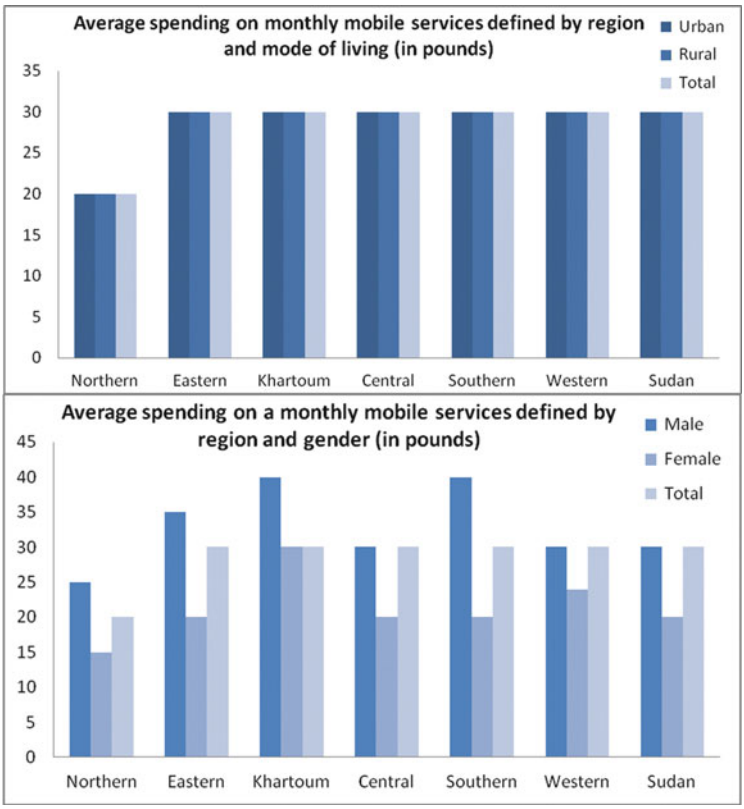

Fig. 6.2 Households average monthly spending on mobile and fixed telephone defined by region and mode of living in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

(71.6 %) are higher than rural (57.6 %) and for males (75.5 %) is higher than females (51.1 %) and total Sudan (63.1 %). The regional distribution implies that the highest proportions of individuals' ownership of mobile is reported in Khartoum followed by Northern, Central, all Sudan, Southern, Western, and Eastern regions respectively (see Table 6.3 and Fig. 6.3).[5]

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile at least once during the year 2011 defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile in urban (91.4 %) is higher than rural (84.3 %) and for males (92 %) is higher than females (82.3 %) and total Sudan (87.1 %). The regional distribution implies that the highest proportion of individuals' use of mobile is reported in

[5] As indicated by 83.3 %, 68 %, 64.9 %, 63.1 %, 62 %, 48.8 % and 46.8 % respectively.

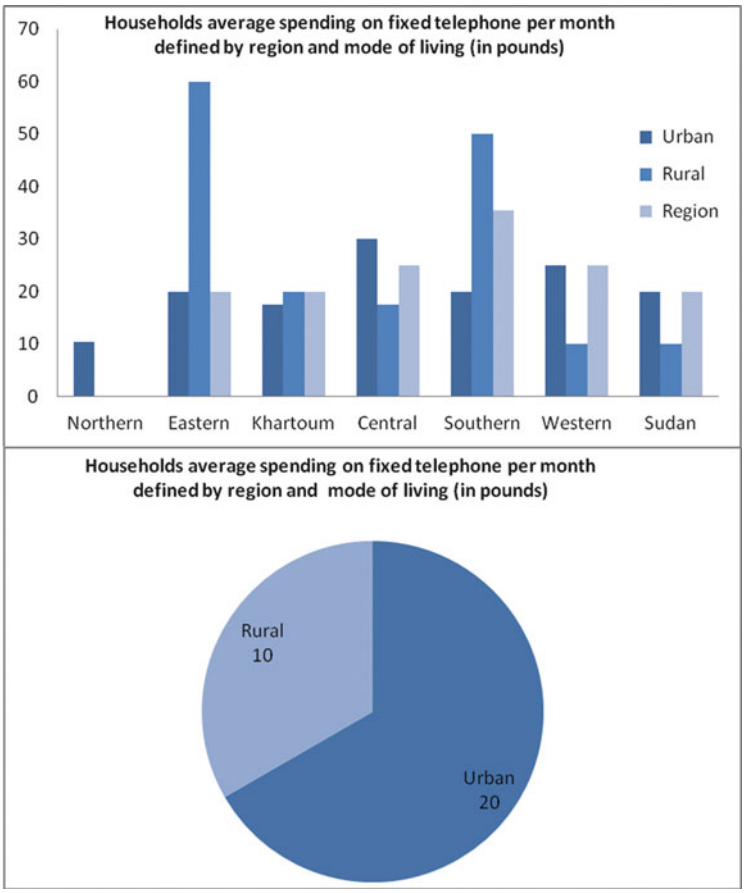

Fig. 6.2 (continued)

Khartoum followed by Northern, Southern, all Sudan, Western, Central, and Eastern regions respectively (see Table 6.3 and Fig. 6.3).[6]

6.2.4 Purposes of the Use of Mobile

From the viewpoint of individuals in Sudan mobile is widely used for several purposes, notably, it is widely used to make phone calls, send and receive messages, entertainment, transfer money, use the Internet, other purposes and to buy a service respectively.[7] The gender gap between males and females appear from several

[6] As indicated by 93 %, 90.7 %, 90.2 %, 87.9 %, 87.1 %, 85.7 % and 77.4 % respectively.

[7] As reported by 99.1 %, 60 %, 30.5 %, 23.3 %, 15.7 %, 8.7 % and 4.4 % respectively for the total Sudan.

Table 6.3 Proportions of individuals owned or used mobile at least once during the year 2011 (% of the total population) defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Proportion of individuals who owned a mobile	Mode of living	Urban	67.5	54.6	85.2	75.8	74.2	36.1	71.6
		Rural	68.2	42.2	74.1	61.3	57.1	53.3	57.6
	Gender	Males	83.2	60.6	89	79.2	79.9	61.2	75.5
		Females	53.3	31.6	76.7	52.9	45.7	37.3	51.1
	Region		68	46.8	83.3	64.9	62	48.8	63.1
Used mobile at least once during 2011	Mode of living	Urban	88	83.4	93.7	89.9	96.8	93.5	91.4
		Rural	91.7	73.8	89.2	84.3	87.6	85.9	84.3
	Gender	Males	94.8	86.1	95.2	91.1	94.6	92.7	92
		Females	86.7	67.8	90.4	81.1	86.2	83.4	82.3
	Region		90.7	77.4	93	85.7	90.2	87.9	87.1

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

Table 6.4 Purposes of the use of mobile defined by region, mode of living and gender in Sudan during 2011

Proportion of individuals who used mobile to			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
To make phone calls	Mode of living	Urban	98.2	99	99.2	99.4	98.8	99.2	99.2
		Rural	99	98.6	99.5	99.2	99.6	98.8	99.1
	Gender	Males	98.9	99	99.3	99.4	99.3	99.1	99.2
		Females	98.7	98.3	99.2	99.1	99.4	98.7	98.9
	Region	Total	98.8	98.7	99.3	99.2	99.3	98.9	99.1
To send and receive messages	Mode of living	Urban	53.6	63.6	71.6	67	64.3	68	68.1
		Rural	56.4	37.8	69.8	59.9	57.3	48.2	54.3
	Gender	Males	60	52.4	74.8	67.6	69	56.9	64.6
		Females	51.1	42.2	67	56.2	49.8	50.3	54.9
	Region	Total	55.7	48.1	71.3	61.7	59.4	53.6	60
To use the internet	Mode of living	Urban	9.3	16.4	29.9	21.1	20.5	13.5	23
		Rural	8	5.8	19	14.2	16.6	3.7	10.5
	Gender	Males	10	12.7	31.9	21.3	26.7	8.6	19.7
		Females	6.5	6.3	23.5	11	8.9	4.2	11.3
	Region	Total	8.3	10	28.1	16	17.7	6.4	15.7
To transfer money	Mode of living	Urban	16.5	28.1	18.2	36.8	29.8	22.2	24.1
		Rural	15	18.9	16.8	36.3	39.3	1.7	22.7
	Gender	Males	19.5	29.3	21.5	45	48	9.8	28.8
		Females	10.9	13.2	13.6	28.2	25	4.8	17.3
	Region	Total	15.3	22.6	17.9	36.4	36.5	7.3	23.3
To buy a service	Mode of living	Urban	11.9	11.2	7.4	2.3	0.5	8.9	6.9
		Rural	12.1	2.2	5	1.7	0.3	0.5	2.5
	Gender	Males	13.4	6.8	7.7	2.3	0.4	3.4	5.1
		Females	10.6	4.4	6.2	1.4	0.3	2.3	3.5
	Region	Total	12.1	5.8	7	1.9	0.4	2.8	4.4

(continued)

Table 6.4 (continued)

Proportion of individuals who used mobile to			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
For entertainment	Mode of living	Urban	30.2	32.7	34.2	34.1	44.1	33.1	34.2
		Rural	23	16.3	37.8	32.9	42.6	20.5	27.9
	Gender	Males	27.7	25.5	35	36.7	50	24.3	32.5
		Females	21.7	19.3	34.6	29.9	36.2	23.6	28.3
	Region		24.8	22.9	34.8	33.2	43.1	24	30.5
For other purposes	Mode of living	Urban	4.2	7.6	6.7	11.1	17.7	7.5	8.2
		Rural	4.5	3.8	4.5	12.3	23.5	4.6	9
	Gender	Males	4.1	6.3	6	13.9	26	5.9	9.5
		Females	4.7	4.1	6.6	10.2	17.5	4.8	7.8
	Region		4.4	5.4	6.3	12	21.8	5.4	8.7

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

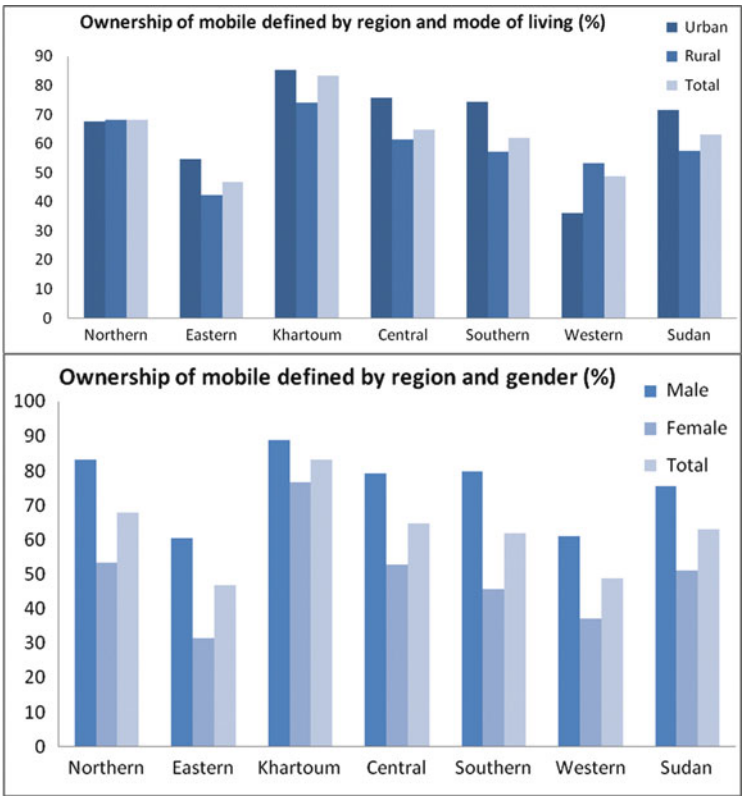

Fig. 6.3 The ownership and use of mobile defined by regions, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

purposes of using mobile defined by gender that implies that for males and females mobile is widely used to make phone calls, send and receive messages, entertainment, transfer money, use the Internet, other purposes and to buy a service for males and females respectively (see Table 6.4 and Fig. 6.4).[8,9]

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile to make phone calls of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile to make phone calls of total mobile users in urban (99.2 %) is slightly higher than rural ((99.1 %) and for males (99.2 %) is slightly higher than females (98.9 %) and total Sudan (99.1 %). The regional distribution implies that the highest proportions of individuals use of mobile to make phone calls of total

[8] As indicated by 99.2 %, 64.6 %, 32.5 %, 28.8 %, 19.7 %, 9.5 % and 5.1 % respectively for males.

[9] As reported by 98.9 %, 54.9 %, 28.3 %, 17.3 %, 11.3 %, 7.8 %, and 3.5 % respectively for females.

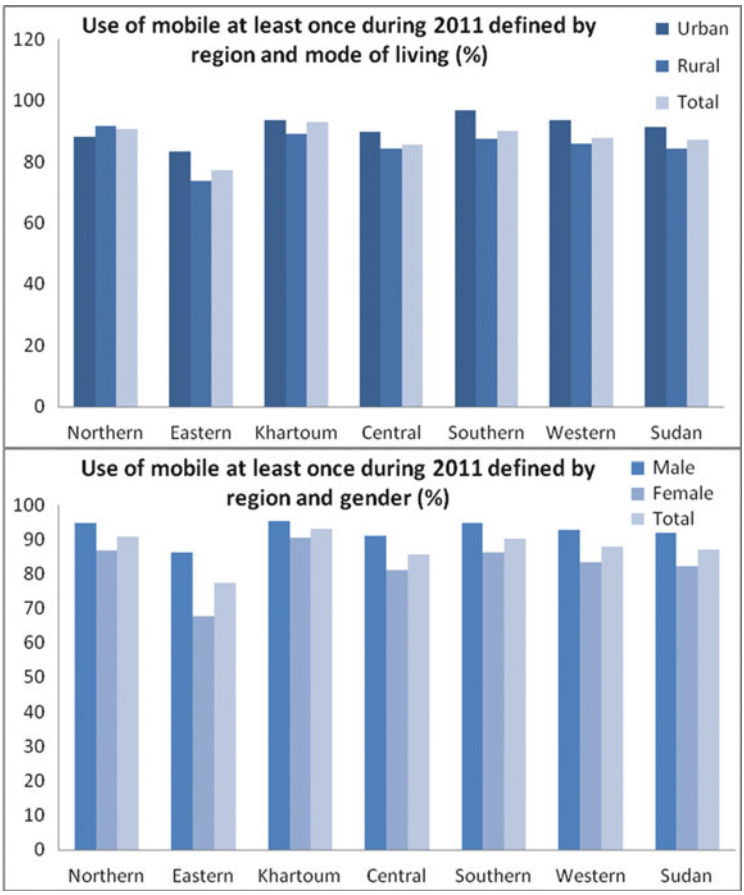

Fig. 6.3 (continued)

mobile users is reported in Khartoum followed by Southern, Central, all Sudan, Western, Northern, and Eastern regions respectively.[10]

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile to send and receive messages of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile to send and receive messages of total mobile users in urban (68.1 %) is higher than rural (54.3 %) and for males (64.6 %) is higher than females (54.9 %) and total Sudan (60 %). The regional distribution implies that the highest proportions of individuals use of mobile to send and receive messages of total mobile users is reported in Khartoum followed by Central, all Sudan, Northern, Southern, Western, and Eastern regions respectively.[11]

[10] As indicated by 99.3 %, 99.3 %, 99.2 %, 99.1 %, 98.9 %, 98.8 % and 98.7 % respectively.

[11] As indicated by 71.3 %, 61.7 %, 60 %, 53.6 % and 48.1 %, respectively.

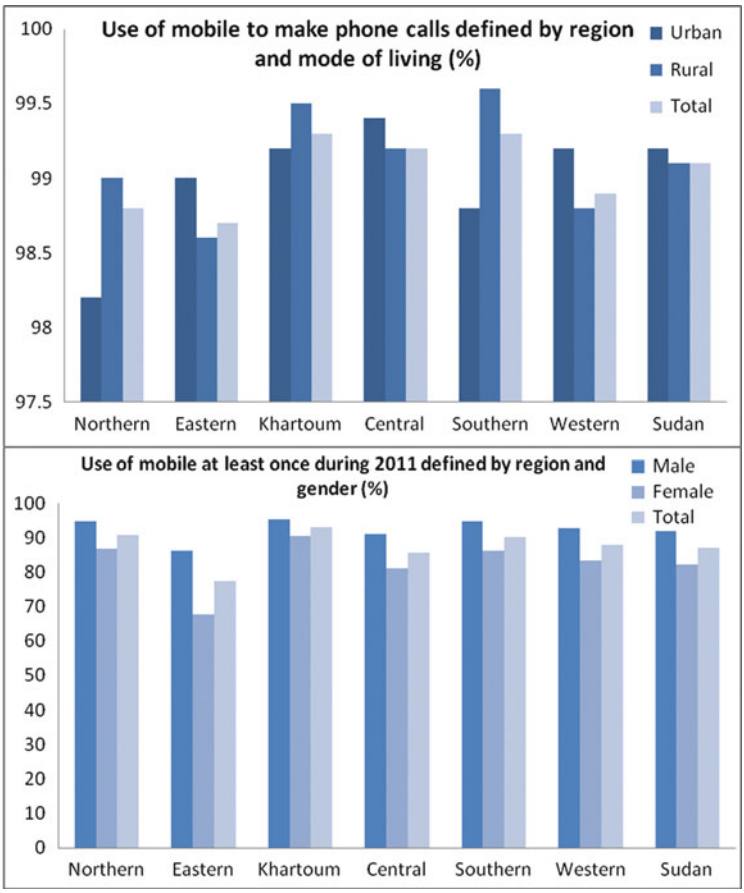

Fig. 6.4 Purposes of the use of mobile defined by regions, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile to use the Internet of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile to use the Internet of total mobile users in urban (23 %) is more than twice higher than rural (10.5 %) and for males (19.7 %) is near to twice higher than females (11.3 %) and total Sudan (15.7 %). The regional distribution implies that the highest proportions of individuals use of mobile to use the Internet of total mobile users is reported in Khartoum followed by Southern, Central, all Sudan, Eastern, Northern, and Western regions respectively.[12] The proportion of

[12] As indicated by 28.1 %, 17.7 %, 16 %, 15.7 %, 10 %, 8.3 % and 6.4 % respectively.

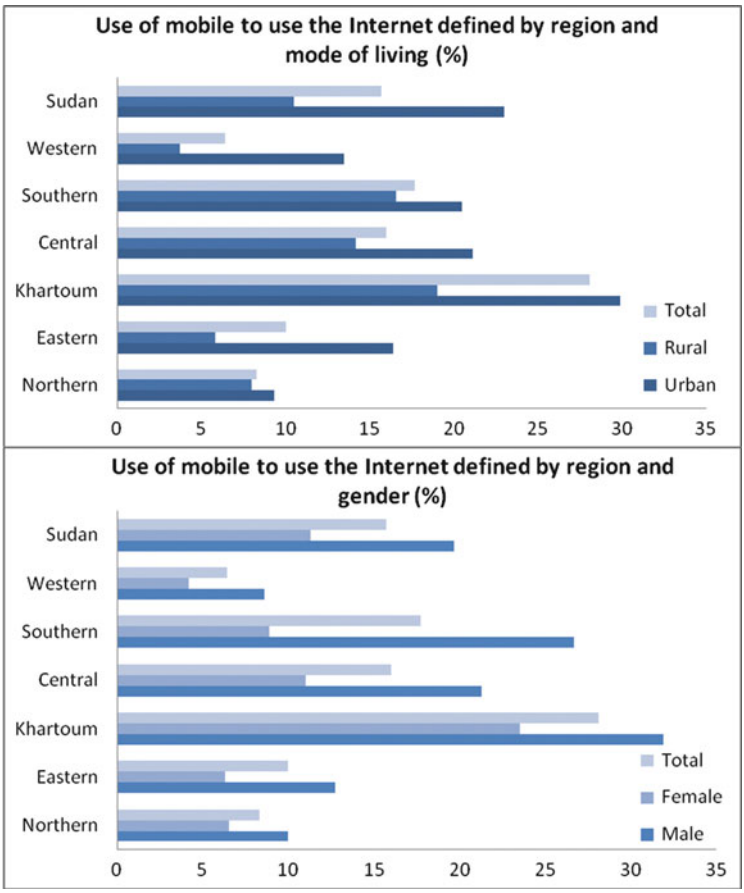

Fig. 6.4 (continued)

individuals use of mobile to use the Internet of total mobile users in Khartoum (28.1 %) is more than four time higher than that in Western region (6.4 %).

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile to transfer money of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile to transfer money of total mobile users in urban (24.1 %) is higher than rural (22.7 %) and for males (28.8 %) is higher than females (17.3 %) and total Sudan (23.3 %). The regional distribution implies that the highest proportions of individuals use of mobile to transfer money of total mobile users is reported in Southern region followed by Central, all Sudan, Eastern, Khartoum, Northern, and Western regions respectively.[13] The proportion of individuals use of mobile to

[13] As indicated by 36.5 %, 36.4 %, 23.3 %, 22.6 %, 17.9 %, 15.3 %, and 7.3 % respectively.

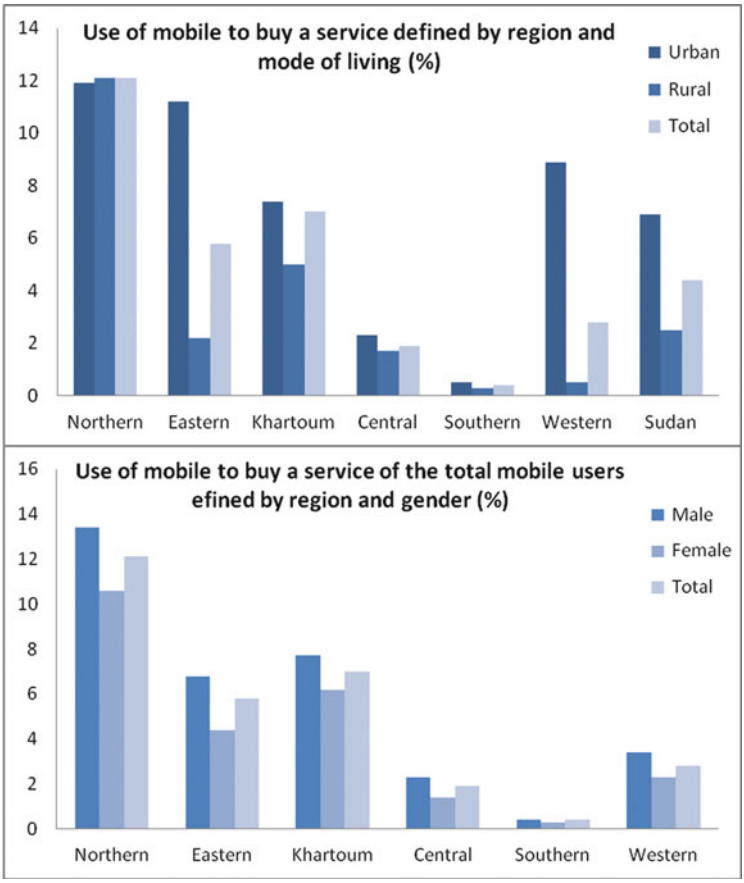

Fig. 6.4 (continued)

transfer money of total mobile users in Central region (36.4 %) is more than twice higher than that in Northern region (15.3 %).

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile to buy a service of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile to buy a service of total mobile users in urban (6.9 %) is more than double/higher than rural (2.5 %) and for males (5.1 %) is higher than females (3.5 %) and total Sudan (4.4 %). The regional distribution implies that the highest proportions of individuals use of mobile to buy a service of total mobile users is reported in Northern region followed by Khartoum, Eastern, all Sudan, Western, Central, and Southern regions respectively.[14] The proportion of individuals' use of mobile to

[14] As indicated by 12.1 %, 7 %, 5.8 %, 4.4 %, 2.8 %, 1.9 % and 0.4 % respectively.

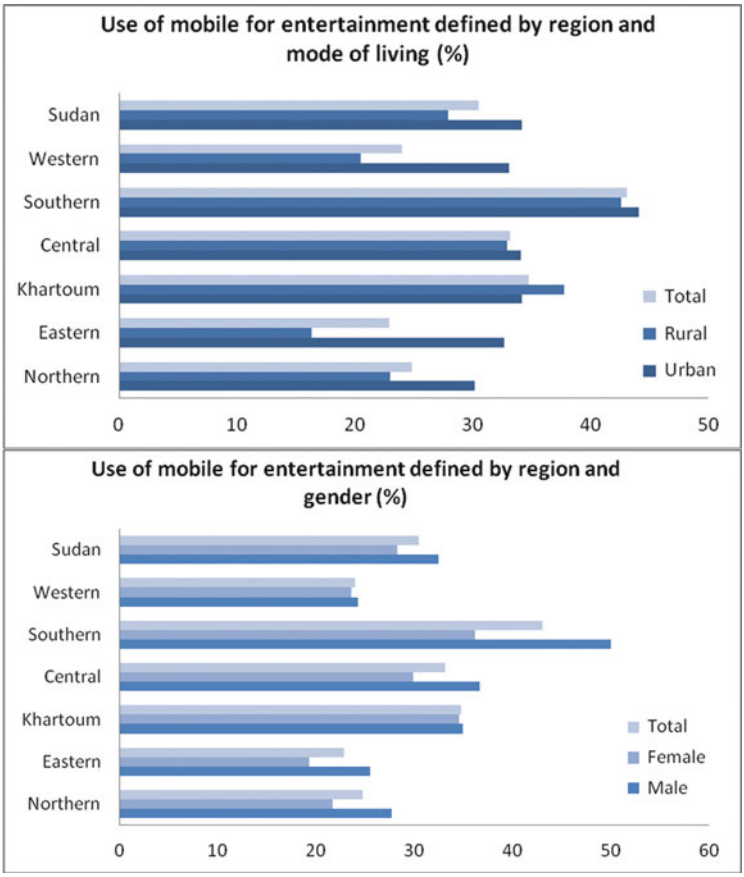

Fig. 6.4 (continued)

buy a service of total mobile users in Northern region (12.1 %) is more than 30 times higher than that in Southern region (0.4 %).

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile for entertainment of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile for entertainment of total mobile users in urban (34.2 %) is higher than rural (27.9 %) and for males (32.5 %) is higher than females (28.3 %) and total Sudan (30.5 %). The regional distribution implies that the highest proportions of individuals use of mobile for entertainment of total mobile users is reported in Southern region followed by Khartoum, Central, all Sudan, Northern, Western, and Eastern regions respectively.[15]

[15] As indicated by 43.1 %, 34.8 %, 33.2 %, 30.5 %, 24.8 %, 24 % and 22.9 % respectively.

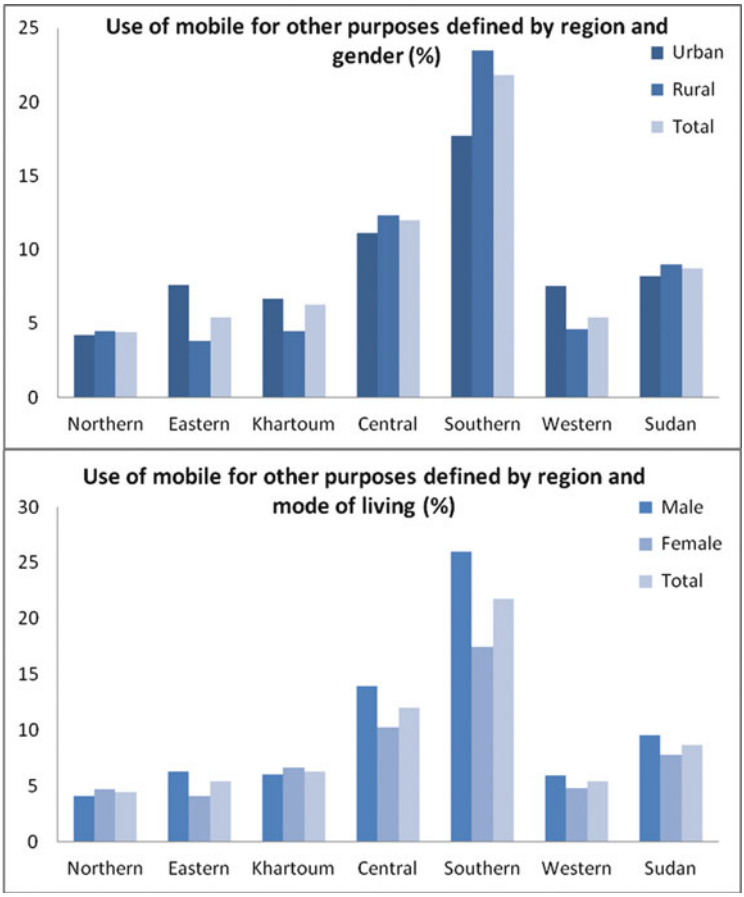

Fig. 6.4 (continued)

The regional disparities in ICT indicators appear from proportions of individuals' use of mobile for other purposes of total mobile users defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' use of mobile for other purposes of total mobile users in rural (9 %) is slightly higher than urban (8.2 %) and for males (9.5 %) is higher than females (7.8 %) and total Sudan (8.7 %). The regional distribution implies that the highest proportions of individuals use of mobile for other purposes of total mobile users is reported in Southern region, followed by Central, all Sudan, Khartoum, Western, Eastern, and Northern regions respectively.[16]

[16] As indicated by 21.8 %, 12 %, 8.7 %, 6.3 %, 5.4 %, 5.4 % and 4.4 % respectively.

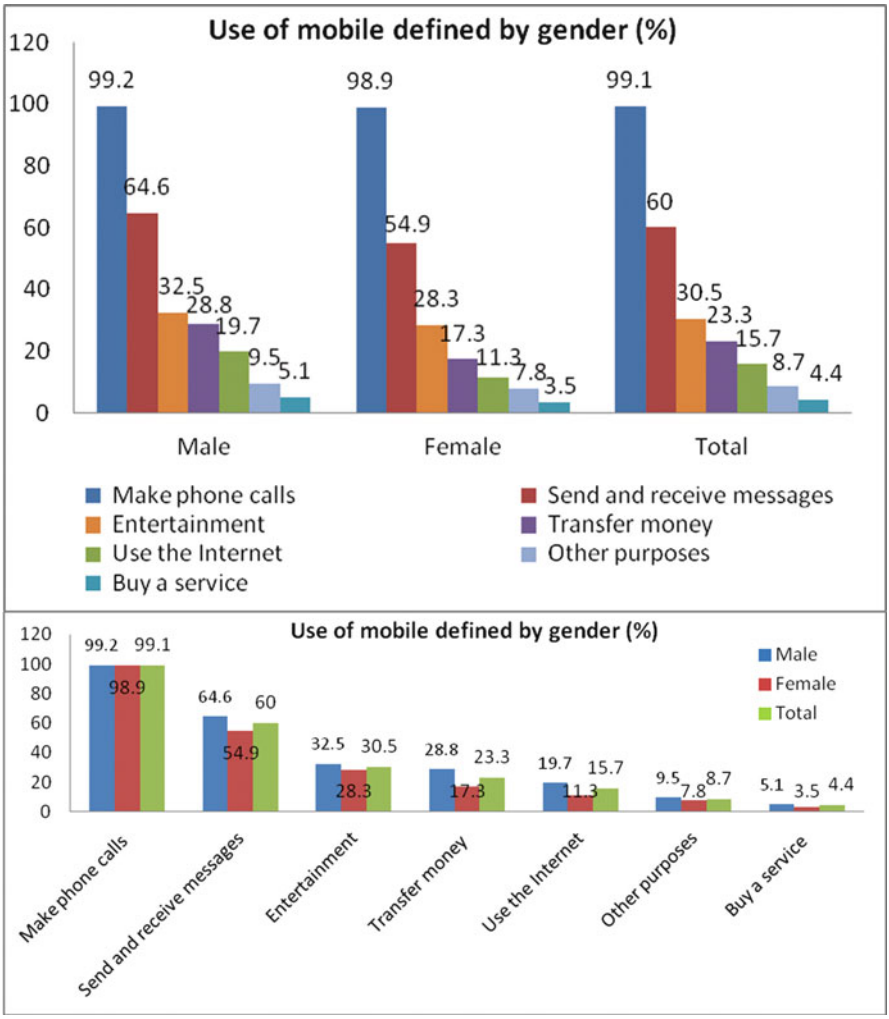

Fig. 6.4 (continued)

6.2.5 Knowledge of the Use of Mobile

We observe some exceptional similarity concerning the average number of SIM owned by individual, as it is similar and equivalent to one for all regions, for both urban and rural areas and for males and females in Sudan. On the one hand, the proportions of individuals bought SIM directly from companies or their agents defined by region, gender and mode of living implies that the proportions of individuals bought SIM directly from companies or their agents in urban areas (65.5 %) are higher than rural areas (50.2 %) and for males (64.5 %) is higher than females (47.8 %) and total Sudan (56.5 %). The highest proportions of individuals

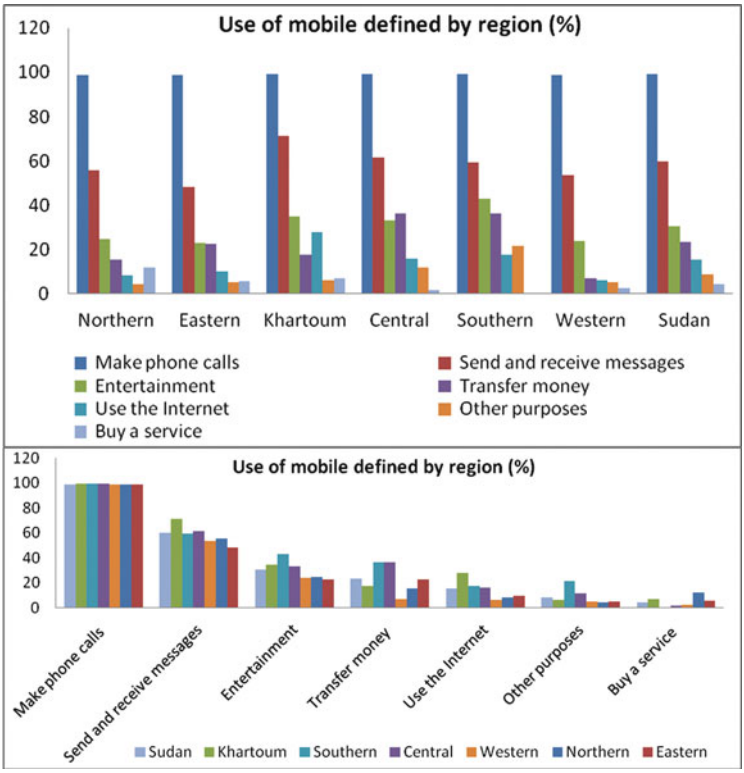

Fig. 6.4 (continued)

bought SIM directly from companies or their agents is reported in Khartoum followed by Central, Northern, all Sudan, Southern, Eastern, and Western regions respectively.[17] On the other hand, the proportions of individuals received SIM from other sources defined by region, gender and mode of living implies that the proportions of individuals received SIM from other sources in rural areas (22.8 %) is higher than urban areas (17.4 %) and for males (23.8 %) is higher than females (17.1 %) and total Sudan (20.6 %). The highest proportions of individuals received SIM from other sources is reported in Western region followed by Southern, Eastern, all Sudan, Northern, Khartoum and Central regions respectively (see Table 6.5 and Fig. 6.5).[18]

The regional disparities in ICT indicators appear from individuals' awareness defined by proportions of individuals' with knowledge of the terms of contract to buy SIM defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' with knowledge of the terms of contract to buy SIM

[17] As reported by 76.1 %, 62.8 %, 61.1 %, 56.5 %, 48.6 %, 43.1 % and 33.5 % respectively.

[18] As indicated by 26.9 %, 26.5 %, 22.1 %, 20.8 %, 20.6 %, 17.3 % and 17 % respectively.

Table 6.5 The average number of SIM card individual owned and proportions of individuals who bought SIM from companies or their agents or received SMI from other sources defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Average number of SIM card owned by individual	Mode of living	Urban	1	1	1	2	2	1	1
		Rural	1	1	1	1	1	1	1
	Gender	Males	1	1	1	2	2	1	1
		Females	1	1	1	1	1	1	1
	Region	Total	1	1	1	1	1	1	1
SIM bought directly from companies or their agents	Mode of living	Urban	71.6	53.9	77.3	71.6	56.3	27.5	65.5
		Rural	57.6	35.9	70.5	59.7	45.3	35.8	50.2
	Gender	Males	72.8	50.8	80.8	72.5	60.6	40.8	64.5
		Females	48.5	32.4	70.6	53.6	36.8	26	47.8
	Region	Total	61.1	43.1	76.1	62.8	48.6	33.5	56.5
SIM received from other sources	Mode of living	Urban	12.9	19.1	17.1	17.7	28.5	13.2	17.4
		Rural	23.5	24	18.2	16.8	25.6	32.1	22.8
	Gender	Males	24.8	25.1	17.3	20.5	33.9	32	23.8
		Females	16.6	17.8	17.3	13.8	19.1	21.6	17.1
	Region	Total	20.8	22.1	17.3	17	26.5	26.9	20.6
Knowledge of terms of contract of purchasing SIM card	Mode of living	Urban	51.3	36.2	63.2	50.6	34.8	22.6	50.2
		Rural	40.9	14.5	52.4	38.8	26.5	32.9	34.3
	Gender	Males	50.8	27.5	67	49.1	35.2	37.7	47.3
		Females	35.7	17.3	54.6	35	22.9	22.2	33.9
	Region	Total	43.5	23.2	61.4	41.9	29	30.1	40.8

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

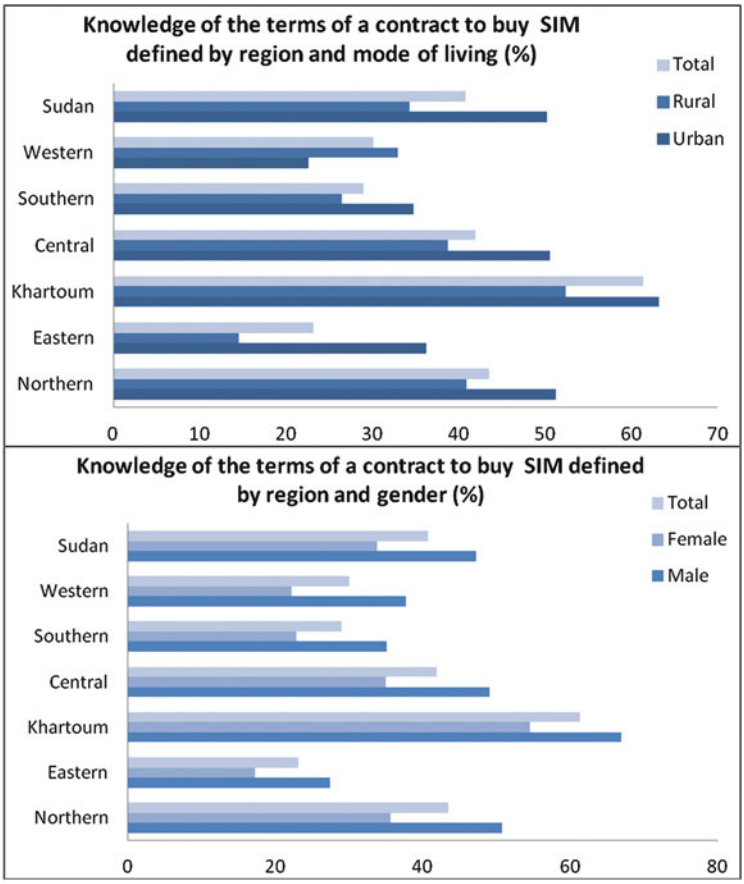

Fig. 6.5 Knowledge of terms of contract of purchasing SIM card defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

in urban (50.2 %) is higher than rural (34.3 %) and for males (47.3 %) is higher than females (33.9 %) and total Sudan (40.8 %). The regional distribution implies that the highest proportions of individuals with knowledge of the terms of contract to buy SIM is reported in Khartoum followed by Northern, Central, all Sudan, Western, Southern, and Eastern regions respectively.[19] The proportion of individuals with knowledge of the terms of contract to buy SIM in Khartoum (61.4 %) is more than twice higher than that in Eastern region (23.2 %) (see Table 6.5 and Fig. 6.5).

[19] As reported by 61.4 %, 43.5 %, 41.9 %, 40.8 %, 30.1 %, 29 % and 23.2 % respectively.

6.2.6 *Prices and Costs of the Uses of Mobile*

The regional disparities in ICT indicators appear from individuals' awareness defined by the proportions of individuals with knowledge of mobile services prices defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals with knowledge of mobile services prices in urban (52.5 %) is higher than rural (41.7 %) and for males (49 %) is higher than females (31.7 %) and total Sudan (40.2 %). The regional distribution implies that the highest proportion of individuals with knowledge of mobile services prices is reported in Khartoum followed by Southern, Central, all Sudan, Northern, Western, and Eastern regions respectively (see Table 6.6 and Fig. 6.6).[20]

The regional disparities in ICT indicators appear from sources of knowledge of mobile services prices defined by region, mode of living and gender in Sudan. That implies that with exception of Western region, the majority in other regions and in all Sudan find information from companies followed by media and other sources (people) respectively.[21] The majority of individuals find information from companies as reported in Khartoum followed by Northern, all Sudan, Central, Southern, Eastern, and Western regions respectively.[22] Some individual find information from media as reported in Western region followed by Southern, all Sudan, Central, Eastern, Northern, and Khartoum, respectively.[23] Few individuals find information from other sources (people) as reported in Eastern region followed by Northern, Central, all Sudan, Khartoum, Southern, and Western regions respectively (see Table 6.6 and Fig. 6.6).[24]

The regional disparities in ICT indicators appear from individuals' viewpoint concerning the cost of using mobile defined by region, mode of living and gender in Sudan. That implies that with exception of Central region, the viewpoint of the majority in other region and all Sudan implies that the cost of using mobile is high followed by reasonable and low respectively.[25] From the viewpoint of the majority of individuals the high cost of using mobile is reported in Western region followed by Southern, Eastern, Khartoum, all Sudan, Northern, and Central regions respectively.[26] From the viewpoint of some people the reasonable cost of using mobile is reported in Central region followed by Northern, all Sudan, Khartoum, Eastern, Southern, and Western regions respectively.[27] From the viewpoint of few people

[20] As reported by 58.3 %, 44.1 %, 41.2 %, 40.2 %, 37.9 %, 31.7 % and 22.4 % respectively.

[21] As indicated by 59.5 %, 33.1 %, and 7.5 % respectively.

[22] As reported by 71.5 %, 63.1 %, 59.5 %, 58.2 %, 55.9 %, 50.2 %, and 43.3 % respectively.

[23] As indicated by 54 %, 39 %, 33.1 %, 32.9 %, 32 %, 24.8 %, and 23.4 % respectively.

[24] As reported by 17.8 %, 12.1 %, 8.9 %, 7.5 %, 5.1 %, 5.1 %, and 2.8 % respectively.

[25] As indicated by 55.9 %, 41.7 %, and 2.3 % respectively.

[26] As reported by 74 %, 63.5 %, 57.5 %, 56.8 %, 55.9 %, 48.2 %, and 46.7 % respectively.

[27] As indicated by 51.3 %, 48.1 %, 41.7 %, 41.5 %, 39.8 %, 31.6 %, and 23.8 % respectively.

Table 6.6 The proportions of individuals with knowledge of mobile services prices and sources of knowledge of mobile services prices and the cost of using mobile from the viewpoint of individuals defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Have knowledge of mobile services prices	Mode of living	Urban	48.8	37.8	63.9	55.3	56.5	22.4	52.5
		Rural	39.5	23.1	56.8	45.4	45.6	41.3	41.7
	Gender	Males	49.3	29.5	64.7	50.2	57.3	41.2	49
		Females	26.8	14.7	50.9	33.5	32.3	22.9	31.7
	Region	Total	37.9	22.4	58.3	41.2	44.1	31.7	40.2
Source of knowledge by region and gender	Males	Companies	50.6	51.2	71.1	57.8	58.1	44.6	59.4
		Media	35.4	29.8	24.2	33.4	37.2	53	33.1
		Other (people)	14	19.1	4.8	8.8	4.7	2.4	7.6
	Females	Companies	68.2	48	72.2	58.6	52.4	41	59.6
		Media	20.5	36.9	22.3	32.3	42	55.6	33
		Other (people)	11.4	15.1	5.6	9.1	5.6	3.4	7.4
	Total	Companies	63.1	50.2	71.5	58.2	55.9	43.3	59.5
		Media	24.8	32	23.4	32.9	39	54	33.1
		Other (people)	12.1	17.8	5.1	8.9	5.1	2.8	7.5
		Total	100	100	100	100	100	100	100
Source of knowledge by region and mode of living	Urban	Companies	50.6	53.2	53.2	71.2	53.3	56.6	63.3
		Media	35.4	34.7	34.7	23.6	36.4	36.3	29.4
		Other (people)	14	12.1	12.1	5.2	10.4	7.2	7.4
	Rural	Companies	68.2	46.8	46.8	73.1	60.3	40.5	56.1
		Media	20.5	29	29	22.3	31.4	57.6	36.3
		Other (people)	11.4	24.2	24.2	4.6	8.3	1.9	7.6
	Total	Companies	63.1	50.2	50.2	71.5	58.2	43.3	59.5
		Media	24.8	32	32	23.4	32.9	54	33.1
		Other (people)	12.1	17.8	17.8	5.1	8.9	2.8	7.5
		Total	100	100	100	100	100	100	100

(continued)

Table 6.6 (continued)

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
The cost of using mobile from the viewpoint of individuals by region and gender	Males	High	47.6	61.2	57.4	50.2	66.5	74.5	58.1
		Reasonable	47.6	36.5	41.2	57.4	28.9	23.2	39.7
		Low	4.8	2.2	1.4	41.2	4.6	2.3	2.2
	Females	High	49.1	49.8	55.9	42.4	58.9	73.3	52.8
		Reasonable	48.8	46.5	42	55.2	35.7	24.6	44.6
		Low	2.1	3.7	2.1	2.5	5.3	2.1	2.6
	Total	High	48.2	57.5	56.8	46.7	63.5	74	55.9
		Reasonable	48.1	39.8	41.5	51.3	31.6	23.8	41.7
		Low	3.8	2.7	1.7	2	4.9	2.2	2.3
		Total	100	100	100	100	100	100	100
The cost of using mobile from the viewpoint of individuals by region and mode of living	Urban	High	38.7	51	57.2	39.8	54.8	71.4	52.8
		Reasonable	50	46.4	41	57.6	41.1	25.6	44.5
		Low	11.3	2.7	1.9	2.6	4.1	3	2.7
	Rural	High	51.4	62.6	54.6	49.6	68	74.6	58.4
		Reasonable	47.4	34.7	44.7	48.7	26.7	23.3	39.5
		Low	1.2	2.7	0.8	1.7	5.3	2.1	2.1
	Total	High	48.2	57.5	56.8	46.7	63.5	74	55.9
		Reasonable	48.1	39.8	41.5	51.3	31.6	23.8	41.7
		Low	3.8	2.7	1.7	2	4.9	2.2	2.3
		Total	100	100	100	100	100	100	100

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

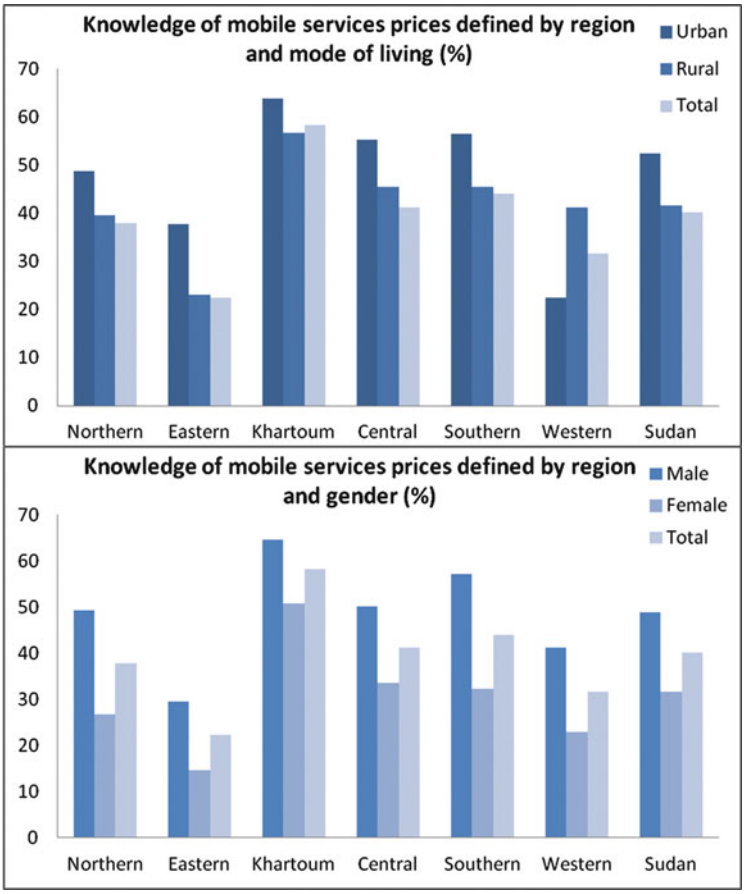

Fig. 6.6 Knowledge of mobile services price, sources of individuals knowledge and the cost of using mobile from the view point of individuals defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

the low cost of using mobile is reported in Southern region followed by Northern, Eastern, all Sudan, Western, Central, and Khartoum regions respectively (see Table 6.6 and Fig. 6.6).[28]

[28] As reported by 4.9 %, 3.8 %, 2.7 %, 2.3 %, 2.2 %, 2 %, and 1.7 % respectively.

