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Managing knowledge in the 21st century and the roadmap to sustainability

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1 Introduction

The objective of this introductory chapter is to provide an overview of the important role that information and communication technologies (ICTs) can play in bridging the knowledge divide and helping raise the necessary global commitment to achieve sustainable development (SD).

There is a consensus that ICTs hold great promise for development, by connecting people to more accurate and up to date sources of information and knowledge. However, the evidence so far shows that the benefits accrued from the utilisation of ICTs have been inequitably distributed with most developing countries (DCs) facing the prospect of being marginalised. Inequality of access to information and technological advantages among scientists has become a crucial factor in formal science and DCs can be said to be suffering from scientific information famine.

Many scholars such as Mansell and When (1998), Danofsky (2005) and Hamel (2005) argue that information can lead to knowledge and that knowledge is a prerequisite for development (see also Ahmed 2005). Juma (2003) and Hamel (2005) argue that education and knowledge are the chief currencies and the essence of the modern age, and can also be a strategic resource and a lifeline for developing countries' sustainable development.

There is also a consensus that ICTs can play an important role in development by connecting people to more accurate and up-to-date sources of information and knowledge (see Stiglitz 1999; Grimshaw and Talyarkhan 2005; Hamel 2005; Sciadas 2005; Tongia *et al.* 2005). The United Nations Educational, Scientific and Cultural Organization's 32nd General Conference in 2003 focused on 'Building knowledge societies and advancement of knowledge-based practices' as an essential component of globalisation and sustainable economic growth, particularly in DCs.

According to various reports by the World Bank (World Bank 2000a, 2000b, 2001, 2003a, 2003b, 2004, 2005) and the International Telecommunication Union (ITU) (ITU 2003, 2004, 2005a, 2005b, 2006a, 2006b, 2007), on a general level, there is little doubt that ICTs are generating social, economic, cultural and political changes. However, it is difficult to quantify the impact of ICTs and to separate their influence from those of other factors, such as governance or economic growth.

Technology and innovation influence and are influenced by globalisation. They are important in developing new products and services and improving existing products and services, as well as doing things in a more efficient or effective way to achieve SD. Technological innovation in ICTs and liberalisation of the regulatory context of the media and telecommunications sectors have profoundly changed the global communications landscape (Nulens *et al.*

2001). Although these changes originally started in developed countries, they also offer great opportunities for the DCs. However, the current pattern of the globalisation process leaves something crucial behind, namely the multifaceted intellectual 'wealth' and 'natural resources' of Africa (Nwagwu 2005). Nwagwu argues that the beauty of a truly globalised world would lie in the diversity of contribution by all country members of the world. A less than multi-coloured global community would have omitted variety and diversity, such a community could not be considered truly global.

The latest World Summit on the Information Society (WSIS) held in Tunis (November 2005) highlighted the importance and potential of ICTs in improving the socioeconomic development of all human beings. Also, that ICTs should not only be seen as a medium of communication, but also as a development enabler to achieve Millennium Development Goals (MDGs)[1].

The eight MDGs endorsed by the OECD and UN in 2000 (UN 2002) are: to eradicate extreme poverty and hunger (MDG1); to achieve universal primary education (MDG2); to promote gender equality and empower women (MDG3); to reduce child mortality (MDG4); to improve maternal health (MDG5); to combat HIV/AIDS, malaria and other diseases (MDG6); to ensure environmental sustainability (MDG7); and to develop a global partnership for development (MDG8). Although there is a growing body of evidence that ICTs have a significant macroeconomic impact, the extent to which ICTs have helped to directly reduce major development concerns reflected in the MDGs, such as poverty, hunger or sickness, is not clear. Table 1 outlines some possible impacts of ICTs on the different MDGs.

