6th World Telecommunication/ICT Indicators Meeting (Geneva, 2007)

Background Documents

INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION DEVELOPMENT BUREAU

Document 004-E
12 December 2007
Original: English

6TH WORLD TELECOMMUNICATION/ICT INDICATORS MEETING, GENEVA, 13-15 DECEMBER 2007

SOURCE: STAT, ITU

TITLE: DRAFT – Toward a Single ICT Index - Considerations for the Formulation of a Single – ICT Index for the ITU

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DRAFT

Toward a Single ICT Index

Considerations for the Formulation of a Single ICT Index for the ITU

Prepared by:
Mike Jensen & Amy Mahan
December 2007

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Acknowledgements

The authors thank Alejandra Davidziuk and Georgia Marnham for editing and research support.

Chapter 1 – Antecedents of a single index

1.1 Introduction

There are today a wide variety of ICT indicators which cover a broad range of factors extending beyond simple access to infrastructure. A composite index might include, for example, pricing indicators to assess affordability, literacy levels to measure potential use, or the amount of available bandwidth, to show quality of access. For policy makers, familiarity with ICT indicators is important, not only in terms of issues at the core of Information Society development and digital divide bridging, but also in areas where ICT underlies other development platforms (such as education, agriculture or health). Moreover, a better understanding of ICT development globally – via measuring and documenting different aspects – can provide a perspective on the challenges for the critical economic and social development in poorer countries.

As will be discussed in the following sections, there are a large number of different ICT indices, each produced with their particular mandate to illuminate a different perspective on ICT adoption and usage.

ITU membership at the ITU Plenipotentiary Conference 2002 (PP02) and the World Telecommunication Development Conference (WTDC) 2006, renewed or gave ITU-D a variety of specific mandates for measuring access to telecommunication and ICT: [1]

- WTDC-2006 Doha Action Plan: Section 3.4 b) Activity 1: Statistics and information on telecommunication/ICT
- WTDC-2006 Resolution 8 (Rev.Doha, 2006): Collection and dissemination of information and statistics
- PP02 (Marrakesh) Resolution 71 – The mission of the ITU-D sector is to "collect, analyse and make available information, data and statistics on ICT in order to assist Member States and Sector Members in making informed policy and development decisions (Goal 6)"
- PP02 (Marrakesh) Resolution 131 – instructs ITU-D to " promote the activities required in their respective Sectors to define and adopt new indicators for the purpose of measuring the real impact of community connectivity on the development of communities"

The main activities for ITU in this respect were included in the WTDC 06 Doha Action Plan:

- To participate in the establishment of core indicators to measure efforts to build the information society and, by doing so, to illustrate the scale of the digital divide;
- To further develop and improve benchmarking efforts, including the ICT Opportunity Index;
- To encourage countries to collect information illustrating national digital divides; and
- To unify all BDT information and statistical databases on the BDT website.

Of particular note here is the need to adopt a set of core indicators which can demonstrate the extent of the digital divide, to further improve existing benchmarking efforts, and to unify the information available in one place.

[1] ITU's mandate in the area of collecting operational and service information data goes back to the treaty-level text of the International Telecommunication Regulations (ITR), Article 8, see: http://www.itu.int/osg/spu/intset/itu-t/mel88/mel-88-e.pdf

Over the last few years, two distinct indices – both global in scope and aimed at measuring countries' progress towards becoming information societies – were developed and published by ITU: the ICT Opportunity Index (ICT-OI) and the Digital Opportunity Index (DOI). The *2007 World Information Society Report*, a joint publication by ITU and UNCTAD, details the use of these two different indices.[2] In November 2006, during the last Plenipotentiary Conference, ITU's Development Sector (BDT) was instructed to develop a single index for ITU and "to promote an ICT index […] with a view to achieving international consensus on this index."[3,4]

Supporting a single ICT index will be a more efficient use of resources, and will also help to reduce any lack of clarity about which index to use. In addition it will encourage all countries to use the same set of benchmarks, and thereby help in the development of common strategies to improve the uptake of ICT, while increasing the visibility of both the achievers and the laggards. However, a single ICT index is a broadbrush instrument and should be recognised as such.

1.1.1 WSIS – THE GENEVA PLAN OF ACTION, THE DOI AND THE ICT-OI

Both the DOI and the ICT-OI reference the Geneva Plan of Action as their genesis (see Box 1). While a useful summary of what would be the ideal, paragraph 28 of the Plan of Action can be regarded as a wish list rather than an actual plan. In this sense, it is a contradictory framework – and contains a bit of everything, reflecting the priorities of the different stakeholders who devised it.