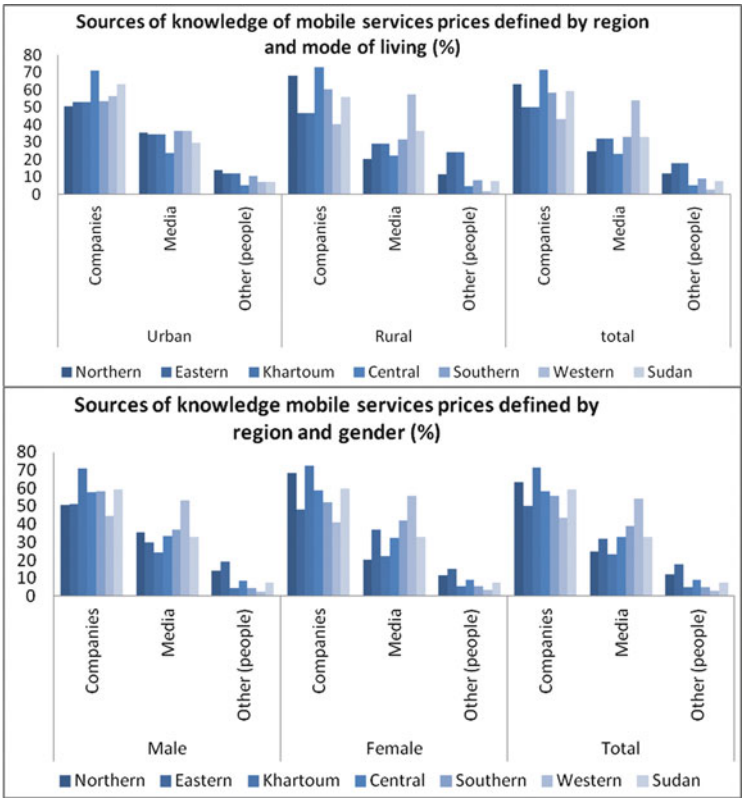

Fig. 6.6 (continued)

6.3 The Use of Computer and Digital Divide in Sudan

This section discusses the use of computer and digital divide in Sudan and explains evidences on the occurrence of the digital divide for households and individuals in terms of ownership, use and purposes of use of computer defined by mode of living, gender and region.

6.3.1 Ownership and Use of Computer by Households

Concerning households' ownership and use of computer, Table 6.7 explains the proportions of households owned or used computer defined by region and mode of living.

The regional disparities in ICT indicators appear from the proportions of households' ownership of computer defined by region and mode of living in Sudan. That implies that the proportions of households' ownership of computer in urban areas

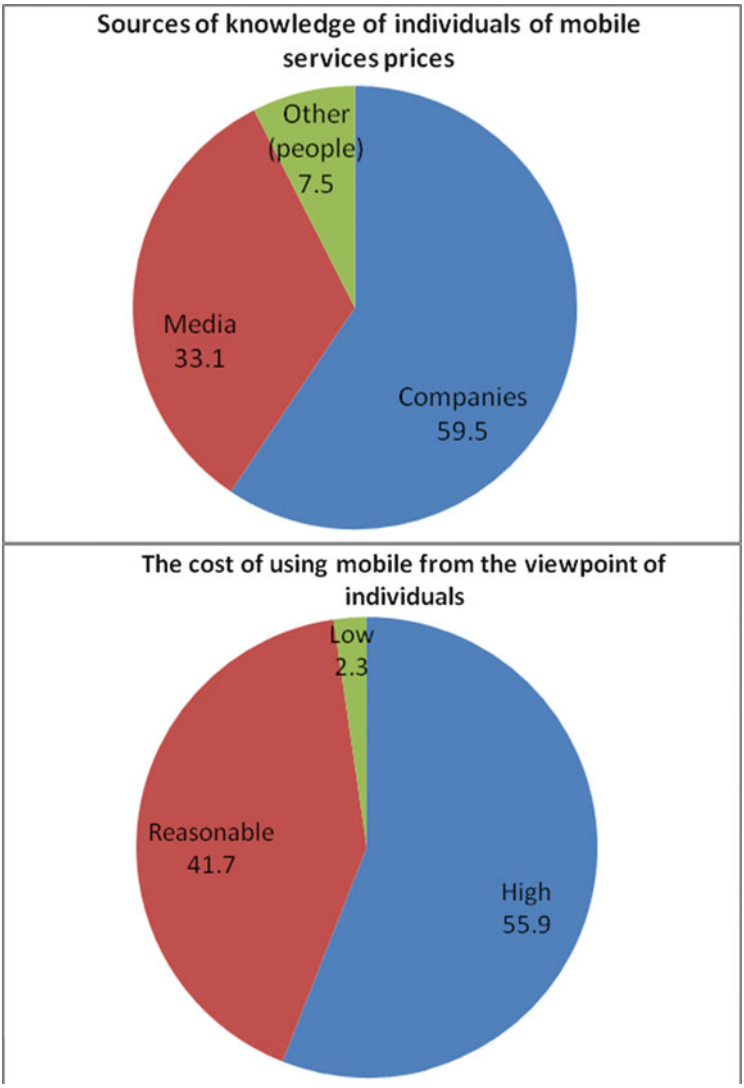

Fig. 6.6 (continued)

(18.9 %) are more than twice higher than rural areas (7.5 %) and total Sudan (14 %). The regional distribution implies that the highest proportions of households ownership of computer is reported in Khartoum followed by Southern, Central, Western, Northern, all Sudan, and Eastern regions respectively.[29] The proportion of

[29] As indicated by 12.8 %, 12 %, 10.4 %, 8.8 %, 14 % and 5.4 % respectively.

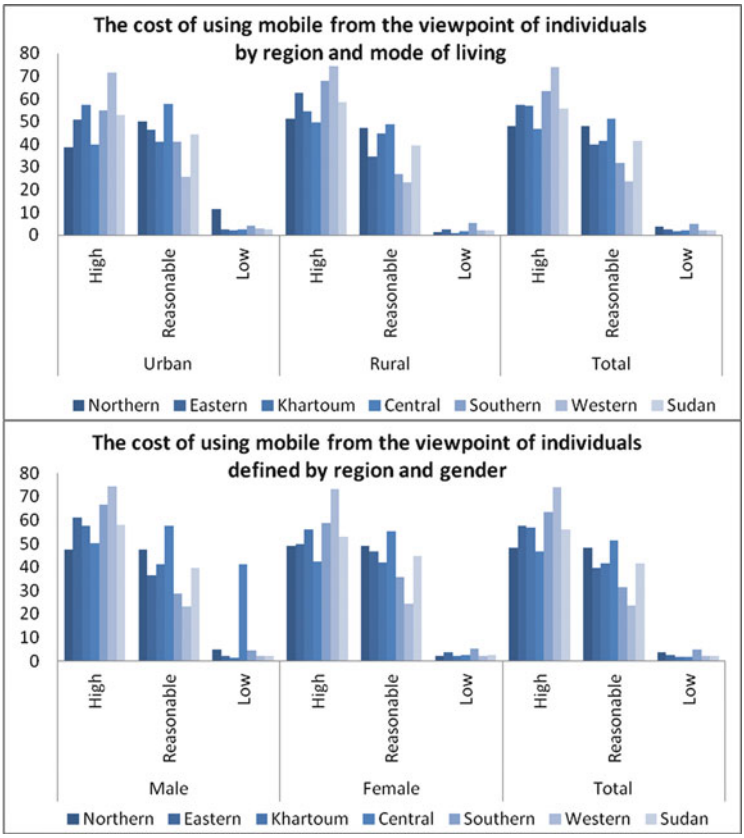

Fig. 6.6 (continued)

households' ownership of computer in Khartoum (34.4 %) is more than six time higher than that in Eastern region (5.4 %) (see Table 6.7 and Fig. 6.7).

The regional disparities in ICT indicators appear from proportions of households' use of computer defined by region and mode of living in Sudan. That implies that the proportions of households' use of computer in urban areas (39.3 %) are more than twice higher than rural areas (18.7 %) and total Sudan (29.7 %). The regional distribution implies that the highest proportions of households use of computer is reported in Khartoum followed by Southern, all Sudan, Northern, Central, Western, and Eastern regions respectively.[30] The proportion of households' use of computer in Khartoum (50.6 %) is more than three time higher than that in Eastern region (14.3 %) (see Table 6.7 and Fig. 6.7).

[30] As indicated by 50.6 %, 40 %, 29.7 %, 27.4 %, 27 %, 23.3 % and 14.3 % respectively.

Table 6.7 The proportions of households owned or used computer (% of the total population) defined by region and mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Proportions of households	Owned a computer	Urban	12.5	12.9	39.5	19.3	17	12.1	20.3
		Rural	7.6	5	15.4	8.7	6.2	1.8	22.4
		Region	8.8	5.4	34.4	12	12.8	10.4	14
	Used a computer	Urban	26.9	29	54.4	39.8	49.2	30.9	39.3
		Rural	22.2	7	37	21.8	25.7	7.8	18.7
		Region	23.3	14.3	50.6	27.4	40	27	29.7

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012," See Household of individuals ICT survey 2012, accessed on August 09, 2014: http://www.ntc.gov.sd/index.php/en/publications-eng/research-studies-eng/tech-stu-eng/14-ntc-departments/research-a-studies/248-communicationsurvey1

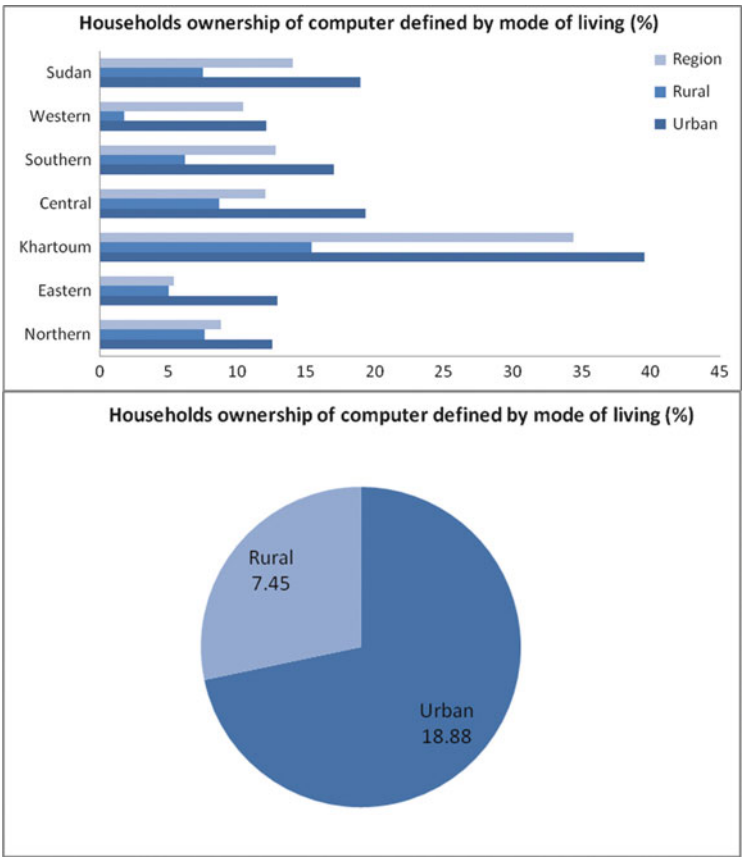

Fig. 6.7 Households ownership and use of computer defined by region and by mode of living in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

6.3.2 Knowledge, Provision and Use of Computer by Individuals

Concerning individual's use of computer, Tables 6.8 and 6.9 explains proportions of individuals with knowledge to use computer, provided with computer at home, used computer at home and outside home and scope/reasons for use of computer at home and outside home defined by region, mode of living and gender.

The regional disparities in ICT indicators appear from awareness to use computer as defined by the proportions of individuals' with knowledge to use computer defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' with knowledge to use computer in urban areas (33 %) is more than three time higher than rural areas (10.6 %) and for males (23.3 %) is higher than females (15.7 %) and total Sudan (19.4 %). The regional

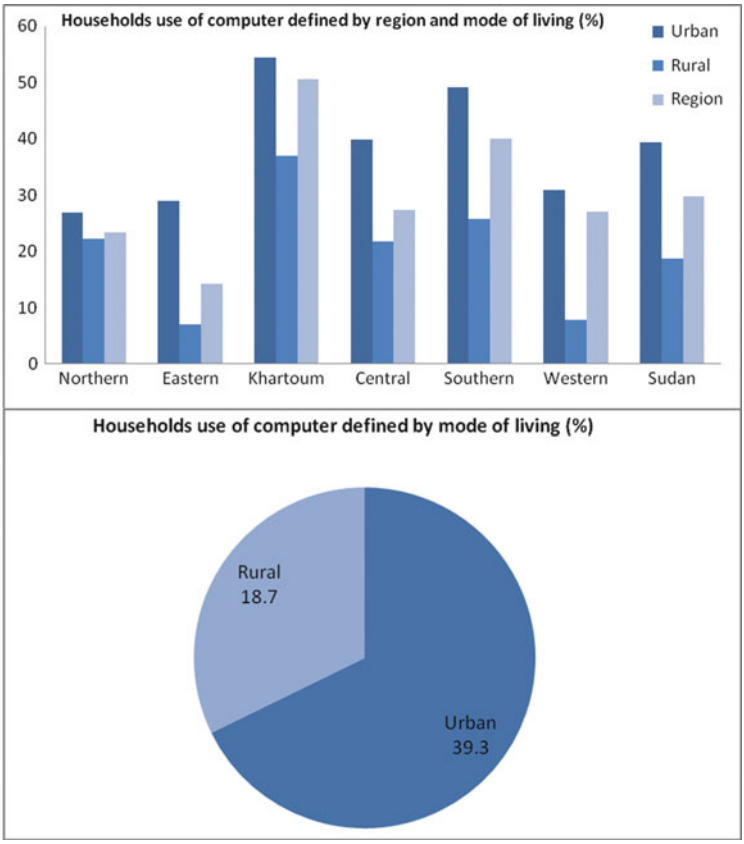

Fig. 6.7 (continued)

distribution implies that the highest proportions of individuals' with knowledge to use computer is reported in Khartoum followed by all Sudan, Southern, Central, Northern, Western, and Eastern regions respectively.[31] Proportions of individuals' with knowledge to use computer in Khartoum is more than four time higher than in Eastern regions (see Table 6.8 and Fig. 6.8).

The regional disparities in ICT indicators appear from awareness to use computer outside home as defined by the proportions of individuals use computer of total individuals with knowledge to use computer outside home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals use computer of total individuals with knowledge to use computer outside home in rural areas (68.6 %) is higher than urban areas (62.4 %) and for males (68.5 %) is higher than females (58.7 %) and total Sudan (64.4 %). The regional distribution implies that the highest proportions of individuals use computer of total individuals

[31] As reported by 41.9 %, 19.4 %, 18.3 %, 15.6 %, 14.8 %, 10.9 % and 9.2 % respectively.

Table 6.8 The proportions of individuals used computer at home and outside home defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Have the knowledge how to use computer	Mode of living	Urban	17.9	19.3	45.9	27.1	30.9	18.6	33
		Rural	13.7	3.2	23.1	11.8	13.3	8.2	10.6
	Gender	Males	16.7	11.9	47.1	19.4	25.1	11.8	23.3
		Females	12.9	6.2	36	12.4	12.1	10	15.7
	Region		14.8	9.2	41.9	15.6	18.3	10.9	19.4
Provided with computer at home	Mode of living	Urban	7.7	9.6	32.4	12.5	14	8.5	20.2
		Rural	5.4	0.8	10.4	5.8	4	1.6	4.1
	Gender	Males	7.6	4.7	31.8	9.7	9.7	3.9	12.7
		Females	4.4	3.4	24.9	5.6	4.3	2.8	8.3
	Region		6	4.1	28.6	7.4	6.9	3.4	10.5
Used a computer at home	Mode of living	Urban	93.4	93.5	95.7	95.3	93.6	94.3	95.3
		Rural	96.6	100	92.4	97.1	85.7	100	95.8
	Gender	Males	96.7	95.6	96.2	97.8	86.9	96.1	96.1
		Females	93.6	92.5	94.5	94.2	97.1	96.6	94.5
	Region		95.5	94.3	95.5	96.3	90.3	96.3	95.4
Used computer outside the home	Mode of living	Urban	53.9	55.3	58.9	71.2	76.3	74.4	62.4
		Rural	69.8	73.9	62.3	66	85.6	68.5	68.6
	Gender	Males	64.9	64.2	64.2	71.1	87.3	74.5	68.5
		Females	64.9	49.5	51.7	64.6	69.8	67.3	58.7
	Region		64.9	59.4	59.2	68.3	81.2	71.1	64.4

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

Table 6.9 Purposes of use of computer at home and outside home defined by region, mode of living and gender in Sudan during 2011

				Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
At home	For games and entertainment	Mode of living	Urban	65.8	72.4	65.2	76	82.1	75.1	68.1
			Rural	91.3	27.4	80.4	86.5	96.7	85.7	85
		Gender	Males	81.4	67.4	64	83.7	87.5	77.3	71.2
			Females	86.2	65.3	69.4	79.9	88.9	81.1	73.6
		Region		83.1	66.6	66.2	82.2	88	78.9	72.2
	To connect to the Internet	Mode of living	Urban	51.6	70.9	82.6	69.8	69.3	75.8	79
			Rural	66.7	83.6	65.1	72.4	88.9	72	72.1
		Gender	Males	61.7	73.3	83.9	74.5	80.2	73.4	79.5
			Females	62.1	71.4	78.1	66.4	71.7	75.8	74.1
		Region		61.9	72.5	81.6	71.3	77.2	74.4	77.3
	To print files	Mode of living	Urban	3.9	21.6	39.5	35.8	38	48.4	37.7
			Rural	15.8	0	22.2	52.2	28.9	29.2	38.5
		Gender	Males	10.9	15.1	41.6	47.9	36	38.9	39.8
			Females	13.8	24.5	33.9	41.5	31.3	44.8	35
		Region		12	18.8	38.5	45.4	34.3	41.4	37.9
	For educational purposes	Mode of living	Urban	62.6	76.2	68.8	72	71.7	77.8	70.1
			Rural	73.8	71.9	59.5	70.6	83.4	63.4	69.6
		Gender	Males	67	74.4	67.9	69.9	73.9	79.5	69.6
			Females	75.9	77.6	68.7	73.2	80.8	63.5	70.5
		Region		70.2	75.6	68.2	71.2	76.4	72.6	70
	To save the data	Mode of living	Urban	47.7	53	60.7	59.1	58.2	76.1	60.5
			Rural	68.4	33.6	36.2	65.8	96.7	92.6	65.3
		Gender	Males	63.6	48.8	63.5	62.9	78	85.8	64.4
			Females	58.6	53.1	52.8	63.1	65.6	77.2	57.5
		Region		61.8	50.5	59.2	63	73.6	82	61.7

(continued)

Table 6.9 (continued)

				Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
	For work-related work	Mode of living	Urban	16.8	15.2	25	22.6	18.4	32	24.1
			Rural	5.3	11	10.3	23.4	10	13.7	17.3
		Gender	Males	10.1	17.4	30	25.7	18.3	34.8	27.3
			Females	6.9	10.2	15.2	19	9.1	13.1	15.2
		Region		9	14.6	14.1	23.1	15	22.4	25.4
Outside home	For games and entertainment	Mode of living	Urban	48.1	47.2	47.5	56.9	65.6	67.4	51.9
			Rural	56.1	62.4	50.7	63.2	82.9	82	66.6
		Gender	Males	65.9	56.5	49.3	62.4	76.9	75.4	59
			Females	39	37.5	45	57.3	71.1	75	53.9
		Region		54.1	51.4	47.8	60.3	75.1	75.2	57.1
	To connect to the Internet	Mode of living	Urban	30.8	59.9	67.7	63.2	52.4	59.6	64
			Rural	40.1	54.7	44.4	54.8	48.7	50	50.3
		Gender	Males	43.3	64	69.8	64.1	54.2	59	64.2
			Females	30.5	43.7	57.2	50.5	41.3	48.9	50.8
		Region		37.7	58.5	65.4	58.6	50.3	54.4	59.2
	To print files	Mode of living	Urban	38	44.2	48.6	48	59.1	54.6	49
			Rural	23.1	27.6	26	56.1	51.7	24.1	41.1
		Gender	Males	28.1	38.1	46.1	52.4	53.4	40	46.3
			Females	25.4	43.7	46.8	52.5	58.7	36	46.2
		Region		26.9	39.6	46.3	52.4	55	38.2	46.2
	For educational purposes	Mode of living	Urban	75.9	61.2	69.1	70.9	62.6	72.7	69
			Rural	68.5	74.5	64	76.1	66.8	90.1	75.1
		Gender	Males	69.7	61.9	65	69.8	63.9	78.4	67.5
			Females	71.2	72.9	75.3	79.4	67.2	86.4	77.2
		Region		70.4	64.9	68.6	73.7	64.9	82	71.2

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

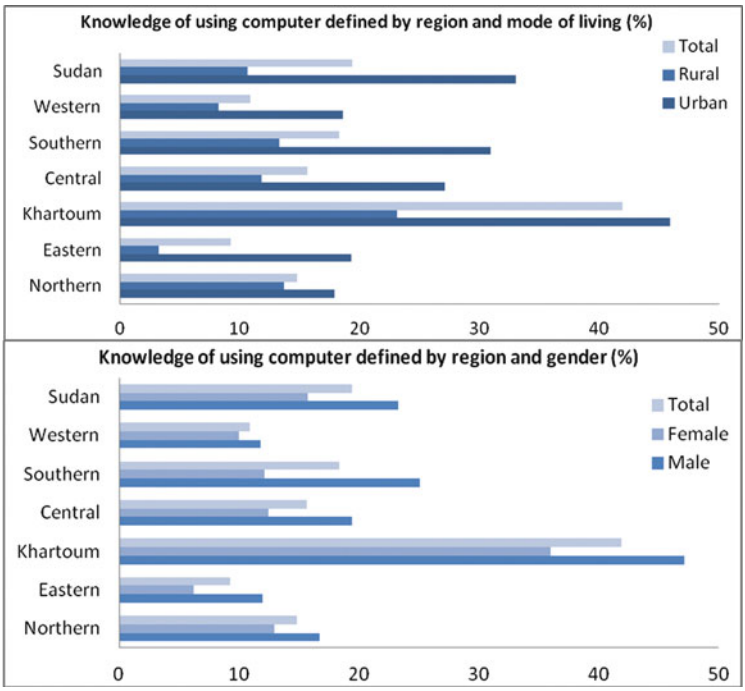

Fig. 6.8 The use of computer at home and outside home defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

with knowledge to use computer outside home is reported in Southern region followed by Western, Central, Northern, all Sudan, Eastern, and Khartoum regions respectively (see Table 6.8 and Fig. 6.8).[32]

The regional disparities in ICT indicators appear from the proportions of individuals' provided with computer at home for their use defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' provided with computer at home for their use in urban areas (20.2 %) is more than four times higher than rural areas (4.1 %) and for males (12.7 %) is higher than females (8.3 %) and total Sudan (10.5 %). The regional distribution implies that the highest proportions of individuals' provided with computer at home for their use is reported in Khartoum followed by all Sudan, Central, Southern, Northern, Eastern, and Western regions respectively.[33] Proportions of individuals' provided with computer at home in Khartoum is more than six time higher than in Eastern regions (see Table 6.8 and Fig. 6.8).

[32] As reported by 81.2 %, 71.1 %, 68.3 %, 64.9 %, 64.4 %, 59.4 %, and 59.2 % respectively.

[33] As indicated by 28.6 %, 10.5 %, 7.4 %, 6.9 %, 6 %, 4.1 %, and 3.4 % respectively.

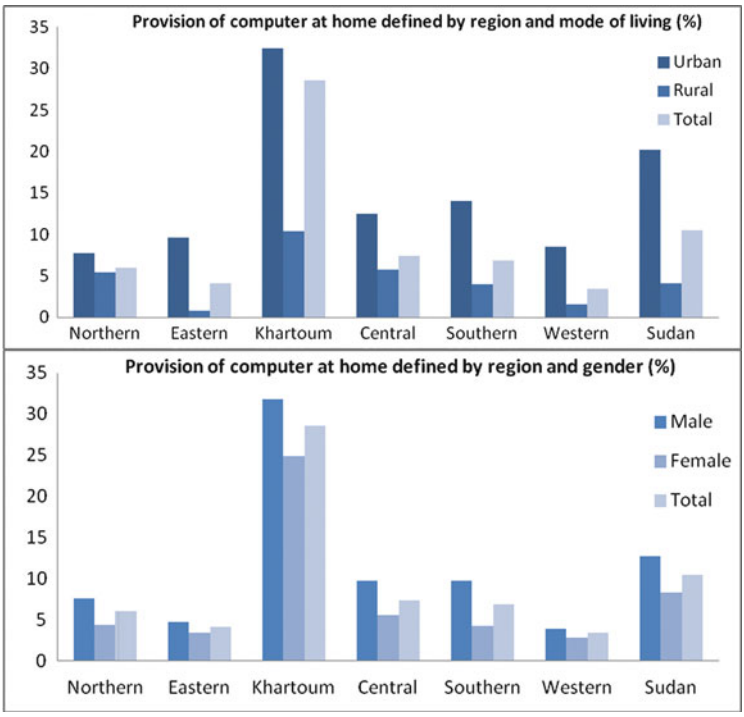

Fig. 6.8 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals use computer of total individuals with knowledge to use computer at home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals use computer of total individuals with knowledge to use computer at home in rural areas (95.8 %) is higher than urban areas (95.3 %) and for males (96.1 %) is higher than females (94.5 %) and total Sudan (95.4 %). The regional distribution implies that the highest proportions of individuals use computer of total individuals with knowledge to use computer at home is reported in Western region followed by Central, Khartoum, Northern, all Sudan, Eastern, and Southern regions respectively (see Table 6.8 and Fig. 6.8).[34]

6.3.3 Purposes of the Use of Computer

From the viewpoint of individuals in Sudan computer is widely used at home and outside home for several purposes, notably, it is widely used at home to connect to the Internet, for games and entertainment, for educational purposes, save the data,

[34] As reported by 96.3 %, 96.3 %, 95.5 %, 95.5 %, 95.4 %, and 94.3 % respectively.

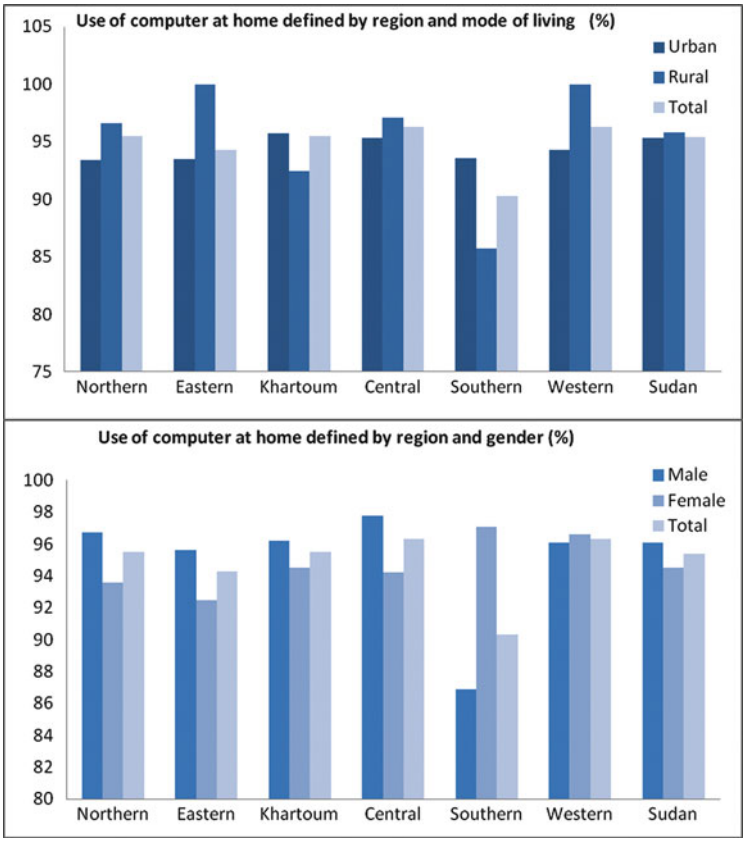

Fig. 6.8 (continued)

print files, and for work-related work respectively, in addition, for all Sudan computer is widely used outside home for educational purposes, to connect to the Internet, for games and entertainment, and to print files respectively.[35] The gender gap between males and females in ICT indicators appear from several purposes of using computer defined by gender that implies that for males and females computer is widely used at home to connect to the Internet, for games and entertainment, for educational purposes, to save the data, to print files, and for work-related work respectively, in addition, computer is widely used outside home for educational purposes, to connect to the Internet, for games and entertainment, and to print files respectively for males and females respectively (see Table 6.9 and Fig. 6.9).[36,37]

[35] As indicated by 77.3 %, 72.2 %, 70 %, 61.7 %, 37.9 % and 25.4 % respectively for at home. And as indicated by 71.2 %, 59.2 %, 57.1 % and 46.2 % respectively for outside home.

[36] As reported by 79.5 %, 71.2 %, 69.6 %, 64.4 %, 39.8 % and 27.3 % respectively at home. And as indicated by 67.5 %, 64.2 %, 59 % and 46.3 % for outside home respectively for males.

[37] As indicated by 74.1 %, 73.6 %, 70.5 %, 57.5 %, 35 % and 15.2 % respectively for females at home. And as indicated by 77.2 %, 50.8 %, 53.9 % and 46.2 % for females outside home respectively.

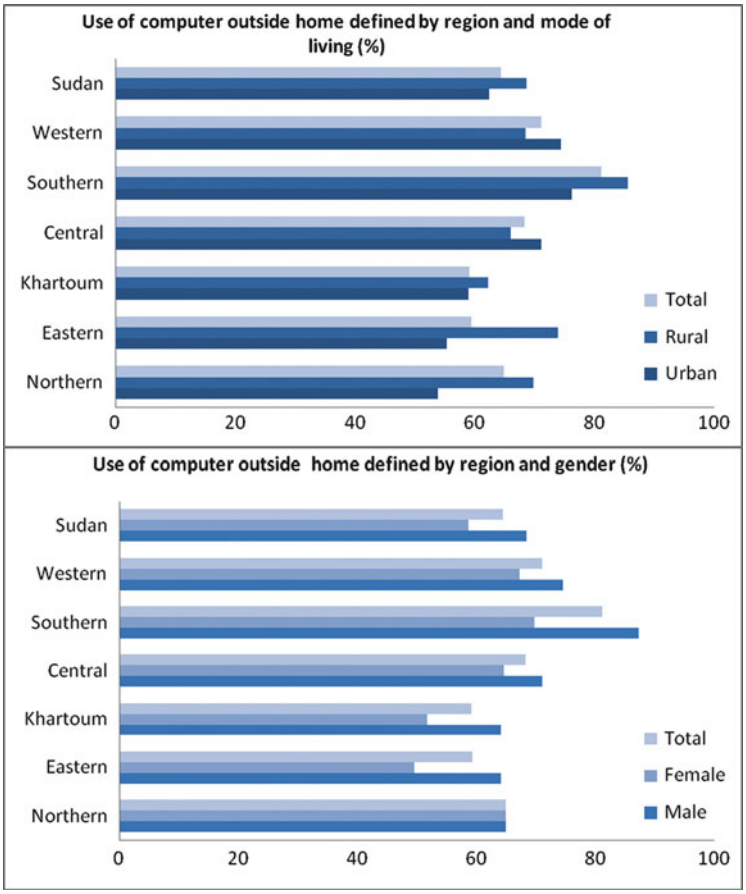

Fig. 6.8 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home for games and entertainment defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer at home for games and entertainment in rural (85 %) is higher than urban (68.1 %) and for females (73.6 %) is higher than males (71.2 %) and total Sudan (72.2 %). The regional distribution implies that the highest proportions of individuals used computer at home for games and entertainment is reported in Southern region followed by Northern, Central, Western, all Sudan, Eastern, and Khartoum regions respectively (see Table 6.9 and Fig. 6.9).[38]

The regional disparities in ICT indicators appear from the proportions of individuals used computer outside home for games and entertainment defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals

[38] As indicated by 88 %, 83.1 %, 82.2 %, 78.9 %, 72.2 %, 66.6 %, and 66.2 % respectively.

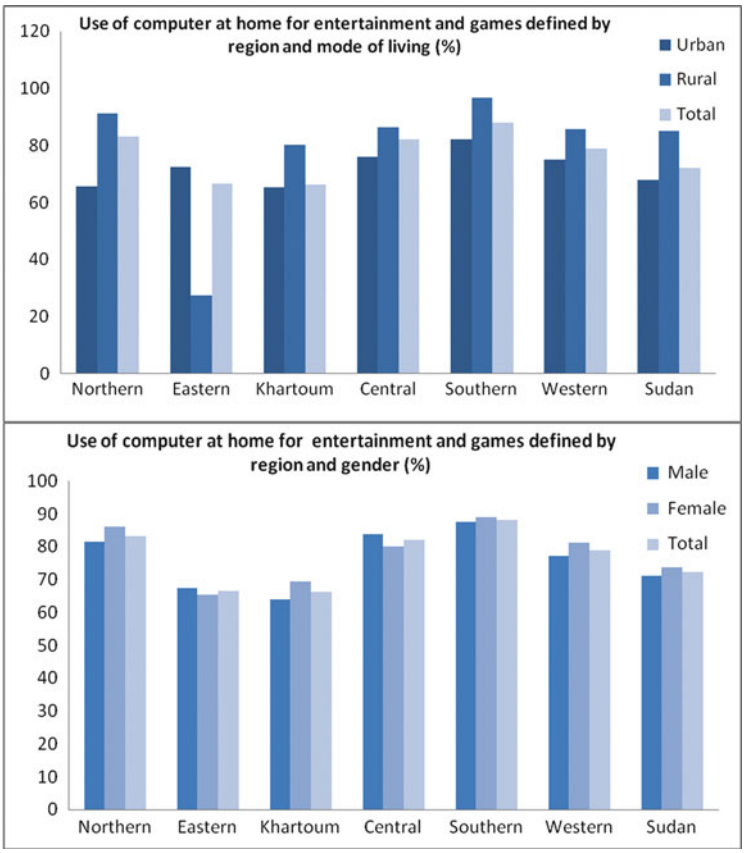

Fig. 6.9 Purposes of use of computer at home and outside home defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

used computer outside home for games and entertainment in rural (66.6 %) is higher than urban (51.9 %) and for males (59 %) is higher than females (53.9 %) and total Sudan (57.1 %). The regional distribution implies that the highest proportions of individuals used computer outside home for games and entertainment is reported in Western region followed by Southern, Central, all Sudan, Northern, Eastern, and Khartoum regions respectively (see Table 6.9 and Fig. 6.9).[39]

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home to connect to the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer at home to connect to the Internet in urban (79 %) is higher than rural

[39] As indicated by 75.2 %, 75.1 %, 60.3 %, 57.1 %, 54.1 %, 51.4 %, and 47.8 % respectively.

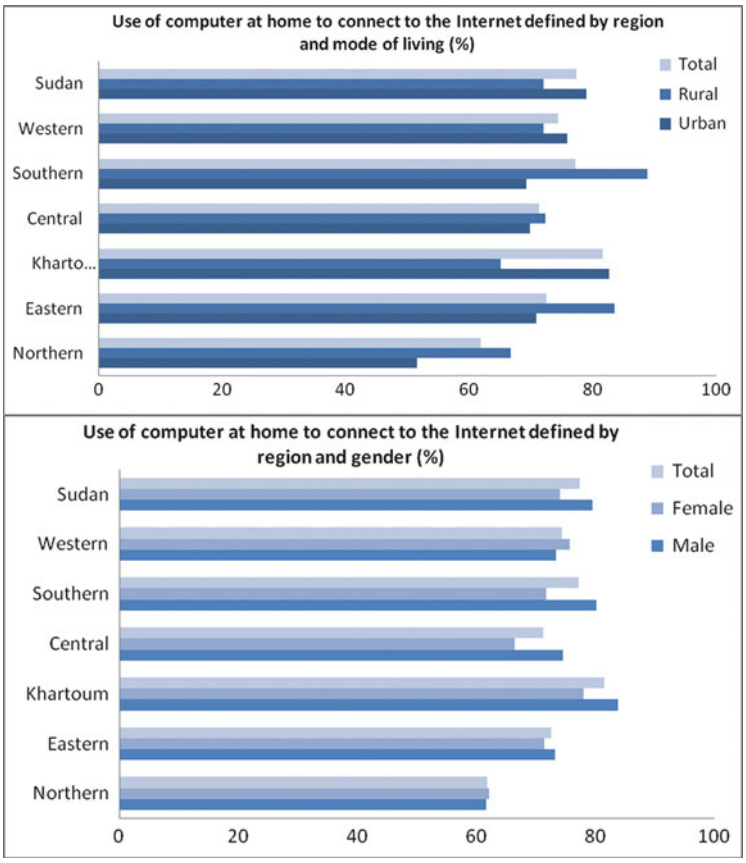

Fig. 6.9 (continued)

(72.1 %) and for males (79.5 %) is higher than females (74.1 %) and total Sudan (77.3 %). The regional distribution implies that the highest proportions of individuals used computer at home to connect to the Internet is reported in Khartoum followed by all Sudan, Southern, Western, Eastern, Central, and Northern regions respectively (see Table 6.9 and Fig. 6.9).[40]

The regional disparities in ICT indicators appear from the proportions of individuals used computer outside home to connect to the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer outside home to connect to the Internet in urban (64 %) is higher than rural (50.3 %) and for males (64.2 %) is higher than females (50.8 %) and total Sudan (59.2 %). The regional distribution implies that the highest proportions of individuals used computer outside home to connect to the Internet is reported in

[40] As reported by 81.6 %, 77.3 %, 77.2 %, 74.4 %, 72.5 %, 71.3 % and 61.9 % respectively.

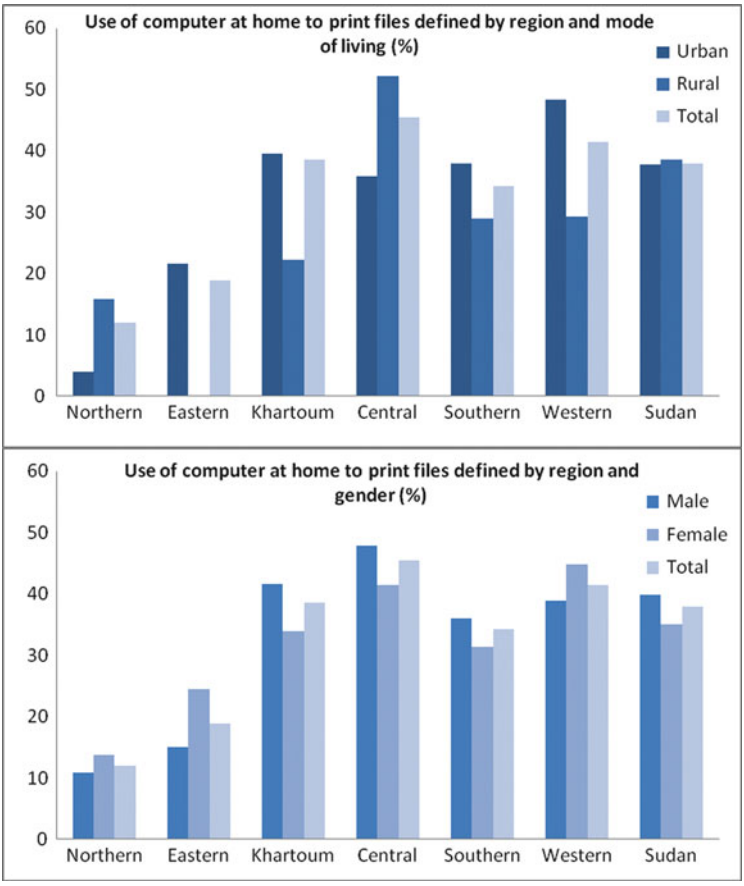

Fig. 6.9 (continued)

Khartoum followed by all Sudan, Central, Eastern, Western, Southern, and Northern regions respectively (see Table 6.9 and Fig. 6.9).[41]

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home to print files defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer at home to print files in rural (38.5 %) is higher than urban (37.7 %) and for males (39.8 %) is higher than females (35 %) and total Sudan (37.9 %). The regional distribution implies that the highest proportions of individuals used computer at home to print files is reported in Central region followed by Western, Khartoum, all Sudan, Southern, Eastern, and Northern regions respectively (see Table 6.9 and Fig. 6.9).[42]

[41] As reported by 65.4 %, 59.2 %, 58.6 %, 58.5 %, 54.4 %, 50.3 %, and 37.7 % respectively.

[42] As indicated by 45.4 %, 41.4 %, 38.5 %, 37.9 %, 34.3 %, 18.8 %, and 12 % respectively.

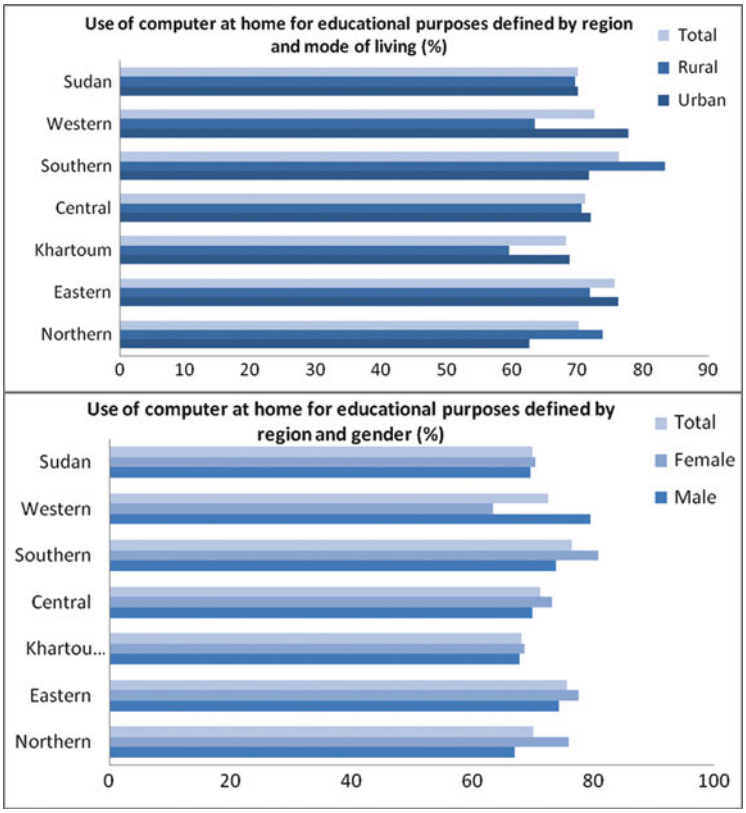

Fig. 6.9 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used computer outside home to print files defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer outside home to print files in urban (49 %) is higher than rural (41.1 %) and for males (46.3 %) is higher than females (46.2 %) and total Sudan (46.2 %). The regional distribution implies that the highest proportions of individuals used computer outside home to print files is reported in Southern region followed by Central, Khartoum, all Sudan, Eastern, Western, and Northern regions respectively (see Table 6.9 and Fig. 6.9).[43]

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home for educational purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer at home for educational purposes in urban (70.1 %) is higher than rural (69.6 %) and for females (70.5 %) is slightly higher than males (69.6 %) and total

[43] As indicated by 55 %, 52.4 %, 46.3 %, 46.2 %, 39.6 %, 38.2 %, and 26.9 % respectively.

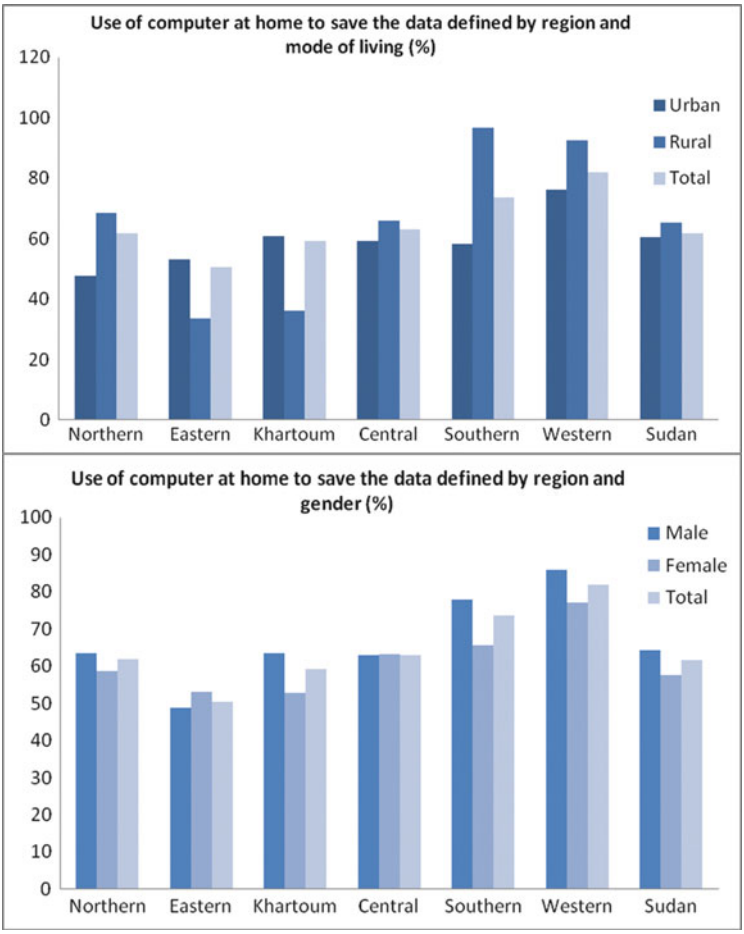

Fig. 6.9 (continued)

Sudan (70 %). This result implies that the use of computer at home is useful to help to increase educational attainment for females and therefore can be used to reduce the gender gap in educational attainment between males and females in Sudan. The regional distribution implies that the highest proportions of individuals used computer at home for educational purposes is reported in Southern region followed by Eastern, Western, Central, Northern, all Sudan, and Khartoum regions respectively (see Table 6.9 and Fig. 6.9).[44]

The regional disparities in ICT indicators appear from the proportions of individuals used computer outside home for educational purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals

[44] As reported by 76.4 %, 75.6 %, 72.6 %, 71.2 %, 70.2 %, 70 %, and 68.2 % respectively.

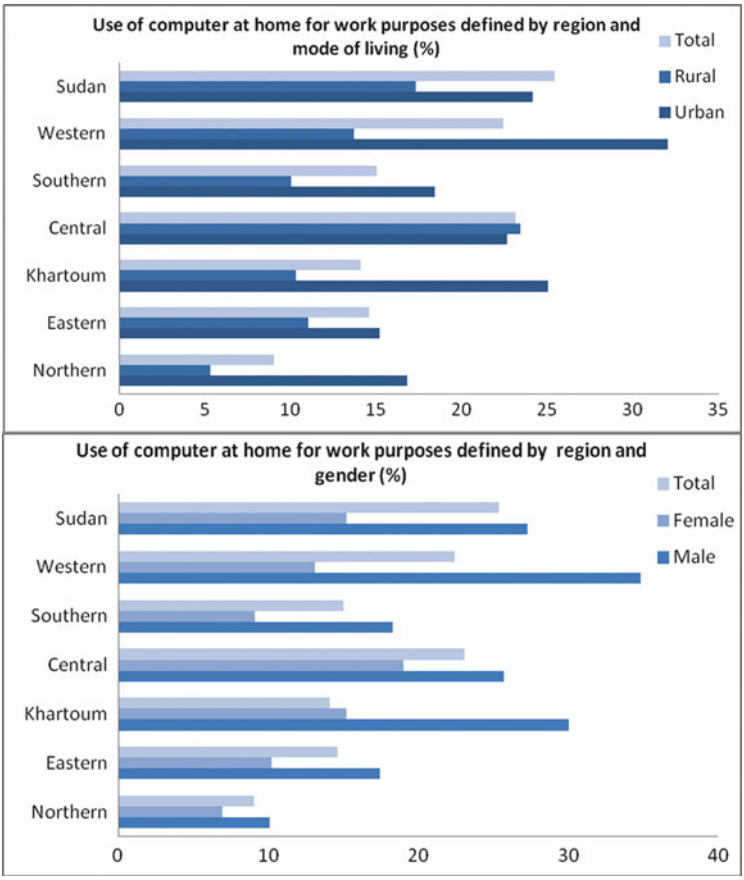

Fig. 6.9 (continued)

used computer outside home for educational purposes in rural (75.1 %) is higher than urban (69 %) and for females (77.2 %) is higher than males (67.5 %) and total Sudan (71.2 %). This result implies that the use of computer outside home is useful to help to increase educational attainment for rural areas and therefore can be used to reduce the regional disparity in educational attainment between urban and rural areas in Sudan. This result also implies that the use of computer outside home is useful to help to increase educational attainment for females and therefore can be used to reduce the gender gap in educational attainment between males and females in Sudan. The regional distribution implies that the highest proportions of individuals used computer outside home for educational purposes is reported in Western region followed by Central, all Sudan, Northern, Khartoum, Southern, and Eastern regions respectively (see Table 6.9 and Fig. 6.9).[45]

[45] As reported by 82 %, 73.7 %, 71.2 %, 70.4 %, 68.6 %, 64.9 %, and 64.9 % respectively.