MDGs	Impact of ICTs
1	Increase access to market information and reduce transaction costs for poor farmers and traders
2	Increase supply of trained teachers through ICT-enhanced distance training
3	Deliver educational and literacy programmes specifically targeted at poor girls and women using appropriate technologies.
4, 5 & 6	▪ Increase access of rural care-givers to specialist support and remote diagnosis ▪ Enhance delivery of basic and in-service training for health workers ▪ Increase monitoring and information-sharing on disease and famine
7	Remote sensing technologies and communications networks permit more effective monitoring, resource management, mitigation of environmental risks
8	Increase the number of IT graduates and reduce youth unemployment

Table 1 Impact of ICTs on the MDGs

Source: ITU (2003, 2006a)

In early 2005, the UN announced the launch of the 'Digital Solidarity Fund' to finance projects that address the uneven distribution and use of ICTs, to enable poor people to enter the new era of the information society. According to the World Bank, the private sector invested $230 billion in telecommunication infrastructure in developing world between 1993 and 2003 (*The Economist* 2005).

2 Digital opportunity index (DOI)

Digital Opportunity Index (DOI) is a new index created from the set of internationally agreed core ICT indicators[2]. In an ideal world, digital opportunity would mean: the whole population having easy access to ICTs at affordable prices; all homes equipped with ICT devices; all citizens having mobile ICT devices; and everyone using broadband. DOI scores will therefore allow analysis of each country's path towards the information society. However, in order to calculate the DOI 2005 and 2006, the World Information Society Reports (WISR) (ITU 2006b, 2007) use eleven indicators (six have a fixed line orientation and five are geared to mobile). (see Appendix 1 for more details about these indicators).

The DOI 2005 and 2006 values are calculated for each indicator by calculating the data value as a proportion of the reference values for each country (usually 100% for per capita penetration, household penetration rates and broadband ratios). This gives an index value for the eleven indicators discussed above. A simple average of these index values is taken to give values for the DOI sub-indices of opportunity, infrastructure and utilisation, which are, in turn, averaged to obtain a country's overall DOI score. According to WISR 2006 and 2007 reports (ITU 2006b, 2007), DOI is the only e-index based solely on internationally agreed ICT indicators, developed for 180 and 181 countries, respectively, in 2005 and 2006. This makes it a valuable tool for benchmarking the most important indicators for measuring the information society. The DOI is a standard tool that governments, operators, development agencies, researchers and others can use to measure the digital divide and compare ICT performance within and across countries.

Table 2 shows the top and bottom ten countries in the world in terms of their DOI world ranks in 2005 and 2006.

The Republic of Korea scores the highest DOI in the last two years followed by Japan, Denmark and Iceland. The USA ranks 21st and 20th in 2005 and 2006 respectively, the UK's rank moved from 7th in 2005 to 10th in 2006, Kuwait's rank moved from 49th in 2005 to 60th in 2006 and Saudi Arabia that stood in 72nd place in 2005 moved back to 75th place in 2006, showing that a nation's economic status does not always correspond to its path towards the information society. However in the case of Saudi Arabia and Kuwait issues concerning freedom of information may be one of the reasons behind their lack of success, as access to the internet brings with it free access to information and, therefore, if the political climate of the country does not permit such access, then rapid progress towards an information society cannot be maintained in that country.

The results also clearly indicate the low progress of most African economies. The DOI for the entire content is only 0.22 and its world rank moved from 139 in 2005 to 140 in 2006. However, according to the latest African Telecommunication Indicators (ITU 2004), Africa is one of the fastest-growing markets for open source and the region with the highest mobile cellular growth rate in the world. Yet, according to the UN (Danofsky 2005), millions of people in Africa have never made a telephone call and without the ability to communicate Africa will remain poor and isolated, lacking the basic means to participate in the global society. The provision of infrastructure remains one of the key challenges facing Africa as it builds an information society. According to a recent report by the UN (Danofsky 2005), availability of ICT infrastructures in Africa is still far from ideal. Most parts of the continent are still without access, and even those with access have infrastructures that are unable to sustain today's applications, due to bandwidth constraints or prohibitive usage costs.