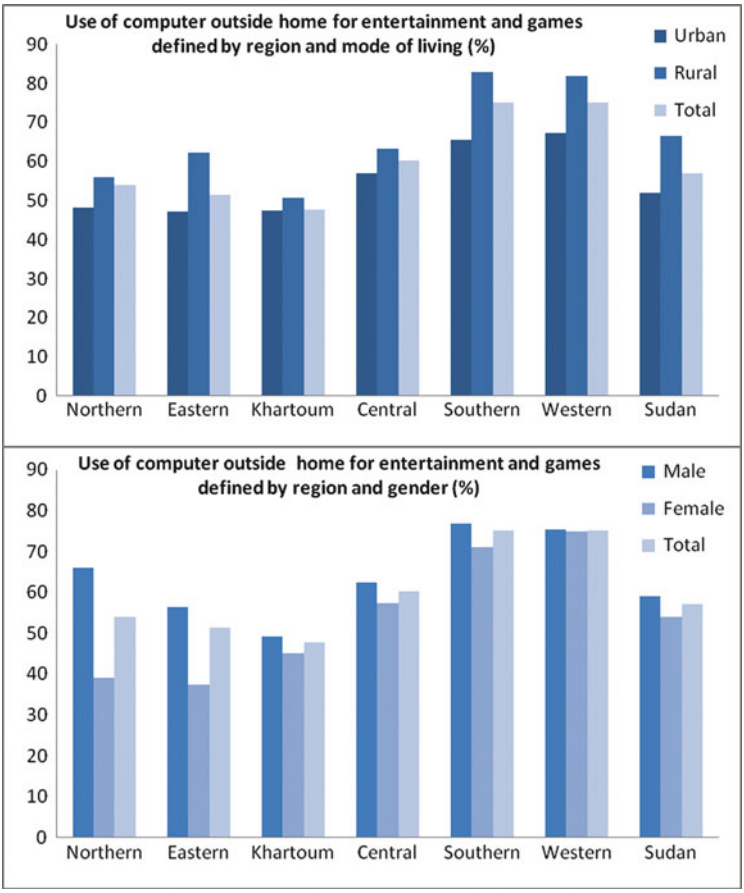

Fig. 6.9 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home to save the data defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used computer at home to save the data in rural (65.3 %) is higher than urban (60.5 %) and for males (64.4 %) is higher than females (57.5 %) and total Sudan (61.7 %). The regional distribution implies that the highest proportions of individuals used computer at home to save the data is reported in Western region followed by Southern, Central, Northern, all Sudan, Khartoum, and Eastern regions respectively.[46]

The regional disparities in ICT indicators appear from the proportions of individuals used computer at home for work-related work defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used

[46] As indicated by 82 %, 73.6 %, 63 %, 61.8 %, 61.7 %, 59.2 %, and 50.5 % respectively.

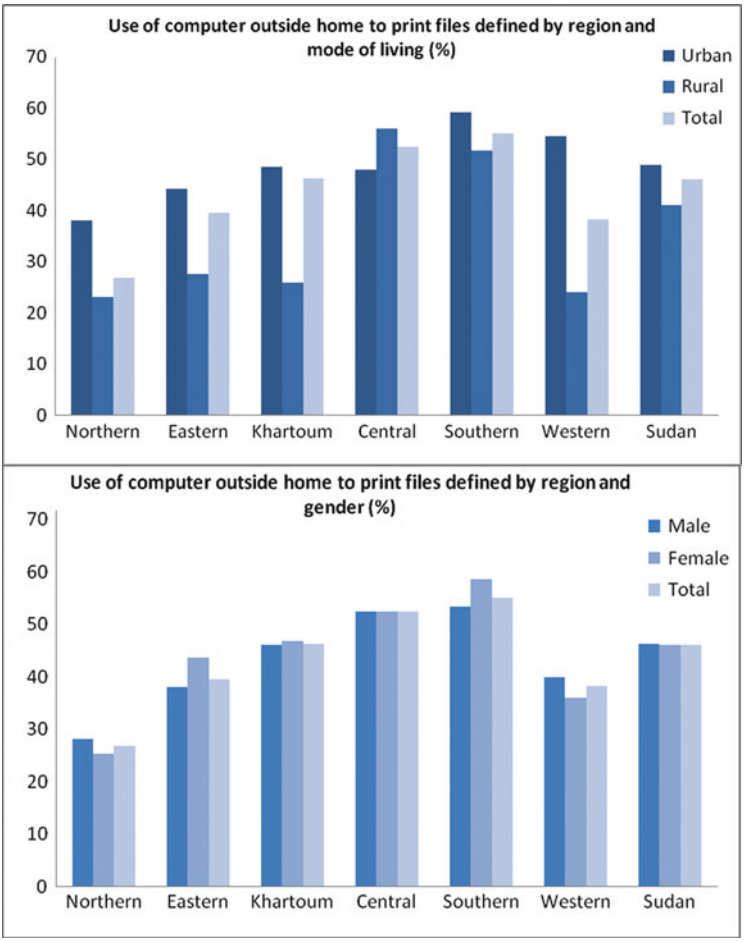

Fig. 6.9 (continued)

computer at home for work-related work in urban (24.1 %) is higher than rural (17.3 %) and for males (27.3 %) is higher than females (15.2 %) and total Sudan (25.4 %). The regional distribution implies that the highest proportions of individuals used computer at home for work-related work is reported in all Sudan followed by Central, Western, Southern, Eastern, Khartoum, and Northern regions respectively (see Table 6.9 and Fig. 6.9).[47]

[47] As indicated by 25.4 %, 23.1 %, 22.4 %, 15 %, 14.6 %, 14.1 %, and 9 % respectively.

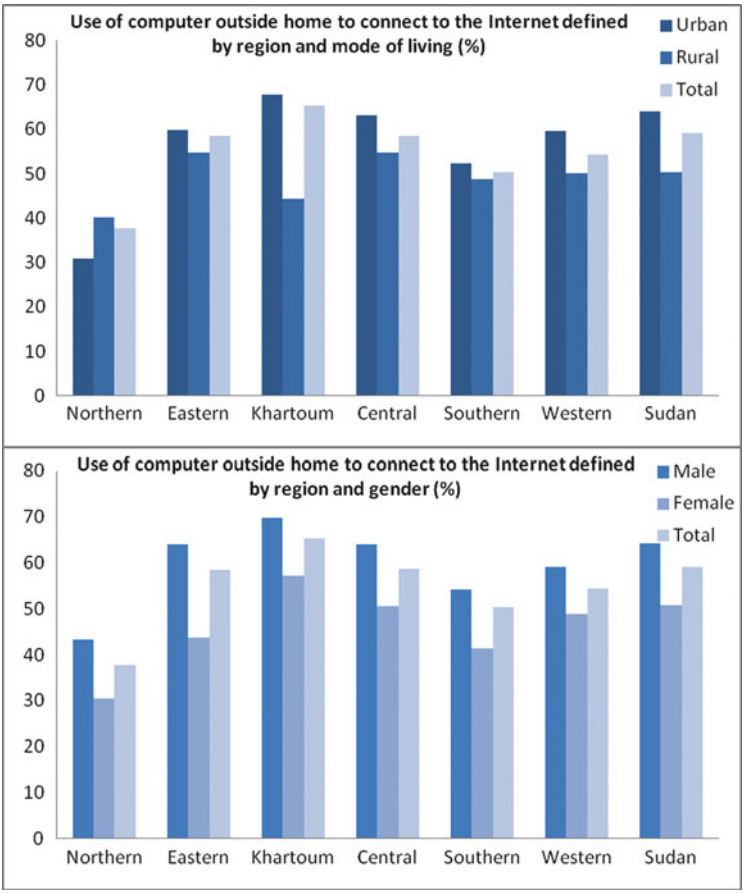

Fig. 6.9 (continued)

6.3.4 Impediment Factors Impeded the Use of Computer

From the viewpoint of individuals, several impediment factors impeded the use of computer at home and outside home. Regarding the factors that hindered the use of computer, Table 6.10 explains that the proportions of individuals to use computer at home and outside home are impeded by impediment factors such as the lack of electricity, the presence of inhibitors related to health reasons, the lack of desire, and for other reasons at home and outside home defined by region, mode of living and gender (see Table 6.10 and Fig. 6.10).

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer at home for the lack of electricity of total who did not use computer at home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer at home for the lack of electricity of total who did not use computer at home in rural (32.1 %) is near

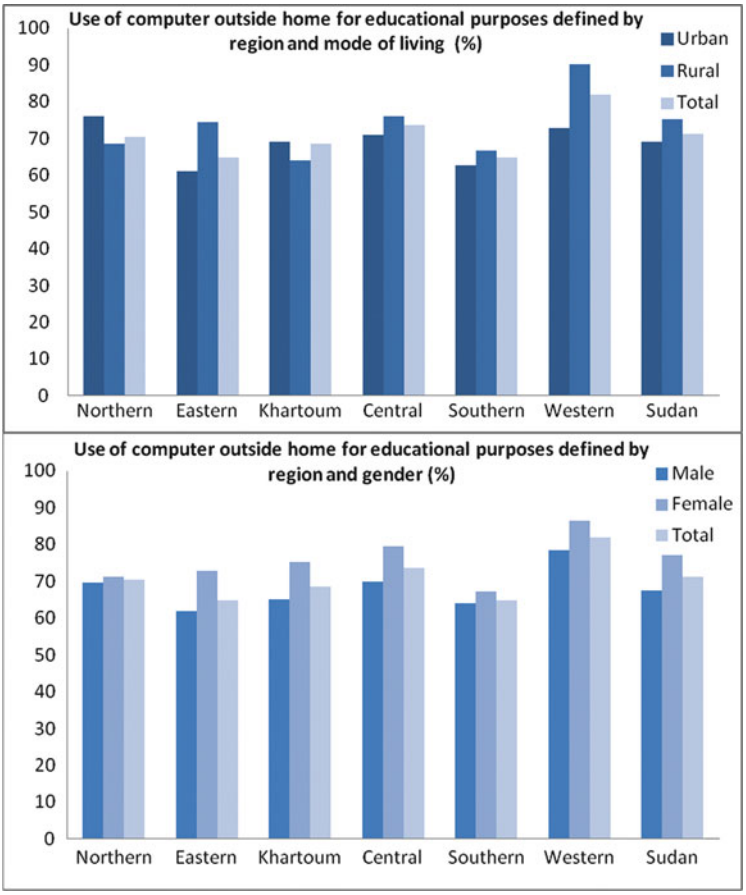

Fig. 6.9 (continued)

to twice/higher than urban (16.4 %) and for males (27.9 %) is more than double/higher than females (11.4 %) and total Sudan (19.9 %). The regional distribution implies that the highest proportions of individuals who did not use computer at home for the lack of electricity of total who did not use computer at home is reported in Southern region followed by Eastern, Western, all Sudan, Khartoum, Central, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[48]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer at home for the presence of inhibitors related to health reasons of total who did not use computer at home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer at home for the presence of inhibitors related to health reasons of total who did not use computer at home in urban (8.7 %) is higher than rural

[48] As reported by 54.4 %, 35.3 %, 33.2 %, 19.9 %, 14.7 %, 14.3 %, and 0 % respectively.

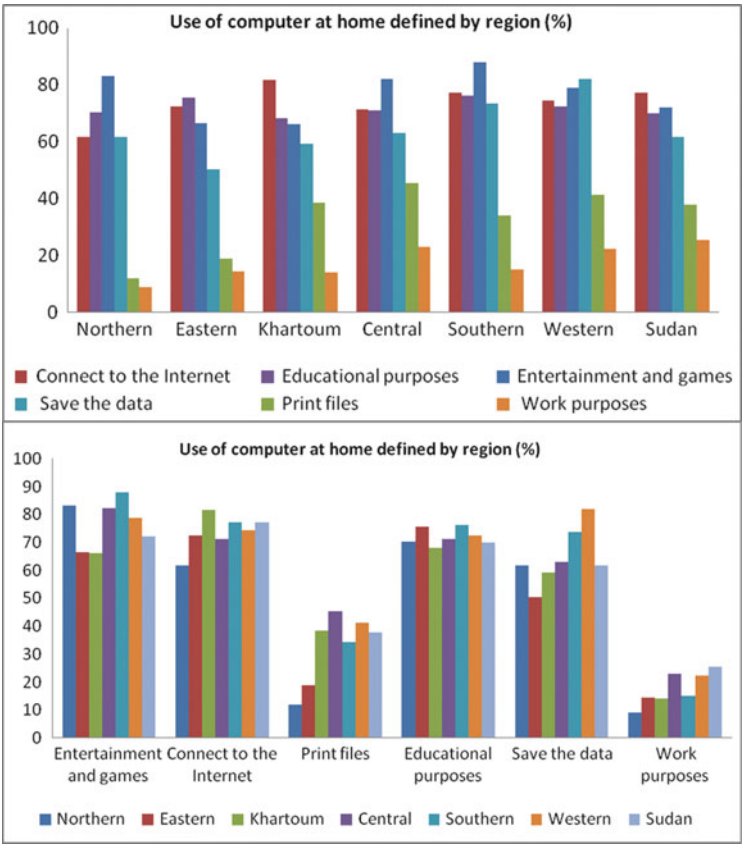

Fig. 6.9 (continued)

(0 %) and for females (7.3 %) is higher than males (6.3 %) and total Sudan (6.8 %). The regional distribution implies that the highest proportions of individuals who did not use computer at home for the presence of inhibitors related to health reasons of total who did not use computer at home is reported in Northern region followed by Western, Khartoum, all Sudan, Southern, Central, and Eastern regions respectively (see Table 6.10 and Fig. 6.10).[49]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer at home for the lack of desire of total who did not use computer at home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer at home for the lack of desire of total who did not use computer at home in urban (27.9 %) is more than twice/higher than rural (13.9 %) and for females (34.6 %) is more than double/higher than males (15.7 %) and total Sudan (24.9 %). The regional distribution

[49] As indicated by 26.6 %, 26.1 %, 7.3 %, 6.8 %, 3.2 %, 0 %, and 0 % respectively.

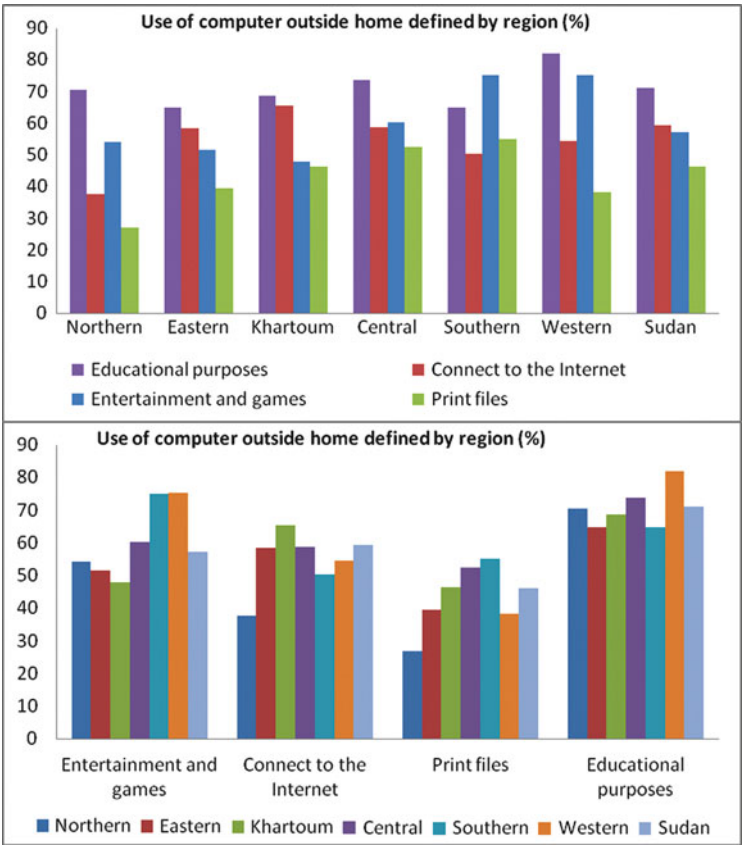

Fig. 6.9 (continued)

implies that the highest proportions of individuals who did not use computer at home for the lack of desire of total who did not use computer at home is reported in Khartoum followed by Western, all Sudan, Central, Southern, Eastern, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[50]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer outside home for the lack of desire of total who did not use computer outside home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' who did not use computer outside home for the lack of desire of total who did not use computer outside home in urban (20.7 %) is higher than rural (18.2 %) and for males (20.7 %) is higher than females (19.2 %) and total Sudan (20 %). The regional distribution implies that the highest proportions of individuals who did not use computer outside home for the lack of desire of total who did not use a computer outside home is reported in

[50] As reported by 31.6 %, 30.1 %, 24.9 %, 22.8 %, 12.8 %, 0 %, and 0 % respectively.

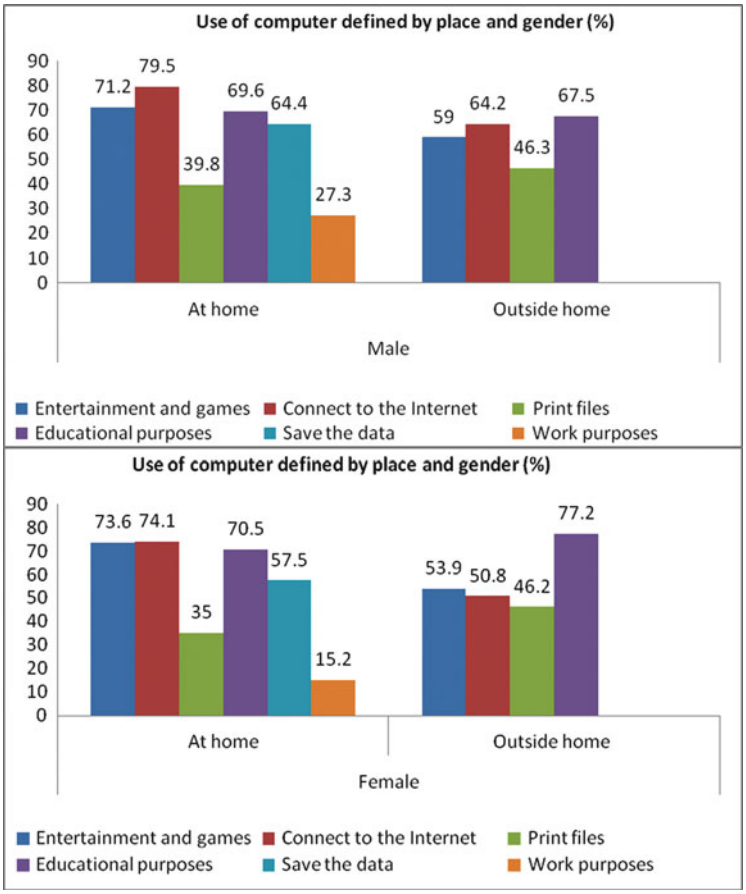

Fig. 6.9 (continued)

Southern region followed by Western region, Eastern, all Sudan, Khartoum, Central, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[51]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer outside home for high value of rent of computer of total who did not use computer outside home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' who did not use computer outside home for high value of rent of computer of total who did not use computer outside home in urban (12.6 %) is higher than rural (9.4 %) and for males (12.7 %) is higher than females (10.5 %) and total Sudan (11.7 %). The regional distribution implies that the highest proportions of individuals who did not use computer outside home for high value of rent of computer of total who did not use computer outside home is reported in Southern region followed by Eastern, all

[51] As indicated by 30.7 %, 28.7 %, 25.1 %, 20 %, 20 %, 14.7 %, and 14 % respectively.

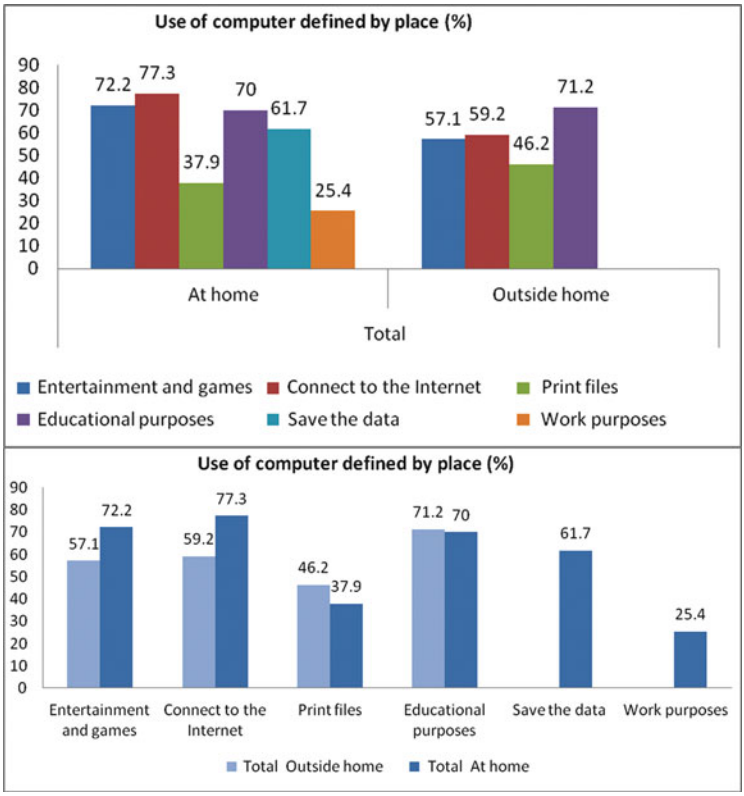

Fig. 6.9 (continued)

Sudan, Central, Khartoum, Western, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[52]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer outside home for the lack of need of total who did not use a computer outside home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer outside home for the lack of need of total who did not use computer outside home in rural (36.6 %) is higher than urban (35.5 %) and for females (41.9 %) is higher than males (30.3 %) and total Sudan (35.9 %). The regional distribution implies that the highest proportions of individuals who did not use computer outside home for the lack of need of total who did not use computer outside home is reported in Northern region followed by Western, Eastern, Southern, all Sudan, Khartoum, and Central regions respectively (see Table 6.10 and Fig. 6.10).[53]

[52] As reported by 27.4 %, 24.5 %, 11.7 %, 10.8 %, 10.7 %, 7.8 %, and 1.4 % respectively.

[53] As indicated by 51.1 %, 45 %, 45 %, 41.8 %, 35.9 %, 35.5 %, and 25.6 % respectively.

Table 6.10 Factors limit the use of computer at home and outside home defined by region, mode of living and gender in Sudan during 2011

				Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Did not use a computer at home	For lack of electricity	Mode of living	Urban	0	35.3	16.4	0	9	33.2	16.4
			Rural	0	0	0	30.9	80	0	32.1
		Gender	Males	0	75	15.9	23.2	58.5	35.3	27.9
			Females	0	0	13.5	9.3	0	30	11.4
		Region		0	35.3	14.7	14.3	54.4	33.2	19.9
	For the presence of inhibitors related to health reasons	Mode of living	Urban	54.7	0	8.2	0	9	26.1	8.7
			Rural	0	0	0	0	0	0	0
		Gender	Males	0	0	7.9	0	3.5	23.5	6.3
			Females	49.9	0	6.7	0	0	30	7.3
		Region		26.6	0	7.3	0	3.2	26.1	6.8
	For the lack of desire	Mode of living	Urban	0	0	33.7	31.6	0	30.1	27.9
			Rural	0	0	14.6	12.7	20	0	13.9
		Gender	Males	0	0	19.8	8.9	13.7	23.5	15.7
			Females	0	0	43.5	30.8	0	40	34.6
		Region		0	0	31.6	22.8	12.8	30.1	24.9
	For other reasons	Mode of living	Urban	45.3	64.8	69.8	62.1	82	77	68.7
			Rural	48.1	0	70.9	69.1	40	0	60.3
		Gender	Males	100	25	76.2	67.9	51.8	88.2	69.5
			Females	0	100	63.5	63.9	100	60	64
		Region		46.8	64.8	69.9	65.3	55.1	77	66.9

(continued)

Table 6.10 (continued)

				Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Did not use a computer outside home	For the lack of desire	Mode of living	Urban	22	20.5	20.2	16.5	20.3	38.5	20.7
			Rural	8.8	52.6	17.9	13.5	46	22.2	18.2
		Gender	Males	15.3	26.8	20.1	15.4	18.1	37.8	20.7
			Females	12.5	22.5	19.9	13.8	40.7	20.5	19.2
		Region		14	25.1	20	14.7	30.7	28.7	20
	For the high value of the total rent of computer	Mode of living	Urban	0	26.8	10.4	15.6	14.8	12.9	12.6
			Rural	2.3	10.9	13.8	7.8	46	4.4	9.4
		Gender	Males	0	23.2	12.5	12.1	18.1	11.3	12.7
			Females	3.1	26.5	8.8	9.4	34.8	4.6	10.5
		Region		1.4	24.5	10.7	10.8	27.4	7.8	11.7
	For the lack of need	Mode of living	Urban	46.8	44.6	33.4	33.9	40.3	42.5	35.5
			Rural	54	47.4	57.6	20.3	44	46.6	36.6
		Gender	Males	42	45.1	30.1	22.2	40.3	26.5	30.3
			Females	62.5	44.9	41.5	29.3	43	61.6	41.9
		Region		51.1	45	35.5	25.6	41.8	45	35.9
	For other reasons	Mode of living	Urban	34.1	36.1	74.8	54.9	70.5	57	66.5
			Rural	35.1	32.1	65.6	64.3	80	40.3	56.6
		Gender	Males	42.5	29.3	144.1	68.8	62.5	54.3	64.6
			Females	25	44.9	212.2	51.6	83.7	40.5	62.5
		Region		34.7	35.6	174.9	60.6	74.4	47	63.6

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

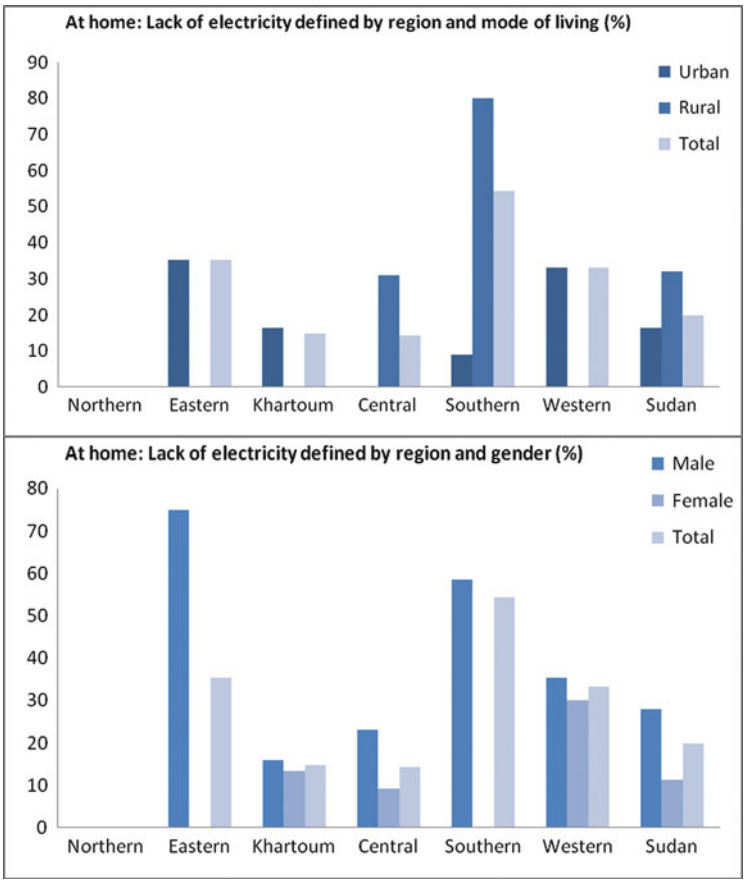

Fig. 6.10 Factors limit the use of computer at home and outside home defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer at home for other reasons of total who did not use computer at home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer at home for other reasons of total who did not use computer at home in urban (68.7 %) is higher than rural (60.3 %) and for males (69.5 %) is higher than females (64 %) and total Sudan (66.9 %). The regional distribution implies that the highest proportions of individuals who did not use computer at home for other reasons of total who did not use computer at home is reported in Western region followed by Khartoum, all Sudan, Central, Eastern, Southern, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[54]

[54] As indicated by 77 %, 69.9 %, 66.9 %, 65.3 %, 64.8 %, 55.1 %, and 46.8 % respectively.

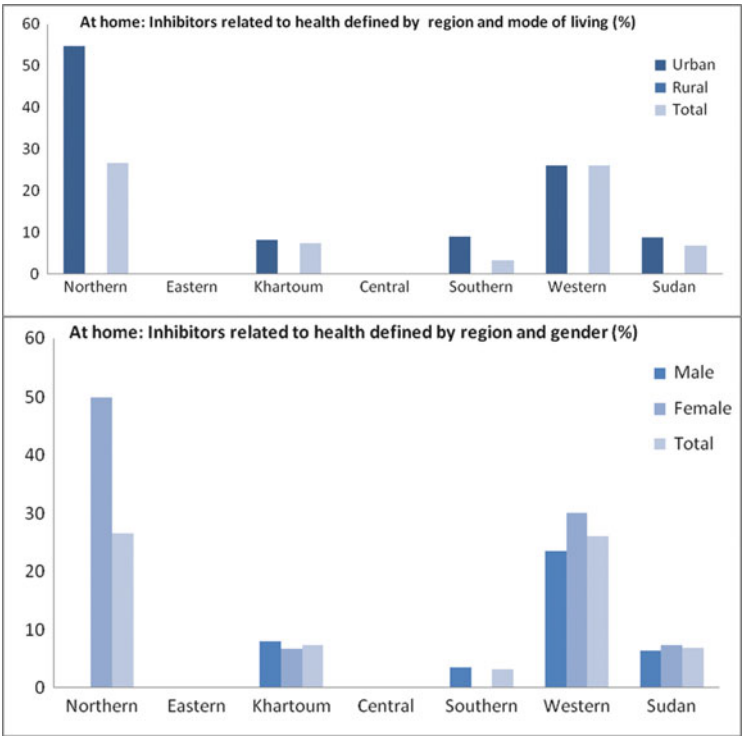

Fig. 6.10 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals who did not use computer outside home for other reasons of total who did not use computer outside home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use computer outside home for other reasons of total who did not use computer outside home in urban (66.5 %) is higher than rural (56.6 %) and for males (64.6 %) is higher than females (62.5 %) and total Sudan (63.6 %). The regional distribution implies that the highest proportions of individuals who did not use computer outside home for other reasons of total who did not use computer outside home is reported in Khartoum followed by Southern, all Sudan, Central, Western, Eastern, and Northern regions respectively (see Table 6.10 and Fig. 6.10).[55]

[55] As reported by 74.9 %, 74.4 %, 63.6 %, 60.6 %, 47 %, 35.6 %, and 34.7 % respectively.

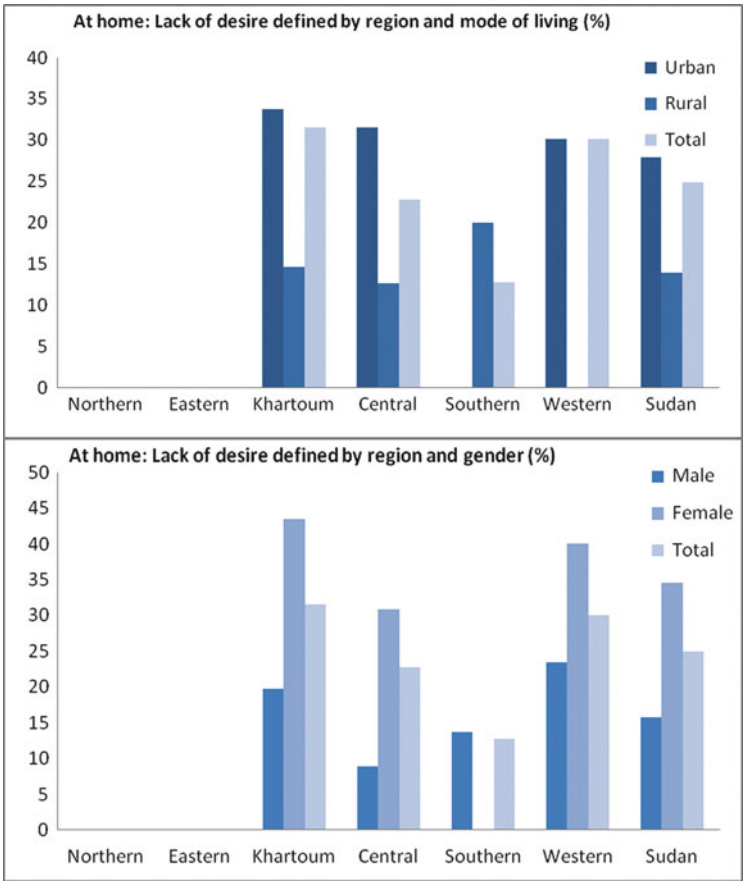

Fig. 6.10 (continued)

6.4 The Use of Internet and Digital Divide in Sudan

This section investigates the use of Internet and digital divide in Sudan and shows evidences on the occurrence of the digital divide for households and individuals in terms of access, use, average spending on the Internet per month, awareness and knowledge to use Internet, locations and purposes of use of Internet defined by mode of living gender, and region.

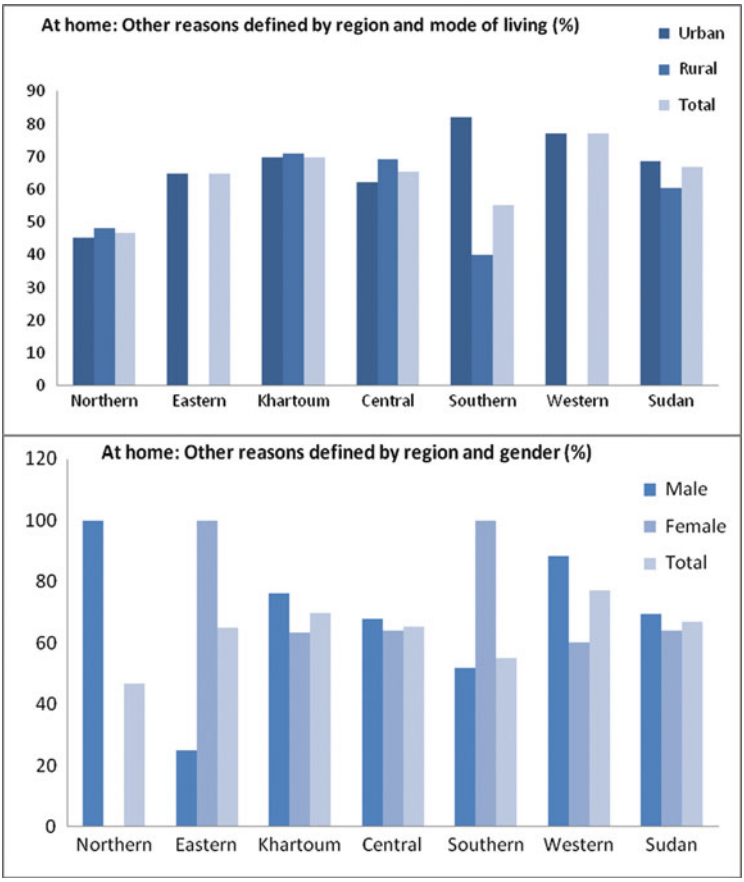

Fig. 6.10 (continued)

6.4.1 Pattern of Access to and Spending on the Internet by Households

Concerning households' access to the Internet, Tables 6.11 and 6.12 explains the proportions of households with access to the Internet, pattern of households' access to the Internet from home, and households and individuals average spending on fixed telephone, Internet mobile per month, defined by region and mode of living.

The regional disparities in ICT indicators appear from proportions of households' access to the internet defined by region and mode of living in Sudan. That implies that households' access to the internet in urban (37.4 %) is near to twice higher than rural (20.1 %) and total Sudan (29.3 %). The regional distribution implies that the highest access to the internet is reported in Khartoum followed by

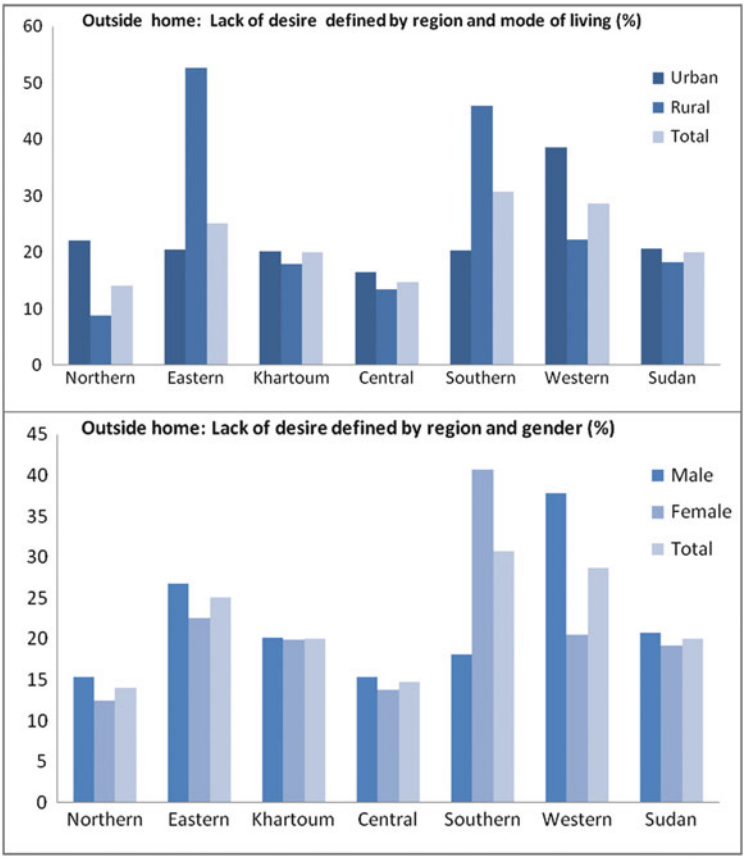

Fig. 6.10 (continued)

Southern, all Sudan, Central, Western, Northern, and Eastern regions respectively.[56] The regional distribution implies that the highest access to the internet in Khartoum (49.4 %) is more than three time higher than in Eastern (14.8 %) region (see Table 6.11 and Fig. 6.11).

The regional disparities in ICT indicators appear from households' average spending on the Internet per month defined by region and mode of living in Sudan. That implies that households' average spending on the Internet per month in urban areas (30 %) is similar to total Sudan (30 %) and both are higher than rural areas (20 %). The regional distribution implies that the highest households' average spending on the Internet per month is reported in Khartoum followed by all Sudan, Western, Eastern, Central, Northern, and Southern regions respectively (see Table 6.11 and Fig. 6.11).[57]

[56] As reported by 49.4 %, 40 %, 29.3 %, 29 %, 25.4 %, 16.9 % and 14.8 % respectively.

[57] As reported by 30 %, 30 %, 30 %, 30 %, 23 %, 21.5 % and 20 % respectively.

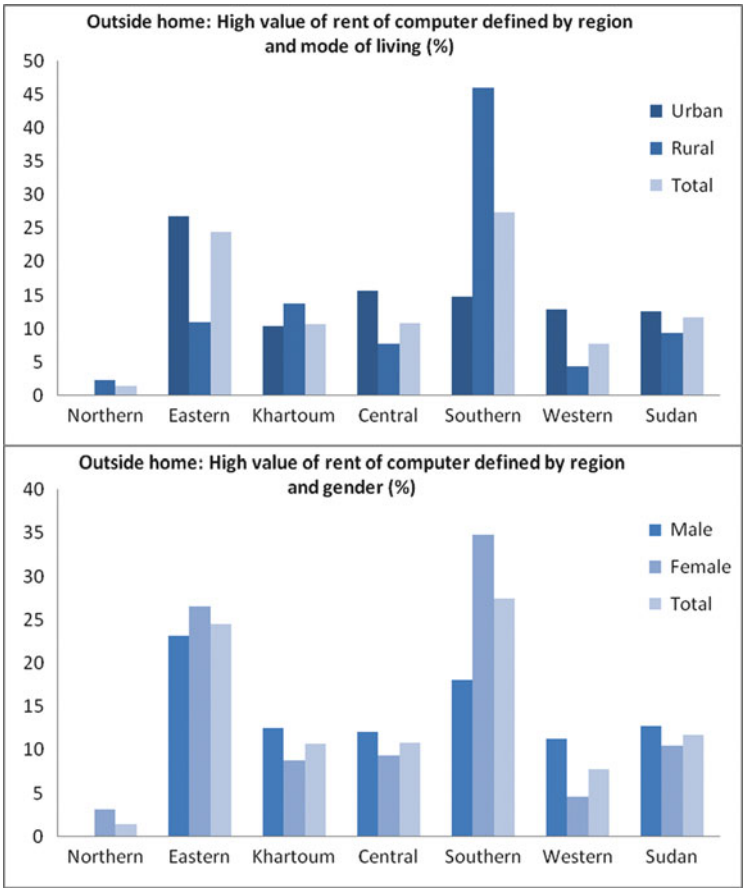

Fig. 6.10 (continued)

6.4.2 Knowledge and Use of the Internet by Individuals

Concerning individual's use of the Internet, Table 6.12 explains proportions of individuals with knowledge to use the Internet, used the Internet, the languages used for using the Internet, the methods for connection to the Internet, places for using the Internet and the purposes of the use of the Internet defined by region, mode of living and gender (see Table 6.12 and Fig. 6.12).

The regional disparities in ICT indicators appear from awareness to use the Internet as defined by the proportions of individuals' with knowledge to use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' with knowledge to use the Internet in urban areas

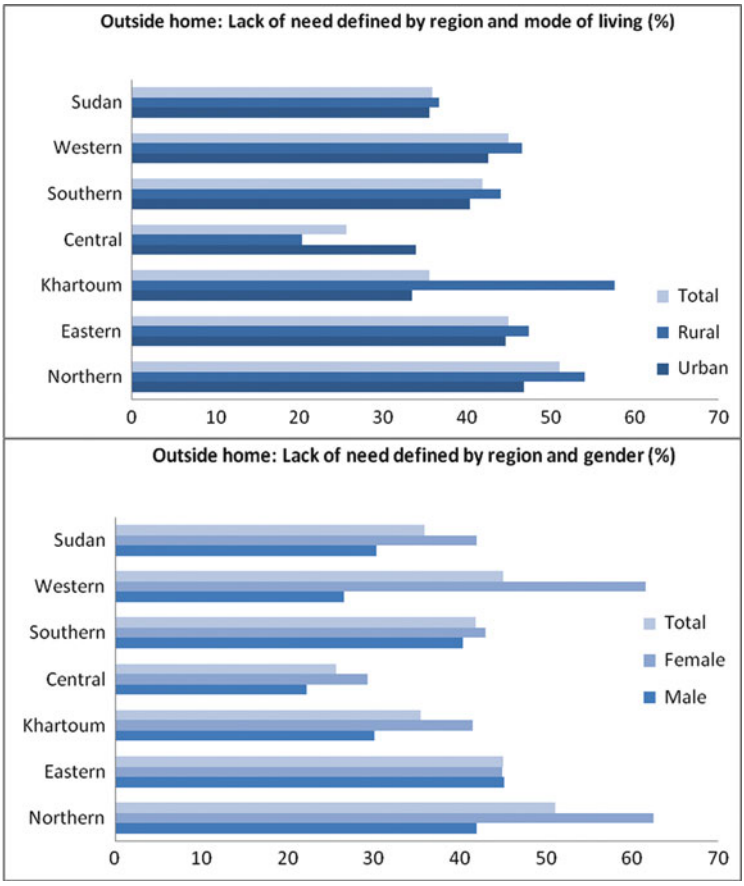

Fig. 6.10 (continued)

(29.1 %) is more than three times higher than rural areas (9.6 %) and for males (22.5 %) is nearly twice higher than females (12.3 %) and total Sudan (17.3 %). The regional distribution implies that the highest proportions of individuals' with knowledge to use the Internet is reported in Khartoum followed by Southern region, all Sudan, Central, Northern, Eastern, and Western regions respectively.[58] The regional disparity in terms of awareness to use the Internet as defined by the proportions of individuals' with knowledge to use the Internet is evidenced from the highest proportions in Khartoum, which is more than twice the proportions in all Sudan, Southern and Central regions, more than three times in Northern, more than

[58] As reported by 37 %, 17.6 %, 17.3 %, 15.5 %, 10.7 %, 9 %, and 7.2 % respectively.

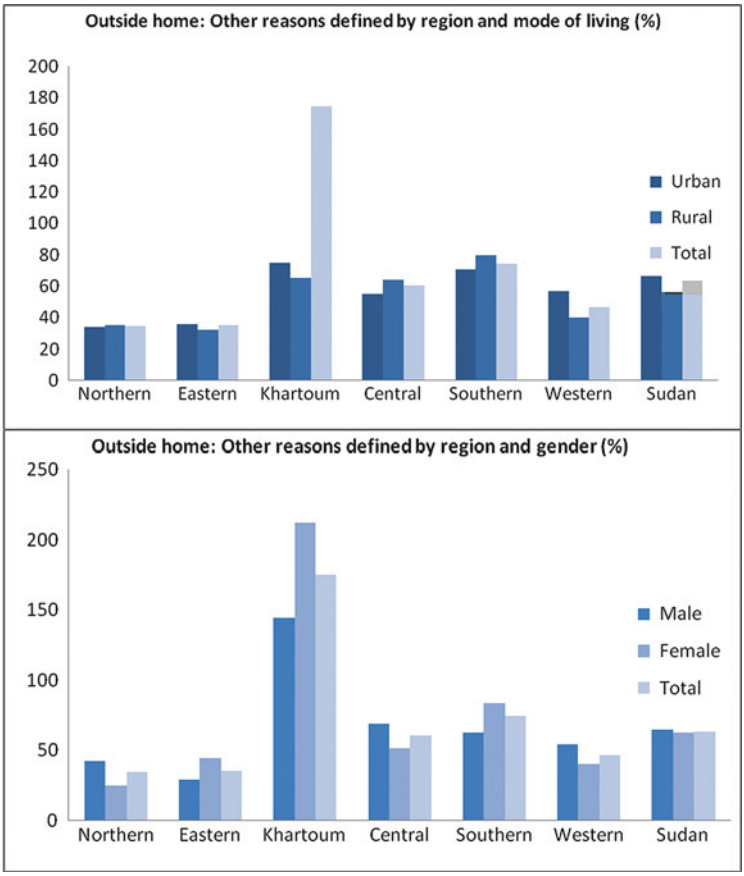

Fig. 6.10 (continued)

four times in Eastern, and more than five times in Western regions respectively (see Table 6.12 and Fig. 6.12).

The regional disparities in ICT indicators appear from the use of the Internet as defined by the proportions of individuals use the Internet of total individuals with knowledge to use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet of total individuals with knowledge to use the Internet in urban areas (94.8 %) is higher than rural areas (94.2 %) and for males (95.1 %) is higher than females (93.8 %) and total Sudan (94.6 %). The regional distribution implies that the highest proportions of individuals used the Internet of total individuals with knowledge to use the Internet is reported in Western region followed by Khartoum, all Sudan, Southern,

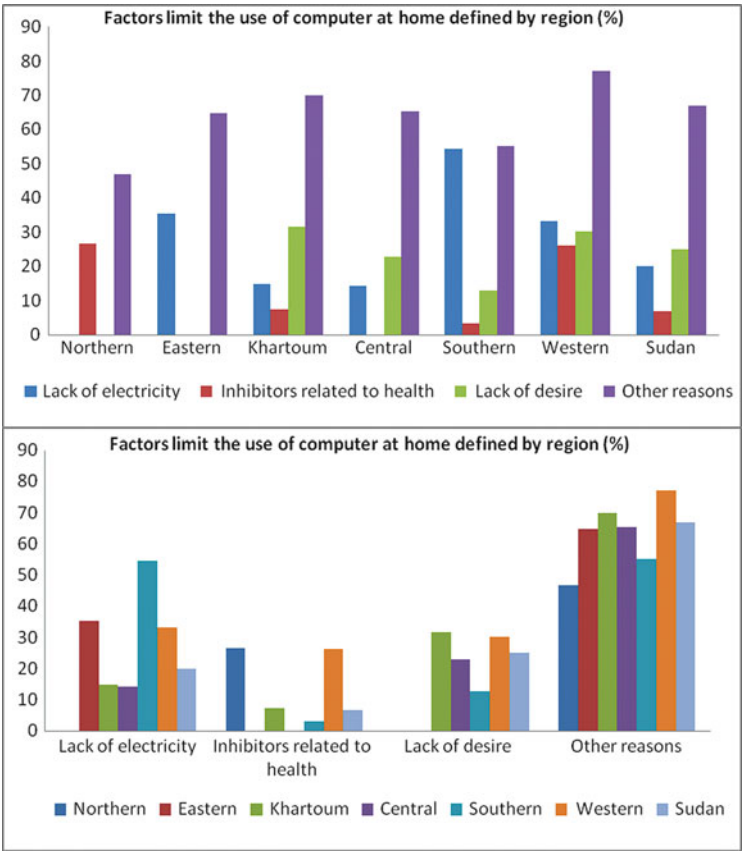

Fig. 6.10 (continued)

Central, Eastern, and Northern regions respectively (see Table 6.12 and Fig. 6.12).[59]

The regional disparities in ICT indicators appear from the proportions of individuals' have E-mail defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' have E-mail in urban areas (58.3 %) is more than four times higher than rural areas (39.8 %) and for males (57.5 %) is higher than females (50.5 %) and total Sudan (55 %). The regional distribution implies that the highest proportions of individuals' have E-mail is reported in Khartoum followed by Northern region, all Sudan, Central, Eastern, Western, and Southern, regions respectively.[60] The regional disparity in terms of the proportions

[59] As reported by 97.7 %, 96.3 %, 94.6 %, 93.5 %, 93.1 %, 92 %, and 86.9 % respectively.

[60] As indicated by 68 %, 56.9 %, 55 %, 50.2 %, 40.5 %, 30.9 %, and 30.4 % respectively.

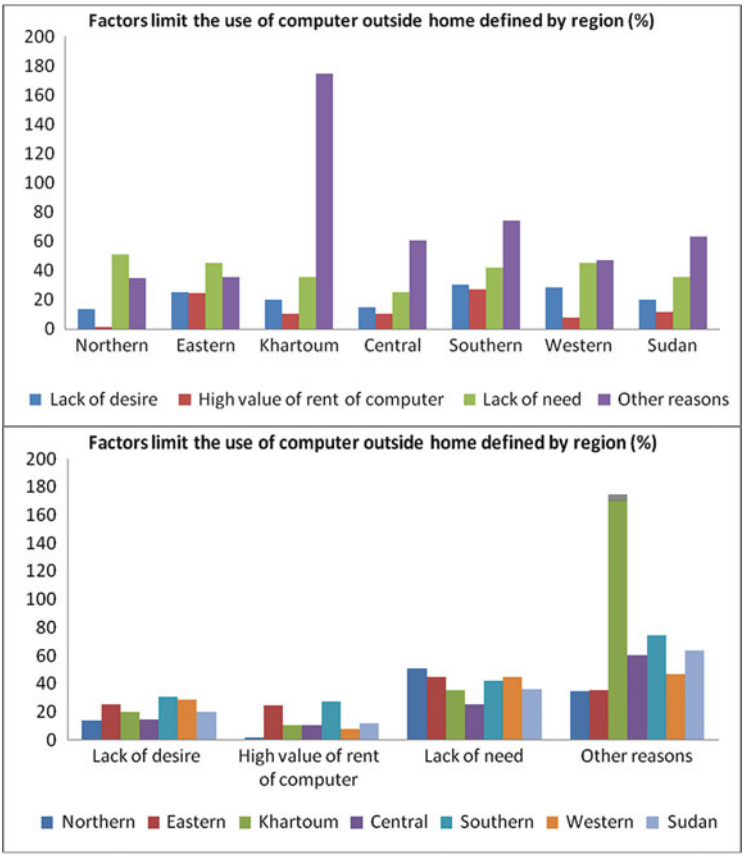

Fig. 6.10 (continued)

of individuals' have E-mail is evidenced from the highest proportions in Khartoum, which is more than twice the proportions in Southern and Western regions (see Table 6.12 and Fig. 6.12).

6.4.3 Language of Connectivity and Use of the Internet

The disparities in ICT indicators appear from the language of connectivity and the use of the Internet measured by the proportions of individuals used the Internet according to language which implies that for the majority of individuals in Sudan Arabic is the most widely used language for using the Internet, followed by the

Table 6.11 Pattern of households' access to the Internet from home, proportions of households with access to the Internet, households average spending on Internet per month (in pounds) defined by region and the mode of living in Sudan during 2011

Mode of living		Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Narrow broadband	Urban	80	48.5	37.8	43.5	23.5	62	
	Rural	78	14.3	44.8	36.6	14.1	0	
Wide fixed broadband	Urban	15	16.2	9.7	18.4	2	11.6	
	Rural	1.9	6.8	7.4	12.9	3.1	0	
Wide flexible (variable) broadband	Urban	25	61.9	78.9	55.1	61.2	52.8	
	Rural	37.3	76.2	62.1	59.8	73.4	87.5	
Proportions of households with access to the internet	Urban	19.2	28.8	52.1	38.1	46.2	29.3	37.4
	Rural	16.3	8	39.6	25	30.3	5.7	20.1
	Region	16.9	14.8	49.4	29	40	25.4	29.3
Average spending on internet	Urban	24.5	30	30	30	20	30	30
	Rural	20	22.5	22.5	20	20	30	20
	Region	21.5	30	30	23	20	30	30

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

Table 6.12 The proportions of individuals used the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Have the knowledge how to use the internet	Mode of living	Urban	12.7	17.2	40.5	24.4	26.3	16.8	29.1
		Rural	10.1	4.1	20.6	12.6	14.1	3.9	9.6
	Gender	Males	13.3	12.4	42.9	21.7	27	9.5	22.5
		Females	8.2	5.2	30.3	10.4	9.1	5.1	12.3
	Region		10.7	9	37	15.5	17.6	7.2	17.3
Used internet	Mode of living	Urban	100	92.7	96.5	90.8	92.8	96.1	94.8
		Rural	100	90.4	94.1	94.6	94	100	94.2
	Gender	Males	88.5	90.4	97.1	94.1	93	97.7	95.1
		Females	84.5	96.3	95	91.5	94.9	97.6	93.8
	Region		86.9	92	96.3	93.1	93.5	97.7	94.6
Have e-mail	Mode of living	Urban	58.8	35.5	67.6	46.6	31.1	48.5	58.3
		Rural	45.4	41.5	45.8	46.8	26.6	2.8	39.8
	Gender	Males	56.7	44.4	69.9	54.5	33.4	35.7	57.5
		Females	57.1	30.8	64.8	42.4	22.5	22.6	50.5
	Region		56.9	40.5	68	50.2	30.4	30.9	55

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

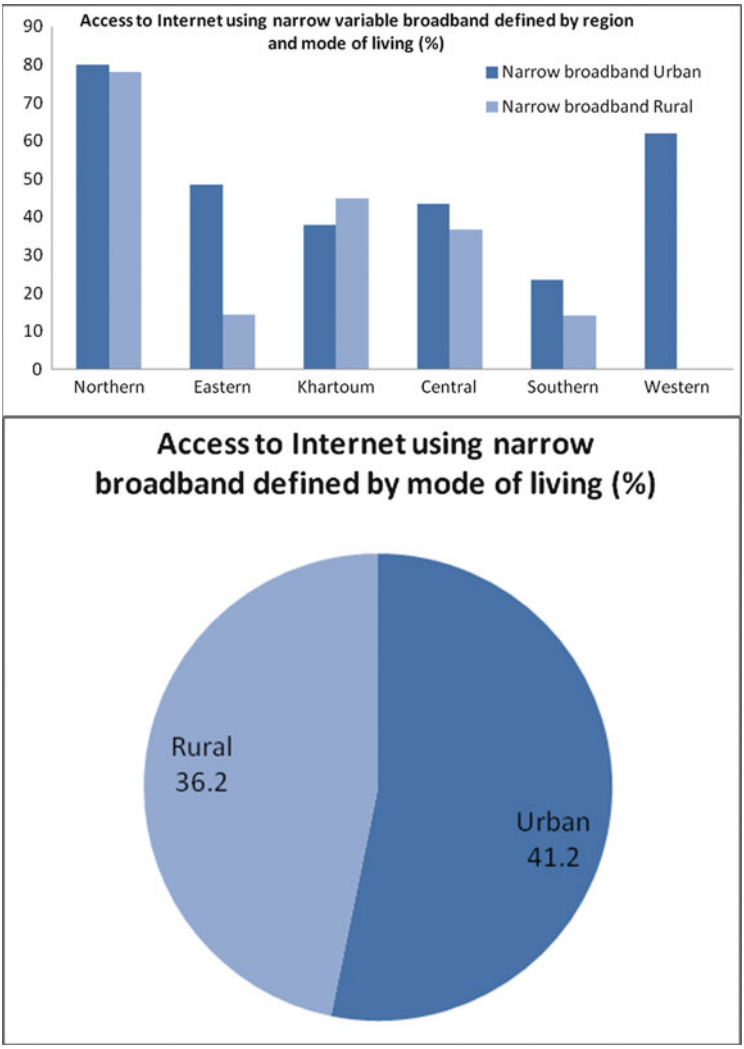

Fig. 6.11 Pattern of households' access to the Internet from home, proportions of households with access to the Internet, households average spending on Internet per month (in pounds) defined by region and the mode of living in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

English language and the other language respectively (see Table 6.13 and Fig. 6.13).[61]

The regional disparities in ICT indicators appear from the use of Arabic language to use the Internet as defined by the proportions of individuals use Arabic

[61] As indicated by 97 %, 49.8 %, and 1.4 % respectively.

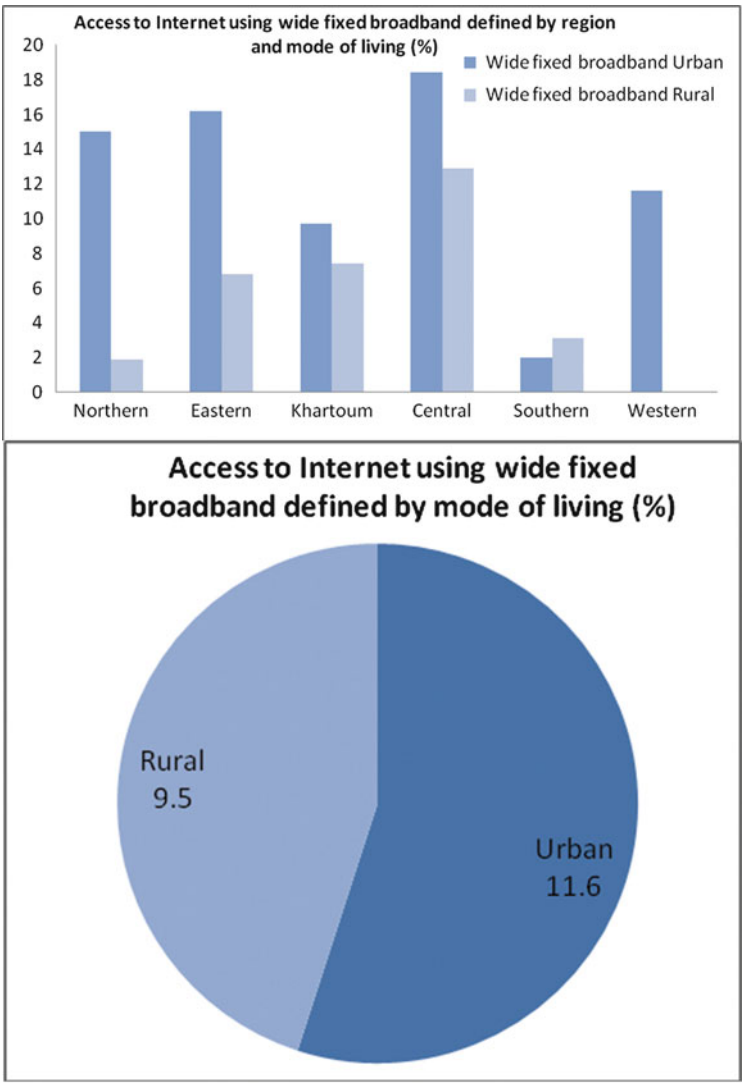

Fig. 6.11 (continued)

language to use the Internet of total individuals use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals use Arabic language to use the Internet of total individuals use the Internet in rural areas (98.8 %) is higher than urban areas (95.8 %) and for males (97 %) is higher than females (96 %) and total Sudan (97 %). The regional distribution implies that the highest proportions of individuals use Arabic language to use the Internet of total individuals use the Internet is reported in Northern region followed by Eastern

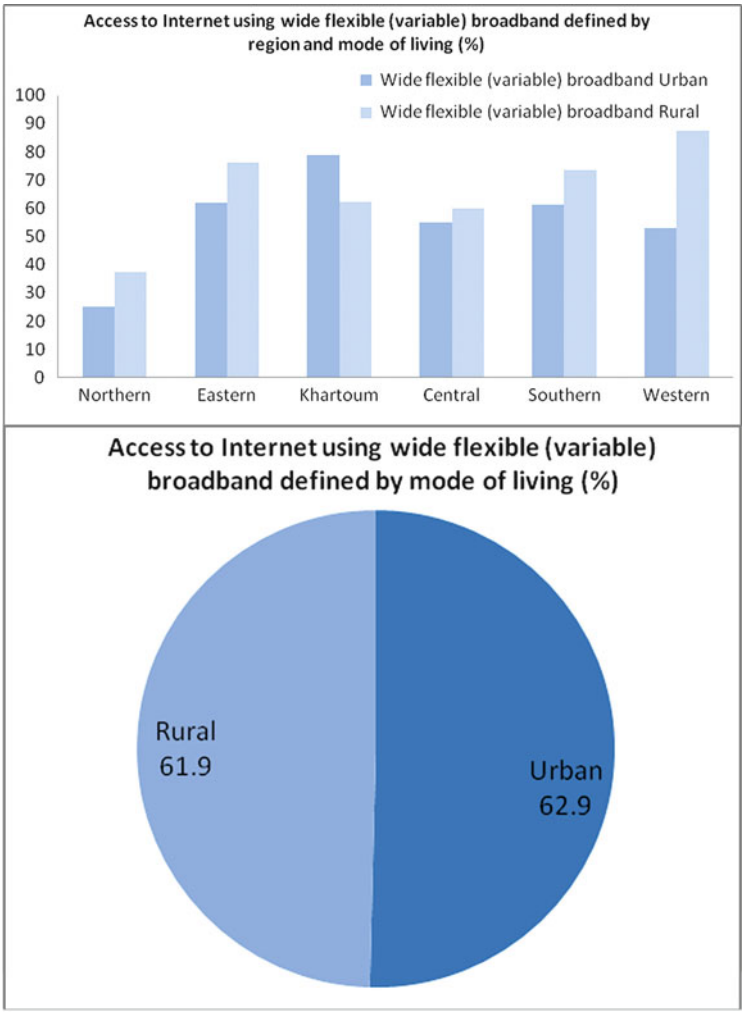

Fig. 6.11 (continued)

region, Western, Central, Southern, all Sudan, and Khartoum regions respectively (see Table 6.13 and Fig. 6.13).[62]

The regional disparities in ICT indicators appear from the use of English language to use the Internet as defined by the proportions of individuals use English language to use the Internet of total individuals use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals use English language to use the Internet of total individuals use the Internet in urban areas (53.1 %) is higher than rural areas (43.3 %) and for females (50.4 %) is higher

[62] As reported by 100 %, 99 %, 99 %, 98 %, 98 %, 97 %, and 95 % respectively.

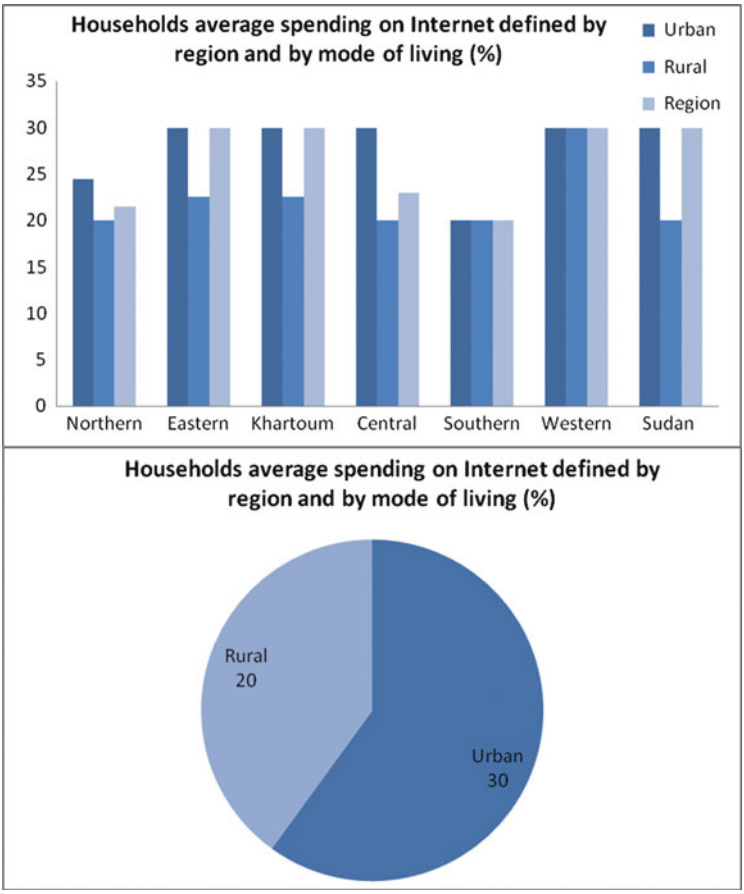

Fig. 6.11 (continued)

than males (49.5 %) and total Sudan (49.8 %). The regional distribution implies that the highest proportions of individuals use English language to use the Internet of total individuals use the Internet is reported in Khartoum followed by Central region, all Sudan, Western, Northern, Southern, and Eastern regions respectively (see Table 6.13 and Fig. 6.13).[63]

The regional disparities in ICT indicators appear from the use of other language to use the Internet as defined by the proportions of individuals use other language to use the Internet of total individuals use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals use other language to use the Internet of total individuals use the Internet in rural areas (1.8 %) is higher than urban areas (1.2 %) and for males (1.2 %) is higher than females (0.2 %) and total Sudan (1.4 %). The regional distribution implies that the

[63] As reported by 58.1 %, 52.9 %, 49.8 %, 42.5 %, 35 %, 31.7 %, and 18.2 % respectively.

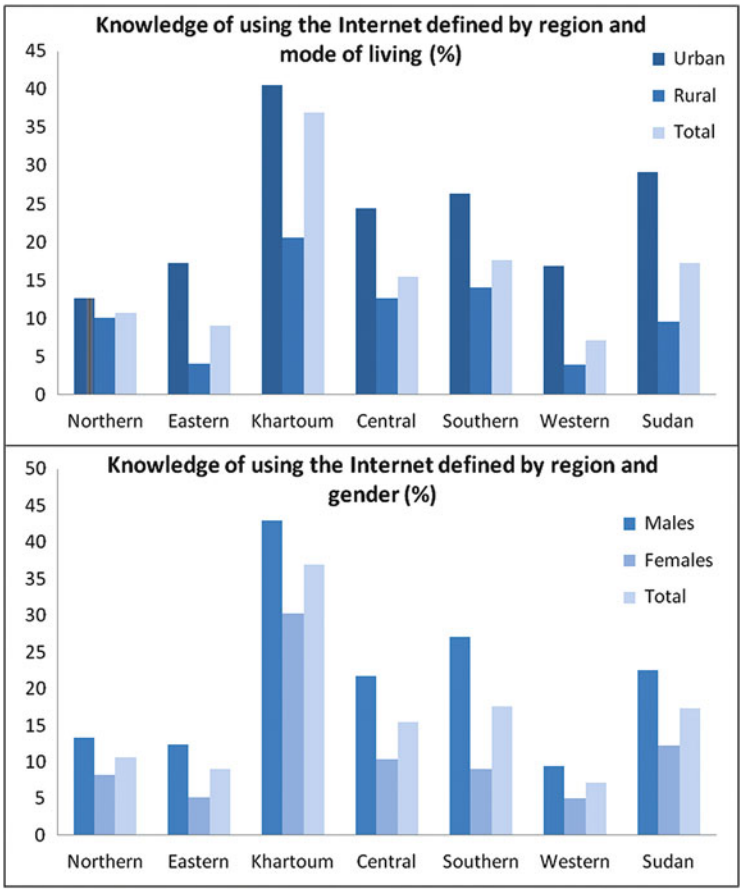

Fig. 6.12 The proportions of individuals used the Internet and E-mail defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012)

highest proportions of individuals use other language to use the Internet of total individuals use the Internet is reported in Central region followed by Western region, Khartoum, all Sudan, Eastern, Southern, and Northern regions respectively (see Table 6.13 and Fig. 6.13).[64]

[64] As reported by 2 %, 1.6 %, 1.4 %, 1.4 %, 0.7 %, 0.1 %, and 0 % respectively.

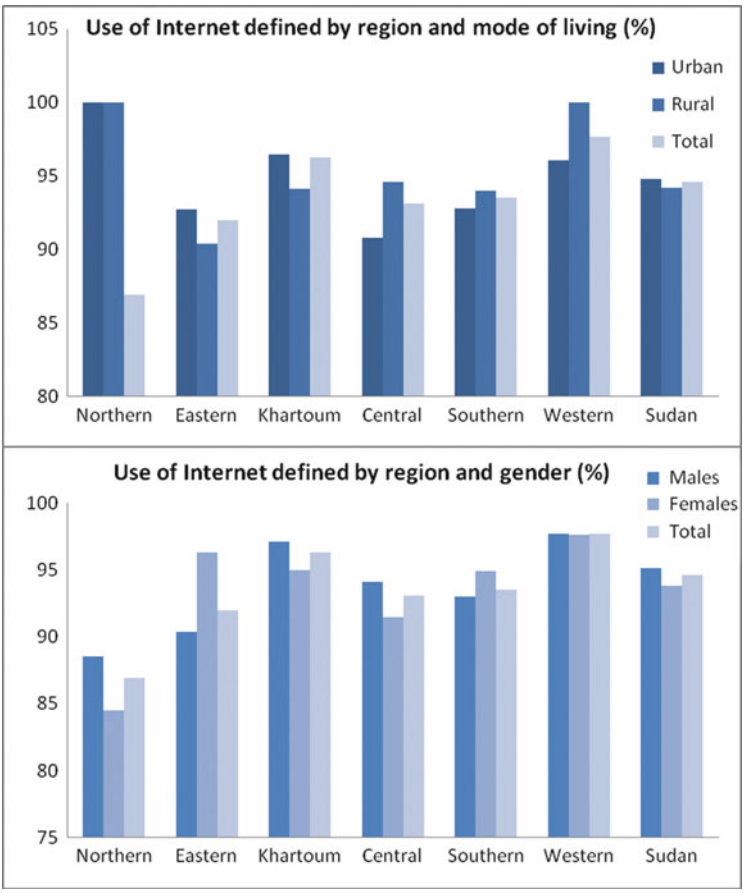

Fig. 6.12 (continued)

6.4.4 Means of Connectivity and Use of the Internet

The disparities in ICT indicators appear from means of connectivity and the use of the Internet measured by the proportions of individuals used the Internet according to means of connectivity or methods of connection which implies that for the majority of individuals in Sudan mobile cellular telephone is the most widely used to methods of connection for using the Internet, followed by DSL/mDSL and fixed telephone respectively.[65] The proportion of individuals using mobile

[65] As indicated by 74.1 %, 59.5 %, and 5.2 % respectively.

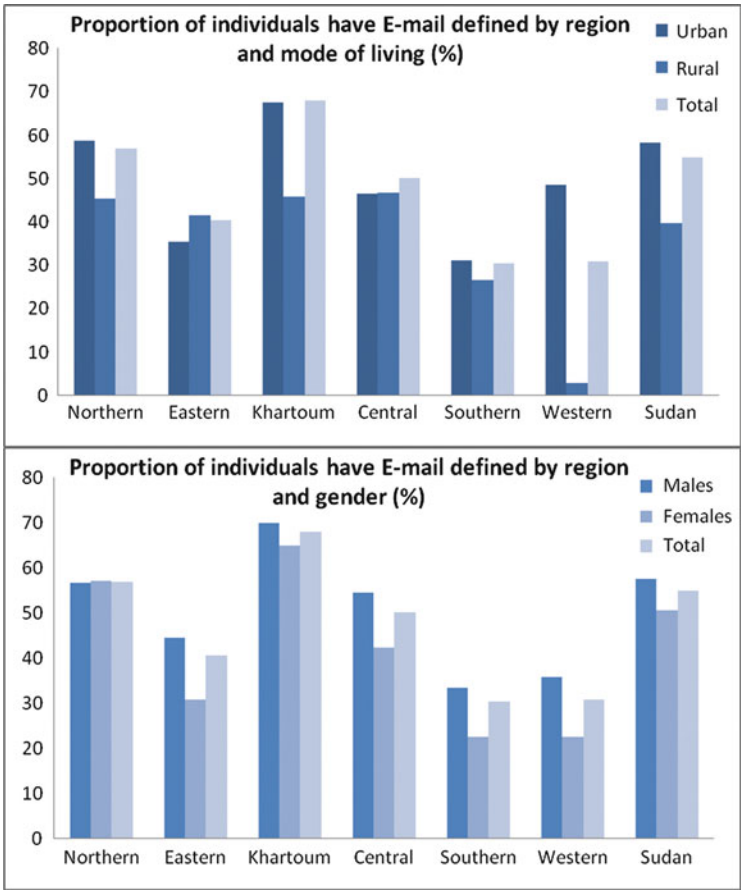

Fig. 6.12 (continued)

cellular telephone is more than fourteen times of the proportion of individuals using fixed telephone (see Table 6.14 and Fig. 6.14).

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet through fixed telephone defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet through fixed telephone in urban (5.4 %) is higher than rural (4.7 %) and for females (5.8 %) is higher than males (4.8 %) and total Sudan (5.2 %). The regional distribution implies that the highest proportions of individuals used the Internet through fixed telephone is reported in Eastern region followed by Central region, all

Table 6.13 Languages of connectivity and the use of the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Used Arabic language to use the internet	Mode of living	Urban	100	98.6	94.2	97.7	99.7	98.4	95.8
		Rural	100	98.7	98.8	98.9	96.3	100	98.8
	Gender	Males	100	99	99	98	98	99	97
		Females	199	98.6	97	98	98	99	96
	Region		100	99	95	98	98	99	97
Used English language to use the internet	Mode of living	Urban	22.5	20.7	60.4	52.5	39.6	41.6	53.1
		Rural	40.2	11.9	36.1	53.2	25.9	43.7	43.3
	Gender	Males	37.6	19.9	58.7	53.2	33.3	36	49.5
		Females	30.6	14.1	57.3	52.4	27.5	53.6	50.4
	Region		35	18.2	58.1	52.9	31.7	42.5	49.8
Used other language to use the internet	Mode of living	Urban	0	1	1.4	1	0.3	0.6	1.2
		Rural	0	0	1.1	2.7	0	3	1.8
	Gender	Males	0	0.5	1.5	1.8	0	0.6	1.2
		Females	0	0.1	0.4	0.2	0	0.2	0.2
	Region		0	0.7	1.4	2	0.1	1.6	1.4

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

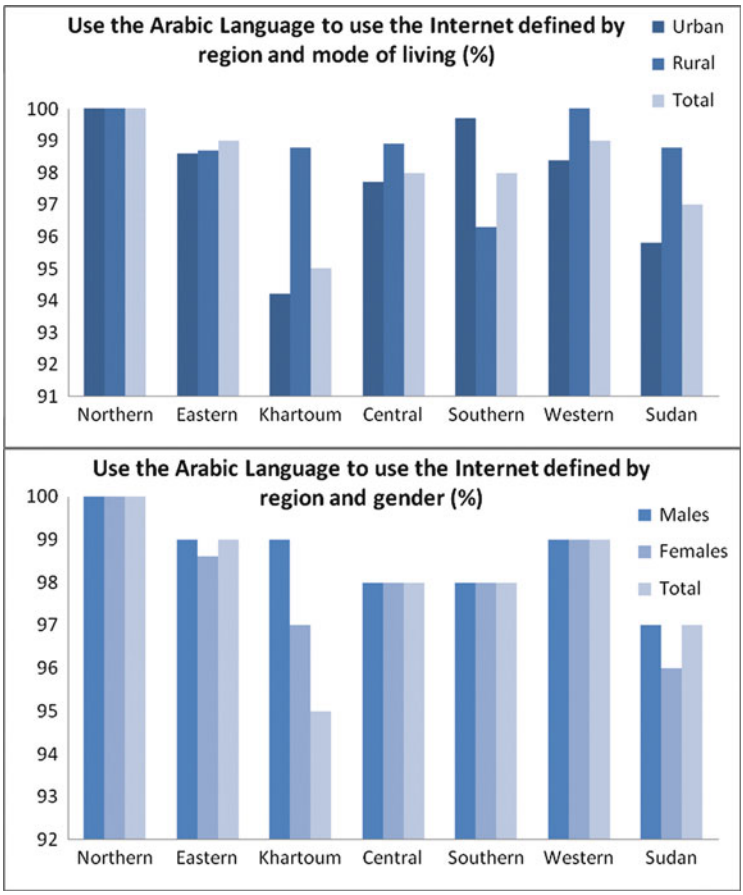

Fig. 6.13 Languages of connectivity and use of the Internet defined by region, mode of living and gender during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

Sudan, Khartoum, Western, Southern, and Northern regions respectively (see Table 6.14 and Fig. 6.14).[66]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet through mobile cellular telephone defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet through mobile cellular telephone in rural (82.5 %) is higher than urban (69.8 %) and for males (76.3 %) is higher than females (70.1 %) and total Sudan (74.1 %). The regional distribution implies that the highest proportions of individuals used the Internet through mobile cellular telephone is reported in Southern

[66] As indicated by 9.1 %, 7 %, 5.2 %, 4.8 %, 2.5 %, 2.2 %, and 0 % respectively.

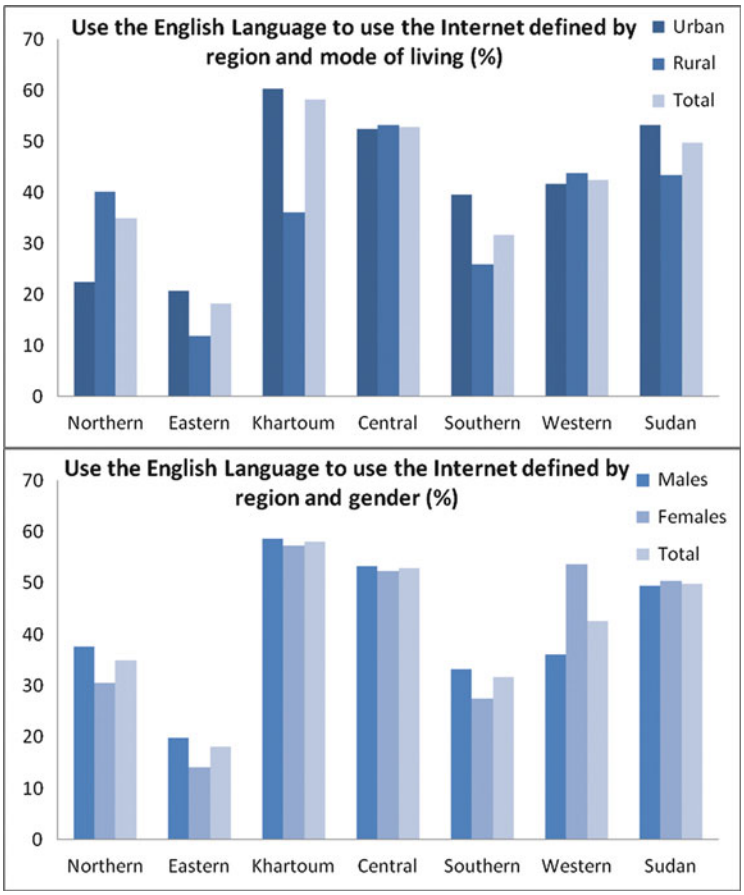

Fig. 6.13 (continued)

region followed by Central region, Eastern, all Sudan, Northern, Khartoum and Western regions respectively (see Table 6.14 and Fig. 6.14).[67]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet through DSL/mDSL defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet through DSL/mDSL in urban (67 %) is higher than rural (44.7 %) and for females (60.2 %) is higher than males (59.1 %) and total Sudan (59.5 %). The regional distribution implies that the highest proportions of individuals used the Internet

[67] As indicated by 90 %, 80.8 %, 76.1 %, 74.1 %, 70.5 %, 69.5 %, and 64 % respectively.

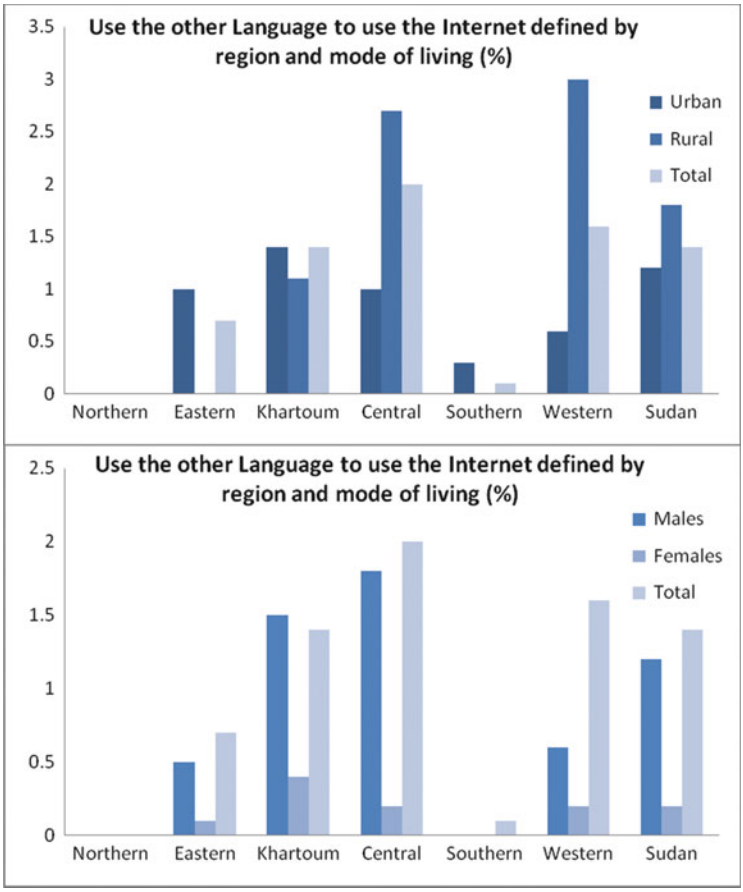

Fig. 6.13 (continued)

through DSL/mDSL is reported in Khartoum followed by all Sudan, Southern, Western, Northern, Eastern, and Central, regions respectively (see Table 6.14 and Fig. 6.14).[68]

6.4.5 Locations of Connectivity and Use of the Internet

The disparities in ICT indicators appear from the location of connectivity and the use of the Internet measured by the proportions of individuals used the Internet according to locations of connectivity or place of connection which implies that for

[68] As indicated by 71.1 %, 59.5 %, 53.1 %, 51.2 %, 49.4 %, 49 %, and 48.7 % respectively.

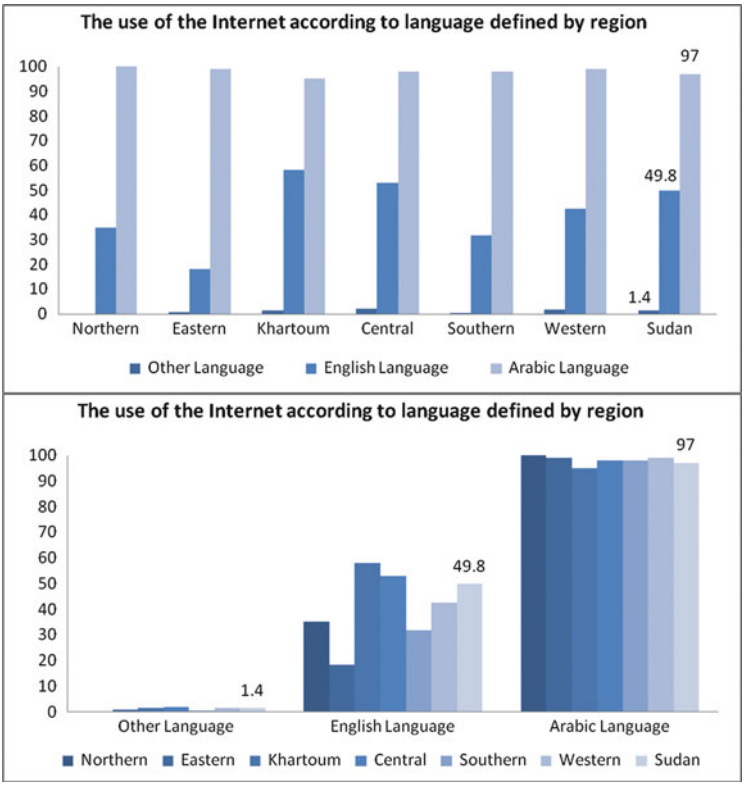

Fig. 6.13 (continued)

the majority of individuals in Sudan home is the most commonly place for using the Internet, followed by house of other person, work place, educational institution, Internet café, other place, and service centre respectively (see Table 6.15 and Fig. 6.15).[69]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet from home defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from home in rural (85.6 %) is higher than urban (83.9 %) and for females (84.9 %) is higher than males (84.3 %) and total Sudan (84.5 %). The regional distribution implies that the highest proportions of individuals used the Internet from home is reported in Western region followed by Northern region, Khartoum, all Sudan, Southern, Central and Eastern regions respectively (see Table 6.15 and Fig. 6.15).[70]

[69] As indicated by 84.5 %, 24.7 %, 23.6 %, 22.6 %, 19.1 %, 7.9 %, and 1.6 % respectively.

[70] As indicated by 88.2 %, 87.4 %, 86.5 %, 84.5 %, 83.6 %, 82.1 %, and 75.8 % respectively.

Table 6.14 Means of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Fixed telephone	Mode of living	Urban	0	10.3	5	6.6	5.3	2.1	5.4
		Rural	0	5.9	2.3	7.3	0	3	4.7
	Gender	Males	0	6.5	4.9	6.6	2.1	1.4	4.8
		Females	0	15.4	4.5	7.8	2.5	4.3	5.8
	Region		0	9.1	4.8	7	2.2	2.5	5.2
Mobile cellular telephone	Mode of living	Urban	71.4	71.8	68.1	73.5	80.4	67.3	69.8
		Rural	70.1	87	82.3	85.3	96.8	59.3	82.5
	Gender	Males	72.4	81	69.8	82.8	92.5	71.6	76.3
		Females	67.4	64.1	68.9	77.2	83.3	50.9	70.1
	Region		70.5	76.1	69.5	80.8	90	64	74.1
DSL/mDSL	Mode of living	Urban	44.2	51.2	73.5	56.7	63.6	59.1	67
		Rural	51.6	43.5	47.5	43.8	45.5	39.8	44.7
	Gender	Males	48.5	48.6	71.4	47.6	52	53.7	59.1
		Females	51	50	70.5	50.7	55.9	46.8	60.2
	Region		49.4	49	71.1	48.7	53.1	51.2	59.5

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

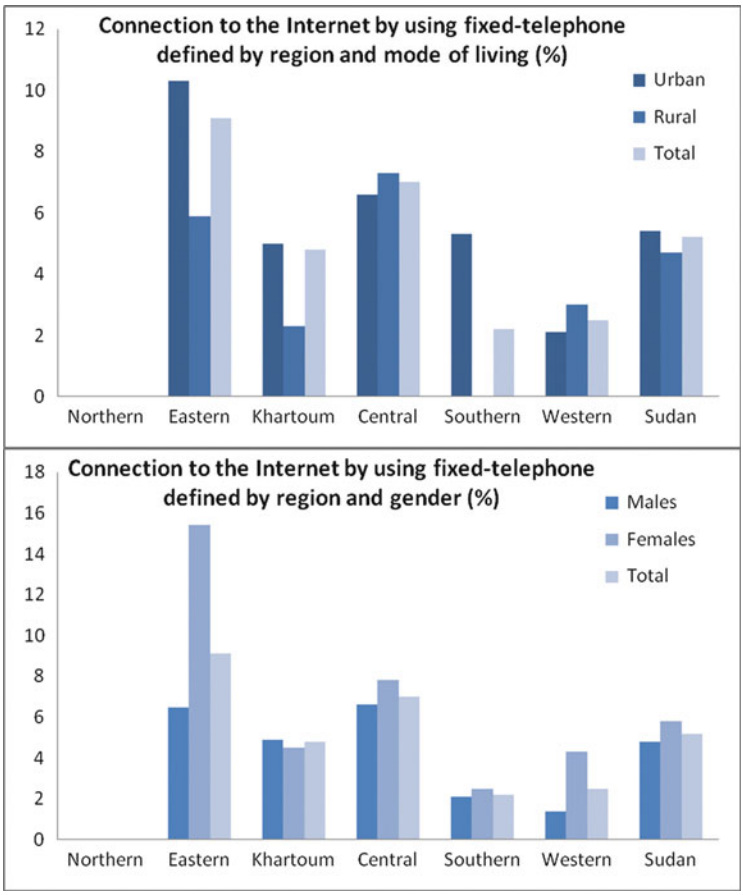

Fig. 6.14 Means of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet at work place defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet at work place in urban (26.2 %) is nearly twice higher than rural (18.5 %) and for males (28.4 %) is nearly twice higher than females (14.9 %) and total Sudan (23.6 %). The regional distribution implies that the highest proportions of individuals used the Internet at work place is reported in Khartoum followed by all Sudan, Central, Southern, Eastern, Western, and Northern, regions respectively (see Table 6.15 and Fig. 6.15).[71]

[71] As indicated by 26.1 %, 23.6 %, 22.3 %, 21.4 %, 21.3 %, 20.7 %, and 18.3 % respectively.

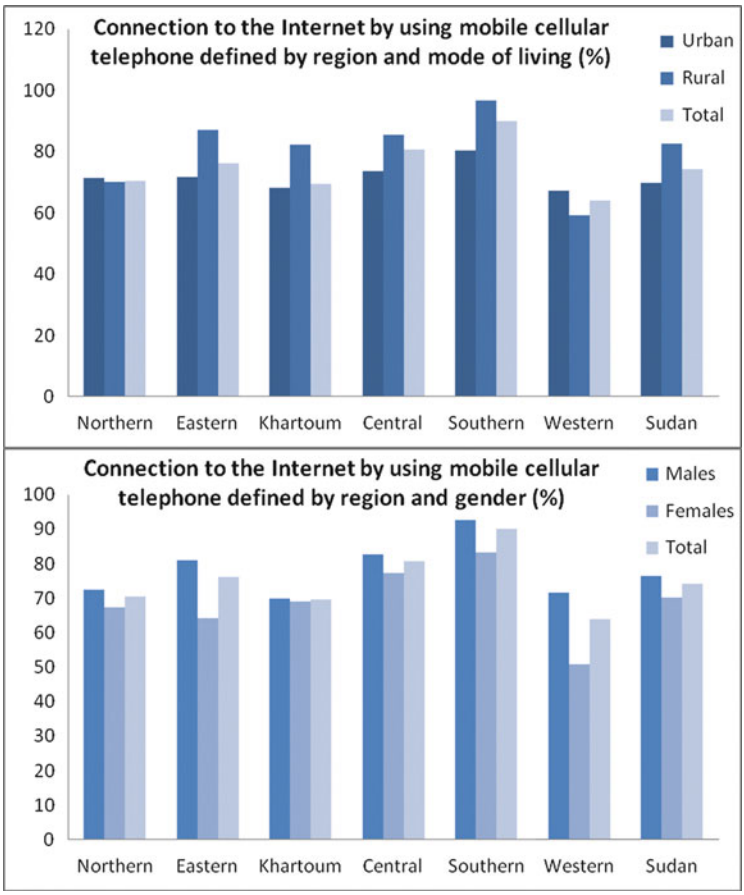

Fig. 6.14 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet from educational institution defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from educational institution in rural (22.7 %) is higher than urban (22.5 %) and for females (27.9 %) is higher than males (19.6 %) and total Sudan (22.6 %). The regional distribution implies that the highest proportions of individuals used the Internet from educational institution is reported in Western region followed by Khartoum, Northern, all Sudan, Southern, Central, and Eastern regions respectively (see Table 6.15 and Fig. 6.15).[72]

[72] As indicated by 30.3 %, 24.4 %, 24 %, 22.6 %, 22 %, 18.9 %, and 15.7 % respectively.

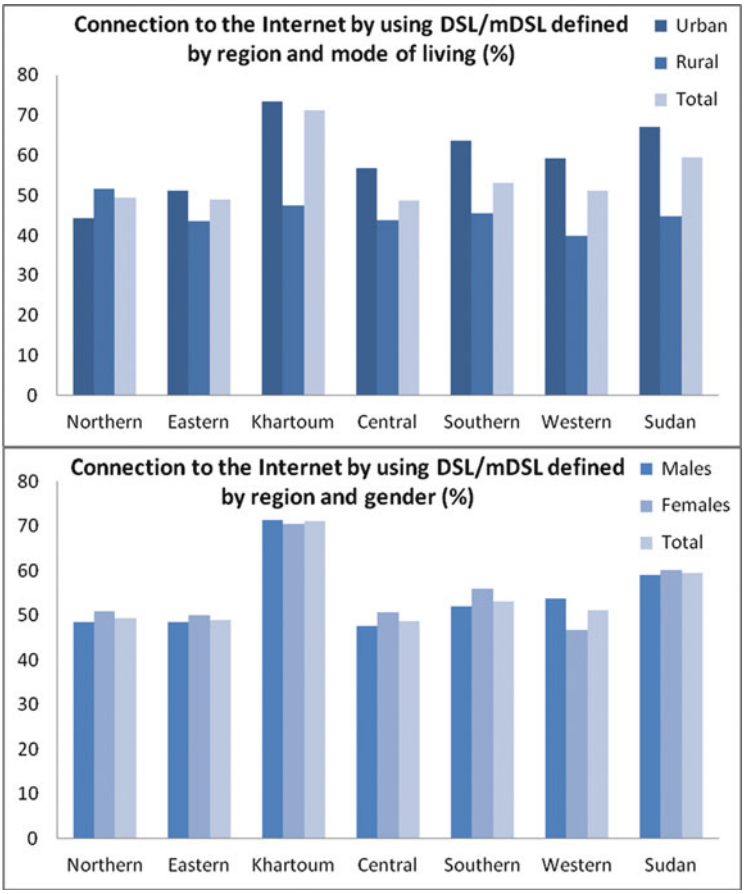

Fig. 6.14 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet from service centre defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from service centre in urban (2.9 %) is more than three times higher than rural (0.8 %) and for males (2.3 %) is more than twice higher than females (1 %) and total Sudan (1.6 %). The regional distribution implies that the highest proportions of individuals used the Internet from service centre is reported in Khartoum followed by all Sudan, Central, Eastern, Western, Southern and Northern, regions respectively.[73] The

[73] As indicated by 3.8 %, 1.6 %, 1.6 %, 0.9 %, 0.7 %, 0.7 %, and 0.1 % respectively.

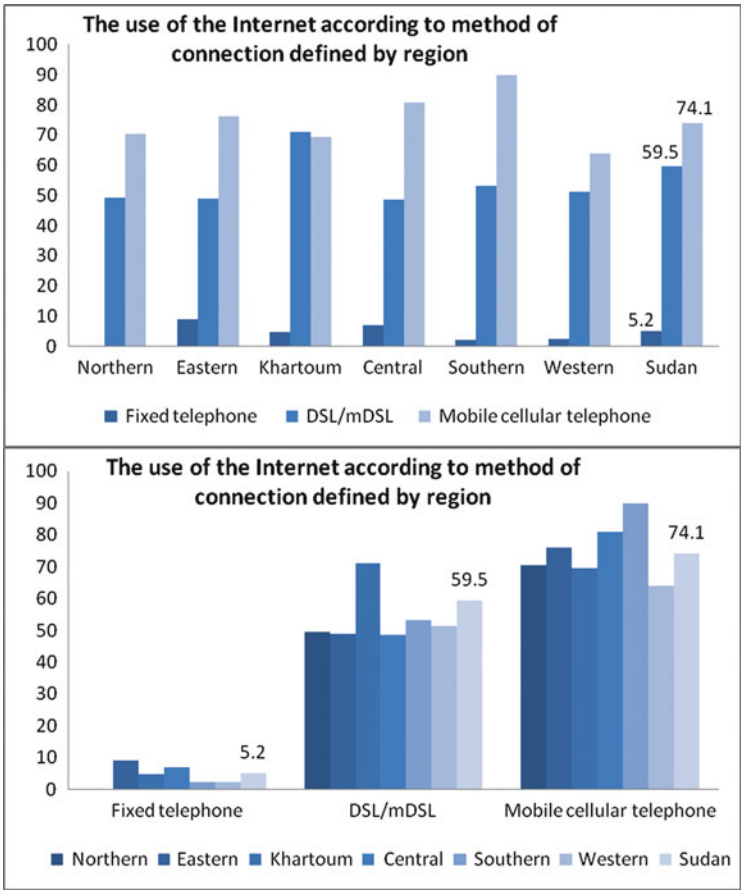

Fig. 6.14 (continued)

regional disparity in terms of the proportions of individuals used the Internet from service centre is evidenced from the highest proportions in Khartoum, which is more than twice the proportions in all Sudan, Southern and Central regions, more than four times in Eastern, more than five times in Western, and 38 times in Northern regions respectively (see Table 6.15 and Fig. 6.15).

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet from Internet café defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from Internet café in rural (19.9 %) is higher than urban (18.7 %) and for males (22.6 %) is nearly twice higher than females (12.8 %) and total Sudan (19.1 %). The regional distribution implies that the highest proportions of individuals used the Internet from Internet café is reported in Eastern region followed by Western

Table 6.15 Locations of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
From home	Mode of living	Urban	94.8	74.1	86.2	78.9	83.3	84	83.9
		Rural	84.4	80.2	89.8	84.2	83.9	94.3	85.6
	Gender	Males	90.9	76.4	85.7	82.1	85	88.4	84.3
		Females	81.6	74.4	87.9	82.2	79.9	87.9	84.9
	Region		87.4	75.8	86.5	82.1	83.6	88.2	84.5
From work place	Mode of living	Urban	22.9	22.7	26.5	25.7	25.8	29.2	26.2
		Rural	16.4	17.7	22.1	20.1	18.1	8.5	18.5
	Gender	Males	20.7	23.2	32.3	26.4	26.1	24.6	28.4
		Females	14.3	16.7	15.6	14.8	8.8	14.1	14.9
	Region		18.3	21.3	26.1	22.3	21.4	20.7	23.6
From educational institution	Mode of living	Urban	11.7	16	24.4	19.6	21	23.2	22.5
		Rural	29.1	15.1	24.7	18.5	22.8	40.5	22.7
	Gender	Males	21.2	14.8	20.8	17.2	20.5	24.8	19.6
		Females	28.6	17.9	30.5	22.1	26	39.8	27.9
	Region		24	15.7	24.4	18.9	22	30.3	22.6
From services centre	Mode of living	Urban	0.5	1.9	4.1	2.6	1.6	1.7	2.9
		Rural	0	0.3	2.1	1.3	0.3	0.3	0.8
	Gender	Males	0.2	1.5	4.9	2.2	1.2	1	2.3
		Females	0	0.3	2.4	1.2	0.2	0.4	1
	Region		0.1	0.9	3.8	1.6	0.7	0.7	1.6

From internet cafe	Mode of living	Urban	2.2	27.7	16.4	29.2	8.6	14.5	18.7
		Rural	5	25.5	17	20.7	9.2	40.2	19.9
	Gender	Males	6.7	32.9	20.5	28.4	9.4	23.4	22.6
		Females	0	12.8	9.8	16	7.8	27.9	12.8
	Region		4.2	27.1	16.5	24	9	25	19.1
From other person's house	Mode of living	Urban	13.4	23.6	22.5	29.4	22.9	31.8	24.3
		Rural	30.8	15.2	29.2	25.8	40.9	5.5	25.6
	Gender	Males	28.9	23.6	23.7	30.2	37.7	26.5	26.9
		Females	20.4	15.4	22.4	21.8	22	11.7	20.8
	Region		25.7	21.2	23.2	27.2	33.4	21	24.7
From other place	Mode of living	Urban	9.1	15.1	4.2	8.6	12.3	25.1	7.7
		Rural	19.6	13	0.6	6.6	12.4	8.3	8.1
	Gender	Males	17.8	15.7	4.5	9	14.6	23.1	9.4
		Females	14.3	11.5	2.8	4.4	6.4	9.8	5
	Region		16.5	14.5	3.8	7.4	12.4	18.2	7.9

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

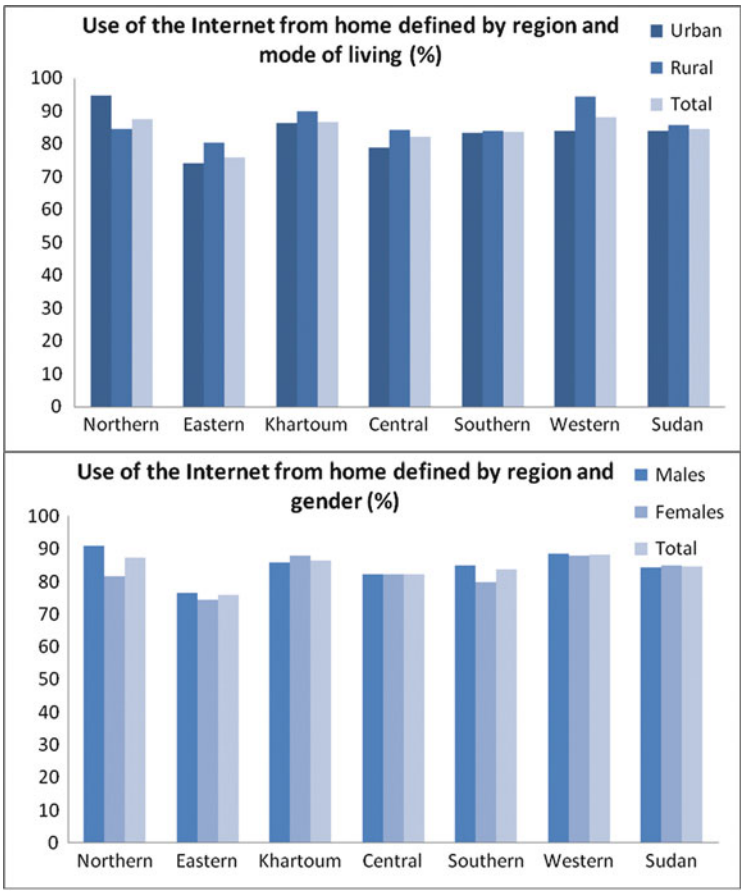

Fig. 6.15 Locations of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012)

region, Central, all Sudan, Khartoum, Southern and Northern regions respectively.[74]

The regional differences in ICT indicators appear from the proportions of individuals used the Internet from house of other person defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from house of other person in rural (25.6 %) is higher than urban (24.3 %) and for males (26.9 %) is higher than females (20.8 %) and total Sudan (24.7 %). The regional distribution implies that the highest proportions of individuals used the Internet from house of other person is reported in Southern region,

[74] As indicated by 27.1 %, 25 %, 24 %, 19.1 %, 16.5 %, 9 %, and 4.2 % respectively.