Top ten 2006		Top ten 2005	
Country	*DOI*	*Country*	*DOI*
Republic of Korea	0.80	Republic of Korea	0.79
Japan	0.77	Japan	0.71
Denmark	0.76	Denmark	0.71
Iceland	0.74	Iceland	0.69
Singapore	0.72	Hong Kong	0.69
Netherlands	0.71	Sweden	0.69
Taiwan	0.71	United Kingdom	0.67
Hong Kong	0.70	Norway	0.67
Sweden	0.70	Netherlands	0.66
United Kingdom	0.69	Taiwan	0.66
Bottom ten 2006		**Bottom ten 2005**	
Country	*DOI*	*Country*	*DOI*
Ethiopia	0.10	Solomon Islands	0.10
Burundi	0.09	Sierra Leone	0.09
Central African Republic	0.09	Ethiopia	0.09
Malawi	0.09	Malawi	0.08
D.R. Congo	0.08	Rwanda	0.08
Eritrea	0.07	Myanmar	0.04
Guinea-Bissau	0.04	Guinea-Bissau	0.04
Myanmar	0.04	Eritrea	0.03
Chad	0.04	Niger	0.02
Niger	0.03	Chad	0.01

Table 2 World Digital Opportunity Index (DOI) 2006 and 2005

Source: Adapted from WISR 2006–2007 and ITU World Telecommunication Indicators Database (ITU 2003, 2005a, 2006a)

3 The digital divide

It is estimated that over the next decade, 30% of the world's economic growth and 40% of all new jobs will be information technology (IT) driven (Vinay and Saran 1998). Today, countries are increasingly judged by whether they are information-rich or information-poor. The world is beginning to divide between information-rich and the information-poor nations (see Ahmed 2004).

Walsham (2000) argues that the industrialised countries of the world have been dominant in the production, development and transfer of information technology and their interest in the use of IT/S in DCs has often been more concerned with the profitability of their own business enterprises than with any broader goals concerning the development of the recipient countries. Anyimadu (2003) argues that the new ICT applications are frequently designed without considering the social and environmental realities of the DCs. Therefore DCs are posed with the challenge of either becoming an integral part of the knowledge-based global culture or facing the very real danger of finding themselves on the wrong side of the digital divide.

3.1 So what does the term 'digital divide' really mean?

The 'digital divide' can simply be defined as the invisible border that separates those who can afford ICTs and those who cannot. This could have far-reaching consequences (for more discussion see Ahmed 2004, 2005; Nulens *et al*. 2001; Marcelle 2004; Mansell and When 1998; Walsham 2000). By digital divide, we refer to inequalities in: access to the internet; extent of use; knowledge of search strategies; quality of technical connections and social support; ability to evaluate the quality of information; and diversity of uses (DiMaggio *et al*. 2001). Moreover, in developed countries, there is a rapidly growing literature on the potential of innovative ICT applications and on the organisational, social, political and economic conditions that are likely to support their effective use (see Dutton1997, 1999; Mansell & When 1998).

According to the recent World Information Society Report (ITU 2007), more than half of the world's population is expected to have access to a mobile phone by the end of 2008. The report also states that India and China are gaining on OECD countries in terms of fixed line penetration, mobile cellular subscriber penetration, Internet usage and broadband penetration (see Table 3).

World percentage	High-income	Upper–middle	Lower–middle	Low-income
Population	15.7	9.0	38.3	37.0
Total GDP	79.9	6.7	10.1	3.2
Mobile phones	38.7	17.8	35.2	8.4
Fixed lines	42.7	10.5	40.1	6.7
Internet users	55.7	11.8	22.3	10.2
Fixed broadband	74.0	5.2	20.0	0.7

Table 3 Distribution of major ICTs by the income group of economies

Source: ITU (2005b, 2007)

The report also indicates that the digital divide is narrowing in terms of Internet usage and evolving from inequalities in basic access to ICTs and their availability, to differences in the quality of the user experience. Therefore, the debate over the future of the digital divide is now moving away from 'quantity' in basic connectivity and access to ICTs to measures of 'quality' and 'capacity', or speed of access.

Table 4 shows the digital divide between the developed and developing countries by dividing the different rates in the developed world by the rate in the developing world. Rates are rounded, whereas the digital divide calculation is based on actual numbers.

The digital-divide underpins much of the ongoing discussion as to whether ICT can be harnessed to mitigate poverty in DCs, with several voices arguing that those who live on less than $1 a day have no need for ICTs. The proponents of ICTs on the other hand however consider ICTs as tools that can be used to provide the poor with economic opportunity and improve human well-being (see World Bank 2001; UNCTAD 2003).