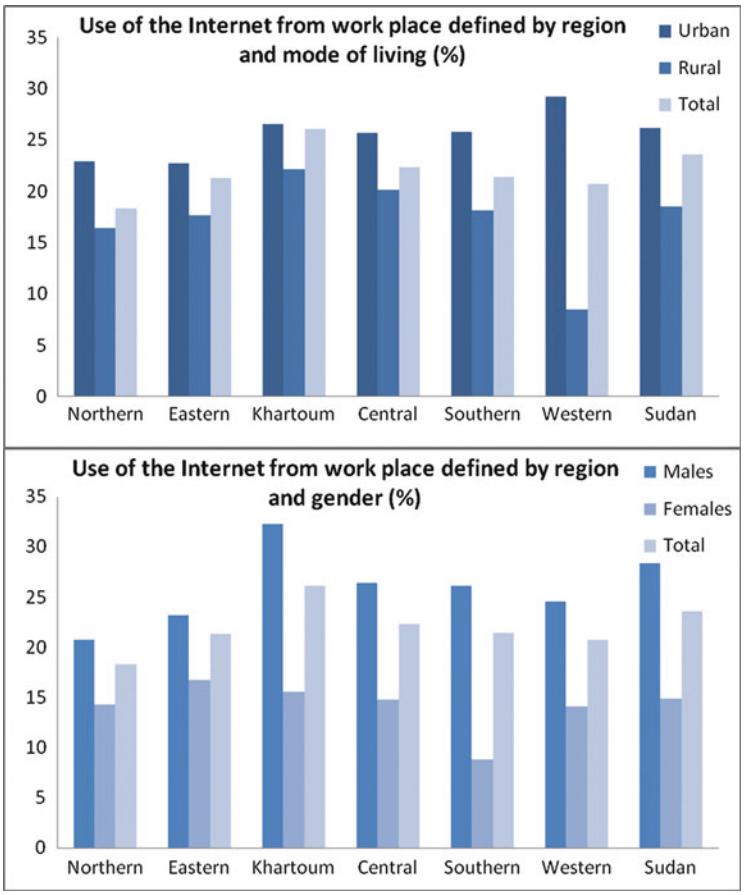

Fig. 6.15 (continued)

followed by Central region, Northern, all Sudan, Khartoum, Eastern, and Western regions respectively (see Table 6.15 and Fig. 6.15).[75]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet from other place defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet from other place in rural (8.1 %) is higher than urban (7.7 %) and for males (9.4 %) is nearly twice higher than females (5 %) and total Sudan (7.9 %). The regional distribution implies that the highest proportions of individuals used the Internet from other place is reported in Western region followed by Northern region, Eastern, Southern, all Sudan, Central, and Khartoum regions respectively (see Table 6.15 and Fig. 6.15).[76]

[75] As indicated by 33.4 %, 27.2 %, 25.7 %, 24.7 %, 23.2 %, 21.2 %, and 21 % respectively.

[76] As indicated by 18.2 %, 16.5 %, 14.5 %, 12.4 %, 7.9 %, 7.4 %, and 3.8 % respectively.

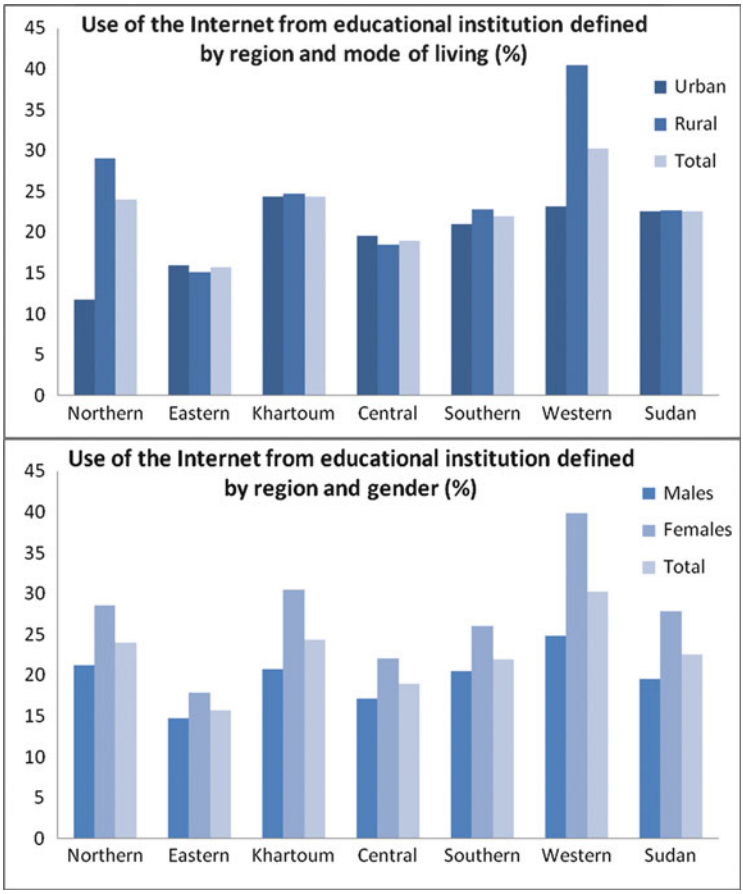

Fig. 6.15 (continued)

6.4.6 Purposes of Connectivity and Use of the Internet

From the viewpoint of individuals in Sudan the Internet is widely used for several purposes, notably, it is widely used for religious purposes, sports purposes, news purposes, educational purposes, commercial transactions purposes, games and entertainment purposes, chatting and forums, exchanging messages, connection, and other purposes. The disparities in ICT indicators appear from the proportions of individuals used the Internet according to purpose of connection which implies that for the majority of individuals in Sudan news purposes is the most commonly purposes for using the Internet for, followed by religious purposes, chatting and forums, commercial transactions purposes, exchanging messages, sports purposes,

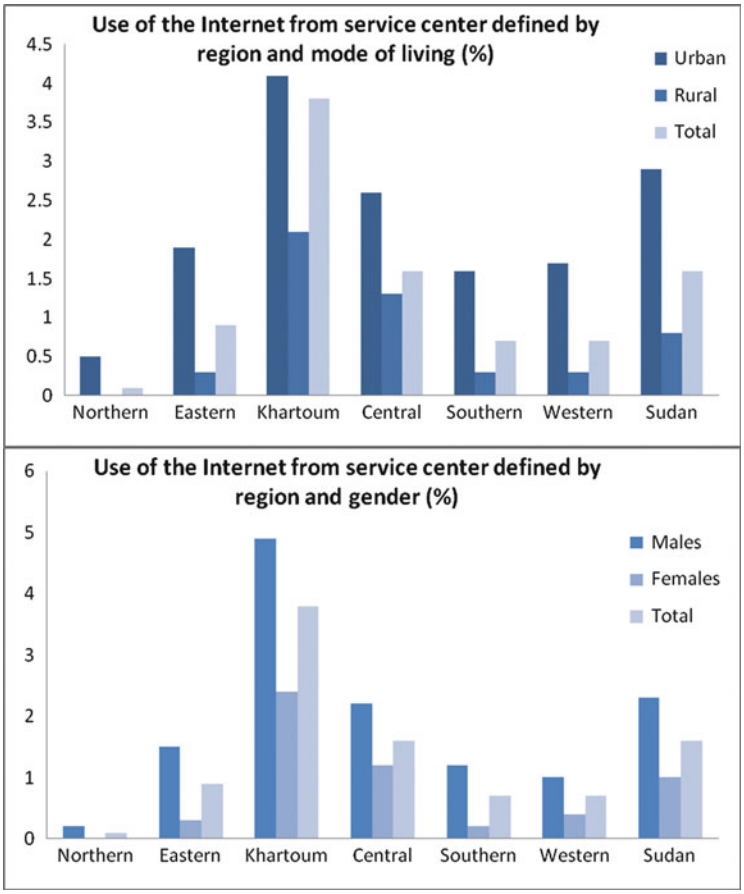

Fig. 6.15 (continued)

connection, other purposes, educational purposes, and games and entertainment purposes respectively (see Table 6.16 and Fig. 6.16).[77]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for religious purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for religious purposes in rural (73.4 %) is higher than urban (68.9 %) and for females (70.5 %) is higher than males (70.4 %) and total Sudan (70.4 %). The regional distribution implies that the highest proportions of individuals used the

[77] As indicated by 72.8 %, 70.4 %, 66.9 %, 64.6 %, 60.1 %, 55.7 %, 54.7 %, 45.6 %, 12.5 %, and 6.4 % respectively.

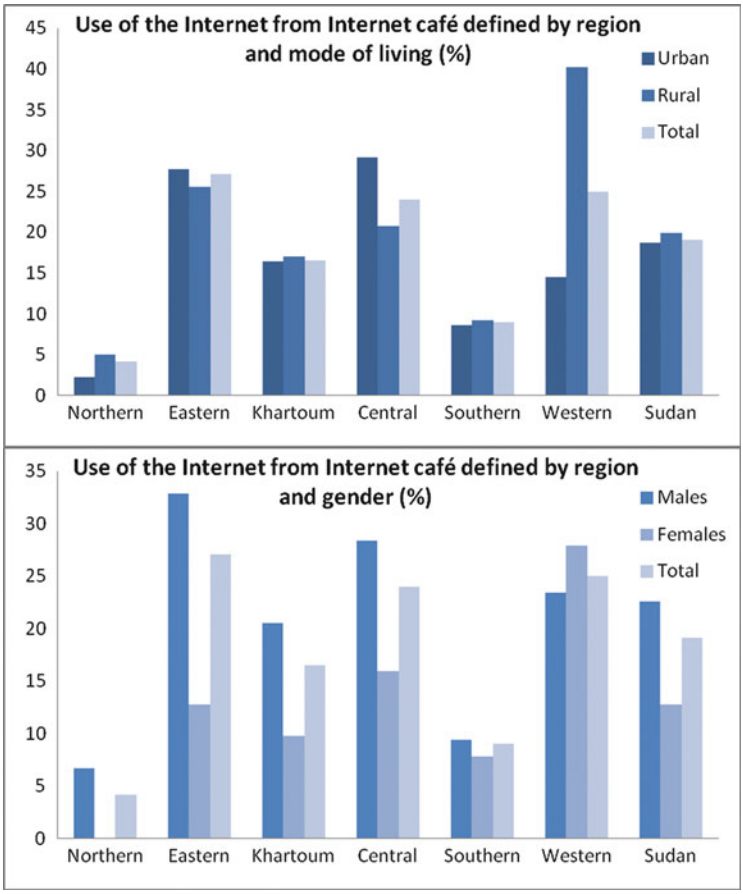

Fig. 6.15 (continued)

Internet for religious purposes is reported in Central region followed by Western region, Southern, Eastern, all Sudan, Khartoum, and Northern regions respectively (see Table 6.16 and Fig. 6.16).[78]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for sports purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for sports purposes in rural (63 %) is higher than urban (52 %) and for males (73.1 %) is nearly three times/higher than females (24.4 %) and total Sudan (55.7 %). The

[78] As indicated by 72.9 %, 72.8 %, 72 %, 70.7 %, 70.4 %, 68.9 %, and 62.3 % respectively.

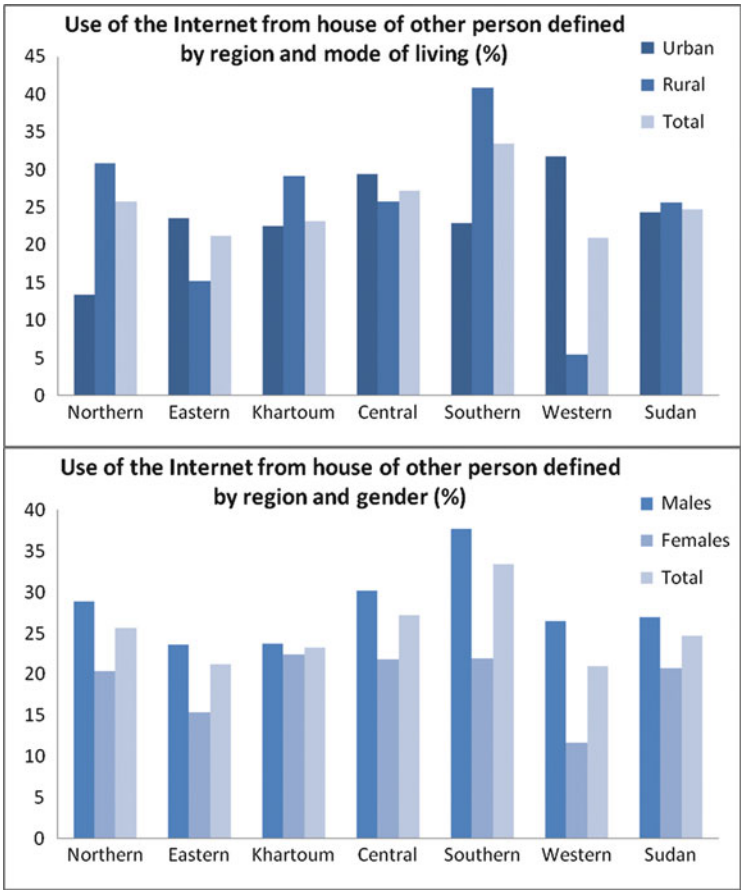

Fig. 6.15 (continued)

regional distribution implies that the highest proportions of individuals used the Internet for sports purposes is reported in Southern region followed by Western region, Central, Eastern, all Sudan, Khartoum, and Northern regions respectively.[79]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for news purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for news purposes in rural (73.9 %) is higher than urban (72.2 %) and for males (78 %) is higher than females (63.3 %) and total Sudan (72.8 %). The regional distribution implies that the highest proportions of individuals used the Internet for news purposes is reported in Western region followed by Southern region, all

[79] As indicated by 71 %, 70.1 %, 60.3 %, 57.5 %, 55.7 %, 48.9 %, and 43.7 % respectively.

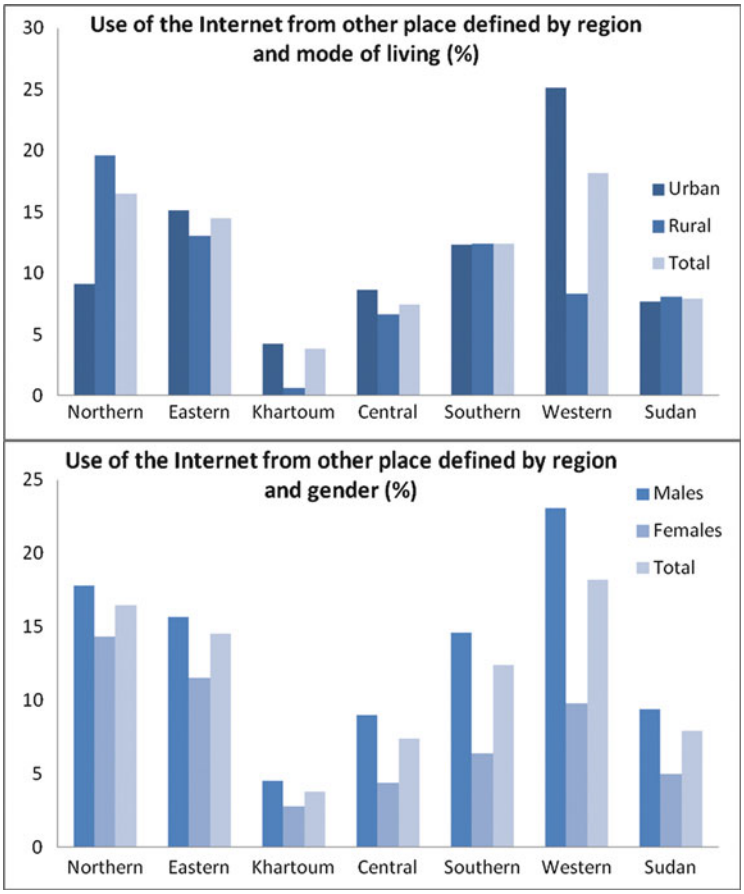

Fig. 6.15 (continued)

Sudan, Central, Khartoum, Eastern, and Northern regions respectively (see Table 6.16 and Fig. 6.16).[80]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for educational purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for educational purposes in rural (14.1 %) is higher than urban (11.6 %) and for males (13.1 %) is higher than females (11.3 %) and total Sudan (12.5 %). The regional distribution implies that the highest proportions of individuals used the Internet for educational purposes is reported in Southern region followed by Eastern region, Western, Central, all Sudan, Northern and Khartoum regions respectively (see Table 6.16 and Fig. 6.16).[81]

[80] As indicated by 89.1 %, 85.1 %, 72.8 %, 71.8 %, 71.3 %, 62.9 %, and 60.7 % respectively.

[81] As indicated by 22.8 %, 18.8 %, 18.6 %, 15.5 %, 12.5 %, 9.2 %, and 7.3 % respectively.

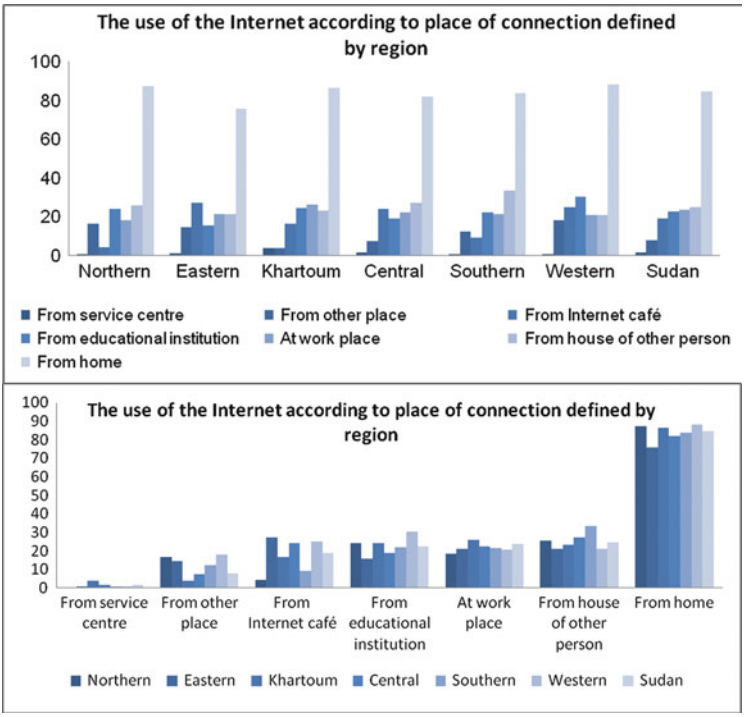

Fig. 6.15 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for commercial transactions purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for commercial transactions purposes in urban (64.6 %) is higher than rural (64.5 %) and for females (71.7 %) is higher than males (60.7 %) and total Sudan (64.6 %). The regional distribution implies that the highest proportions of individuals used the Internet for commercial transactions purposes is reported in Western region followed by Central region, all Sudan, Khartoum, Southern, Eastern, and Northern regions respectively (see Table 6.16 and Fig. 6.16).[82]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for games and entertainment purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for games and entertainment purposes in urban (7.3 %) is higher than rural (4.6 %) and for males (7.6 %) is nearly twice higher than females (4.1 %) and total Sudan (6.4 %). The regional distribution implies that the highest proportions of individuals used the Internet for games and entertainment purposes is

[82] As indicated by 73.4 %, 66.7 %, 64.6 %, 64.4 %, 59.4 %, 56.8 %, and 56.6 % respectively.

Table 6.16 Purposes of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Religious purposes	Mode of living	Urban	70.1	74.3	69.8	62.5	65	71.3	68.9
		Rural	59	61.9	60	79.3	77	75	73.4
	Gender	Males	56.8	70.8	69.5	74.2	70.1	68	70.4
		Females	71.4	70.5	67.8	70.5	76.9	81.5	70.5
	Region		62.3	70.7	68.9	72.9	72	72.8	70.4
Sports reasons	Mode of living	Urban	39.3	55.9	48.3	56	67.5	65.5	52
		Rural	45.6	61.6	54.9	63	73.5	76.8	63
	Gender	Males	62.6	73.6	67	79.1	82.4	81.7	73.1
		Females	12.3	18	19	26.4	40.7	50	24.4
	Region		43.7	57.5	48.9	60.3	71	70.1	55.7
News reasons	Mode of living	Urban	60.6	63.2	72.2	69.1	83.1	85.3	72.2
		Rural	60.7	62.2	62.6	73.5	86.4	94.5	73.9
	Gender	Males	61.6	67.1	76.8	79	88.7	90	78
		Females	59.2	52.6	62.1	58.7	75.5	87.4	63.3
	Region		60.7	62.9	71.3	71.8	85.1	89.1	72.8
Educational purposes	Mode of living	Urban	13.8	20.3	7.8	13.5	24.8	23.5	11.6
		Rural	7.3	15.1	2.9	16.8	21.3	11.5	14.1
	Gender	Males	8.6	21.8	7.3	16.4	22.1	18.4	13.1
		Females	10.2	11.5	7.3	13.8	24.5	18.9	11.3
	Region		9.2	18.8	7.3	15.5	22.8	18.6	12.5
Commercial transactions reasons	Mode of living	Urban	46.3	57.9	65.3	64.8	64.5	70.2	64.6
		Rural	60.8	54.1	56.3	67.8	55.6	78	64.5
	Gender	Males	57.4	56.9	59.3	64	56.2	65.7	60.7
		Females	55.1	56.4	72.9	71.4	67.7	86.6	71.7
	Region		56.6	56.8	64.4	66.7	59.4	73.4	64.6

Games and entertainment reasons	Mode of living	Urban	6.5	7.6	7.7	7.1	3.4	5.9	7.3
		Rural	3.1	8.1	3.4	5.6	1.7	2.8	4.6
	Gender	Males	5.3	8.8	8.9	7.3	3	5.9	7.6
		Females	2	5.1	4.7	4.3	1	2.3	4.1
	Region		4.1	7.7	7.3	6.2	2.4	4.6	6.4
Chatting and forums reasons	Mode of living	Urban	58.5	55.2	67.8	69.4	62.4	60.6	66.1
		Rural	65.2	76.5	59.5	74.4	59.9	58	68.6
	Gender	Males	58.3	64.8	65.9	70.3	61.6	53.2	65.4
		Females	71.4	52.6	68.7	76.5	59.3	70.4	69.7
	Region		63.2	61.3	67	72.5	61	59.5	66.9
Exchanging messages reasons	Mode of living	Urban	76.2	56.6	67.2	62.2	43.5	48.4	63.3
		Rural	66.1	62.3	54.3	64.6	35.2	2.8	53.7
	Gender	Males	68.8	61.6	66.3	65.4	41.6	34.8	61.4
		Females	69.4	50	65.4	60.5	30.9	20.8	57.8
	Region		69	58.2	65.9	63.7	38.7	29.7	60.1
Connection reasons	Mode of living	Urban	67.1	49.3	65.2	51.8	41.6	49.2	59.6
		Rural	54.7	45.9	48.6	52.8	36.3	0	44.8
	Gender	Males	57.8	51.9	66.1	55.2	39	33.1	56.9
		Females	59.2	39.8	59.5	47.4	37.2	22.2	50.6
	Region		58.3	48.8	63.6	52.4	38.5	29.1	54.7
Other reasons	Mode of living	Urban	34.6	39.7	61.8	40.4	28.1	40.4	53.1
		Rural	29.9	27	45	34.9	23.9	2.8	30.8
	Gender	Males	31.7	35.7	61.9	38.1	26.1	28.5	46.6
		Females	30.6	37.2	57.3	35	24.5	18.9	43.9
	Region		31.3	36.1	60.2	37	25.7	25	45.6

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

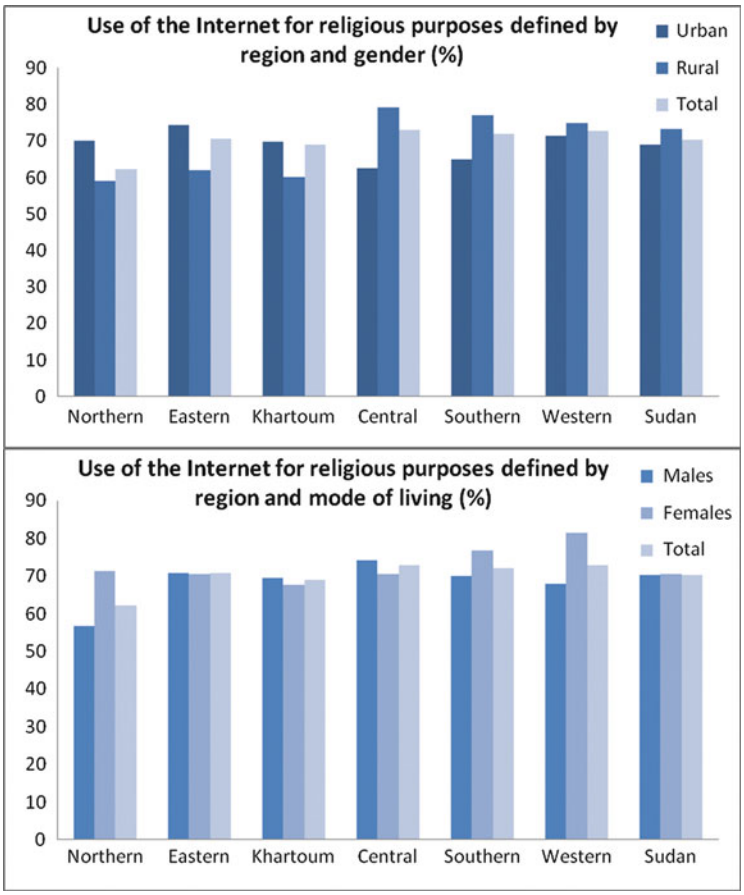

Fig. 6.16 Purposes of connectivity and use of the Internet defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

reported in Eastern region followed by Khartoum, all Sudan, Central, Western, Northern, and Southern regions respectively (see Table 6.16 and Fig. 6.16).[83]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for chatting and forums defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for chatting and forums in rural (68.6 %) is higher than urban (66.1 %) and for females (69.7 %) is higher than males (65.4 %) and total Sudan (66.9 %). The regional distribution implies that the highest proportions of individuals used the Internet for chatting and forums is reported in Central region followed by

[83] As indicated by 7.7 %, 7.3 %, 6.4 %, 6.2 %, 4.6 %, 4.1 %, and 2.4 % respectively.

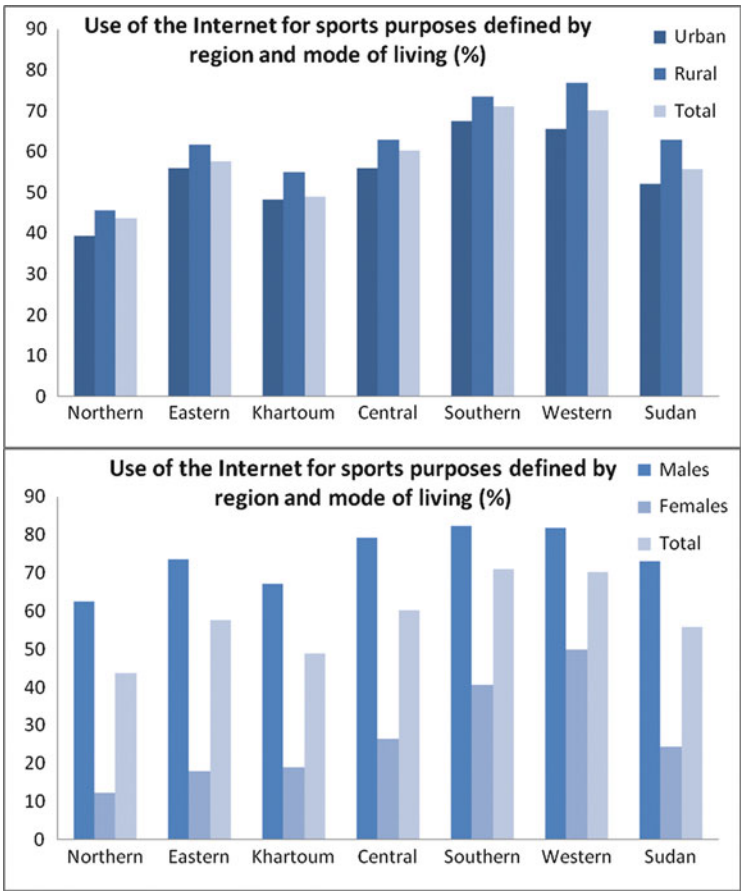

Fig. 6.16 (continued)

Khartoum, all Sudan, Northern, Eastern, Southern, and Western regions respectively (see Table 6.16 and Fig. 6.16).[84]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for exchanging messages defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for exchanging messages in urban (63.3 %) is higher than rural (53.7 %) and for males (61.4 %) is higher than females (57.8 %) and total Sudan (60.1 %). The regional distribution implies that the highest proportions of individuals used the Internet for exchanging messages is reported in Northern followed by Khartoum, Central, all Sudan, Eastern, Southern, and Western, region regions respectively.[85]

[84] As indicated by 72.5 %, 67 %, 66.9 %, 63.2 %, 61.3 %, 61 %, and 59.5 % respectively.

[85] As indicated by 69 %, 65.9 %, 63.7 %, 60.1 %, 58.2 %, 38.7 %, and 29.7 % respectively.

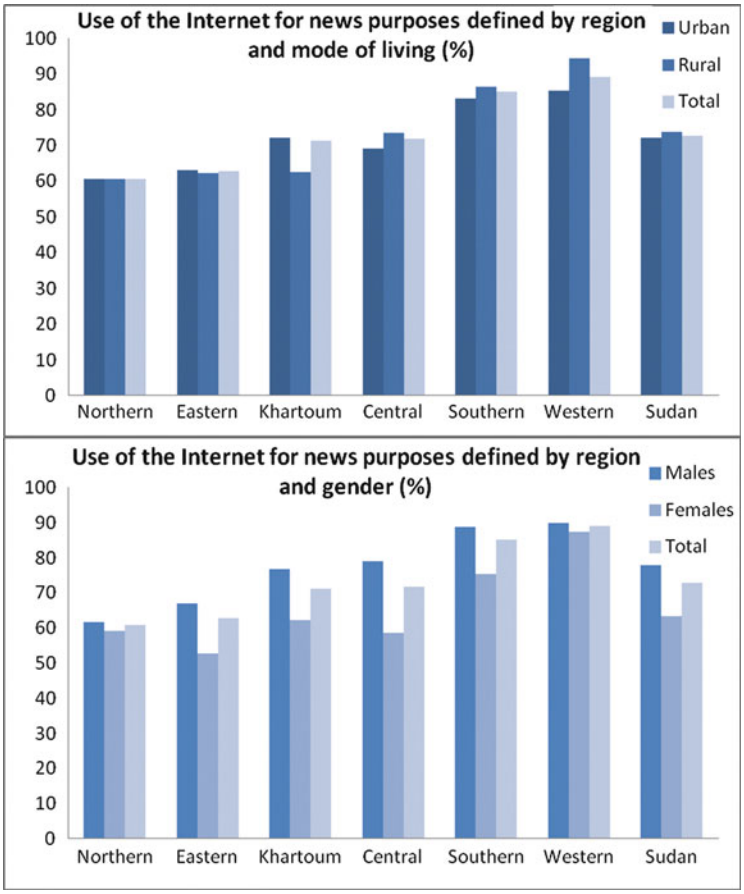

Fig. 6.16 (continued)

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for connection defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for connection in urban (59.6 %) is higher than rural (44.8 %) and for males (56.9 %) is higher than females (50.6 %) and total Sudan (54.7 %). The regional distribution implies that the highest proportions of individuals used the Internet for connection is reported in Khartoum followed by Northern, all Sudan, Central, Eastern, Southern, and Western regions respectively (see Table 6.16 and Fig. 6.16).[86]

The regional disparities in ICT indicators appear from the proportions of individuals used the Internet for other purposes defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals used the Internet for other purposes in urban (53.1 %) is higher than rural (30.8 %) and for males

[86] As indicated by 63.6 %, 58.3 %, 54.7 %, 52.4 %, 48.8 %, 38.5 %, and 29.1 % respectively.

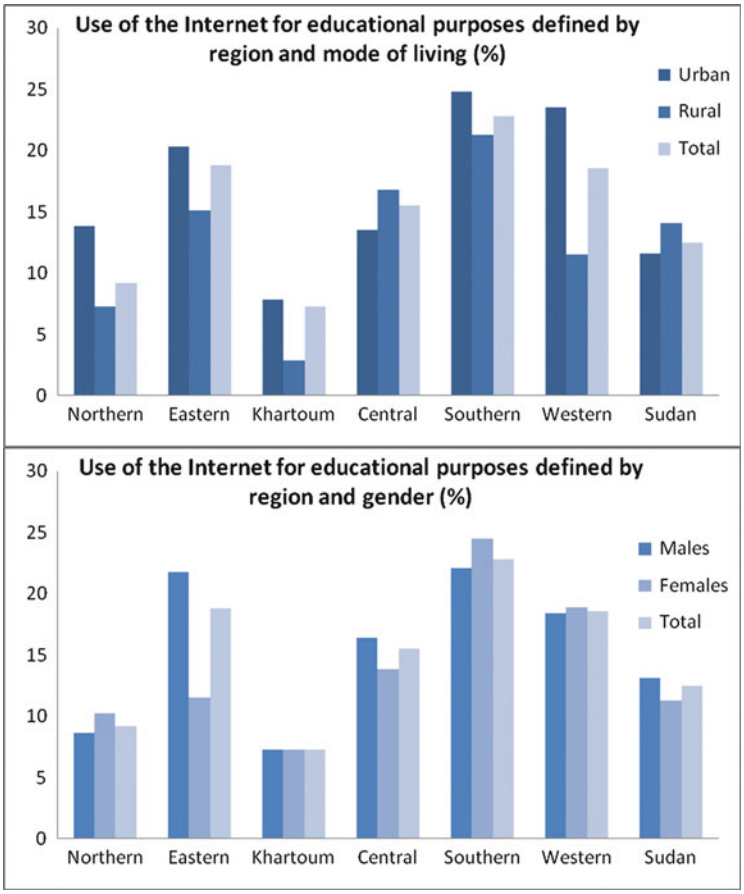

Fig. 6.16 (continued)

(46.6 %) is higher than females (43.9 %) and total Sudan (45.6 %). The regional distribution implies that the highest proportions of individuals used the Internet for other purposes is reported in Khartoum followed by all Sudan, Central, Eastern, Northern, Southern and Western regions respectively (see Table 6.16 and Fig. 6.16).[87]

[87] As indicated by 60.2 %, 45.6 %, 37 %, 36.1 %, 31.3 %, 25.7 %, and 25 % respectively.

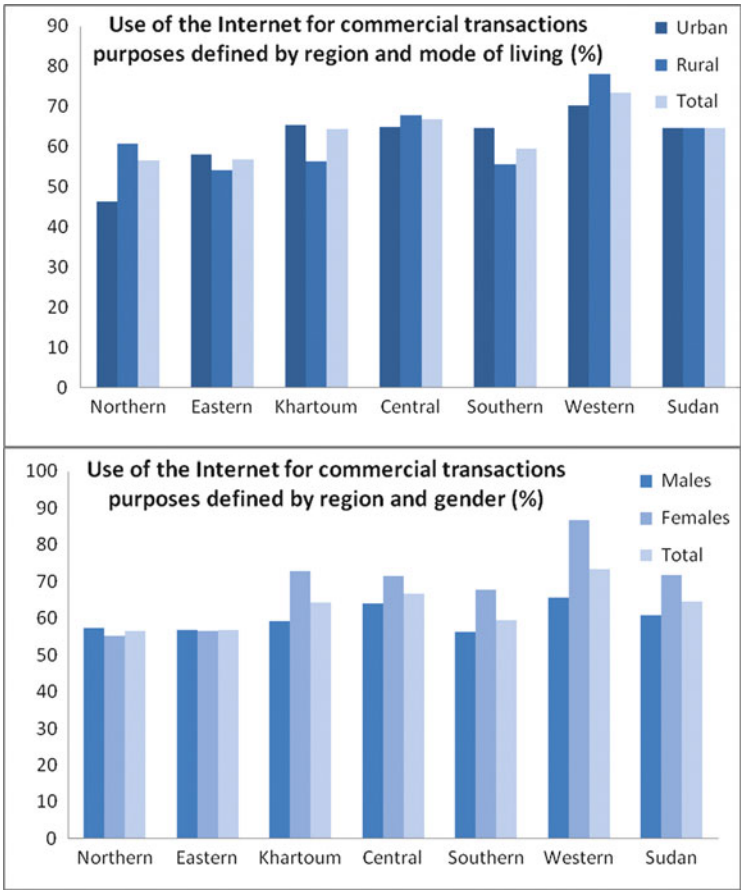

Fig. 6.16 (continued)

6.4.7 Impediment Factors Impeded the Use of the Internet

From the viewpoint of individuals, several impediment factors impeded the use of the Internet. Regarding the factors that hindered the use of the Internet, Table 6.17 explains that the proportions of individuals to use the Internet are impeded by impediment factors such as the non availability of the Internet service, cost, language, and for other reasons defined by region, mode of living and gender. The disparities in ICT indicators appear from the proportions of individuals used the Internet according to factors limit the use of the Internet that implies that for the majority of individuals in Sudan other reasons are the most commonly reasons

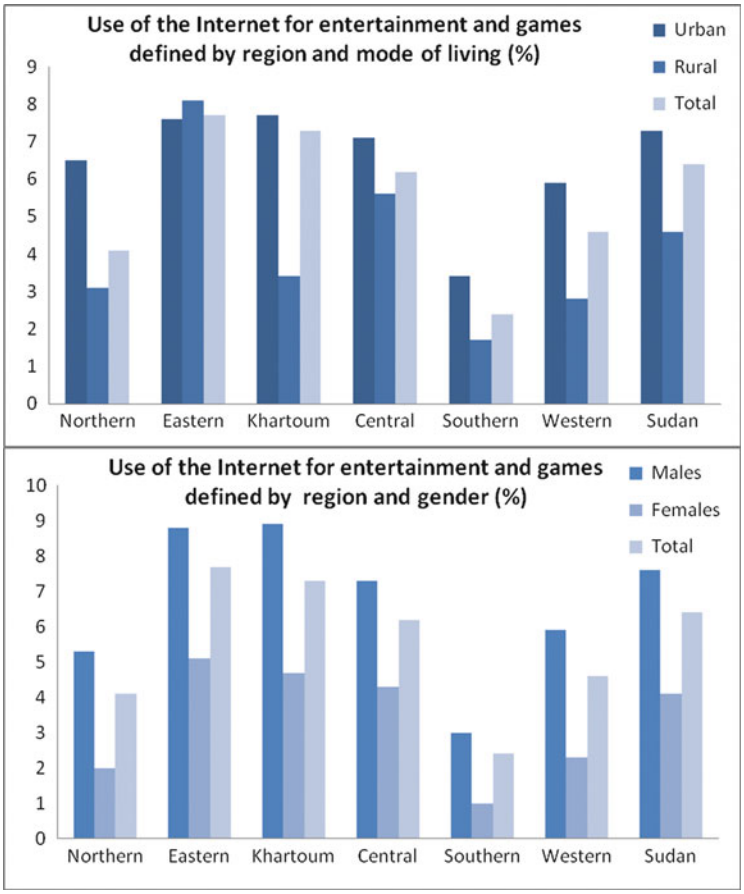

Fig. 6.16 (continued)

impeded the use of the Internet, followed by the cost, non availability of Internet service and the language respectively.[88] For nearly third of individuals in Sudan, the cost and non availability of the Internet service impeded the use of the Internet (see Table 6.17 and Fig. 6.17).

The regional disparities in ICT indicators appear from the proportions of individuals who did not use the Internet due to the non availability of the Internet service of total who did not use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use the Internet due to the non availability of the Internet service of total who did not use the Internet in rural (39.8 %) is nearly twice higher than urban (24.9 %) and for males (35.9 %) is nearly twice higher than females (22.4 %) and total Sudan (30.3 %). The regional distribution implies that the highest proportions of individuals who did not use the Internet due to the non availability of the Internet service,

[88] As indicated by 53.8 %, 30.4 %, 30.3 %, and 3.2 % respectively.

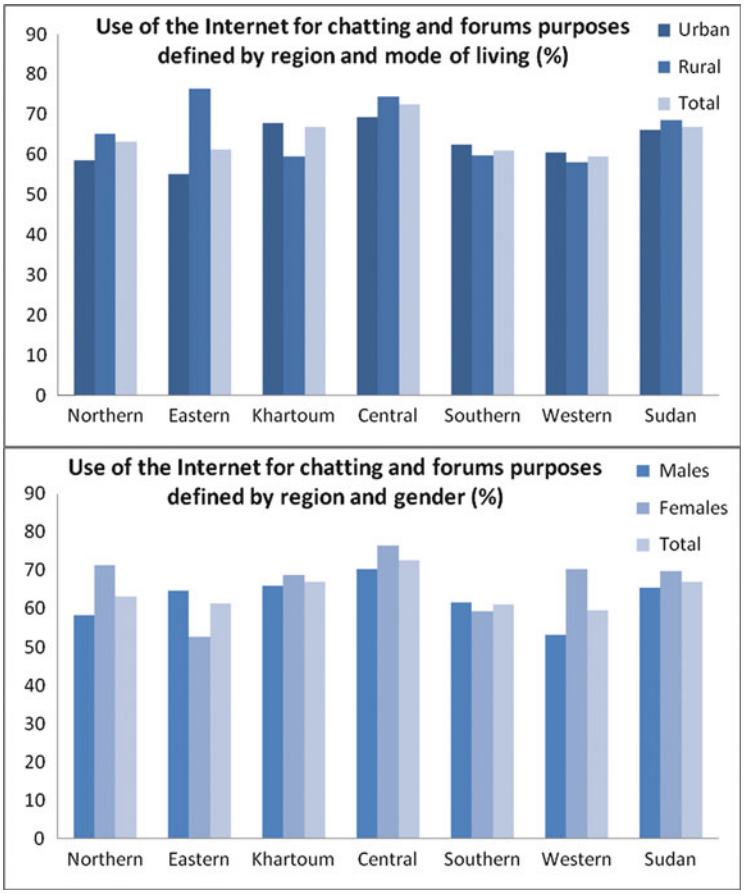

Fig. 6.16 (continued)

of total who did not use the Internet is reported in Eastern region followed by Central region, Southern, all Sudan, Western, Khartoum, and Northern regions respectively.[89]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use the Internet because of the cost of the Internet service of total who did not use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use the Internet because of the cost of the Internet service of total who did not use the Internet in urban (33.1 %) is higher than rural (25.6 %) and for males (32.1 %) is higher than females (27.9 %) and total Sudan (30.4 %). The regional distribution implies that the highest proportions of individuals who did not use the Internet because of the cost of the Internet service of total who did not use the Internet is reported in

[89] As reported by 61.6 %, 38.3 %, 33.6 %, 30.3 %, 21.4 %, 16.6 %, and 10.2 % respectively.

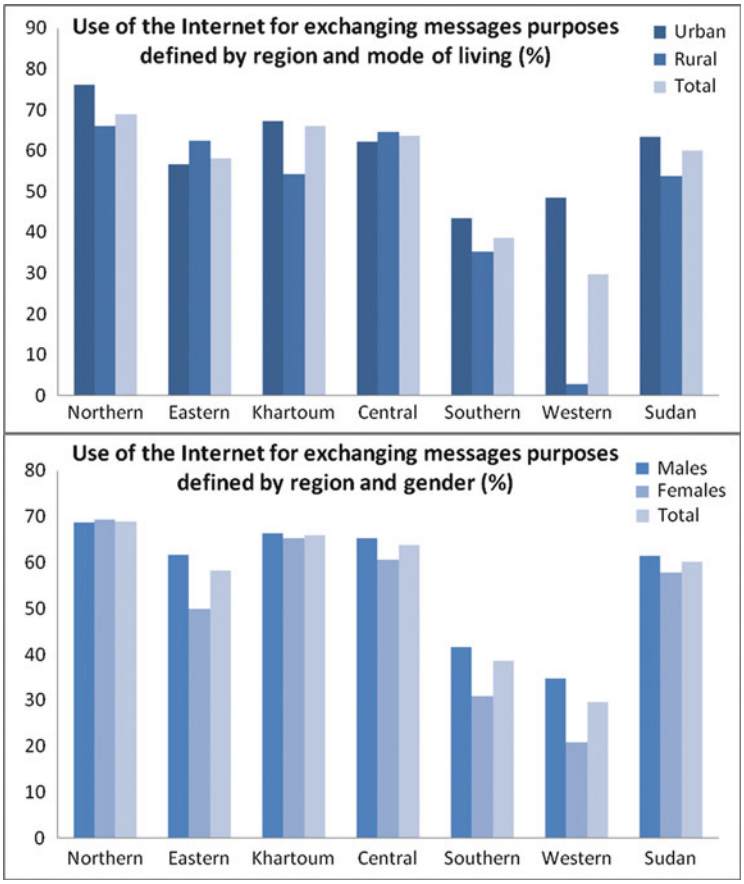

Fig. 6.16 (continued)

Eastern region followed by Khartoum, Southern, Western, all Sudan, Central, and Northern regions respectively.[90]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use the Internet because of the language of total who did not use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals who did not use the Internet because of the language of total who did not use the Internet in rural (4.2 %) is near to twice higher than urban (2.6 %) and for males (4.9 %) is more than six times/higher than females (0.8 %) and total Sudan (3.2 %). The regional distribution implies that the highest proportions of individuals who did not use the Internet because of the language of total who did not use the Internet is reported in Southern region followed by

[90] As indicated by 41.7 %, 36.5 %, 33.5 %, 32.7 %, 30.4 %, 29.5 %, and 0 % respectively.

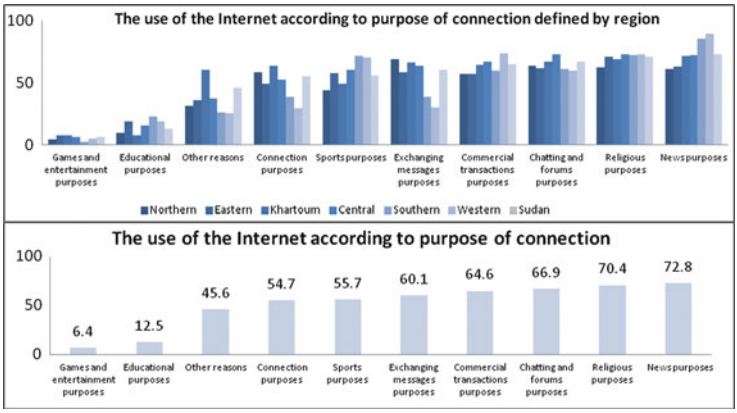

Fig. 6.16 (continued)

Western region, Central, all Sudan, Khartoum, Eastern, and Northern regions respectively.[91]

The regional disparities in ICT indicators appear from the proportions of individuals who did not use the Internet because of other reasons of total who did not use the Internet defined by region, mode of living and gender in Sudan. That implies that the proportions of individuals' who did not use the Internet because of other reasons of total who did not use the Internet in rural (54.4 %) is higher than urban (53.4 %) and for females (58.6 %) is higher than males (50.4 %) and total Sudan (53.8 %). The regional distribution implies that the highest proportions of individuals who did not use the Internet because of other reasons of total who did not use the Internet is reported in Northern region followed by Southern region, Khartoum, Western, all Sudan, Central, and Eastern regions respectively.[92]

6.4.8 Costs of Connectivity and Use of the Internet

The regional disparities in ICT indicators appear from individuals' viewpoint concerning the cost of using the Internet defined by region, mode of living and gender in Sudan. That implies that the viewpoint of the majority in other region and all Sudan implies that the cost of using the Internet is reasonable followed by high and low respectively.[93] From the viewpoint of the majority of individuals the high cost of using the Internet is reported in Western region followed by Northern region, Eastern, Southern, all Sudan, Khartoum, and Central regions respectively.[94] From the viewpoint of some people the reasonable cost of using the Internet is

[91] As reported by 16.4 %, 7.8 %, 4.5 %, 3.2 %, 0 %, 0 %, and 0 % respectively.