Furthermore, the new ICT products and applications are frequently designed in ignorance of the realities of DCs, particularly of sub-Saharan Africa (SSA), and fail to address the needs of the most disadvantaged sections of the community (Mansell and When 1998). Castells (1998) provides evidence and argues that the use of IT in DCs is deeply implicated in the processes of social exclusion and that the 'fourth world', defined as including areas of social deprivation in the DCs, is increasing in size. The risks for DCs are greater simply because they are less developed and are faced with the prospect of having to integrate advanced technologies, while their economic development and infrastructure is not yet mature. The workers in these countries are susceptible to greater vulnerability as a result.

Regions	Fixed telephone*		Mobile telephone**		Internet users***	
	1994	*2004*	*1994*	*2004*	*1994*	*2004*
Developed	48.80	53.5	5.20	76.8	2.18	53.8
World	11.54	18.8	1.00	27.4	0.46	13.8
DCs	04.40	12.8	0.19	18.8	0.03	6.70
Africa	01.70	03.1	0.06	08.8	0.01	2.62
Digital divide	11	4	27	4	72	8

* Fixed telephone lines per 100 inhabitants
** Mobile telephone subscription per 100 inhabitants
*** Internet users per 100 inhabitants

Table 4 The digital divide between developed and developing countries

Source: ITU Reports (2003, 2004, 2005b, 2005c, 2006b, 2007).

4 Knowledge partnership

The gulf in the levels of science and technology between developed and the DCs will tend to widen further with the rapid expansion of the internet in the West and the speedy transition to electronic publishing, and this can lead to increased brain drain and dependence on foreign aid of a different kind (knowledge imperialism) (Arunachalam 2000). According to a recent report by the UK Government (2004) entitled 'Scientific Publications: Free for all?', the movement to a digital-only environment would result in reducing access to scientific research and exclude over 50% of scientists. Indeed, for many scholars, electronic publication has failed to address the problem of accessibility: one of its promises, lower costs (irrespective of who has to pay for them in the end), is simply not happening fast enough. There are strong indications, in fact, that consumers—scholars, their libraries and their institutions—are paying for the development of electronic versions of scholarly information (Create Change 2000).

Whilst libraries in the developed world are struggling to purchase access to all the scientific publications they need, subscriptions are prohibitively expensive for institutions in the developing world, particularly SSA. This could eventually lead to an increasing marginalisation of science and scientists in poorer countries, with a growing gulf in technological proficiency and economic development between rich and poor. Therefore, the challenge of how to foster global free flow of scientific publications should be a matter of serious interest to scientists, their institutions and governments. As a matter of fact, scientists all over the world constitute a single community of people working together to solve human problems and, therefore, require access to each other's research results (Price 1963; Merton 1973; Mengxiong 1993).

The recent example of the Severe Acute Respiratory Syndrome (SARS) epidemic demonstrates how knowledge sharing can accelerate development in science and benefit people, when the Human Genome Project data was made available to scientists to turn a collection of individual sequences into an incomparably richer resource (see PLoS for more details).

Governments spend vast amounts on scientific research; yet, the majority of the papers reporting the results of this valuable investment are locked in archives, which only give access to paying subscribers. Restricting access to knowledge restricts the development of science and has severe effects on the general well-being of people.

Many scholars have provided overwhelming evidence for the disparity in scientific output between the developing and already developed countries (see Gibbs 1995; May 1997;

Goldemberg 1998; Riddoch 2000; Cetto 2001) with more than 60% of the total world output relating to science and technology (S&T) produced by only 11 industrially developed countries. DCs have not made any significant contribution and during 2001 supplied only 0.7% (Africa), 1.9% (India) and 2% (China) of S&T output. Although these statistics may well be a true reflection of scientific activities in DCs (Gaillard and Hassan 2002), there is sufficient basis to suggest that part of the reason for the low profile of scientists in DCs is the poor access to scientific publications from developed countries, exacerbated by the institution of copyright (Tagler 1996).

It is argued that many international scientific journals, published mostly within developed countries, are a major part of the problem. Early this year, one of the top international journals in the field of science and technology, Research Policy, announced that, after 35 years of its existence, it will increase the number of Advisory Editors from outside of North America and Western Europe to ensure that the composition of the Advisory Board is appropriately reflects the regions of the world.

However, unlike the situation in the developed countries, there is a growing literature in DCs, but it is more fragmented and often restricted to sector applications or to country specific interests. It is therefore difficult for decision-makers in DCs to access systematic information about the potential applications that are being developed and implemented, and to consider how they could be applied to meet their own development needs. Equally, it is important to acknowledge that some DCs such as India, Brazil and South Africa have become regional hubs for innovation and technology development.

4.1 Mutual benefits

Many research problems can only be tackled by working with and within DCs themselves, for example, combating the results of climate change, diseases such as malaria, preservation of natural resources, fighting against land degradation or limiting the loss of biodiversity. Though 93% of the world's burden of preventable mortality occurs in DCs, too little research funding is targeted at health problems of DCs, creating a dangerous funding differential. DCs are considered 'hot spots' of global research issues related to SD, where sustainability is understood to consist of socially sustainable systems, in addition to economic and environmental aspects.

Scientists in DCs are well-placed to identify priority problem areas, to interact with policymakers and international colleagues, and to contribute to training. However, developed countries also need to overcome historical, traditional and resource-related patterns of 'partnership' that do not adequately recognise the knowledge, capacity for innovation and valuable sociocultural assets of partners within the developing world.

Building capacity in DCs is a necessary strategy for preventing the global spread of infectious agents. In addition to technical issues, successfully implementing a new technology depends on economic support, political cooperation, functional infrastructure, good communication and an understanding of sociocultural issues and environmental concerns.

4.2 Open access movement

According to Professor Peter Suber's Timeline of the Open Access Movement, the international movement of open access (OA) started in 1966 and since then the movement has been going from strength to strength, even the UN World Summit on the Information Society (2003) endorsed OA in its declaration of principles and plan of action.

The missions of the different OA initiatives include, among others, advocating that scien-

tific publications be excluded from copyright protection and that scientific papers be made available to scientists and other users free of charge. OA publishing aims to provide free online access to all journals, in which case, the reader will not be asked to pay subscription fees, thus increasing the mass audience any paper can reach and promoting further creation of knowledge. The extent of constructive discussions over issues, which will contribute to establishment of new ideas and theories, will definitely be enlarged as communication becomes cheaper, easier and faster via the internet.

On-line knowledge has distorted geography by shrinking distances and removing access barriers. Networking (subscribing to focused knowledge content), specialised forums, interest groups and e-conferences offer extraordinary means for knowledge transfer and partnership. In a recent paper by UNECA, Hamel (2005) argues that on-line or e-knowledge is the best thing ever to happen to African nations. Indeed, the Internet provides a bonanza of knowledge. It is the new revolutionary instrument for accessing knowledge. Knowledge portals and on-line knowledge searching and knowledge sharing have grown fast and have considerably reduced the isolation of most DCs.

Weerawarana and Weeratunga (2004) argue that the critical factor for OA incorporation of the Internet, as development occurs primarily via e-mail communication and shared repositories published on the Internet. Also, it should not be forgotten, that an internet connection still requires a telephone line and at least 80% of the world's population, including Africa, does not have access to one. Therefore several strategy and policy implications concerning bridging the knowledge divide and building OA in DCs will need to be critically examined. These include issues such as government commitments and funding; institutional and individual local actions; adoption of the OA paradigm; and development and training. Moreover, there is still a long way to go, but the potential benefits of ICTs and OA in particular are there at the end of the journey. Adoption of the OA paradigm needs to be encouraged in DCs as the first true step towards sustainability.

5 The roadmap to sustainability

Sadly, to many people in the world, SD is just another form of foreign aid and not a recognised discipline within the literature! Similarly, for others, SD has been seen merely as a matter of sound environmental and/or economic practice. The term sustainable development encompasses many different meanings, but the most frequently quoted definition is from the report Our Common Future (also known as the Brundtland Report). The Brundtland report (WCED 1987) defined SD as 'development that meets the needs of the present without comprising the ability of future generations to meet their own needs.'