[92] As indicated by 89.8 %, 64.8 %, 61.3 %, 54 %, 53.8 %, 41.6 %, and 31.3 % respectively.

[93] As indicated by 67.4 %, 29.4 %, and 3.2 % respectively.

[94] As reported by 43.1 %, 39 %, 35.2 %, 30.6 %, 28.5 %, 28 %, and 21.1 % respectively.

Table 6.17 Factors limit the use of the Internet defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Non availability of services	Mode of living	Urban	0	47.1	16.3	27.6	56.4	21.4	24.9
		Rural	16	89	18	50.2	13.6	0	39.8
	Gender	Males	0	60.9	21.4	47.6	30.3	25	35.9
		Females	22.2	66.7	12.2	26.9	45.6	15.4	22.4
	Region		10.2	61.6	16.6	38.3	33.6	21.4	30.3
Cost	Mode of living	Urban	0	34.8	43.1	28	19.7	32.7	33.1
		Rural	0	54.8	0	31.1	45.5	0	25.6
	Gender	Males	0	47.8	42.9	26.3	30.2	29.2	32.1
		Females	0	0	30.5	33.3	45.3	38.5	27.9
	Region		0	41.7	36.5	29.5	33.5	32.7	30.4
Language	Mode of living	Urban	0	0	0	6.5	3.9	7.8	2.6
		Rural	0	0	0	2.3	27.3	0	4.2
	Gender	Males	0	0	0	6.5	20.8	12.5	4.9
		Females	0	0	0	2	0	0	0.8
	Region		0	0	0	4.5	16.4	7.8	3.2
Other reasons	Mode of living	Urban	100	18.9	59.2	49.1	55.7	54	53.4
		Rural	84	54.8	73	33.3	72.7	0	54.4
	Gender	Males	100	26.1	52.4	41.9	65.1	54.2	50.4
		Females	77.8	66.6	69.5	41.2	63.9	53.8	58.6
	Region		89.8	31.3	61.3	41.6	64.8	54	53.8

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

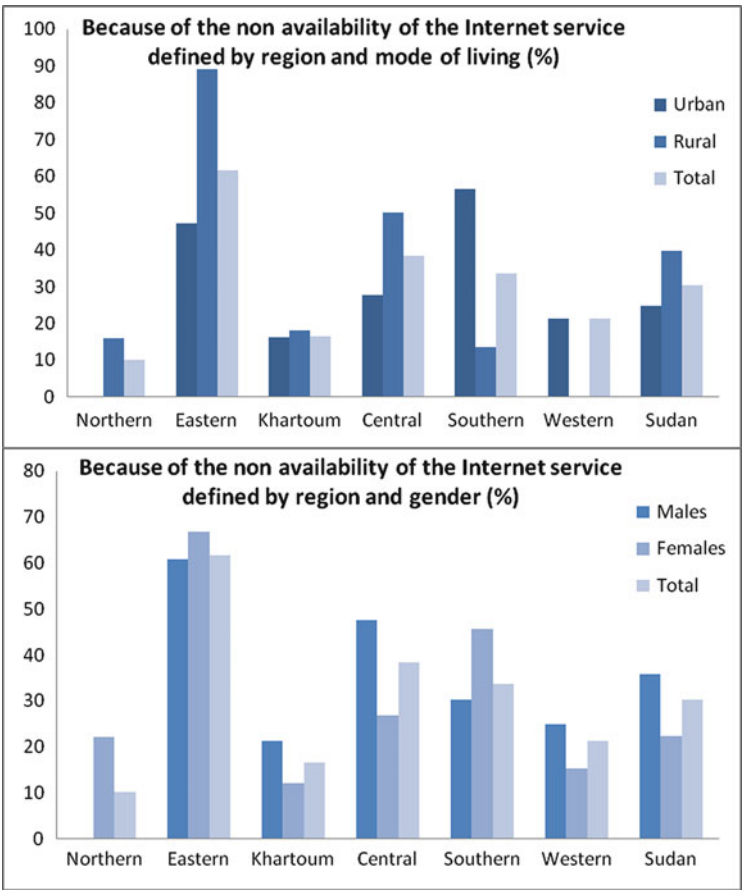

Fig. 6.17 Factors limit the use of the Internet defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

reported in Central region followed by Khartoum, all Sudan, Southern, Northern, Eastern, and Western regions respectively.[95] From the viewpoint of few people the low cost of using the Internet is reported in Eastern region followed by Southern, Western, Central, all Sudan, Khartoum, and Northern regions respectively.[96] From individuals' viewpoint the cost of using the Internet and mobile cellular telephone implies that the viewpoint of the majority in Sudan implies that the cost of using the Internet is reasonable followed by high and low respectively, while the cost of using

[95] As indicated by 74.7 %, 68.9 %, 67.4 %, 63.1 %, 59 %, 55.9 %, and 51.9 % respectively.

[96] As reported by 8.8 %, 6.3 %, 5 %, 4.2 %, 4.1 %, 3.1 %, and 2.1 % respectively.

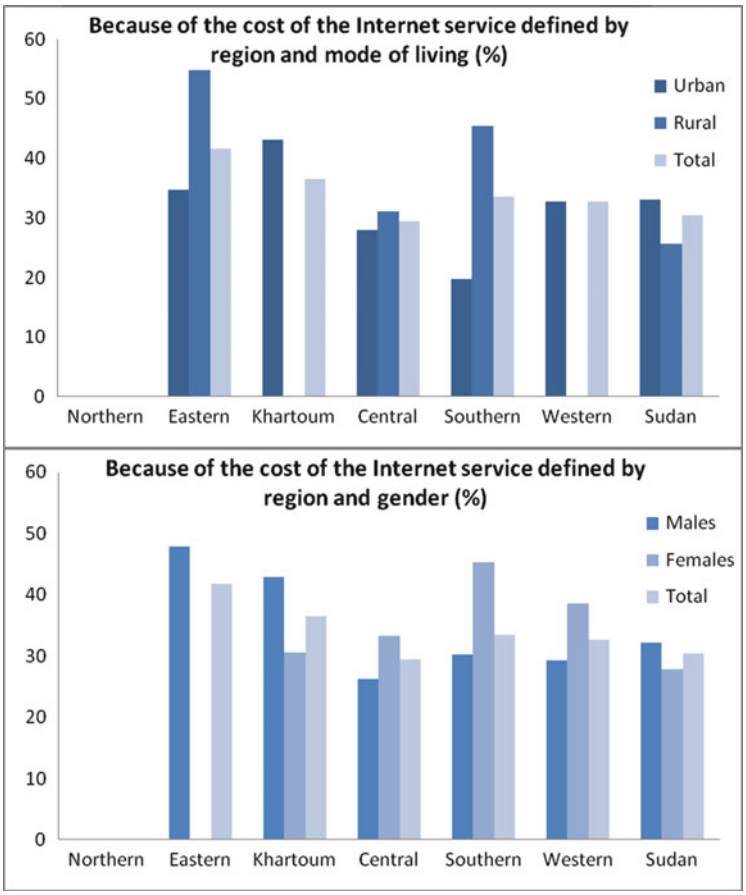

Fig. 6.17 (continued)

mobile cellular telephone is high followed by reasonable and low respectively (Table 6.18 and Fig. 6.18).[97]

[97] As indicated by 67.4 %, 29.4 %, and 3.2 % for the Internet and as indicated by for mobile cellular telephone respectively.

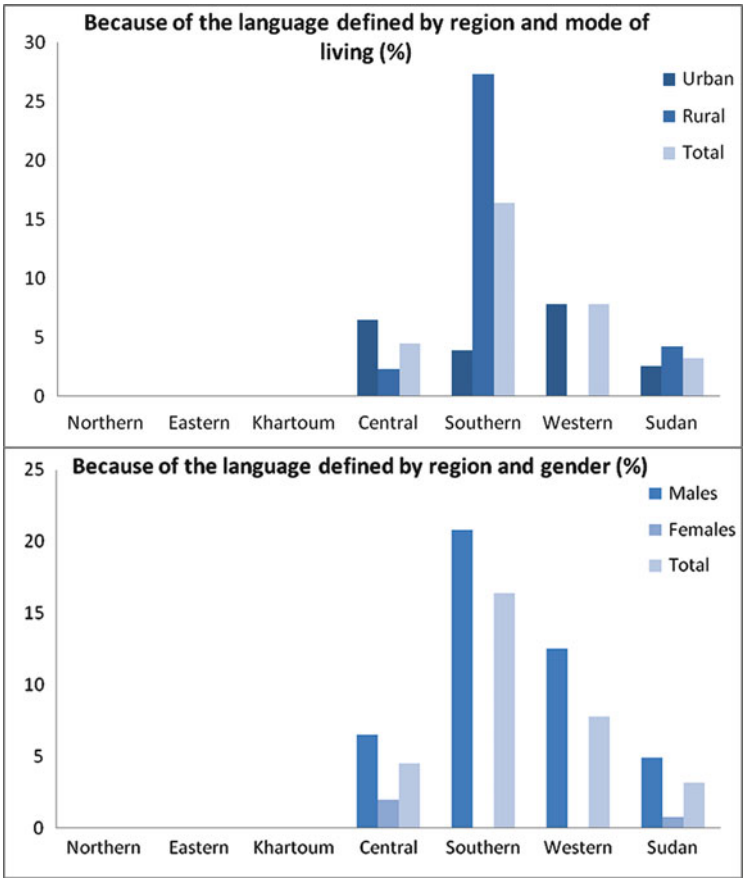

Fig. 6.17 (continued)

6.5 Determinants of the Digital Divide

This section examines the determinants of the digital divide that appears from the relationships between the use of ICT (mobile, computer and Internet) and age, educational and professional levels, and the use of ICT and per capita income, poverty and urbanization.

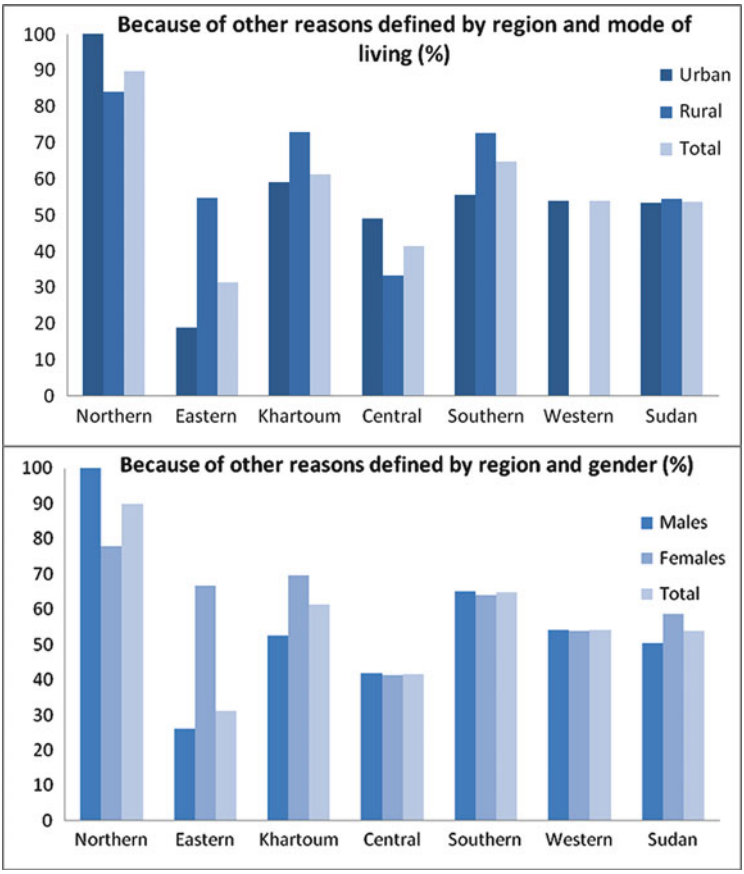

Fig. 6.17 (continued)

6.5.1 Relationships Between the Use of ICT, Age, Educational Level and Professional Level

This section examines the relationships between the use of mobile, computer and Internet and age, educational and professional levels. Table 6.19 explains the distribution of individuals used mobile at least once during the year 2011, computer at home and outside home and Internet defined by age, educational and professional levels (see Table 6.19, Figs. 6.19 and 6.20).

We examine the relationship between the use of ICT and educational level appear from the proportions and distribution of individuals used computer at home and outside home and the Internet defined by age and educational level in Sudan. We find positive relationship between the proportion of individuals used computer at home and outside home and the Internet and educational level that

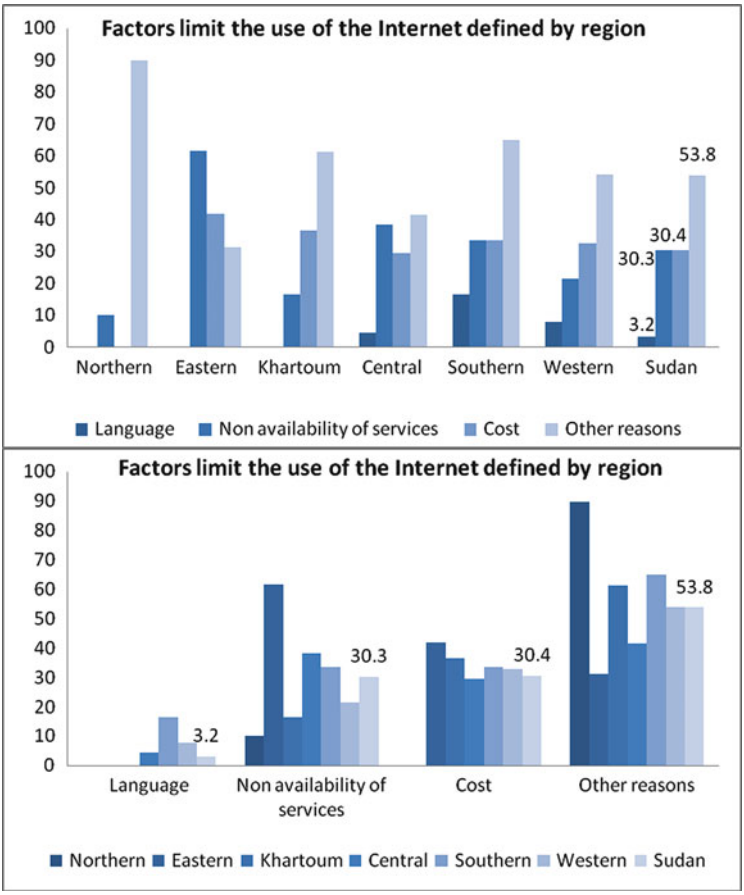

Fig. 6.17 (continued)

implies that the proportions of individuals used computer at home and outside home increases with the level of education, it is higher for university level, followed by secondary, basic, literate and illiterate levels respectively.[98,99,100] We find negative relationship between the proportion of individual use of computer at home and outside home and the Internet and age that implies that the proportions of individuals used computer at home and outside home and the Internet decreases with the

[98] As reported by 54.6 %, 37.5 %, 6.9 %, 1 %, and 0 % respectively for at home.
[99] As indicated by 50.6 %, 38.5 %, 9.5 %, 1.3 %, and 0.1 % respectively for outside home.
[100] As indicated by 47.1 %, 39.5 %, 11.4 %, 1.8 %, and 0.2 % respectively for Internet.

Table 6.18 Cost of using Internet from the viewpoint of individuals defined by region, mode of living and gender in Sudan during 2011

			Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Southern (%)	Western (%)	Sudan (%)
Gender	Males	High	34.1	32.2	26.7	23.1	30.7	38.9	27.7
		Reasonable	62.6	59.1	70	73.1	62.1	55	67.9
		Low	3.3	8.7	3.3	3.8	7.2	6	4.4
	Females	High	47	42.7	30.2	17.3	30.4	50.2	29.8
		Reasonable	53	48	67.2	77.7	65.9	46.5	66.5
		Low	0	9	2.6	4.8	3.3	3.3	3.6
	Total	high	39	35.2	28	21.1	30.6	43.1	28.5
		reasonable	59	55.9	68.9	74.7	63.1	51.9	67.4
		low	2.1	8.8	3.1	4.2	6.3	5	4.1
		Total	100	100	100	100	100	100	100
Mode of living	Urban	High	9.1	34.8	28.5	17.6	33.4	40.9	28
		Reasonable	88.8	54.3	68.4	76.6	59	52.5	67.4
		Low	2.2	11	3.1	5.7	7.6	6.6	4.6
	Rural	High	51.5	36.4	23.5	23.2	28.6	46.2	29.4
		Reasonable	46.5	60	74.2	73.5	66.1	51	67.4
		Low	2	3.6	2.3	3.3	5.3	2.8	3.2
	Total	High	39	35.2	28	21.1	30.6	43.1	28.5
		Reasonable	59	55.9	68.9	74.7	63.1	51.9	67.4
		Low	2.1	8.8	3.1	4.2	6.3	5	4.1
		Total	100	100	100	100	100	100	100

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

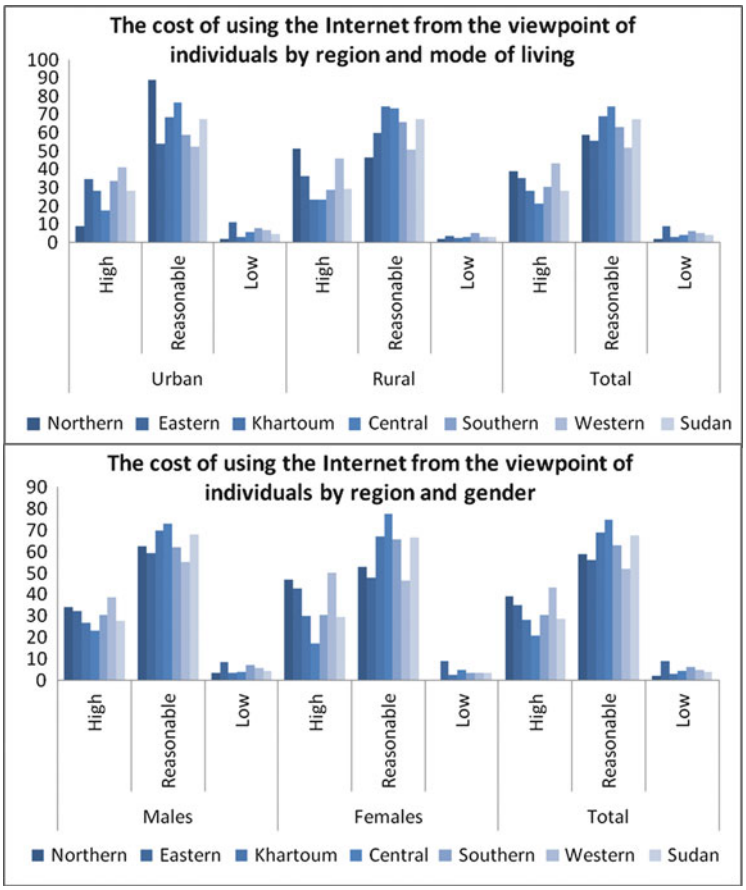

Fig. 6.18 Cost of using Internet from the viewpoint of individuals defined by region, mode of living and gender in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

increase of age, it is higher for age (15–24) followed by age (25–34), (35–44), (45–54), (55–64), (65–74), and (75) respectively (see Table 6.19, Figs. 6.19 and 6.20).[101,102,103]

We examine the relationship between the use of ICT and professional level appear from the proportions and distribution of individuals used computer at home

[101] As indicated by 43.6 %, 29.2 %, 14.3 %, 9.1 %, 3.4 %, 0.4 % and 0 % respectively for at home.

[102] As reported by 45.1 %, 31.3 %, 14.6 %, 6.8 %, 1.8 %, 0.3 %, and 0.1 % respectively for outside home.

[103] As indicated by 45.7 %, 30.6 %, 14.6 %, 6.7 %, 2 %, 0.4 %, and 0.1 % respectively for Internet.

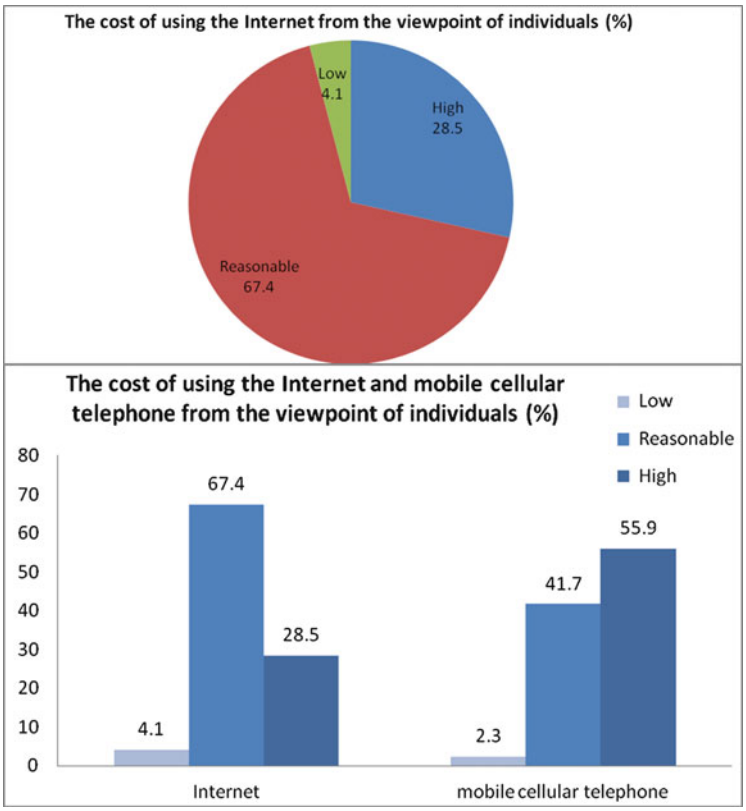

Fig. 6.18 (continued)

and outside home defined by age and professional level in Sudan. The distribution of individuals used computer at home implies that the relative distribution defined by professional level is higher for professional level, followed by services workers, clerks, technical, simple jobs, regular workers, executive and legislative, craftsmen, agricultural workers, and operational workers respectively.[104] The distribution of individuals used computer outside home implies that the relative distribution defined by professional level is higher for professional level, followed by services workers, clerks, technical, regular workers, simple jobs, craftsmen, executive and legislative, agricultural workers, and operational workers respectively.[105] The

[104] As indicated by 37.4 %, 17.8 %, 13 %, 8.3 %, 7.3 %, 5.8 %, 3.9 %, 3.3 %, 2.5 %, and 0.7 % respectively for at home.

[105] As indicated by 33.8 %, 17 %, 11.5 %, 9.5 %, 8.6 %, 7.8 %, 4.4 %, 3.6 %, 2.9 %, and 1.1 % respectively for outside home.

Table 6.19 The use of mobile at least once during 2011, computer and Internet defined by age, educational level and professional level in Sudan during 2011

			15–24	25–34	35–44	45–54	55–64	65–74	75	Sudan (%)
Used a mobile	Age and educational level	Illiterate	2.2	2.8	3.5	3.7	2.2	1.4		16.4
		Literate	3.2	2.7	2.9	2.5	1.8	1		14.5
		Basic	11.2	6.1	4.4	2.6	1.2	0.4		26
		Secondary	13	6.2	4.5	2.5	1	0.3		27.6
		University	3.9	6.3	2.9	1.5	0.6	0.2		15.5
		Sudan	33.5	24.1	18.1	12.9	6.8	3.3		100
	Age and professional level	Executive and legislative	0	0.2	0.3	0.4	0.2	0		1.2
		Professional	0.6	4	3.3	2.1	0.8	0.1		11
		Technical	0.4	1.4	1.4	1.1	0.6	0.1		5
		Clerks	0.4	1.5	1.2	0.8	0.3	0		4.2
		Services workers	2	4.2	4.7	3.4	1.7	0.7		16.8
		Agricultural workers	3.3	5	4.6	4.3	2.8	1.4		21.6
		Craftsmen	1.5	2.4	1.9	1.1	0.6	0.2		7.6
		Operational workers	0.3	0.6	0.7	0.4	0.2	0		2.2
		Simple jobs	4.3	6	6.6	4.7	2.5	1.1		25.4
		Regular workers	1.2	1.8	1.2	0.5	0.2	0		4.9
		Total	13.8	27.2	25.9	18.8	9.7	3.7		100
Used a computer at home	Age and educational level	Illiterate	0	0	0	0	0	0	0	0
		Literate	0.3	0.1	0.2	0.2	0.1	0.1	0	1
		Basic	5.3	0.5	0.3	0.6	0.1	0	0	6.9
		Secondary	23.4	6.4	4.2	2.7	0.9	0	0	37.5
		University	14.6	22.2	9.6	5.6	2.3	0.3	0	54.6
		Sudan	43.5	29.2	14.3	9	3.4	0.5	0.1	100

	Age and professional level	Executive and legislative	0.1	0.3	1.2	1.7	0.6	0	0	3.9
		Professional	3.1	15	10.8	6.3	1.9	0.2	0.1	37.4
		Technical	0.8	3.5	1.6	1.8	0.6	0	0	8.3
		Clerks	0.8	6.4	3.3	2.3	0.3	0	0	13
		Services workers	1.6	6.2	5.7	3	1.3	0	0	17.8
		Agricultural workers	0.4	1.3	0.3	0.5	0.2	0	0	2.5
		Craftsmen	0.8	1.3	0.8	0.2	0.1	0	0	3.3
		Operational workers	0.1	0.1	0.3	0	0.1	0	0	0.7
		Simple jobs	1.3	3.1	1.4	0.9	0.4	0.1	0	7.3
		Regular workers	0.8	2.3	1.6	0.7	0.3	0	0	5.8
		Total	9.8	39.6	27	17.4	5.7	0.3	0.1	100
Used a computer outside home	Age and educational level	Illiterate	0	0	0.1	0	0	0	0	0.1
		Literate	0.5	0.4	0.2	0.1	0.1	0	0	1.3
		Basic	6.9	1.2	0.9	0.4	0.1	0	0	9.5
		Secondary	23.7	7.8	4.7	2	0.3	0	0	38.5
		University	13.9	21.8	8.8	4.4	1.4	0.2	0.1	50.6
		Sudan	45.1	31.3	14.6	6.8	1.8	0.3	0.1	100
	Age and professional level	Executive and legislative	0	0.8	1.2	1.3	0.3	0	0	3.6
		Professional	2.3	14.8	10.5	5	1	0.1	0.1	33.8
		Technical	0.9	4.3	2.1	1.8	0.3	0.1	0	9.5
		Clerks	1.3	5.2	2.7	2	0.3	0.1	0	11.5
		Services workers	2.6	6.4	5.2	2.2	0.5	0	0	17
		Agricultural workers	0.3	1.5	0.8	0.3	0	0	0	2.9
		Craftsmen	1.5	1.3	1.2	0.4	0	0	0	4.4
		Operational workers	0	0.3	0.5	0.1	0.1	0	0	1.1
		Simple jobs	2	3.2	1.7	0.5	0.4	0	0.1	7.8
		Regular workers	1.9	3.6	2.1	0.8	0.2	0	0	8.6
		Total	12.7	41.5	28	14.3	3.1	0.3	0.2	100

(continued)

Table 6.19 (continued)

			15–24	25–34	35–44	45–54	55–64	65–74	75	Sudan (%)
Used the Internet	Age and educational level	Illiterate	0	0	0.1	0	0	0	0	0.2
		Literate	0.7	0.4	0.4	0.2	0.1	0	0.1	1.8
		Basic	7.5	2	1.2	0.6	0.1	0	0	11.4
		Secondary	24	8.2	4.7	1.9	0.5	0	0	39.5
		University	13.4	19.9	8.2	4	1.3	0.2	0	47.1
		Sudan	45.7	30.6	14.6	6.7	2	0.4	0.1	100
	Age and professional level	Executive and legislative	0.1	0.4	0.9	1	0.3	0	0	2.8
		Professional	2.5	12.7	8.9	4.9	1	0.1	0.1	30.1
		Technical	1	3.3	2.3	1.3	0.2	0	0	8.1
		Clerks	1	5.1	2.7	1.5	0.3	0.1	0	10.7
		Services workers	2.7	7.2	5.8	1.9	0.7	0	0	18.4
		Agricultural workers	0.7	1.8	1.2	0.5	0.1	0.1	0	4.3
		Craftsmen	1.5	2	1.3	0.4	0	0	0	5.2
		Operational workers	0.3	0.3	0.6	0	0.1	0	0	1.4
		Simple jobs	2.5	4	2.5	0.6	0.3	0	0.1	10
		Regular workers	2.1	4	2	0.9	0.2	0	0	9.2
		Total	14.5	40.7	28.2	13	3.2	0.2	0.2	100

Source Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

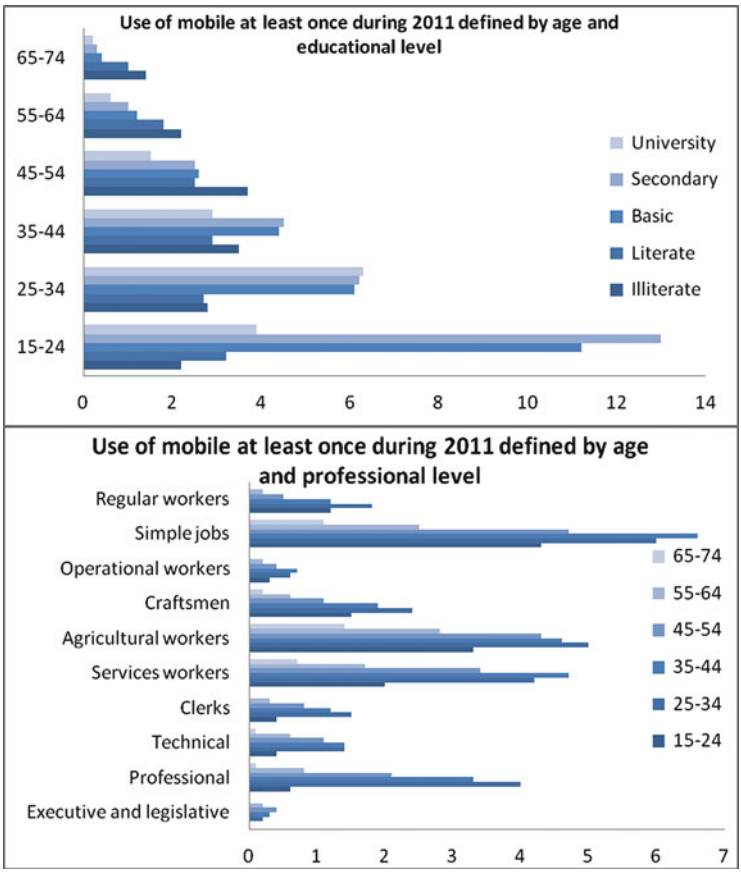

Fig. 6.19 The use of mobile at least once during 2011, computer and Internet defined by age, educational level and professional level in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

relative distribution at home and outside home defined by age is higher for age (25–34), followed by (35–44), (45–54), (15–24), (55–64), (65–74), and (75) respectively (see Table 6.19, Figs. 6.19 and 6.20).[106,107]

We examine the relationship between the use of ICT and educational level appear from the proportions and distribution of individuals used mobile at least once during 2011 defined by age and educational level in Sudan. We find inconclusive relationship between the proportion of individuals used mobile and

[106] As reported by 39.6 %, 27 %, 17.4 %, 9.8 %, 5.7 %, 0.3 %, and 0.1 % respectively for at home.

[107] As reported by 41.5 %, 28 %, 14.3 %, 12.7 %, 3.1 %, 0.3 %, and 0.2 % respectively for outside home.

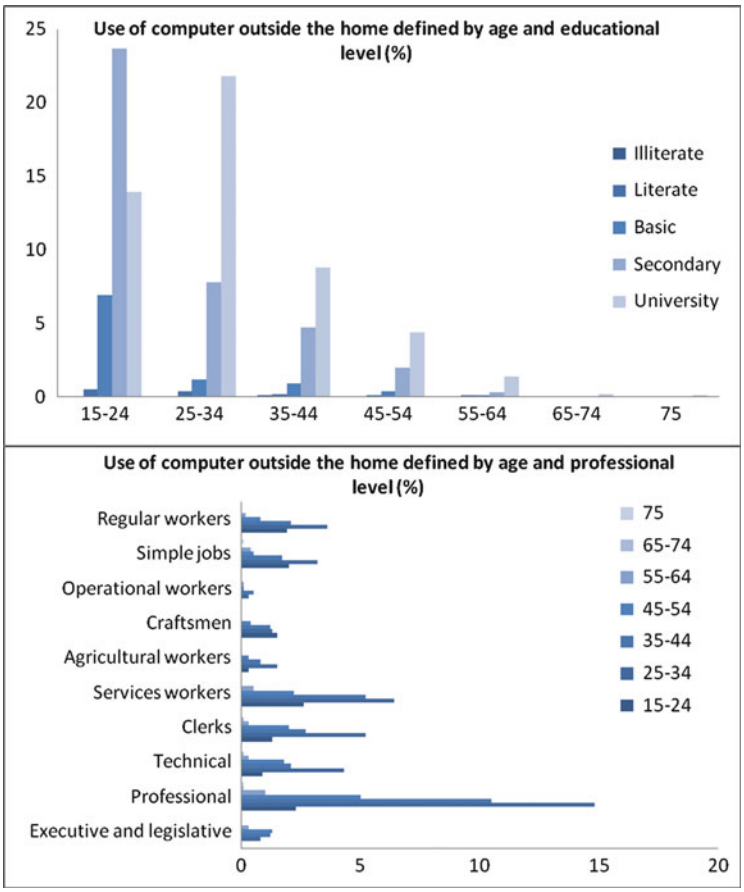

Fig. 6.19 (continued)

educational level that implies higher use of mobile for secondary level, followed by basic, illiterate, university, and literate respectively.[108] We find negative relationship between the use of mobile and age that implies the use of mobile decreases with the increase of age, it is higher for age (15–24) followed by (25–34), (35–44), (45–54), (55–64), and (65–74) respectively (see Table 6.19, Figs. 6.19 and 6.20).[109]

We examine the relationship between the use of ICT and professional level appear from the proportions and distribution of individuals used mobile at least once during the year 2011 defined by age and professional level in Sudan. We find

[108] As indicated by 27.6 %, 26 %, 16.4 %, 15.5 %, and 14.5 % respectively.

[109] As reported by 33.5 %, 24.1 %, 18.1 %, 12.9 %, 6.8 %, and 3.3 % respectively.

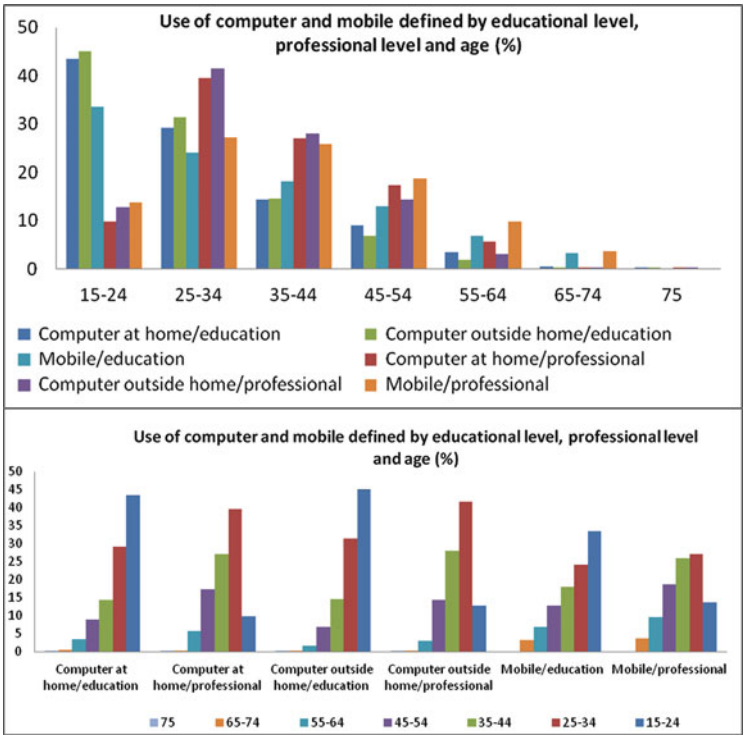

Fig. 6.19 (continued)

that inconclusive relationship between the proportion of individual used mobile and professional level that implies that the distribution defined by professional level is higher for simple jobs, agricultural workers, services workers, professional, craftsmen, technical, regular workers, clerks, operational workers, and executive and legislative respectively.[110] We find negative relationship between the use of mobile and age that implies that the use of mobile decrease with the increase of age, it is higher for age (25–34), followed by (35–44), (45–54), (15–24), (55–64), (65–74), and (75) respectively (see Table 6.19, Figs. 6.19 and 6.20).[111]

The above results are consistent with the OLS regression using E-views program reported in Table 6.20, which indicates the correlations between the use of ICT and

[110] As indicated by 25.4 %, 21.6 %, 16.8 %, 11 %, 7.6 %, 5 %, 4.9 %, 4.2 %, 2.2 %, and 1.2 % respectively.

[111] As reported by 13.8 %, 27.2 %, 25.9 %, 18.8 %, 9.7 % and 3.7 % respectively.

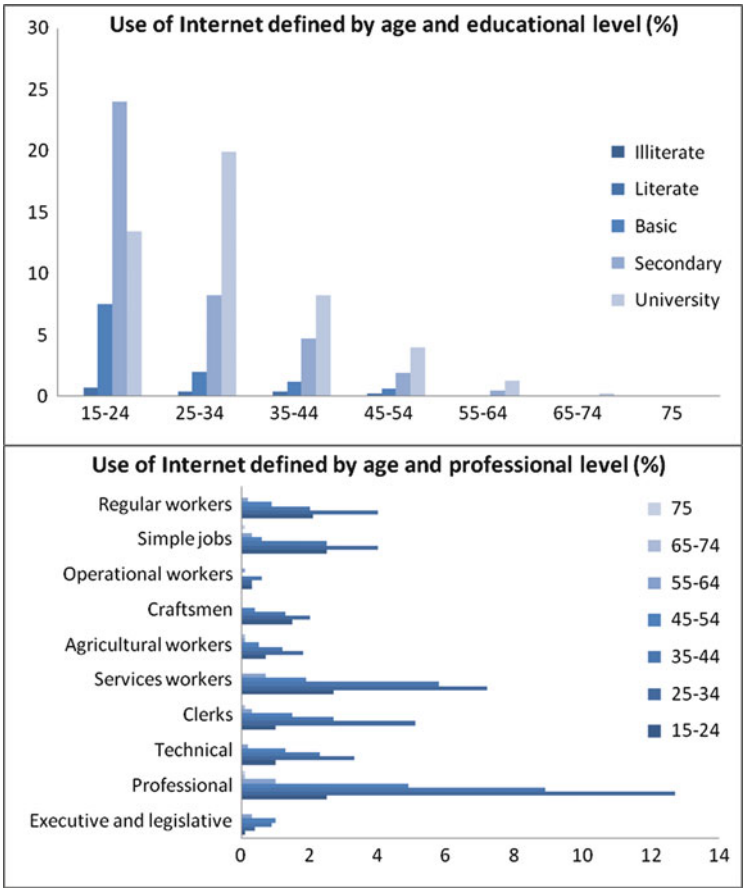

Fig. 6.19 (continued)

education level and age For instance, Table 6.20 illustrates plausible positive significant correlations between the use of ICT (mobile, computer and Internet) and education level and plausible negative significant correlations between the use of ICT (mobile, computer and Internet) and age. Our findings support our results from Table 6.19 that indicate that the increase in education level and decrease in age would imply increase in the use of ICT in Sudan and therefore, the use of ICT is increasing in education and decreasing in age. Our results are consistent with the results in the international literature (See Chinn and Fairlie 2004; Dasgupta et al. 2001; ITU 2013; OECD 2001). Our results in Table 6.20 imply that the correlations

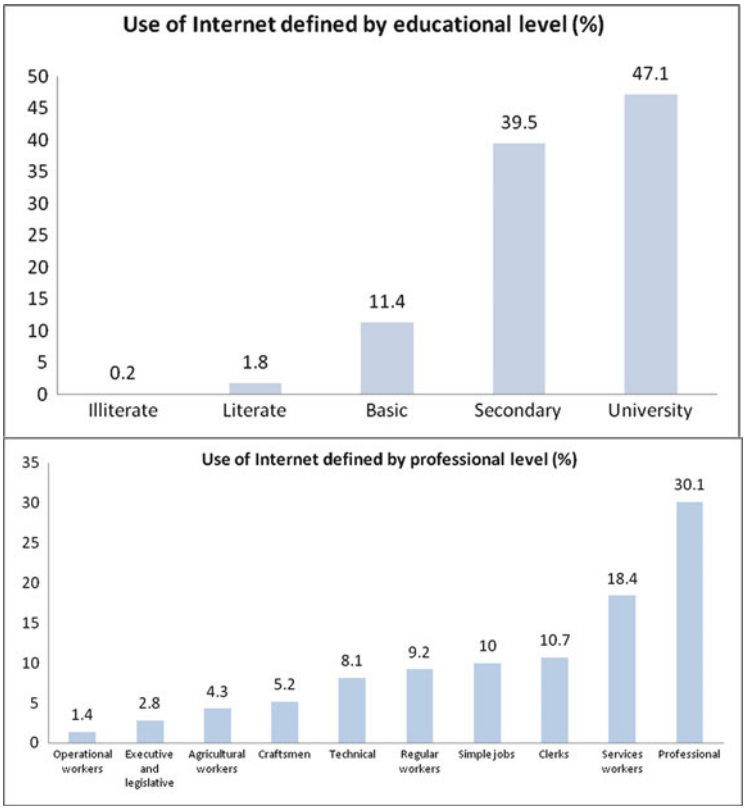

Fig. 6.19 (continued)

between education and the use of computer seem more significant than the correlations between education and use of Internet and use of mobile respectively These results are plausible and seem consistent with the findings in the literature that imply that according to computers may require substantial levels of education for use, but telephones and the Internet may require very little (cf. Dasgupta et al. 2001). Our results in this chapter presented in Tables 6.19 and 6.20 confirm the seventh hypothesis in Chap. 1 about the relationship between the use of ICT and the incidence of the digital divide defined by age and educational level in Sudan.

We use the OLS and the data in the data from Table 6.21. We examine the relationship between the use of ICT and net enrolment rate in primary education, literacy rate and the share in total population: Table 6.22 illustrates plausible

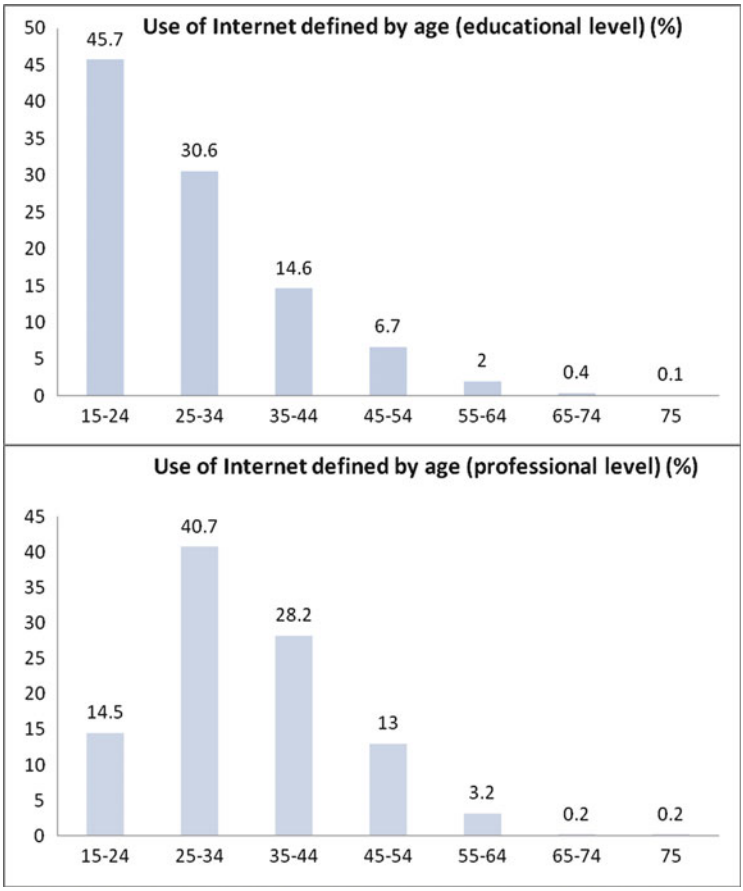

Fig. 6.19 (continued)

positive significant correlations between the use of ICT and net enrolment rate in primary education, literacy rate and the share in total population. We find positive significant correlation between ownership of mobile and computer, use of mobile, computer and Internet, knowledge of computer and Internet and provision of computer and both net enrolment rate in primary education and literacy rate. We find positive significant correlation between the use of Internet and the share in total population. Our findings imply that the increase in net enrolment rate in primary

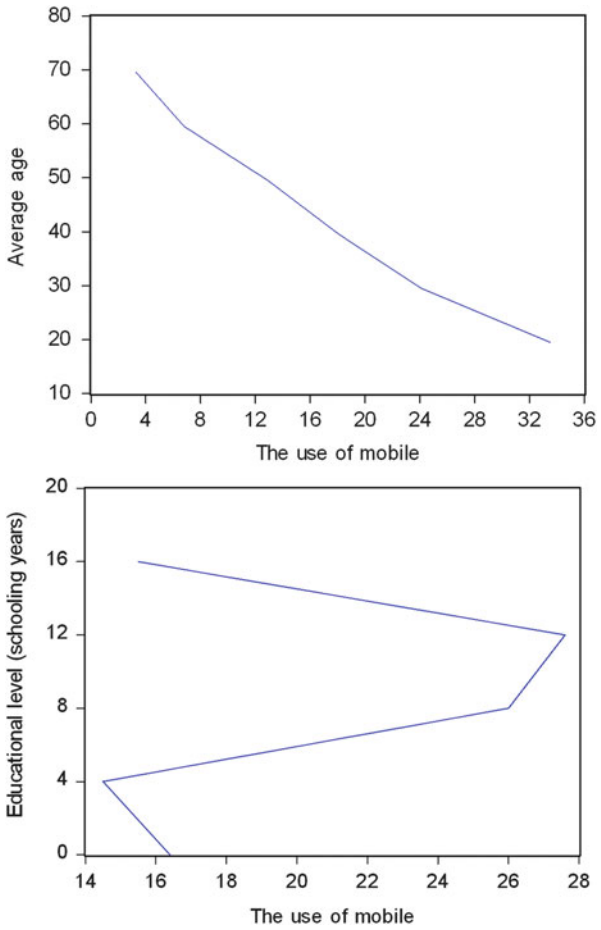

Fig. 6.20 The use of mobile at least once during 2011, computer and Internet defined by age and educational level in Sudan during 2011 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012")

education and literacy rate would imply increase in the use of ICT in Sudan. Our results are consistent with the results in the international literature (See Chinn and Fairlie 2004; Dasgupta et al.2001; ITU 2013; OECD 2001).

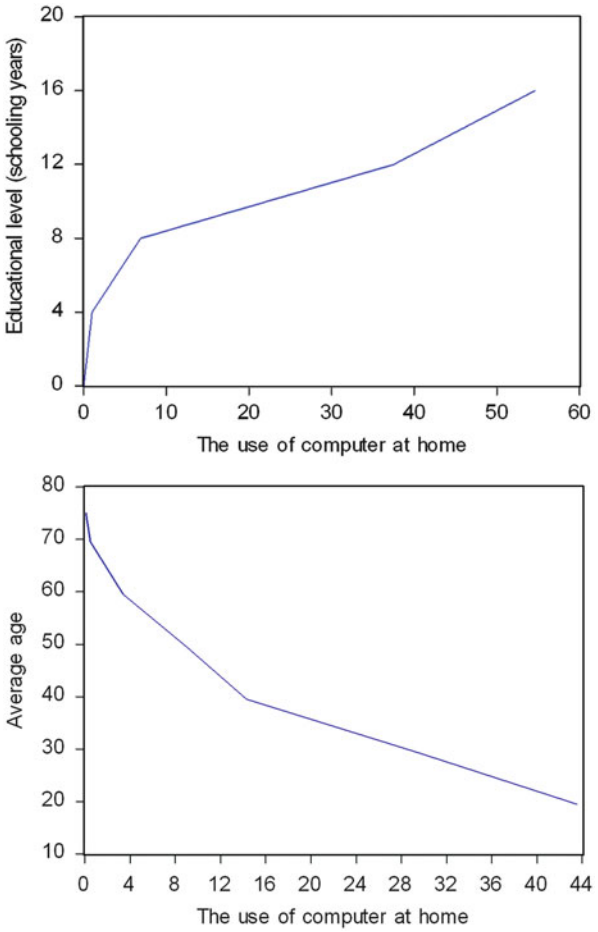

Fig. 6.20 (continued)

6.5.2 Relationships Between the Use of ICT, Per Capita Income, Poverty and Urbanization

We examine the relationship between the use of ICT and per capita income, poverty gap ratio and rate of urbanization: Table 6.23 illustrates plausible positive significant correlations between the use of ICT and both per capita income and rate of urbanization and negative correlation between the use of ICT and poverty gap ratio. We find positive significant correlation between ownership of mobile and

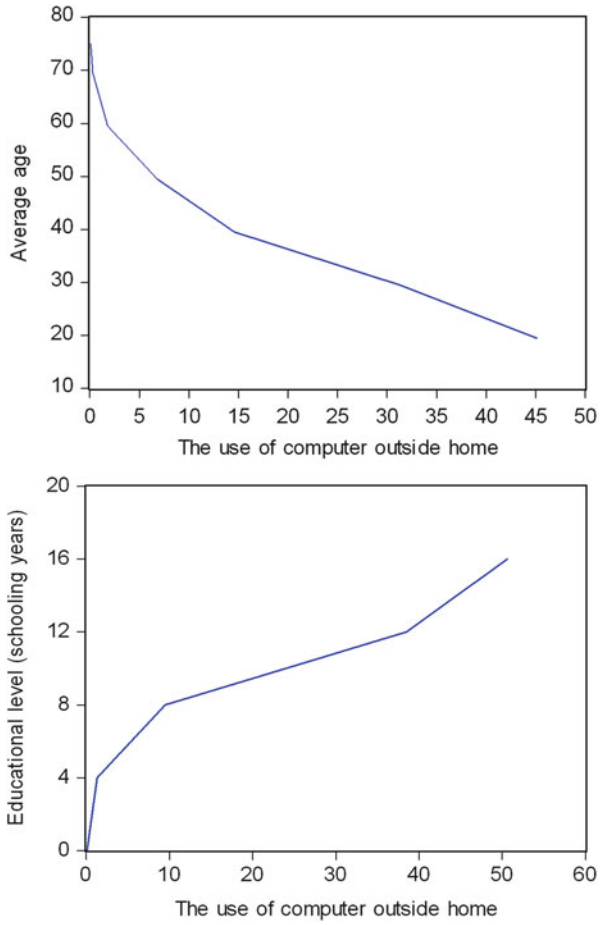

Fig. 6.20 (continued)

computer, use of mobile, computer and Internet, knowledge of computer and Internet and provision of computer and per capita income. We find negative significant correlation between ownership of mobile and computer, use of mobile, computer and Internet, knowledge of computer and Internet and provision of computer and poverty gap ratio. We find positive correlation between ownership and use of mobile and rate of urbanization, and positive significant correlation between ownership of computer, use of computer and Internet, knowledge of computer and Internet and provision of computer and rate of urbanization. Our

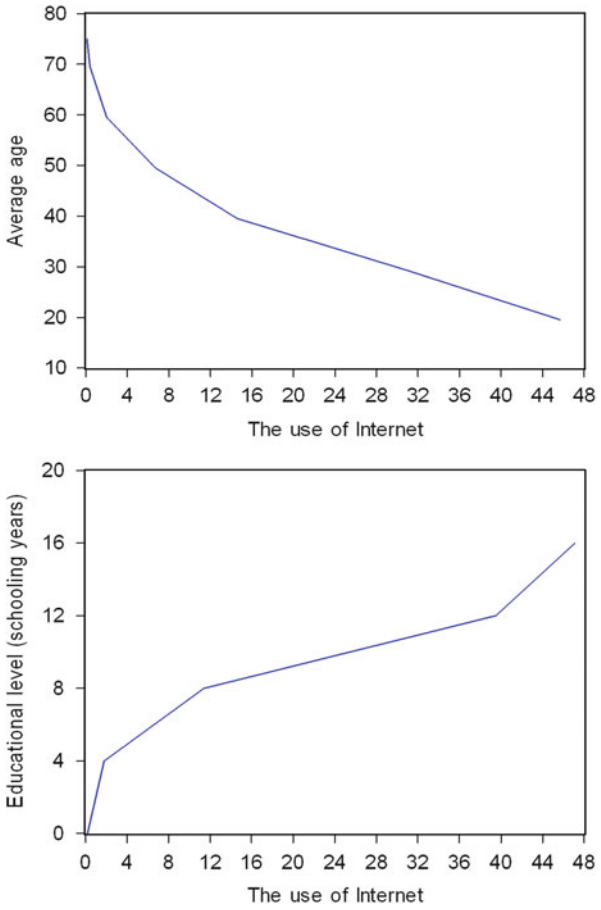

Fig. 6.20 (continued)

findings imply that the increase in per capita income, decline in poverty rate and increase in urbanization rate would imply increase in the use of ICT in Sudan. Our results are consistent with the results in the international literature (See Chinn and Fairlie 2004; Dasgupta et al. 2001; ITU 2013; OECD 2001).

Table 6.20 Correlation between the use of ICT and education and age in Sudan (defined by education, age and region) during 2011

		Coefficient (t-value)				
Independent variables		Education	Age	Constant	R^2	N
Dependent variable (use of ICT)						
Mobile	All Sudan	0.162 (0.428)		2.644 (3.107)	0.083809	4
	All regions	0.053 (0.549)		2.870 (3.063)	0.010648	4
	All Sudan		−1.692** (−5.088)	8.819 (7.102)	0.866168	4
	All regions		−1.675** (−6.053)	7.025 (6.797)	0.566844	4
Computer at home	All Sudan	3.019** (11.311)		−4.196 (−7.010)	0.984608	4
	All regions	2.675** (5.505)		−5.702 (−5.244)	0.602427	4
	All Sudan		−4.020** (−4.148)	16.725 (4.513)	0.774795	4
	All regions		−2.191** (−2.531)	8.129 (2.548)	0.242600	4
Computer outside home	All Sudan	2.763** (10.805)		−3.503 (−6.111)	0.983158	4
	All regions	1.899** (2.898)		−4.108 (−2.729)	0.295703	4
	All Sudan		−4.370** (−4.941)	17.8697 (5.284)	0.830012	4
	All regions		−2.821406 (−3.691551)	10.373 (3.679)	0.393546	4
Internet	All Sudan	2.476** (9.305)		−2.761 (−4.629)	0.977423	4
	All regions	2.088** (3.831)		−4.252 (−3.488)	0.423237	4
	All Sudan		−4.262** (−4.910)	17.511 (5.276)	0.828231	4
	All regions		−2.819** (−4.002)	10.501 (4.042)	0.432679	4

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

Table 6.21 Regional disparity in the use of ICT, per capita income, poverty, education literacy and urbanization in Sudan during 2005–2011

Region	Year	Northern (%)	Eastern (%)	Khartoum (%)	Central (%)	Western (%)	Total (%)
Population[a]	2008	1,819	4,534	5,274	7,423	5,922	30,893
	2008	5 %	12 %	13 %	19 %	15 %	100 %
Revenues[b]	2005	14,853	25,382	15,678	19,267	10,087	95,354
	2005	16 %	27 %	16 %	20 %	11 %	100 %
Actual per capita federal Allocation[b]	2005	9,068	2,553	8,497	4,872	3,249	5,248
Urbanization[b]	2005	27 %	43 %	88 %	29 %	25 %	39 %
Poverty gap ratio[c]	2009	9.4	17.7	6.4	13.8	24	16.2
Net enrolment rate in primary education[c]	2009	83	57	85	67	61	67
Literacy rate of 15–24-year olds[c]	2009	88	63	94	77	72	77
Individual used mobile[d]	2011	90.7	77.4	93	85.7	87.9	87.1
Household owned mobile[d]	2011	98.6	79.5	97.6	93.4	92.7	92.2
Household used mobile[d]	2011	97.1	88.8	98.1	95.7	95.5	95.2
Household owned computer[d]	2011	8.8	5.4	34.4	12	10.4	14
Household used computer[d]	2011	23.3	14.3	50.6	27.4	27	29.7
Individual have the knowledge to use computer[d]	2011	14.8	9.2	41.9	15.6	10.9	19.4
Individual provided with a computer at home[d]	2011	6	4.1	28.6	7.4	3.4	10.5
Individual used a computer at home[d]	2011	95.5	94.3	95.5	96.3	96.3	95.4
Individual used a computer outside home[d]	2011	64.9	59.4	59.2	68.3	71.1	64.4
Proportions of households with access to the internet[d]	2011	16.9	14.8	49.4	29	25.4	29.3
Have the knowledge how to use the internet[d]	2011	10.7	9	37	15.5	7.2	17.3
Used internet[d]	2011	86.9	92	96.3	93.1	97.7	94.6
Have e-mail[d]	2011	56.9	40.5	68	50.2	30.9	55

[a]Adapted from Sudan Central Bureau of Statistics Population Census Data (2010), in thousands: The Fifth Sudan Population and Housing Census (2008)
[b]Elbadawi and Suleiman (2008, p 107)
[c]The Sudan Central Bureau of Statistics (2011, p. 12)
[d]Adapted from National Telecommunication Corporation (NTC) (2012) "Households and individuals ICT survey 2012"

Table 6.22 Correlation between the use of ICT and education, literacy and population in Sudan during 2005–2011

			Coefficient (t-value)				R^2
Independent variables			Education	Literacy	Population	Constant	
Dependent variable (use of ICT)							
Mobile	Ownership	Household	0.398** (2.564)			2.834 (4.2999)	0.687
		Household		0.490** (3.645)		2.388 (4.074)	0.816
	Use	Household	0.176** (2.365)			3.808 (12.076)	0.651
		Household		0.222** (3.614)		3.587 (13.407)	0.813
		Individual	0.333** (2.749)			3.048 (5.915)	0.716
		Individual		0.412** (4.195)		2.669 (6.239)	0.854
Computer	Ownership	Household	2.579* (1.615)			−8.502 (−1.253)	0.465
		Household		3.359** (2.201)		−12.189 (−1.832)	0.617
	Use	Household	1.744* (1.674)			−4.133 (−0.934)	0.483
		Household		2.314** (2.446)		−6.814 (−1.652)	0.666
		Individual (at home)	0.009 (0.313)			4.524 (39.255)	0.032
		Individual (at home)		0.019 (0.6496)		4.477 (35.204)	0.123

(continued)

Table 6.22 (continued)

			Coefficient (t-value)				R^2
Independent variables			Education	Literacy	Population	Constant	
	Knowledge of computer	Individual	2.629** (2.343)			−8.3998 (−1.763)	0.647
		Individual		3.146** (2.814)		−10.949 (−2.246)	0.725
	Provision of computer	Individual	3.502* (1.973)			−12.905 (−1.712)	0.565
		Individual		4.0899** (2.137)		−15.863 (−1.901)	0.603
Internet	Use	Household	1.266 (0.941)			−2.170 (−0.3795)	0.228
		Household		1.858* (1.367)		−4.888 (−0.825)	0.384
		Individual			0.072** (2.272)	4.687 (67.899)	0.633
		Individual (use E-mail)	1.465** (2.942)			−2.355 (−1.113)	0.743
		Individual (use E-mail)		1.541** (2.327)		−2.851 (−0.988)	0.644
	Knowledge of internet	Individual	2.463* (1.657)			−7.874 (−1.247)	0.478
		Individual		2.907* (1.808)		−10.087 (−1.439)	0.521

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

Table 6.23 Correlation between the use of ICT and per capita income, poverty and urbanization in Sudan during 2005–2011

			Coefficient (t-value)				R^2
Independent variables			Per capita income	Poverty	Urbanization	Constant	
Dependent variable (use of ICT)							
Mobile	Ownership	Household	0.131** (2.8695)			3.406 (8.734)	0.733
		Household		−0.096** (−1.225)		4.768 (23.426)	0.333
		Household			4.118[a] (0.2498)	90.614 (11.320)	0.020
	Use	Household	0.057** (2.524)			4.066 (21.005)	0.6798
		Household		−0.043* (−1.223)		4.665 (50.532)	0.333
		Household			3.116[a] (0.402)	93.719 (24.896)	0.051
		Individual	0.106** (2.689)			3.563 (10.621)	0.707
		Individual		−0.085* (−1.3699)		4.6796 (29.156)	0.385
		Individual			7.596[a] (0.615)	83.719 (13.956)	0.112
Computer	Ownership	Household	0.763* (1.414)			−4.054 (−0.880)	0.3998
		Household		−0.908* (−1.666)		4.765 (3.367)	0.481
		Household			0.875* (1.558)	3.303 (5.419)	0.447

(continued)

Table 6.23 (continued)

			Coefficient (t-value)				R^2
Independent variables			Per capita income	Poverty	Urbanization	Constant	
	Use	Household	0.526* (1.517)			−1.225 (−0.413)	0.434
		Household		−0.549* (−1.413)		4.671 (4.628)	0.3996
		Household			40.017**, a (2.222)	11.553 (1.321)	0.622
		Household			0.455 (1.066)	3.714 (8.018)	0.275
		Individual (at home)	0.004 (0.431)			4.529 (62.176)	0.058
	Knowledge of Computer	Individual	0.787* (1.989)			−3.942 (−1.169)	0.569
		Individual		−0.985** (−3.059)		5.274 (6.307)	0.757
		Individual			0.860** (2.032)	3.601 (7.834)	0.579
	Provision of computer	Individual	1.039* (1.694)			−6.895 (−1.317)	0.489
		Individual		−1.435** (−3.366)		5.621 (5.079)	0.791
		Individual			1.343** (2.613)	3.274 (5.867)	0.695

Internet	Use	Household	0.369 (0.838)			0.064732 (0.017241)	0.1896
		Household		−0.462 (−1.007)		4.385 (3.682)	0.253
		Household			0.547* (1.286)	3.741 (8.098)	0.355
		Individual	0.069** (2.462)			3.952 (16.703)	0.669
		Individual			0.028 (0.581)	4.561 (87.412)	0.101
		Individual (use E-mail)	0.462** (2.823)			−0.075 (−0.054)	0.726
		Individual (use E-mail)		−0.575** (−8.034)		5.332 (28.670)	0.956
		Individual (use E-mail)			0.355* (1.313)	4.210 (14.334)	0.365
	Knowledge of internet	Individual	0.735* (1.467)			−3.6796 (−0.861)	0.418
		Individual		−1.057** (−2.872)		5.278 (5.525)	0.733
		Individual			1.014** (2.513)	3.574 (8.151)	0.678

Correlation is significant *at the 0.05 level (one-tailed); **at the 0.01 level (one-tailed)
Note [a]Linear regression

6.6 Conclusion

This chapter presents an overview of the use of ICT and the digital divide in Sudan and highlights the need for bridging the digital divide to enhance equality in the use of ICT in Sudan. This chapter uses the conceptual and theoretical frameworks presented in Chap. 3 and uses the most recent secondary data to discuss the use of ICT indicators (mobile, computer and Internet) at the macro level and the incidence of the digital divide in Sudan.

Our findings in this chapter seem quite consistent with the results in the international literature on the digital divide, we provide significant contribution and we extend our analysis to compare the digital divide for different modes of ICT in Sudan. We fill the gap in the Sudanese literature and provide a more comprehensive analysis by investigating use of ICT and digital divide according to the conceptual framework: subjects of connectivity (defined by households and individuals); characteristics or attributes of connectivity (defined by geographic location, mode of living, gender, education and age); means of connectivity (fixed telephone, mobile telephone, Internet, DSL/mDSL); and purposes of connectivity (connecting or not connecting) using (or not using) Internet and ICT; and locations of connectivity.

This chapter confirms the seventh hypothesis in Chap. 1 about the relationship between the use of ICT and the incidence of the digital divide defined by geographic location, mode of living, gender, age and educational level in Sudan. Our results are useful to improve understanding about the urgent need to stimulate ICT infrastructure development and support policies that aim to enhance adequacy and equality of use and utilization of ICT in Sudan.

The results concerning significant disparities in the use of ICT and digital divide can be interpreted along with the well-documented massive inequality and disparities between urban and rural areas between regions and between males and females. Our findings are consistent with the findings in Chap. 2 that demonstrates large inequalities with respect to MDG, mainly, gender, rural–urban areas at the regional and sub-regional level in Sudan.

Section 6.2 examines the use of mobile and digital divide in Sudan and shows evidences on the incidence of the digital divide for households and individuals in terms of ownership, use, spending and purposes of use of mobile defined by mode of living, gender and region. For instance, households' and individuals' ownership and use of mobile in urban areas are higher than rural areas and for males are higher than females, and average spending on fixed telephone per month in urban areas is twice average spending in rural areas. The divide also appears from the awareness and knowledge of mobile services prices and knowledge of the terms of contract to buy SIM and purposes of use of mobile. For instance, the purposes of use of mobile to use the Internet and to buy a service in urban areas are more than twice higher than rural areas and for males are nearly twice higher than females. The divide defined by region implies that individuals use of mobile to use the Internet in Khartoum is more than four time higher than in Western region; to transfer

money in Central region is more than twice higher than in Northern region; to buy a service in Northern region is more than thirty times higher than in Southern region.

Section 6.3 discusses the use of computer and digital divide in Sudan and explains evidences on the occurrence of the digital divide for households and individuals in terms of ownership, use and purposes of use of computer defined by mode of living, gender and region. For instance, households' and individuals' ownership and use of computer in urban areas are more than twice higher than rural areas and for males are higher than females, households' ownership and use of computer in Khartoum is more than six time and more than three times higher than in Eastern region respectively. The divide also appears from individuals' awareness and knowledge to use computer and provision of computer at home. For instance, individuals' awareness and knowledge to use computer and in urban areas is more than three times higher than rural areas and in Khartoum is more than four times higher than in Eastern regions. In addition, the divide also appears from individuals' provided with computer at home in urban areas is more than four times higher than in rural areas, in Khartoum is more than six times higher than in Eastern region and individuals' provided computer outside home in Khartoum is nearly twice higher than in Northern region. The divide also appears from the impediment factors hindered the use of computer at home, for instance, the lack of electricity hindered the use of computer at home in rural areas nearly twice higher than in urban areas. The divide also appear from the use of computer at home and outside home for educational purposes that implies that the proportions of individuals used computer at home and outside home for educational purposes for females is slightly higher than males in Sudan. This result implies that the use of computer at home is slightly useful to help to increase educational attainment for females and therefore can be used to reduce the gender gap in educational attainment between males and females in Sudan. This result is consistent with the findings in the international literature that suggest that women tend to use the Internet more than men for educational activities (cf. ITU 2013).

Section 6.4 investigates the use of Internet and digital divide in Sudan and shows evidences on the occurrence of the digital divide for households and individuals in terms of access, use, average spending on the Internet per month, awareness and knowledge to use Internet, locations and purposes of use of Internet defined by mode of living gender, and region. For instance, households' access to Internet and average spending on the Internet per month in urban areas are nearly twice higher than rural areas, households' access and use of Internet in Khartoum is more than six time and more than three times higher than in Eastern region respectively. For instance, individuals' use of Internet in urban areas is higher than rural areas and for males is higher than females. In addition, individuals' awareness and knowledge to use Internet in urban areas is more than three times higher than rural areas and for males is nearly twice higher than females and in Khartoum is more than twice in Southern and Central regions, more than three times in Northern region, more than four times in Eastern region, and more than five times in Western region. The divide also appears from the proportions of individuals' have E-mail, for instance, the proportion of individuals' have E-mail in urban areas is more than four times higher

than rural areas, for males is higher than females and in Khartoum is more than twice higher than Southern and Western regions.

The divide also appears from the locations of the use of Internet, for instance, the use of the Internet at work place in urban is nearly twice higher than rural and for males is nearly twice higher than females. The use of the Internet from educational institution in rural is higher than urban and for females is higher than males. The use of the Internet from service centre in urban is more than three times higher than rural, for males is more than twice higher than females and in Khartoum is more than twice higher than in Southern and Central regions, more than four times in Eastern region, more than five times in Western region, and 38 times in Northern region. The divide also appears from the purposes of the use of the Internet, for instance, the use of the Internet for educational purposes in rural is higher than urban and for males is higher than females, the use of the Internet for commercial transactions purposes in urban is higher than rural and for females is higher than males. These results seem opposite to the findings in the international literature that suggest that women tend to use the Internet more than men for educational activities (cf. ITU 2013). The divide also appears from the impediment factors hindered the use of the Internet, for instance, non availability of the Internet service hindered the use of the Internet in rural areas nearly twice higher than in urban areas and for males is nearly twice higher than females in Sudan.

Our results concerning the impediment factors impeded and hindered the use of the Internet implies that for the majority of individuals in Sudan other reasons are the most commonly reasons impeded the use of the Internet, followed by the cost, non availability of Internet service and the language respectively. For nearly third of individuals in Sudan, the cost and non availability of the Internet service impeded the use of the Internet.

Our result regarding the language of connectivity and the use of Internet implies that for the majority of individuals in Sudan Arabic is the most widely used language for using the Internet, followed by the English language and the other language respectively. Our finding concerning the means of connectivity and the use of the Internet implies that for the majority of individuals in Sudan mobile cellular telephone is the most widely used mean or method of connection for using the Internet, followed by DSL/mDSL and fixed telephone respectively. The proportion of individuals using mobile cellular telephone is more than 14 times of the proportion of individuals using fixed telephone. Our result regarding the location of connectivity and the use of the Internet implies that for the majority of individuals in Sudan home is the most commonly place for using the Internet, followed by house of other person, work place, educational institution, Internet café, other place, and service centre respectively.

Our finding concerning the cost of connectivity and using the Internet and mobile cellular telephone implies that the viewpoint of the majority in Sudan implies that the cost of using the Internet is reasonable followed by high and low respectively, while the cost of using mobile cellular telephone is high followed by reasonable and low respectively.

Section 6.5 examines the determinants of the digital divide that appears from the relationships between the use of ICT (mobile, computer and Internet) and age, educational and professional levels, and the use of ICT and per capita income, poverty and urbanization. Our results show positive relationship between the proportions of individuals used computer at home and outside home and the Internet and educational level that implies that the proportions of individuals used computer at home and outside home and Internet increases with the level of education, it is higher for university level, followed by secondary, basic, literate and illiterate levels respectively. We find negative relationship between the use of computer at home and outside home, the Internet and mobile and age that implies that the proportions of individuals used computer at home and outside home, mobile and the Internet decreases with the increase of age, it is higher for age (15–24) followed by age (25–34), (35–44), (45–54), (55–64), (65–74), and (75) respectively. Our findings imply inconclusive relationship between the use of mobile and educational and professional levels and inconclusive relationship between the use of computer at home and outside home and the Internet and professional levels. Our results using the OLS regression reported in Table 6.20 illustrates plausible positive significant correlations between the use of ICT (mobile, computer and Internet) and education level and plausible negative significant correlations between the use of ICT (mobile, computer and Internet) and age. Our findings imply that the use of ICT is increasing in education and decreasing in age. Our results are consistent with the results in the international literature (See Chinn and Fairlie 2004; Dasgupta et al. 2001; ITU 2013; OECD 2001).

We examine the relationship between the use of ICT and net enrolment rate in primary education, literacy rate, the share in total population, per capita income, poverty gap ratio and rate of urbanization: Tables 6.22 and 6.23 illustrate plausible positive significant correlations between the use of ICT and net enrolment rate in primary education, literacy rate, per capita income and rate of urbanization and negative correlation between the use of ICT and poverty gap ratio. We find positive significant correlation between ownership of mobile and computer, use of mobile, computer and Internet, knowledge of computer and Internet and provision of computer net enrolment rate in primary education, literacy rate, per capita income and rate of urbanization. We find negative significant correlation between ownership of mobile and computer, use of mobile, computer and Internet, knowledge of computer and Internet and provision of computer and poverty gap ratio. Our findings imply that the increase in per capita income, increase in enrolment rate in primary education and literacy rate, decline in poverty rate and increase in urbanization rate would imply increase in the use of ICT in Sudan. Our results are consistent with the results in the international literature (See Chinn and Fairlie 2004; Dasgupta et al. 2001; ITU 2013; OECD 2001).

Our results in this chapter confirms the seventh hypothesis in Chap. 1 about the relationship between the use of ICT and the incidence of the digital divide defined by age and educational level in Sudan. These results are plausible and seem consistent with the findings in the literature that imply that according to computers

may require substantial levels of education for use, but telephones and the Internet may require very little (cf. Dasgupta et al. 2001).

The major policy implication and recommendation from our findings is that it is essential for policy making in Sudan to enhance adequate and equitable access and use of ICT to bridge the digital divide between geographic locations (regions), urban and rural areas, males and females. It is essential to improve adequate and equitable ICT infrastructure, provision of computer at home and availability of electricity and Internet services, particularly for rural areas in Sudan. In addition to encouraging the effective use of ICT for creation and transfer of knowledge, enhancing the quality and accumulation of human capital education, literacy and skill, improving the degree of urbanization, increasing per capita income, alleviating poverty and offering adequate budget for enhancing ICT in all geographic locations (regions) and in urban and rural areas in Sudan.

References

Chinn MD, Fairlie RW (2004) The determinants of the global digital divide: a cross-country analysis of computer and internet penetration. Economic Growth Center, Yale University, Center discussion paper no. 881, Mar 2004. http://www.econ.yale.edu/growth_pdf/cdp881.pdf

Dasgupta S, Lall S, Wheeler D (2001) Policy reform, economic growth and the digital divide: an econometric analysis. World Bank Working Paper No. 2567, Mar 2001

Elbadawi I, Suleiman K (2008) Toward an equitable inter-governmental transfer system for the Sudan. In Abd El Rhman S (ed) Generating growth and making fiscal decentralization work in post-conflict Sudan, Chapter 3. Ministry of Finance and National Economy, Khartoum. Table 3, p 107

International Telecommunication Union (ITU) (2013) Measuring the information society. Geneva, pp 24, 39–40, 43

National Telecommunication Corporation (NTC) (2012) Household and individuals ICT survey 2012. Khartoum

Nour S (2002a) The impact of ICT on economic development in the Arab world: a comparative study of Egypt and the Gulf countries. Economic Research Forum for the Arab Countries, Iran and Turkey, ERF working paper series WP Number: 200237, Cairo

Nour S (2002b) ICT opportunities and challenges for development in the Arab world. UNU-WIDER discussion paper series DP2002/83. Paper prepared for UNU-WIDER conference on the new economy in development, UNU-WIDER, Helsinki, 10–11 May 2002

Nour S (2006) ICT opportunities and challenges for development in the Arab region. In: D'Costa AP (ed) The new economy in development: ICT challenges and opportunities: series of technology, globalization, and development, vol 2, Chapter 8. Macmillan, Sept 2006

Nour S (2013) Technological change and skill development in Sudan. Springer, Berlin

Organisation for Economic Co-operation and Development (OECD) (2001) Understanding the digital divide. OECD, Paris, p 5

Sudan Central Bureau of Statistics Population Census Data (2010) In thousands: the 5th Sudan population and housing census (2008). Sudan Central Bureau of Statistics, Khartoum

The Sudan Central Bureau of Statistics (2011) Sudan national baseline household survey 2009, p 12

Chapter 7
The Supply Side of ICT

7.1 Introduction

The data from the university survey presented in Chap. 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.

This chapter examines the supply of ICT in Sudan. Section 7.1 presents introduction. Section 7.2 explains ICT regulatory framework and ICT market structure in Sudan. 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 concerning the supply side of ICT, methods and places of connection to ICT in Sect. 7.3. Next, we explain the difficulties on the supply and demand sides in Sect. 7.4. We explain the suggestions for relevant solutions on the supply and demand sides in Sect. 7.5 and Sect. 7.6 provides the conclusions.

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Contributions to Economics, DOI 10.1007/978-3-319-13999-9_7

7.2 Overview of ICT Regulatory Framework and ICT Market Structure in Sudan[1]

This section first explains ICT regulatory framework and regulation and then provides overview of ICT market and market structure, mainly the level of competition and the market shares in ICT market in Sudan.

7.2.1 ICT Regulatory Framework and Regulation in Sudan

As for regulatory framework and regulation, the Ministry of Information and Communication manages the National Telecom Corporation (NTC) and Sudan Academy for Communications Sciences. NTC is responsible for regulating the telecommunications market, and the IT market. NTC was formed in September 1996 to provide an effective regulatory framework and adequate safeguards to ensure fair competition and protection of consumers' interests.[2]

Concerning regional initiatives, NTC is the responsible entity for broadband access networks, open-source software, Arabic digital content and cybersecurity. Regarding, broadband access networks, currently, there are three commercial broadband technologies in Sudan; one fixed (wired)-broadband technology (DSL), and two wireless-broadband technologies (UMTS/HSPA and CDMA 1xEVDO). DSL has been deployed by Sudatel and Canar, while MTN and Zain have deployed 3G networks. MTN Sudan launched its 3G/3.5G services in 2007, followed by Zain Sudan and Sudatel in 2009.[3]

Regarding Arabic digital content, NTC is promoting the creation of e-government websites and donated 800 computers to the different governorates of Sudan. The objective is to establish data centers in order to ensure the governorates are connected to the National Information Center.[4] As for the support of Arabic domain names, this has not been officially addressed by Sudan's IT regulator or local online service providers in the private sector. Information on the top 20 most visited online web portals by Internet users in Sudan, implies that the adoption of Arabic online

[1] Data and information in this section and this chapter refer to the situation in Sudan before the independence of South Sudan in July 2011. This section is obtained from International Telecommunication Union (ITU) (2012) "ICT Adoption and Prospects in the Arab Region," International Telecommunication Union, 2012, Geneva, Switzerland. Section II—Country level analysis of ICT regulations, adoption and project—Sudan: pp. 107–111.

[2] See www.ntc.gov.sd

[3] See Arab Advisors Group (2011c): Arab Advisors Group (2011c), 'LTE & 3G/3.5G Cellular Services in the Arab World', December 2011.

[4] See http://ntc.gov.sd/index.php?n=b3B0aW9uPWNvbV9jb250ZW50JnZpZXc9YXJ0aWNsZSZpZD0yMyZJdGVtaWQ9MzAmbG FuZz11aw%3D%3D

content remains behind the adoption of content offered by global websites, such as Google, Youtube and Facebook.

7.2.2 ICT Market Structure: Level of Competition and Market Shares in ICT Market in Sudan

This section provides overview of ICT market structure, mainly the level of competition and the market shares in ICT market in Sudan.

7.2.2.1 ICT Market Structure: Level of Competition in ICT Market in Sudan

The main characteristics of ICT market structure defined by the level of competition of ICT in Sudan and the Arab States implies that the market structure in Sudan is characterized by partial competition that is dominant for local services, domestic fixed long distance, international fixed long distance, DSL, VSAT, Leased lines, Fixed Wireless Broadband, Mobile Fixed sat, Mobile sat, IMT 2000 and International gateways, whereas, market structure is characterized by full competition only for Internet services (see Table 7.1).

7.2.2.2 ICT Market Structure: The Market Shares in ICT Market in Sudan

Concerning the market shares in ICT market in Sudan, we find that the structure of ICT market implies that for fixed-telephone market, by December 2011, Sudatel and Canar were the only fixed-telephone operators. Sudatel, established in 1993, Sudatel's monopoly of fixed services ended as Canar began its operations in April 2005. Both operators provide fixed voice through PSTN technology.[5] By end 2010, there were about 375,000 fixed-telephone subscriptions in Sudan, translating into a penetration rate of 0.9 %. As for mobile-cellular market, strong competition exists between the three mobile-cellular operators: Zain, Sudatel (Sudani) and MTN (Areeba). By end of 2010, total mobile-cellular subscriptions were about 17.6 million, translating into a penetration rate of 40.5 %. During the first 6 months of 2011, mobile-cellular subscriptions increased by 0.54 %, as 4,428 subscriptions were added. By end of June 2011, Sudan's total mobile-cellular subscriptions stood at just over 22 million, translating into a penetration rate of 50.1 %. As for broadband Internet market, by end of 2010, there were about 165,000 fixed

[5] See www.canar.sd/canar-profile.html

Table 7.1 Structure of ICT market defined by level of competition in Sudan and the Arab States

Country	Local services	Domestic fixed long dist	International fixed long dist	Wireless local loop	Data	DSL	Cable modem	VSAT	Leased lines	Fixed wireless broadband	Mobile	Cable TV	Fixed sat	Mobile sat	GMPCS	IMT 2000	Internet services	International gateways
Algeria[a]	P	P	P	P	C	C	…	P	C	P	P	…	…	…	P	…	C	P
Bahrain[b]	C	C	C	…	…	C	…	…	C	C	P	…	C	…	…	…	C	C
	2004	2004	2004			2004			2004	2007	2003		2004				2004	2004
Comoros[a]	M	M	M	M	M	M	M	M	M	…	M	…	…	…	…	…	M	M
Djibouti[a]	M	M	M	M	M	M	M	M	M	M	M	M	M	M	…	M	M	M
Egypt[b]	P	P	P	…	…	C	…	C	…	C	C	…	…	…	…	C	C	P
Iraq[a]	M	M	…	P	…	M	M	P	M	P	P	…	…	…	…	…	P	M
Jordan[a]	C	C	C	C	C	C	C	C	C	C	P	C	C	C	C	…	C	C
	2005	2005	2005	2005			2005	2005		2005	1999		2005					2005
Kuwait[a]	M	…	M	…	P	…	…	M	M	M	M	P	M	M	M	…	P	M
	M	…	M	M	…	P	…	…	M	P	M	P	…	…	…	…	C	M
Lebanon[b]						2007				1998							1995	
Libya[a]	M	M	M	…	…	…	…	…	M	…	M	…	M	M	…	…	…	…
	C	C	C	C	C	C	C	C	C	…	C	…	C	C	C	C	C	C
Mauritania[a]	2006	2004	2004	2000	2004	2004	2004	2000	2000		2000		2004	2002	2002	2006	2006	2000
	C	C	C	C	…	C	…	C	C	…	C	…	C	C	…	C	C	C
Morocco[b]	2005	2005	2005			2003		2001	2001		1999		2000	2000		2006		
	C	C	C	C	…	C	…	C	C	C	P	…	C	C	…	P	C	C
Oman[b]	2009	2009	2009	2009		2009		2003	2009	2003	2005		2003	2003		2005	2009	2009
	P	P	P	P	…	P	…	P	P	P	P	M	…	…	…	P	P	P
Qatar[b]	2010	2010	2010	2010		2010		2010	2010	2010	2008					2008	2010	
	C	C	C	C	…	C	…	C	C	C	C	…	C	C	…	C	C	C
Saudi Arabia[b]	2009					2009		2006		2009	2004			2006		2009	2004	

Somalia[a]	C	C	C	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
Sudan[b]	P	P	P	P	…	P	…	P	P	P	P	…	P	P	…	P	C	P
	M	M	M	M	…	P	…	M	M	P	P	…	M	…	…	P	P	M
Syria[b]						2003					2000					2009		
	M	M	C	M	…	M	…	C	C	C	C	…	…	C	…	M	C	P
Tunisia								2004	2002	2009	2010			2002			2009	
United Arab Emirates[b]	P	P	P	…	…	P	P	P	P	P	P	P	P	C	…	P	P	P
	2007	2007	2007			2007	2007	2007	2007	2007	2007		2007			2007	2007	
Yemen[a]	M	M	M	…	M	M	…	M	M	…	C	…	M	…	C	…	C	M

Source ITU World Telecommunication Regulatory Database

Note This table reflects what is legally permissible; therefore it may not reflect the actual number of operators in the market

Date: year when partial or full competition was introduced

M Monopoly, *P* Partial competition, *C* Full competition, . . . Not available

[a]2013 data

[b]Pre-2013 data

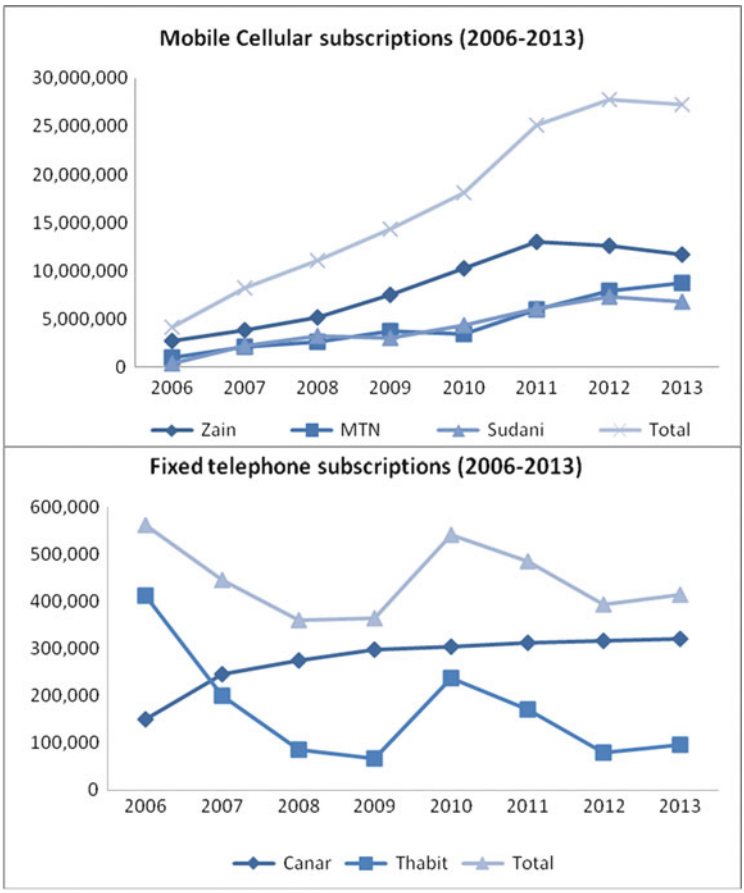

Fig. 7.1 (continued)

(wired)-broadband Internet subscriptions, translating into a penetration rate of 0.40 %.[6]

Core ICT indicators, mainly fixed telephone and mobile cellular subscriptions over the period (2006–2013) implies remarkable dynamic evolution as can be seen from the significant growth in mobile cellular subscriptions compared to significant reduction in fixed telephone subscriptions (see Fig. 7.1). There is similar remarkable dynamic evolution in market structure as can be seen from the significant structural change in terms of the share of the ICT services supplier companies (see Fig. 7.1). For instance, the share of fixed telephone supplier companies implies significant reduction in the share of Thabit Company from 73 % in 2006 to 44 % in 2010 and to 23 % in 2013, compared to significant growth in the share of Canar

[6] See ITU estimates and Arab Advisors Group.

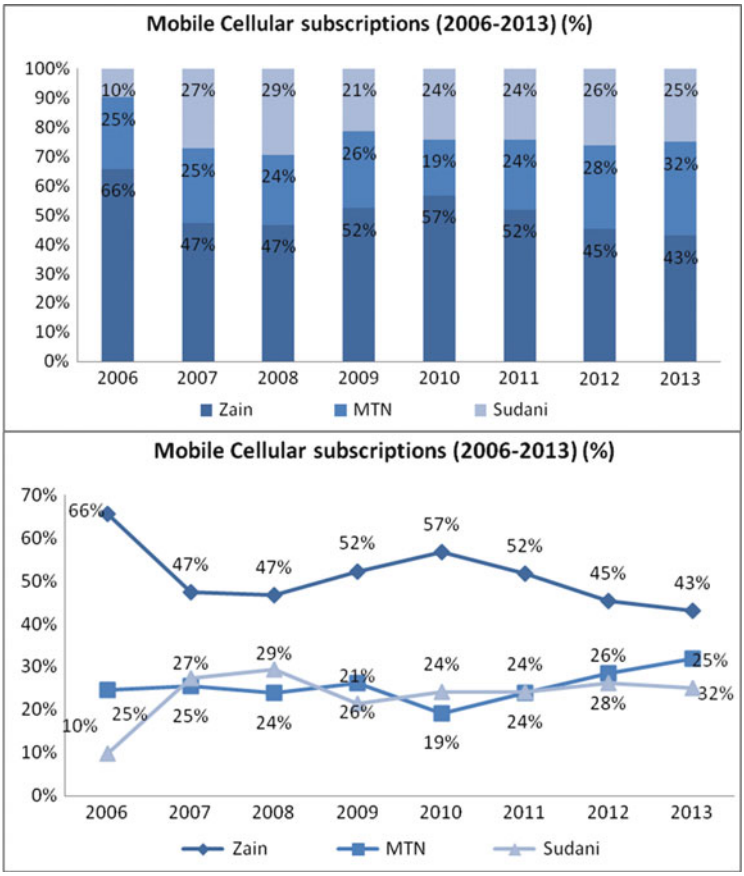

Fig. 7.1 (continued)

Company from 27 % in 2006 to 56 % in 2010 and to 77 % in 2013. Over the period 2006–2013, the dominance in fixed telephone market shifted from Thabit Company to Canar Company (see Fig. 6.1). Moreover, the share of mobile cellular supplier companies implies significant reduction in the share of Zain Company from 66 % in 2006 to 57 % in 2010 to 43 % in 2013, compared to significant growth in the share of Sudani Company from 10 % in 2006 to 24 % in 2010 and to 25 % in 2013, while the share of MTN company declined from 25 % in 2006 to 19 % in 2010, then increased to 32 % in 2013. Over the period 2006–2013, despite reduction in the share Zain Company and growth in the share of the competing companies MTN and Sudani, mobile cellular market, continued to be dominated by Zain Company (see Fig. 7.1).

In addition the dynamic evolution can be seen also from the slight improvement in terms of telecommunication networks coverage of the land area that increased from 34 to 36.2 % and the corresponding slight improvement in terms of the

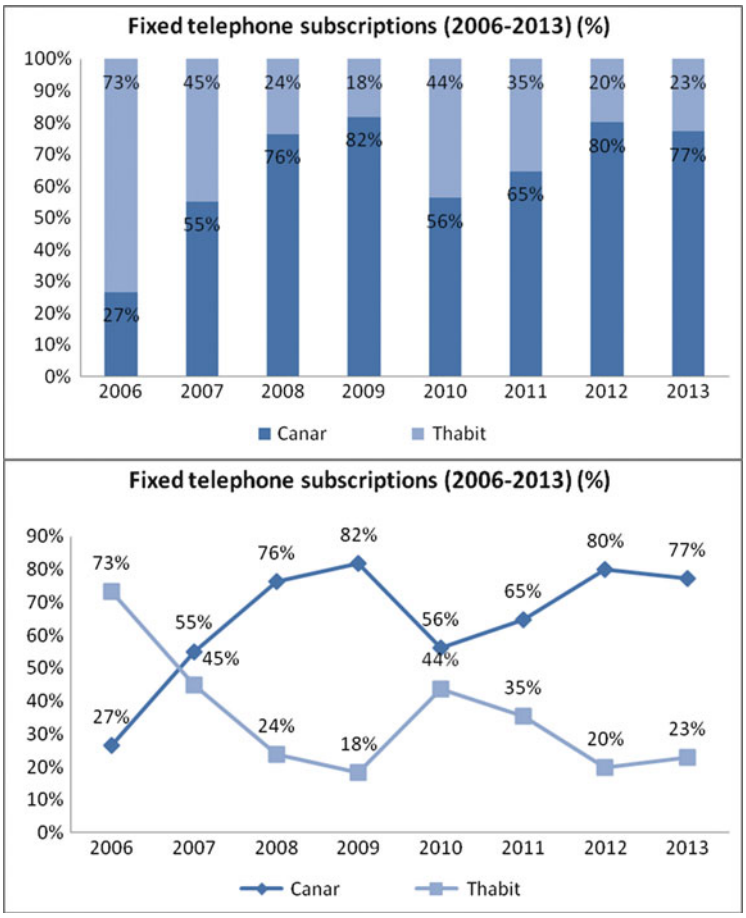

Fig. 7.1 Core ICT indicators- fixed telephone and mobile cellular subscriptions 2006–2013 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012–2013) See National Telecommunication Corporation (NTC): http://www.ntc.gov.sd. Accessed on August 09, 2014)

percentage of the population covered that increased from 88 to 88.4 % over the period 2012–2013 (see Fig. 7.2).

Furthermore, the dynamic evolution can be seen also from the slight improvement in Short Messages Service (SMS), which implies the minor growth in the share of local SMS from 96 % in 2012 to 97 % in 2013 and the slight reduction in the share of international outgoing SMS from 4 % in 2012 to 3 % in 2013 (see Fig. 7.3). Over the period 2012–2013, traffic implies minor growth in the share of local traffic (off net) from 67 % in 2012 to 71 % in 2013, minor growth in the share of international outgoing traffic from 7 % in 2012 to 8 % in 2013 and the slight reduction in the share of international incoming traffic from 25 % in 2012 to 20 % in 2013 (see Fig. 7.3). Over the period 2012–2013, the highest growth rate was

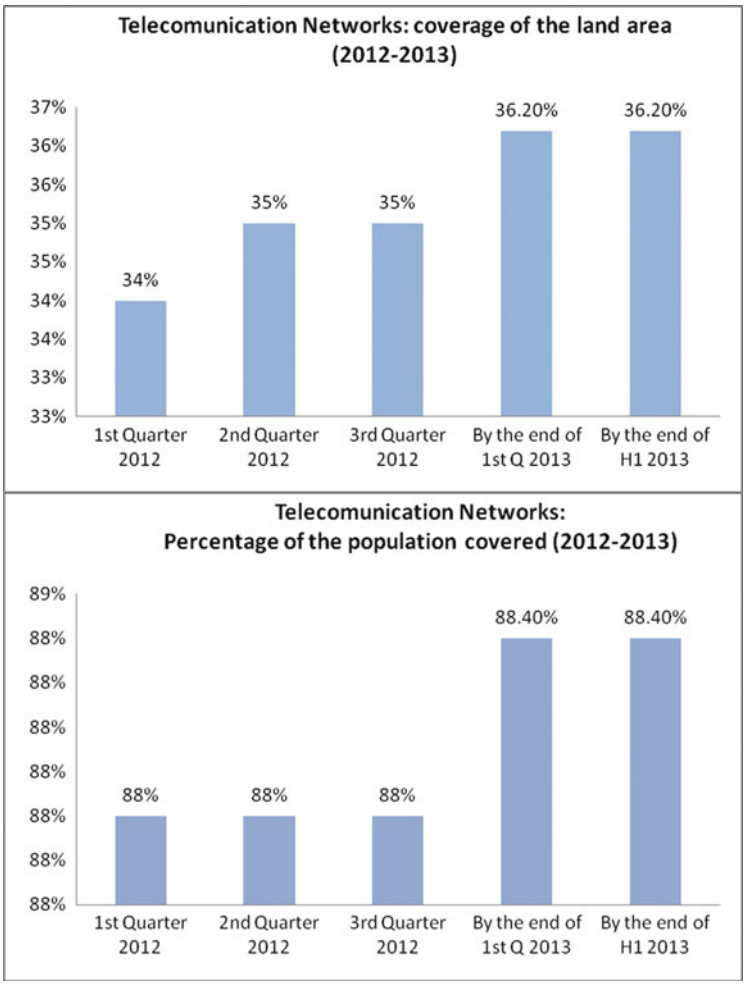

Fig. 7.2 Telecommunication networks: coverage of the land and percentage of the population covered 2012–2013 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012–2013) See National Telecommunication Corporation (NTC): http://www.ntc.gov.sd. Accessed on August 09, 2014)

reported for international outgoing traffic (0.287), followed by local traffic (off net) (0.259) and international incoming traffic (0.038) respectively. In 2012 the short messages service (local SMS) was offered mainly by Zain (56.30 %), followed by MTN (17.40 %) and Sudani (26.30 %) respectively, but in 2013 was mainly offered by Sudani (47 %), followed by Zain (33 %) and MTN (19 %) (see Fig. 7.3). In 2012–2013 the short messages service (international outgoing SMS) was offered mainly by Zain (83 %; 64.40 %), followed by Sudani (15 %; 21.30 %)) and MTN (2 %; 14.30 %) in 2012 and 2013 respectively (see Fig. 6.3). In 2012–2013 the short messages service implies major share of local SMS compared to minor share of

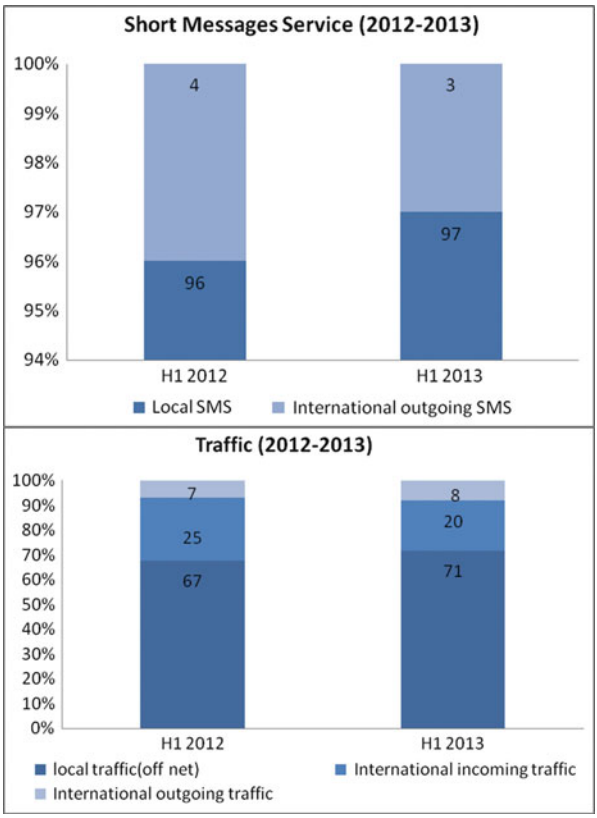

Fig. 7.3 (continued)

international outgoing SMS for all companies (96 %, 97 %) and (4 %, 3 %), particularly, for Sudani (97 %, 99 %) and (1 %, 4 %), followed by MTN (100 %, 98 %) and (0 %, 2 %), and Zain (95 %, 95 %) and (5 %, 5 %), in 2012 and 2013 respectively (see Fig. 7.3).

7.3 Characteristics of the Supply Side of ICT at Macro–Micro Levels in Sudan

This section is explains 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.