In simple terms, SD refers to maintaining development over time but, so far, there are well over four hundred definitions of SD currently available in the literature (see Ahmed and Stein 2004; Pearce *et al*. 1989; Holmberg 1992; Morita *et al*. 1993; Murcott 1997; Elliot 2001) providing different concepts, perspectives, concerns and solutions for SD. How they relate to each other and provide a clear understanding of our common future still remains a key question to be addressed. Therefore, it is essential that research and policy development fully takes account of the differing perspectives of SD and makes explicit the particular perspective(s) that they are taking. No single definition necessarily fully captures the concept, but by being clear about our meaning and the underlying assumptions, we can progress understanding of our common future challenges and their relationships to SD.

The concept of SD is multi-dimensional and it is no accident that the EU's policies on inter-

national cooperation in S&T, both within and, particularly, beyond Europe, stress research on a multidisciplinary approach to sustainability such as sustainable agriculture and management of natural resources; the idea of sustainability underpins the very basis of European cooperation. Equally important, when we study or practice development, we must recognise and be sensitive to the heterogeneity, uniqueness and diversity of DCs.

The different dimensions of SD are illustrated in Figure 1 as a framework that involves all issues such as science, technology, economic growth and development, health, ICT, education, FDI and MNCs, international debt and aid, trade, politics, war, natural disasters, population growth, terrorism, etc.

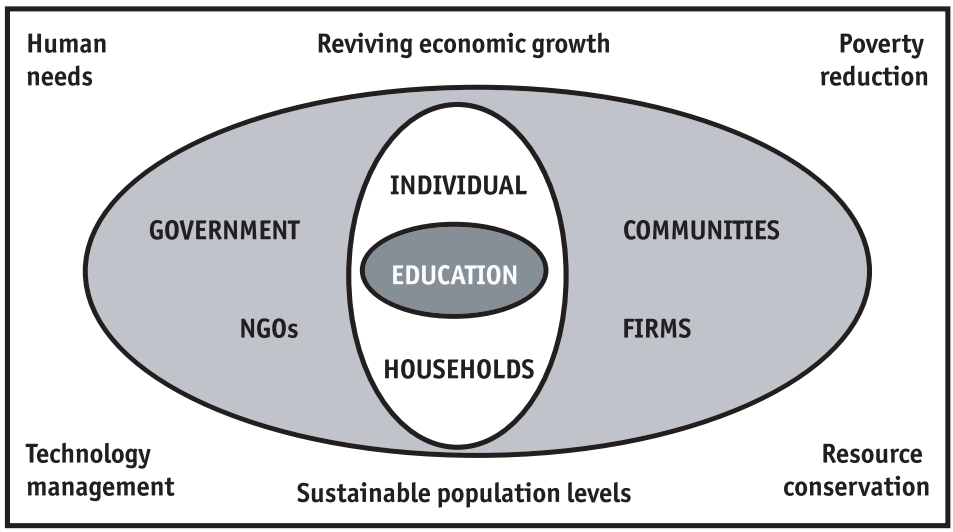

Figure 1 Dimensions of sustainable development

However from the above illustration, education is considered to be the key issue in achieving SD and therefore, there is an urgent need for strong commitment to education and training in all countries, particularly the low income countries, as well as commitment to the 'hard' infrastructure policies often so dominant in the past.

It is also incumbent upon Europe, and the rest of the developed world, to share the solutions it has developed over the past half century, in relation to all dimensions of SD, with its global partners from the DCs, to find ways to apply lessons learned in a way that is applicable to S&T partnerships in the world as a whole.

Knowledge partnerships between the developed and the developing world could help in the rapid generation and diffusion of knowledge, coupled with rapid technological advances affecting all facets of life in all countries. Such partnership arrangements are often more nominal than genuine, however, in terms of shared prioritisation, responsibility and management. Moreover they often have uneven consequences in DCs, in terms of economic growth and social progress. It can therefore be misleading to view knowledge generation as primarily originating from Europe and other developed countries, if publication is used as the primary indicator.

Many scholars argue that endogeneity is far more important to successful innovation in the developing world than transfer and adaptation of technology developed elsewhere. It is argued that the prevailing character of cooperation between the developed world and DCs, which

stresses the transfer of resources, does not adequately recognise the knowledge, capacity for innovation and valuable sociocultural assets of partners within the developing world.

There is no doubt that some DCs are rich in traditional knowledge, while some others are doing very well even in the most technologically advanced fields. Both types of knowledge claim to be part of the process, which generates further knowledge as equal members in partnership. It is also evident that knowledge generated in the developed world may have little relevance to pressing needs in food production, health care, clean water and education in the developing world. As we work towards more sustainable development, we must strive not to lose sight of the big picture; we must think and act both globally and locally.

Finally, the proposed new partnership approach must seek to change the behaviours of individuals and institutions. To do this, it is necessary to recognise all the dimensions of the global information society and telecommunications trends and to seek to deal with them.

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Notes

1 Over the last ten years, the UN, World Bank, IMF and other world leading organisations and institutions have introduced a general approach to establish an agreed universal framework of international development goals and targets to be reached in the near future (2010 & 2015) by all countries in the world as a whole. In 2000, the OECD and UN's Copenhagen plus Five Conference, endorsed and adopted eight development goals, universally referred to as the UN Millennium Development Goals (MDG) (see UN 2002).

2 Partnership on Measuring ICT for Development, Core ICT Indicators, November 2005, available at: www.itu.int/ITU-D/ict/partnership/material/CoreICTIndicators.pdf.

Appendix 1: Digital Opportunity Index (DOI)

Eleven core ICT indicators are used by the World Information Society Report (WISR) to calculate the DOI ranks. Six of the eleven indicators have a fixed line orientation and five are geared to mobile communication. Indicators are:

a Indicators that provide an **opportunity** for the country's citizen to use ICTs:
   1 Percentage of population covered by mobile cellular telephony
   2 Internet access tariffs as a percentage of per capita income
   3 Mobile cellular tariffs as a percentage of per capita income

b Indicators that represent the **infrastructure** needed by any country to use ICTs:
   1 Proportion of households with a fixed line telephone
   2 Proportion of households with a computer
   3 Proportion of households with internet access at home
   4 Mobile cellular subscribers per 100 inhabitants
   5 Mobile Internet subscribers per 100 inhabitants

c Indicators show the extent of ICTs **utilisation** within the country:
   1 Proportion of individuals that used the internet
   2 Ratio of fixed broadband subscribers to total internet subscribers
   3 Ratio of mobile broadband subscribers to total mobile subscribers

Glossary of Definitions

Digital Divide
The 'Digital Divide' can simply be defined as the invisible border, that separates those who can afford ICTs and those who cannot and could therefore have far-reaching consequences (for more discussion see Ahmed 2004, 2006; Nulens *et al*. 2001; Marcelle 2004; Mansell and When 1998; Walsham 2000)].

Digital Opportunity Index (DOI)
DOI is a new index created from the set of internationally agreed core ICT indicators. In an ideal world, digital opportunity would mean: the whole population having easy access to ICTs at affordable prices; all homes equipped with ICT devices; all citizens having mobile ICT devices; and everyone using broadband. DOI scores will therefore allow analysis of each country's path towards the information society.

Bandwidth
International bandwidth in bits per capita is the new measure of internet use, it shows how a country is progressing towards an information-based economy.

Open Access Literature
Open Access literature is digital, on-line, free of charge and free of most copyright and licensing restrictions. OA publication is defined by the Bethesda Meeting on Open Access Publishing (11 April 2003) as one that meets the following two conditions:

- The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute,

transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use.

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Journals make content freely available immediately on publication. Content is often defined as anything that is not a computer program, but can be recorded or stored and reproduced digitally such as scientific publications.

Open Access/Self-Archiving
Authors make copies of published work open accessible (in a subject or institutional repository)

Open Source Knowledge
OSK means open technical standards and open forms of technical infrastructures, network technologies, computer architectures, system software and generic drug (for more details see Hamel 2005; Weerawarana and Weeratunga 2004).

Open Source Software
Open Source or Open Access software is digital, online, free of charge and free from most copyright and licensing restrictions. It can help users with limited resources to take full advantage of the opportunities offered by the information society. Several promising initiatives were launched to promote open access to software and technical resources.