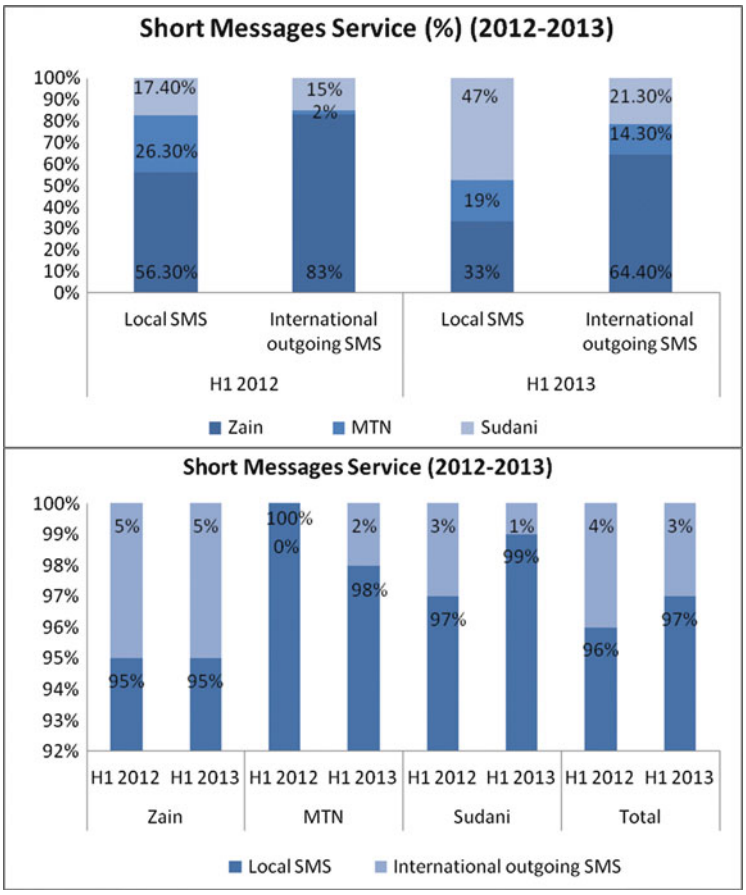

Fig. 7.3 Short messages service (SMS) and traffic 2012–2013 (*Source* Adapted from National Telecommunication Corporation (NTC) (2012–2013) See National Telecommunication Corporation (NTC): http://www.ntc.gov.sd. Accessed on August 09, 2014)

7.3.1 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.[7,8] In particular, the NTC attempts to enhance the promotion of ICT supply and to 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). [9] According to Zain (2007), 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.[10]

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, leased lines and Internet broadband services. The technologies used

[7] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

[8] 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.

[9] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

[10] See Zain (2007) 'Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR', NTC Workshop on Internet Issues, 19 July 2007.

to provide Internet services enable the subscriber to choose from the available options of technologies according to the required speed and future need. The main characteristics of the Internet service are linking individuals and corporate entities to information centres and performing e-commerce applications though 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. 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.[11] In 2004, 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.[12]

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).[13] 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. Enhanced Voice-Data Optimized or Enhanced Voice-Data Only (EVDO) and Digital Subscriber Line (DSL) service were then introduced. Then the infrastructure of communications was developed in Sudan to include the Fiber Optic National Backbone Network that

[11] 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.

[12] 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.

[13] 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.

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.[14] 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 the modernisation and development of telecommunications in Sudan. 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. 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. Zain (2007) started with the objective of providing developed Internet services and integrated solutions for the corporate market. 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. [15]

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 18dial-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.[16]

[14] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

[15] See Zain (2007) 'Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR', NTC Workshop on Internet Issues, 19 July 2007.

[16] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

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 General packet radio service (GPRS) and Code division multiple access (CDMA), in addition to high speed land line technologies ADSL and High-bit-rate Digital Subscriber Line (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 rise of the other advanced alternatives.[17]

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 that led to decrease in dial-up use and a decline in financial returns to beyond 56 %.[18]

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.

7.3.2 Characteristics of the Supply Side of ICT at the Micro Level in Sudan

Regarding the supplier companies, our results from the University Survey (2009) 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

[17] 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.

[18] See Zain (2007) 'Zain Presentation for NTC Workshop ISP/ASP/SMS/IVR', NTC Workshop on Internet Issues, 19 July 2007.

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 7.2).

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

Table 7.2 Assessment of preferences of specific characteristics related to ICT supplier companies offering ICT services

	Sudatel (%)	Sudani (%)	Areeba MTN (%)	Zain (%)	Canar (%)	Others (%)
a. Preferences of the company offering ICT services: fixed telephone, mobile telephone and Internet						
All staff						
Fixed telephone	42	10		6	23	
Mobile telephone	0	23	15	68		
Internet	28	25		19	16	90
Public staff						
Fixed telephone	34	9		8	25	
Mobile telephone	2	23	16	67	13	88
Internet	25	25		22		
Private staff						
Fixed telephone	71	12		24	18	
Mobile telephone	12	24	12	71		
Internet	41	24		6	29	100
Students						
Fixed telephone	38	19			38	
Mobile telephone	12	15	8	62	23	
Internet	19	38		15		100
Support staff						
Fixed telephone	60	20			40	
Mobile telephone		40	20	60		
Internet	20	20		38	60	100
b. Assessment of the importance of characteristics related to ICT for satisfaction of personal need/utility						
Distinguished characteristics	Sudatel	Sudani	Areeba MTN	Zain	Canar	Others
All staff						
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	
Public staff						
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	

(continued)

Table 7.2 (continued)

	Sudatel (%)	Sudani (%)	Areeba MTN (%)	Zain (%)	Canar (%)	Others (%)
Private staff						
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	
Students						
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	
Support staff						
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

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 7.2).

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.

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 7.3).

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

Table 7.3 Common ways and methods for connection to the Internet

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

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 7.3).

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 7.4).

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

Table 7.4 Common locations for the use of ICT

		Fixed (%)	Mobile (%)	Computer (%)	Internet (%)
All					
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
Public					
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
Private					
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
Students					
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

(continued)

Table 7.4 (continued)

		Fixed (%)	Mobile (%)	Computer (%)	Internet (%)
Support staff					
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

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.

7.4 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.[19] In Sudan main access to Internet is still via dial-up; study of the use of dial-up service and Internet status in 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. 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

[19] See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services In Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

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 1 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 5 km diameter area cantered in the midtown area (Dar el Hatif). Therefore, Sudan is considered a country with no broadband services, as indicated in the ITU year book.[20]

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

[20] See Ashraf Communication Company (2007) 'The Importance of Internet Services', NTC Workshop on Internet Issues, 19 July 2007.

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).[21] 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[22] (see Table 7.5).

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 [23] (see Table 7.6). The problems of Internet service in Sudan include capacity, as the estimated Internet capacity in Sudan ranges between 300 and 450 Mb. Though it is more than those of some neighbouring countries (Ethiopia, Eritrea and Chad) it is still well below other regional 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

[21] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

[22] See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services in Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

[23] See Mobitel (2007) 'Internet Issues', NTC Workshop on Internet Issues, 19 July 2007.

Table 7.5 The Internet users, personal computer (PC) owners, the use of DSL services and International Internet band width in Sudan and selected countries 2001–2005

(a) Internet user/100 inhabit & Pc owner/100												
	2002		2001		2002		2003		2004		2005	
	Pc 100	Internet 100	Pc 100	Internet 100	Pc 100	Internet 100	Pc 100	Internet 100	Pc 100	Internet 100	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)[c]							
	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	1,412	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 7.6 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

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.[24]

[24] 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.

At the micro level our findings from the University Survey (2009) 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.[25] 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[26] (see Table 7.7). 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 %),

[25] 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.

[26] 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.

Table 7.7 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

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.

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 7.8).

Table 7.8 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	

7.5 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.[27]

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.[28] Mobitel Road Map includes that Mobitel provides multi-technology Internet access through 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.[29] 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

[27] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

[28] See Mohamed Abdelaziz Tangasawi (2007) 'Internet Services in Sudan', V 1.0. NTC Workshop on Internet Issues, 19 July 2007.

[29] See Mobitel (2007) 'Internet Issues', NTC Workshop on Internet Issues, 19 July 2007.

(news, sports, banks, etc.) and new technologies (Wi-Fi, WiMax).[30] 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.[31] 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 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.[32] Proposals for upgrading Internet services imply that most Sudanese cities are covered with state-of-the-art telecommunications infrastructure.[33]

[30] 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.

[31] 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.

[32] 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.

[33] See National Telecom Corporation (2007) NTC Workshop on Internet Issues, 19 July 2007.

Table 7.9 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

At the micro level, our findings from the University Survey (2009) 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[34] (see Table 7.9).

7.6 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. Section 7.1 presents introduction. Section 7.2 explains ICT regulatory framework and ICT market structure in Sudan. Section 7.3 defines the main characteristics of the supply side of ICT at the macro and micro levels in Sudan and shows an indepth analysis from the demand and consumer perspective concerning the supply side of ICT and methods and places of connection to ICT. Section 7.4 explains the difficulties on the supply and

[34] 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 %, 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.

demand sides. Section 7.5 provides some suggestions for relevant solutions on the supply and demand sides and finally, Section 7.6 provides the conclusions.

Our findings in this chapter provide further evidence in support of the second hypothesis in Chap. 1 above on the incidence of structural change in the demand for ICT. In particular, in this chapter we complement our discussion in Chap. 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 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. The major policy recommendation from our results in this chapter is the improvement of availability, efficiency and sustainability of ICT supply.

References

Abu-Al-Fedl Mokhtar (2007) Internet management in Sudan. Ministry of the Cabinet Affairs, National Information Center

Almuneer Taha Elkabashi (2007) Introduction and enhancement of Internet services in Sudan the role of Sudatel. NTC workshop on Internet issues, 19 Jul 2007

Ashraf Communication Company (2007) The importance of Internet services. NTC workshop on Internet issues, 2007

Mobitel (2007) Internet issues. NTC workshop on Internet issues, 19 Jul 2007

Mohamed Abdelaziz Tangasawi (2007) Internet services in Sudan. V 1.0. NTC workshop on Internet issues, 19 Jul 2007

Mohammed Al Bashier Ahmed (2007) Development of Internet services in Sudan challenges and prospects. Sudanese Internet Society, NTC workshop on Internet issues, 19 Jul 2007

National Telecom Corporation (2007) NTC workshop on Internet issues, 19 Jul 2007

University Survey (2009) The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities, Khartoum

Zain (2007) Zain Presentation for NTC workshop ISP/ASP/SMS/IVR. NTC workshop on Internet issues, 19 Jul 2007. Confidential Document Sudatel 8/5/2007

Chapter 8
The Effect of ICT in Knowledge in Sudanese Universities and the Labour Market

8.1 Introduction

The data from the university survey presented in Chap. 4 provides us with the required information that is particularly useful for presenting interesting public-private comparative analysis to examine and 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 Sect. 8.2. Next, we show 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 Sect. 8.3. 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 Sect. 8.4. Section 8.5 provides the conclusions.

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8.2 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 8.1 provides a quantitative perspective of some selected system indicators. (See Amr Hamdy (2007) 'ICT in Education in Sudan: Survey of ICT and Education in Africa: Sudan Country Report' (June 2007), pp. 3–5. "http://www.infodev.org/"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" \l "sd"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.).

Table 8.1 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. See also Ministry of Education. *Education Statistic Yearbook* 2004–2005, 2002–2003; Khartoum

8.3 ICT and Knowledge Production Institutions in Sudanese Universities

Based on the literature on ICT and knowledge production, notably in African universities presented in Chap. 3, this section explains first 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.

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 Fig. 8.1.

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

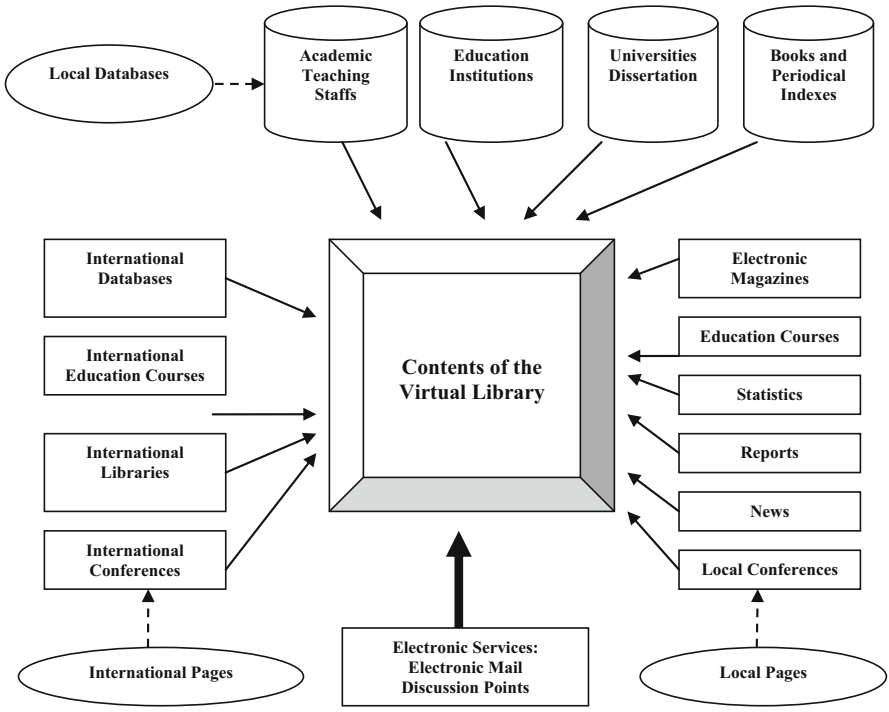

Fig. 8.1 Sudanese Universities Virtual Library (SUVL) Process Diagram. *Source* Sudan Ministry of Higher Education and Scientific Research. See Sudanese Universities Virtual Library (SUVL): http://www.suvl.edu.sd/content_1/about.htm

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 6 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

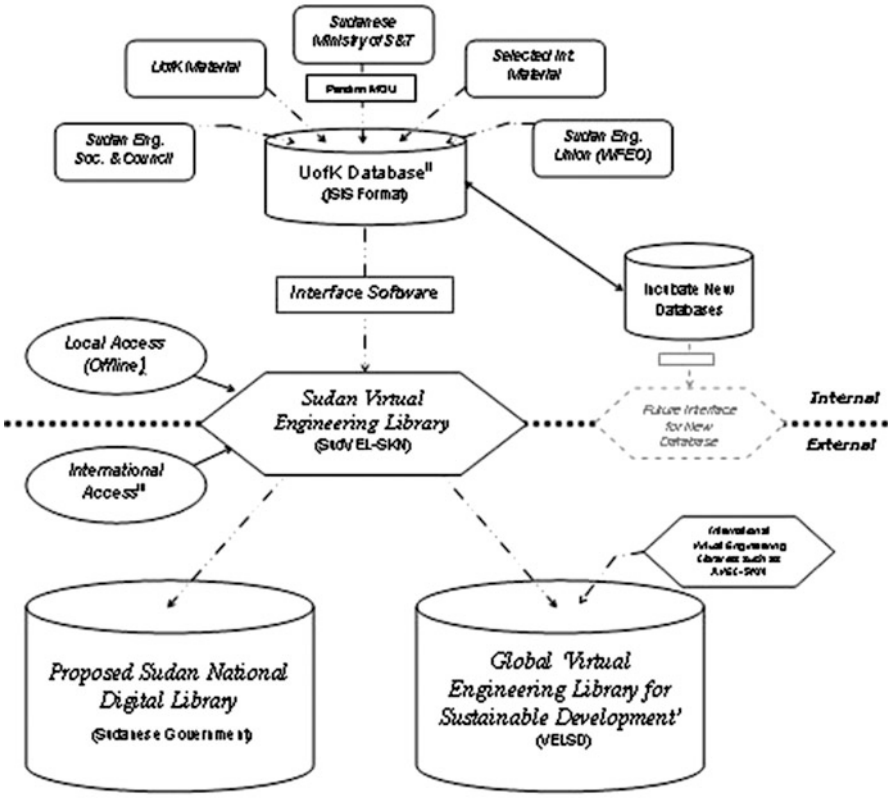

Fig. 8.2 Sudan Virtual Engineering Library (SudVEL) Process Diagram. *Source* Sudan Virtual Engineering Library Sustainability Knowledge Network

held by the Faculty of Engineering and Architecture. For more details about SudVEL see Fig. 8.2. (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. (See Khartoum University Engineering Association Scientific Secretariat Magazine (April, 2009), p. 3.). 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 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. (See the Sudan University of Science and Technology (SUST) website: http://www.sustech.edu/, Accessed: 12 May 2009.).

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 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. (See Juba University website: http://www.juba.edu.sd/, Accessed: 12 May 2009.).

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 h, the second stage 15 h and the third stage takes 6 h. The training programme includes the following stages and topics: Stage One includes introduction to the computer; word processing software; and spreadsheets. Stage 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 1998/1999. 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. (See Ahfad University website: http://www.ahfad.org/computer_unit.html, Accessed: 10 May 2009.).

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 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. (See Computerman university website: http://www.computerman.edu/, Accessed: 10 May 2009.).

8.4 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 8.2).

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.[1] 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.[2] Whereas from the private universities' academic teaching 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.[3] 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

Table 8.2 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)

[1] As indicated by 73 %, 70 %, 68 % and 59 % of the respondent all universities academic staff respectively.

[2] As indicated by 74 %, 70 %, 68 % and 58 % of respondent public university academic staff respectively.

[3] As reported by 81 %, 71 %, 65 %, 59 % of respondent private university academic staff respectively.

institutions.[4] 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.[5]

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 (Fig. 8.3).

8.4.1 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 8.3 and 8.4).

[4] As indicated by 80 %, 60 %, 60 %, 60 % of the respondent support staff respectively.

[5] As reported by 65 %, 69 %, 69 %, 69 % of the respondent students respectively.

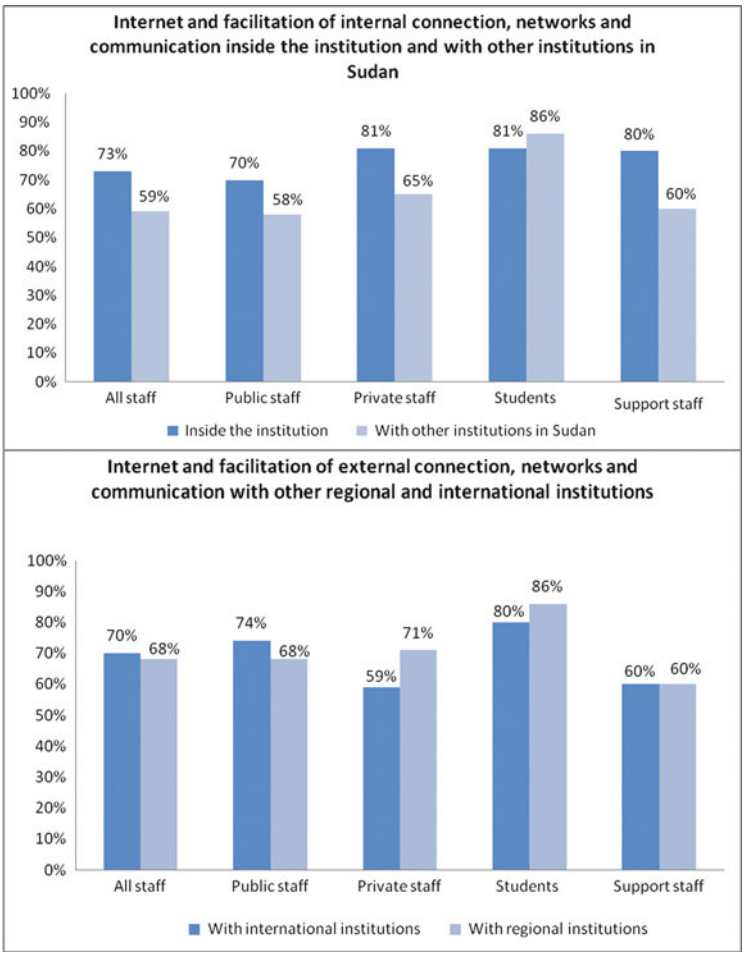

Fig. 8.3 Internet and facilitation of internal and external connection, networks and communication. *Source* Own calculation based on the University Survey (2009)

8.4.1.1 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

Table 8.3 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	95 %	93 %	100 %	91 %	80 %

(continued)

Table 8.3 (continued)

Internet opportunities/advantages	All staff	Public staff	Private staff	Students	Support staff
users for the use electronic data, information and documents					
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)

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 8.3).

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.[6] 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.[7] 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.[8] 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.[9] 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

[6] As indicated by 100 %, 100 %, 99 %, 99 % and 99 % of the respondent all universities academic staff respectively.

[7] As reported by 97, 97, and 96 % of the respondent all universities academic staff.

[8] As indicated by 96 % of the respondent all university academic staff.

[9] As reported by 95 % of the respondent all university academic staff.

Table 8.4 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 %

(continued)

Table 8.4 (continued)

Internet challenges/difficulties	All	Public staff	Private staff	Students	Support staff
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)

scientific research and introduction of important change in techniques and technologies of distribution, dissemination, evaluation and storage of data and information electronically or digitally.[10] In addition to introduction of change in the role of

[10] As indicated by 93 % of the respondent all university academic staff.

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.[11] Furthermore, facilitated transfer of protected materials in the Internet and facilitated digital networks and the use of materials across boarders and reduced monopoly in creation of knowledge earlier dominated by universities and researchers.[12] 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.[13]

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 the use of materials across boarders.[14] This is followed by introduction of the use of new ways and modern

[11] As indicated by 93 % of the respondent all university academic staff.

[12] As reported by 92 and 91 % of academic staff in all the respondent universities.

[13] As reported by 86 %, 83 %, 83 % of the respondent all universities academic staff respectively.

[14] As indicated by 80 % of the respondent support staff.

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.[15] And finally to a lesser extent facilitated introduction of change by reducing the use of written paper.[16]

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.[17] 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.[18] 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.[19] 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 increase of knowledge and facilitated contact between academic teaching staff colleagues and students in academic institutions.[20] In addition to

[15] As reported by 60 % of the respondent support staff.

[16] As indicated by 40 % of the respondent support staff.

[17] As reported by 100 % of the respondent students.

[18] As indicated by 100 % of the respondent students.

[19] As reported by 96, 95, 95, 95 and 95 % of the respondent students.

[20] As indicated by 95, 95, 95 and 95 % of the respondent students.

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.[21] 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.[22] 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 boarders.[23] 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.[24]

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 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

[21] As indicated by 91 % of the respondent students.

[22] As indicated by 91 % of the respondent students.

[23] As reported by 91 % of the respondent students.

[24] As reported by 86 %, 82 % and 65 % of the respondent students respectively.

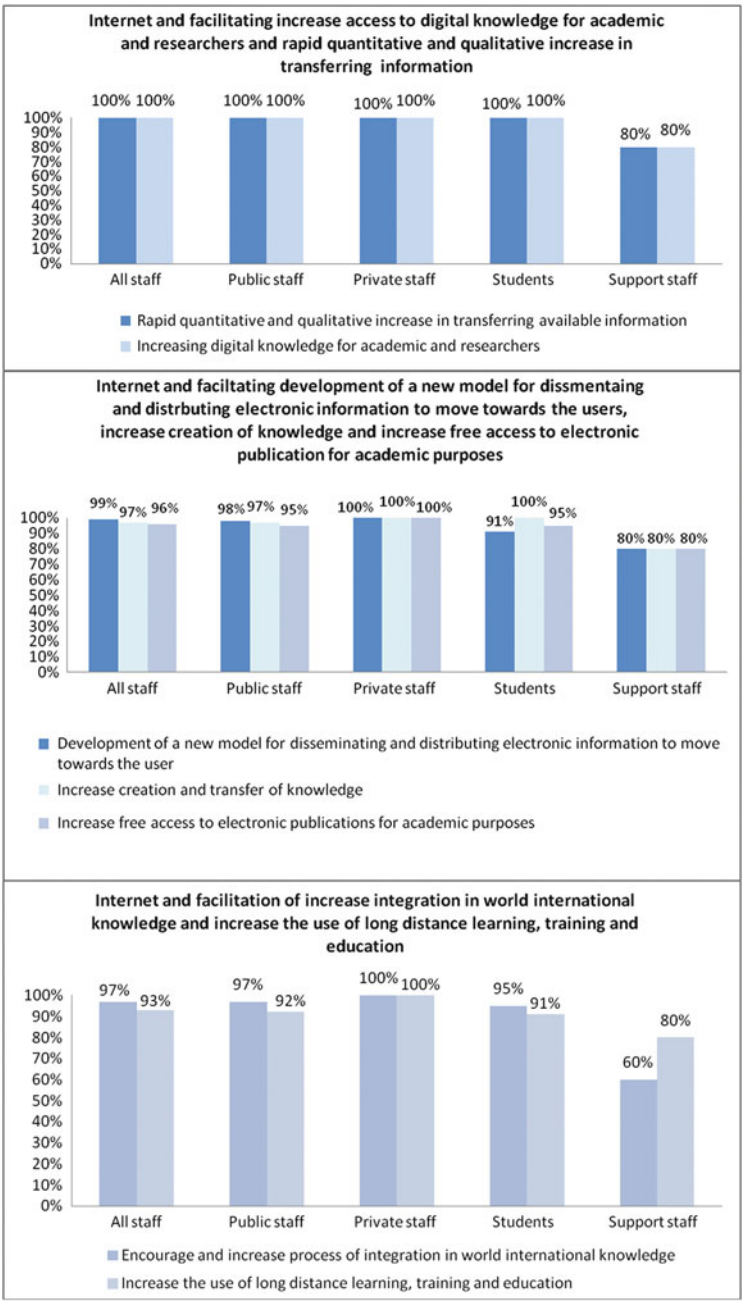

Fig. 8.4 The impacts of Internet in facilitating opportunities and advantages for creation and transfer of knowledge. *Source* Own calculation based on the University Survey (2009)

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 (Fig. 8.4).

8.4.1.2 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 8.4.

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.[25] 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.[26] 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.[27] 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.[28] 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.[29] In addition to the difficulties of high costs of acquiring licenses for access to electronic libraries

[25] As indicated by 96 % of the respondent all universities academic staff.

[26] As indicated by 94, 94, 93, 93, and 93 % of the respondent all universities academic staff.

[27] As reported by 92 % of the respondent all universities academic staff.

[28] As reported by 92 % of the respondent all universities academic staff.

[29] As reported by 90 % of the respondent all universities academic staff.

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.[30] 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.[31] Other problems include 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, 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. [32]

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.[33] 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

[30] As indicated by 89 % of the respondent all universities academic staff.

[31] As indicated by 88, 87, 86, 86 and 85 % of the respondent all universities academic staff.

[32] As reported by 82 %, 81 %, 81 %, 79 % and 73 % of the respondent all universities academic staff respectively.

[33] As indicated by 80 % of the respondent support staff.

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.[34] 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 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.[35]

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.[36] 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.[37] 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.[38] 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.[39] 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

[34] As reported by 60 % of the respondent support staff.

[35] As indicated by 40 % of the respondent support staff.

[36] As reported by 100 % of the respondent students.

[37] As reported by 96 %, 95 %, 95 % and 95 % of the respondent students respectively.

[38] As indicated by 95 % of the respondent students.

[39] As indicated by 91 % and 90 % of the respondent students respectively.

personal purposes.[40] 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.[41] 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.[42] Other 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.[43]

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 (Fig. 8.5).

8.4.2 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

[40] As indicated by 90 % of the respondent students.

[41] As indicated by 89 % of the respondent students.

[42] As reported by 85, 85, 85 and 83 % of the respondent students.

[43] As indicated by 79, 79, 77, 75, 74 and 73 % of the respondent students.

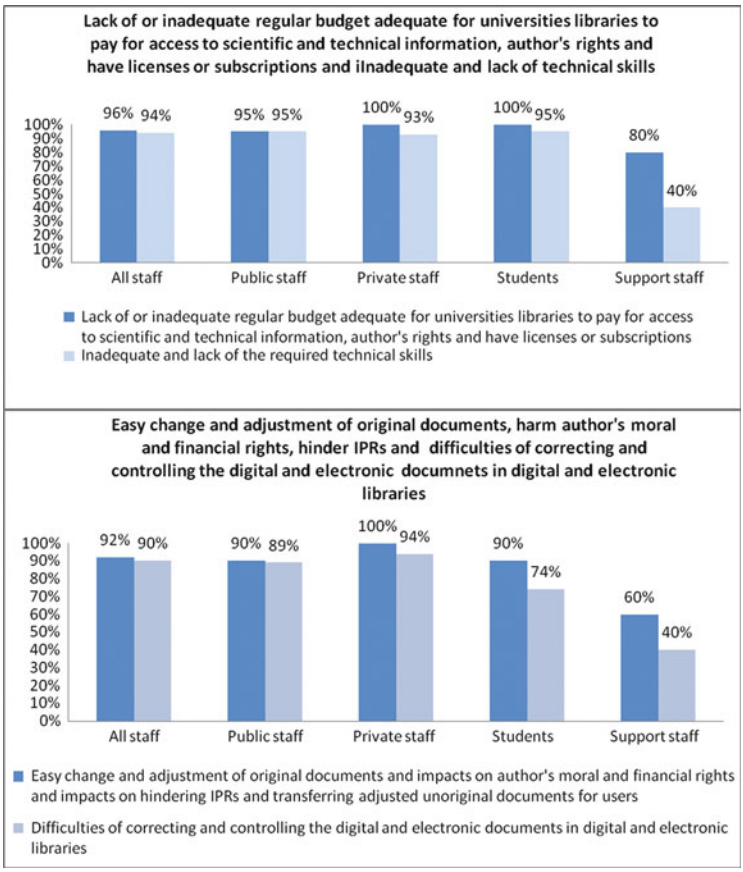

Fig. 8.5 (continued)

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[44] (see Table 8.5).

[44] 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.

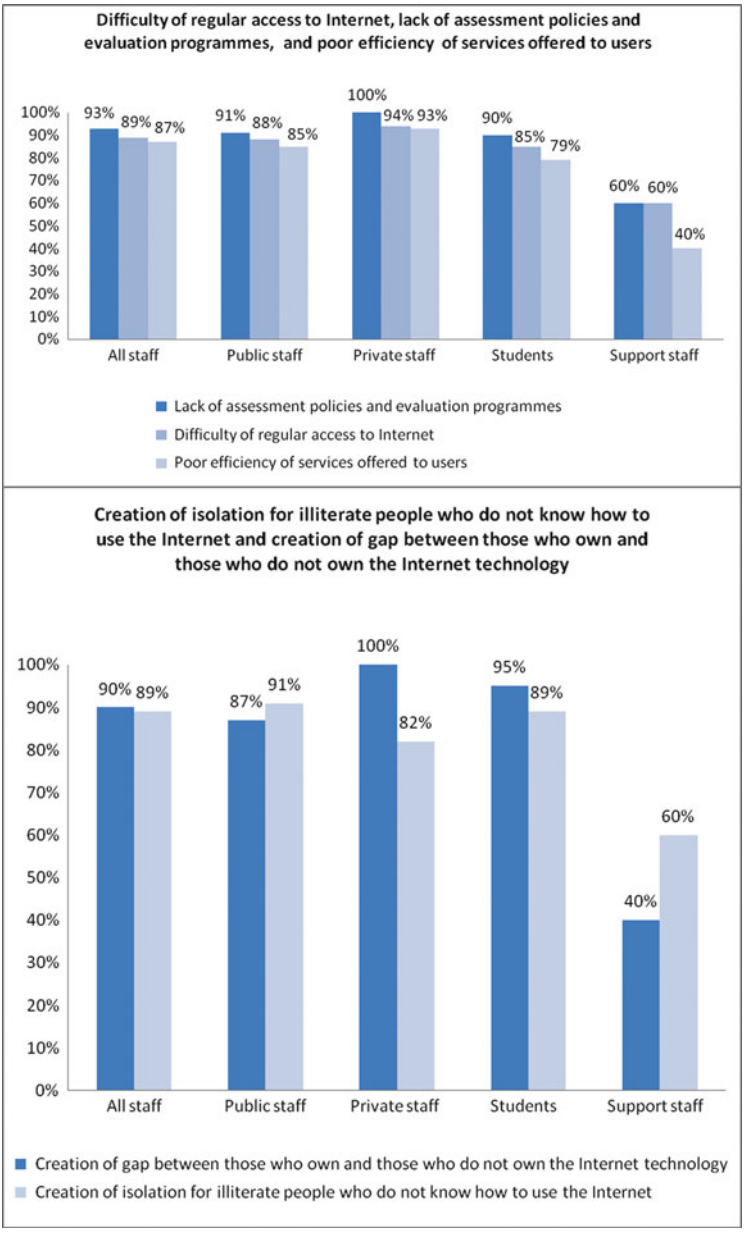

Fig. 8.5 (continued)

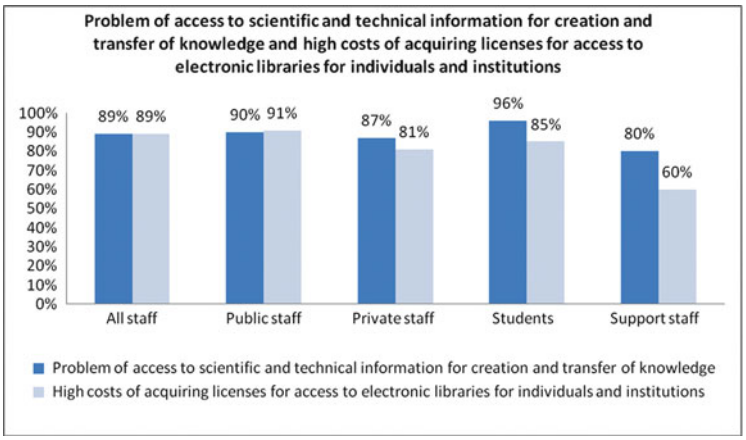

Fig. 8.5 The impacts of difficulties and problems for the use of Internet in hindering creation and transfer of knowledge. *Source* Own calculation based on the University Survey (2009)

Table 8.5 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

8.5 Conclusions

This chapter focuses on the impacts of ICT in the connection, transformation, creation and transfer of knowledge in Sudan. Section 8.1 presents an introduction. Section 8.2 shows Sudanese national ICT strategy and policy in higher education. Section 8.3 explains 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. Section 8.4 discuses explain from the demand perspective the effect of ICT and opportunities and challenges for the creation and transfer of knowledge in Sudanese universities.

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 Chap. 3. Our results in this chapter verify the fifth and sixth hypotheses in Chap. 1 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.

References

Ahfad University. http://www.ahfad.org/computer_unit.html. Accessed 10 May 2009

Hamdy A (2007) ICT in education in Sudan: survey of ICT and education in Africa: Sudan Country Report (June 2007), pp 3–5. www.infodev.org. Accessed 11 May 2009

Computerman University. http://www.computerman.edu/. Accessed 10 May 2009

Elamin AK (2004) Promoting ICT for Human Development in Sudan, ICS portal for technology transfer. http://www.ics.trieste.it/Documents/Downloads/df2124.doc. Accessed 11 May 2009

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

Khartoum University. www.uofk.edu. Accessed 16 June 2009, Khartoum, Sudan

Khartoum University Engineering Association Scientific Secretariat Magazine (2009) 30 % only supports the dependence on the new on-line or electronic registration system. Khartoum University Engineering Association Scientific Secretariat Magazine, Issue of April 2009, p 3

Juba University. http://www.juba.edu.sd/. Accessed 12 May 2009

Sudan. Internet World Stats. http://www.Internetworldstats.com/africa.htm#sd. Accessed May 2009

Sudan Ministry of Education. Education Statistic Yearbook 2004–2005, 2002–2003, Khartoum

Sudan Ministry of Higher Education and Scientific Research: http://www.mohe.gov.sd/. Accessed: 11 May 2009, Khartoum, Sudan

Sudan University of Science and Technology (SUST). http://www.sustech.edu/. Accessed 12 May 2009

Sudanese Universities Virtual Library (SUVL). http://www.suvl.edu.sd/content_1/about.htm. Accessed 11 May 2009, Khartoum, Sudan

Sudan Virtual Engineering Library Sustainability Knowledge Network. http://www2.uofk.edu/SudVEL/Contents/reports.htm. Accessed 11 May 2009

United Nations Economic Commission for Africa (UNECA). http://www.uneca.org/aisi/nici/Sudan/sudan.htm. Accessed 11 May 2009

University Survey (2009, April) The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities, Khartoum

Part IV
Policy Recommendations, Summary and Conclusions

Chapter 9
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 (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 2 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. This chapter presents an overview of Sudanese economy and the trend and

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Contributions to Economics, DOI 10.1007/978-3-319-13999-9_9

status of ICT in Sudan. Section 2.2 explains some stylised facts along with other strategic problems confronting economic development in Sudan that, it 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. Section 2.3 explains the trend and status of core ICT indicators in Sudan. We show that in the recent years, Sudan has shown growing telecommunication networks and Internet services and the diffusion of ICT in Sudan has increased significantly. We explain that recent indicators from International Telecommunication Union (ITU) (2014) show the trend of core ICT indicators and illustrate that despite recent slowdown in terms of fixed telephone, the recent average growth rate of the total online population, Internet, fixed (wired)-broadband and mobile-cellular subscribers in Sudan during the period 2000–2013 has been significant. ITU (2014) data for 2000–2013 indicates that in Sudan the growth rate of mobile-cellular telephone (1,039.71) is faster than Internet (755.67), fixed (wired)-broadband (59) and fixed telephone (−0.04) respectively. We show that the status of ICT indicators in Sudan in 2013 can be explained by regional and international standards compared to Arab countries and world regions respectively. We find that ITU (2014) data for 2000–2013 indicates that by regional and international standards the rapid increase in ICT indicators in Sudan that appear from the increasing use of Internet and mobile-cellular telephone and the increasing proportion of households with Internet and proportion of households with computer are above that of Africa but below Arab region and World region, whereas the use of fixed-telephone in Sudan is less than Africa, Arab region and World region. This implies that by regional and international standards, ICT indicators in Sudan are below compared to Arab countries and World regions. 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. We find evidences in support of the incidence of the global digital divide between Sudan and the World countries, developed countries and developing countries that appear from ICT Development Index (IDI), access sub-index, use sub-index and skills sub-index over the period (2011–2012). Our results indicate that the reported digital gap in core ICT indicators at the aggregate macro level in Sudan compared to world regions seems consistent with the observed development gap in social, economic, human development and education indicators in Sudan compared to world regions.

Chapter 3 presents the conceptual and theoretical framework and theoretical and empirical literature. It provides a background for the empirical analysis in the following chapters by surveying the theoretical and empirical literature that emphasizes the positive effects of ICT in enhancing knowledge and economic growth and the negative effects of ICT through exacerbating the digital divide. In Sect. 3.2 we define the conceptual framework; the theoretical and empirical literature on the relationship between ICT, knowledge and the digital divide are presented in Sect. 3.3.Section 3.3.2 describes the relationship between ICT and economic growth; Sects. 3.3.3 and 3.3.4 discusses the relationship between ICT, education and knowledge. We explain the 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. We illustrate that on the one hand, some studies provide robust results showing the various influences of ICT on enhancing economic growth and development, not only directly, but also indirectly through enhancing knowledge and through the complementary relationships between ICT, human capital and skill upgrading. We explain that on the other hand, several studies discuss the hazards ICT creates for economic development. In particular, the rapid progress in ICT will make it harder for the developing countries to bridge the already existing and widening gap and digital divide between the developed and developing countries. Based on our findings from the existing studies in the literature we highlight the need for improvement of investment in ICT to alleviate the digital divide, enhance production, creation and transfer of knowledge in higher education institutions and to enhance economic growth and sustainable development in Sudan.

Chapter 4 explains the research methodology and methods of data collection and illustrates the composition and operation of the survey in this chapter. Section 4.1 presents introduction. Section 4.2 explains the motives for performing the university survey and selection of a case study. Section 4.3 shows the selection of the sample and composition of the survey. Section 4.4 explains the structure and design of the questionnaire and Sect. 4.5 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 5.1 presents introduction. Section 5.2 defines the main characteristics of the respondent including academic teaching staff, support staff and students in the respondent universities. Section 5.3 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 5.4 explains and examines the income and price effects of the use of ICT in public and private Sudanese universities, and Sect. 5.5 provides the conclusions. Chapter 5 presents our findings and proves the first hypothesis in Chap. 1 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 Chap. 1 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 presents an overview of the use of ICT and the digital divide in Sudan and highlights the importance of bridging the digital divide to enhance equality in the use of ICT in Sudan. Section 6.2 shows the use of mobile and digital divide in Sudan. Section 6.3 discusses the use of computer and digital divide in Sudan. Section 6.4 investigates the use of Internet and digital divide in Sudan. Section 6.5 examines the determinants of the digital divide that appears from the relationships between the use of ICT (mobile, computer and Internet) and age, educational and professional levels, and the use of ICT and per capita income, poverty and urbanization. Finally, Sect. 6.6 draws conclusions and proposes policies to bridge the digital divide and enhance adequacy and equality of the use and utilization of ICT in Sudan. Our findings in Chap. 6 are consistent with the findings in the international literature on the incidence and the main reasons for the incidence of the digital divide. We provide significant contribution and fill the gap in the Sudanese literature, a novel element in our analysis is that different from the Sudanese literature we use recent secondary data at the macro level to discuss the use of ICT and the incidence of the digital divide in Sudan and we provide a more comprehensive analysis by investigating and comparing the digital divide for different modes of ICT in Sudan. Our results confirm the seventh hypothesis in Chap. 1 about the relationship between the uses of ICT (mobile, computer and

Internet) and the occurrence of the digital divide for households and individuals in terms of ownership, use, spending, awareness and knowledge and purposes of uses of mobile, computer and Internet defined by region (geographic location), mode of living, gender, age and educational level in Sudan. Our results imply that the observed disparities in the use of ICT and digital divide implies that ICT adds a new dimension to the already existing and longstanding challenges of inequalities and disparities in Sudan that has been well-documented in the literature as we explained in Chap. 2. We find that the major impediment factors that hindered the use of computer at home and the use of Internet are the lack of electricity that hindered the use of computer and the non availability of the Internet service that hindered the use of the Internet in rural areas nearly twice higher than in urban areas. We find that home is the most commonly place for using the Internet, Arabic is the most widely used language for using the Internet and mobile cellular telephone is the most widely used mean or for using the Internet. The use of mobile cellular telephone is more than fourteen times higher than fixed telephone. We find positive relationship between the use of computer and Internet and educational level, and negative relationship between the use of computer, Internet and mobile and age. Our findings imply inconclusive relationships between the use of mobile and educational level and between the use of computer, mobile and Internet and professional levels. We find positive correlations between the use of ICT and net enrolment rate in primary education, literacy rate, per capita income and rate of urbanization and negative correlation between the use of ICT and poverty gap ratio. Our results in this chapter confirms the seventh hypothesis in Chap. 1 about the relationship between the use of ICT and the incidence of the digital divide defined by age and educational level in Sudan. Our results are plausible and consistent with the findings in the literature that imply positive relationship between the uses of ICT and educational level, that particularly important for computer, since computer may require substantial levels of education for use, but telephones and the Internet may require very little.

Chapter 7 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 7.1 defines the main characteristics of the supply side of ICT in Sudan. Section 7.2 shows an indepth analysis from the demand perspective the supply side of ICT, methods and places of connection to ICT. Section 7.3 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 Chap. 5 verify the third hypothesis in Chap. 1 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 Chap. 1 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 8 focuses on the impacts of ICT in connection, transformation, creation and transfer of knowledge in Sudanese universities. Section 8.1 presents an introduction. Section 8.2 shows Sudanese national ICT strategy and policy in higher education in section. Section 8.3 explains 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. Section 8.4 discuses explain from the demand perspective the effect of ICT and opportunities and challenges for the creation and transfer of knowledge in Sudanese universities. Finally, Sect. 8.5 provides the conclusions. Our results discussed in Chap. 8 verify the fifth and sixth hypotheses in Chap. 1 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 Chap. 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; Olukoshi 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 Chap. 8 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 is 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.

References

Adei S (2003) Overview of university level education in Africa. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata

McGraw-Hill Publishing Co., New Delhi, India, pp 90, 108–109, Chapter 4, http://www.africadotedu.org/

Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, http://www.africadotedu.org/

Durrant S (2004) Sharing information: African perspectives: bridging the knowledge divide. African research and documentation, journal of the standing conference on library materials on Africa, No. 96, 2004, pp 63–79

International Telecommunication Union (ITU) (2014) World telecommunication (ITU)/ICT indicators database. http://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx

Massingue V (2003) ICT in Mozambique: the role of Eduardo Mondlane University. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, Chapter 20, http://www.africadotedu.org/

Mwenechanya J (2003) Pioneering the internet in Zambia: university role and challenges. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M(eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, Chapter 24 http://www.africadotedu.org/

Mutagahywa B (2003) Information and communication technology in Tanzania: the role of the University of Dar es Salaam. In: Beebe M, Kouakou K, Oyeyinka B, Rao M (eds) Africa dot edu; IT opportunities and higher education in Africa. Tata McGraw-Hill, New Delhi

Olukoshi A, Zeleza PT (2004) The African universities in the twenty-first century: future challenges and research agenda, In: Zeleza PT, Olukoshi A (eds) African universities in the twenty-first century. Volume II: Knowledge and society, council for the development of social science research in Africa CODERSRIA, p 611, Conclusion

Oyeyinka BO, Adeya C (2003) Internet access in Nigerian and Kenyan universities. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, Chapter 22, http://www.africadotedu.org/

Radwan R (2003) IT and higher education: the case of Egypt. In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, pp 387, 399, 400–401, Chapter 18, http://www.africadotedu.org/

Thairu H (2003) The Kenya Education Network (KENET). In: Beebe MA, Kouakou KM, Oyeyinka BO, Rao M (eds) (2003) Africa Dot Edu: IT opportunities and higher ED in Africa. Tata McGraw-Hill Publishing Co., New Delhi, India, Chapter 19, http://www.africadotedu.org/

University Survey (2009, April) The impacts of ICT in connections, transformation and production of knowledge in Sudanese Universities, Khartoum

Appendix: Questionnaire: The Use and Economic Impacts of ICT: The Case of Sudan

a. Background information

Please give the following background information

1. Name:
   . . . .
2. Address:
   . . . .
3. Age:
   . . . .
4. Position:
   . . . .
5. Education and date:
   . . . .
6. Schooling years:
   . . . .
7. Experience years:
   . . . .
8. Monthly Income (in Sudanese pounds):
   . . . .
9. Gender:
   . . . .

Male	Female

10. Residence

Khartoum	Omdurman	Khartoum north	Others

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b. Pattern and importance of the use of ICT

11. Please give an assessment of your personal knowledge of Computer and Internet

	Excellent	Very good	Good	Weak	No previous knowledge and require training
Computer					
Internet					

12. Please give an assessment of the importance of ICT for satisfaction of personal need and utility

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

13. Please give an assessment of the importance of characteristics related to ICT for satisfaction of personal need/utility

Distinguished characteristics	Fixed telephone	Mobile telephone	Computer	Internet
Fashion, style and good design				
Cheap price				
Easy for use				
Efficiency and high quality				

14. Please give the name of the company offering the services of fixed telephone, mobile telephone and internet

	Sudatel	Sudani	Ariba MTN	Zain	Kanar	Others
Fixed telephone						
Mobile telephone						
Computer						
Internet						

15. Please give an assessment of the importance of characteristics related to ICT for satisfaction of personal need/utility

Distinguished characteristics	Sudatel	Sudani	Ariba MTN	Zain	Kanar	Others
Fashion, style and good design						
Cheap price						
Easy for use						
Efficiency and high quality						
Price discrimination (reduce price in certain time or seasons or by increasing the usage)						

16. Please give an assessment of the common way for connection with the Internet

	Often	Sometimes	Not at all
Connection through the use of ADSL			
Connection through the use of Fixed telephone			
Connection through the use of Wireless			
Others (specify)			

17. Please give an assessment of the common place for the use of ICT for satisfaction of personal need/utility

		Fixed telephone	Mobile telephone	Computer	Internet
Home	Often				
	Sometimes				
	Not at all				
Office	Often				
	Sometimes				
	Not at all				
Internet café/telecommunication office	Often				
	Sometimes				
	Not at all				

c. Expenditure on the use of ICT: trend and impact of spending, income and price

18. Please give an assessment of your personal trend for the use of ICT over the past 4 years

Fixed telephone			Mobile telephone			Computer			Internet		
Increase	Decrease	Constant	Increase	Decrease	Constant	Increase	Decrease	Constant	Increase	Decrease	Constant

19. Please determine the approximate costs of expenditure on the use of ICT over the past 4 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				

(continued)

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

(continued)

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

(continued)

		Degree of importance			
		Unimportant	Slightly important	Moderately important	Extremely important
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?

	Degree of importance			
Opportunities	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				

(continued)

	Degree of importance			
Opportunities	Unimportant	Slightly important	Moderately important	Extremely important
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				
Challenges				
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
Policies in the Supply sides				
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				
Policies on the Demand side				
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				

g. 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?

Internet opportunities/advantages	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

(continued)

Internet opportunities/advantages	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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)				

(continued)

Internet opportunities/advantages	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

h. 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				

(continued)

Internet challenges/difficulties	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

(continued)

Internet challenges/difficulties	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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				

i. 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				

(continued)

	Degree of importance			
	Unimportant	Slightly important	Moderately important	Extremely important
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?

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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. First Class) 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 an affiliated researcher (and former visiting research fellow and fomer Ph.D. fellow) at UNU-MERIT School of Business and Economics, Maastricht University, Maastricht, the Netherlands. Currently, she is an Associate Professor of Economics at the Department of Economics, Faculty of Economic and Social Studies, Khartoum University, Sudan, since January 2012. Currently she is also an Associate Professor of Economics at the Department of Economics, Faculty of Economics and Administration, King Abdualaziz University, Jeddah, Kingdom of Saudi Arabia, since September 2013. 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), as Assistant Professor of Economics (December 2005–December 2011), and as a teaching assistant (April 1995–December 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 was recipient of the Arab Fund for Economic and Social Development Distinguished Scholar Award and Post-Doctoral Fellowship, the Arab Fund for Economic and Social Development, Kuwait (October 2010–December 2011). She was recipient of the University of Khartoum Scientific Excellence Award Prize in Humanities and Educational Studies (in the field of Economics) (February 2013). She completed several research projects supported by several regional and international institutions. Dr. Samia is currently Economic Consultant for the International Labor Organization (ILO) Regional office for the Arab countries and International Labor Organization (ILO) Consultancy Research

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