The opening sentence of paragraph 28 includes the qualifier *realistic*. From this it could be understood that the primary intention is to be practical, or that the performance evaluation and benchmarks should actually take place. However, *realistic* is also a pointed acknowledgement that reliable indicators do not exist for the countries whose progress needs to be most urgently monitored and targeted for appropriate policy development.

Thus, there are two approaches suggested by paragraph 28. First, that an international performance evaluation is a priority; and second, that the practices of collecting and using reliable indicators need to be cultivated at national levels across the developing world.

The subparagraphs of the Plan of Action specifically mandate the collection of community connectivity indicators, qualitative benchmarking or gender-specific indicators on the one hand; and more standard and internationally comparable indicators on the other. Clearly, ITU has an important role to play at both of these levels. However, if only one index is to be maintained by ITU, then a choice needs to be taken and not all of these points can adequately be taken into account today. For example, appropriate statistics to measure the extent of community access do not yet exist.

[2] ITU/UNCTAD *2007 World Information Society Report* . Beyond WSIS. http://www.itu.int/osg/spu/publications/worldinformationsociety/2007/

[3] Final Acts of the Plenipotentiary Conference (Antalya, 2006). http://www.itu.int/council/groups/stakeholders/Background-Documents/final-acts.doc

[4] The Tunis Agenda for the Information Society also mandates a non-duplicative undertaking of indicator work (WSIS 2005: para 117), however, it is also possible to observe these indices are not necessarily duplicative (see further below).

Box 1 – **Geneva Plan of Action**
E. Follow-up and evaluation

28. A realistic international performance evaluation and benchmarking (both qualitative and quantitative), through comparable statistical indicators and research results, should be developed to follow up the implementation of the objectives, goals and targets in the Plan of Action, taking into account different national circumstances.

- In cooperation with each country concerned, develop and launch a composite ICT Development (Digital Opportunity) Index. It could be published annually, or every two years, in an ICT Development Report. The index could show the statistics while the report would present analytical work on policies and their implementation, depending on national circumstances, including gender analysis.
- Appropriate indicators and benchmarking, including community connectivity indicators, should clarify the magnitude of the digital divide, in both its domestic and international dimensions, and keep it under regular assessment, and tracking global progress in the use of ICTs to achieve internationally agreed development goals, including those of the Millennium Declaration.
- International and regional organizations should assess and report regularly on universal accessibility of nations to ICTs, with the aim of creating equitable opportunities for the growth of ICT sectors of developing countries.
- Gender-specific indicators on ICT use and needs should be developed, and measurable performance indicators should be identified to assess the impact of funded ICT projects on the lives of women and girls.
- Develop and launch a website on best practices and success stories, based on a compilation of contributions from all stakeholders, in a concise, accessible and compelling format, following the internationally-recognized web accessibility standards. The website could be periodically updated and turned into a permanent experience-sharing exercise.
- All countries and regions should develop tools so as to provide statistical information on the Information Society, with basic indicators and analysis of its key dimensions. Priority should be given to setting up coherent and internationally comparable indicator systems, taking into account different levels of development.

The difference in approaches is illustrated by the two indices: the ICT-OI providing a broad sweep perspective on both ICT development and the digital divide at a comparable and international level; and the DOI offering a more diagnostic perspective on both existing and emerging technologies, and including measures of opportunity in addition to availability.

The Tunis Agenda for the Information Society (see Box 2) recognized the development of both, the DOI and the ICT-OI. Here again, what is mandated (between paragraphs 112 and 119) as a priority for indicators and documentation is a full-blown indicator programme comprising perspectives of the sector and its divides between nations, to detailed analytical devices at national and even project levels. This is not necessarily a question of choosing between these different lenses: the full range of vantage points is necessary and thus have been included as complementary – not competing – perspectives. As always, the development of gender disaggregated indicators is included in the top priorities.

Paragraph 117 asserts that “The further development of these indicators should be undertaken in a collaborative, cost-effective and non-duplicative fashion”. As discussed further below, the ICT-OI and the DOI have very little overlap in either methodology or indicators used. And further, their intended levels of analysis are quite distinct.

Box 2 – **Tunis Agenda for the Information Society**

112. We call for periodic evaluation, using an agreed methodology, such as described in paragraphs 113-120.

113. Appropriate indicators and benchmarking, including community connectivity indicators, should clarify the magnitude of the digital divide, in both its domestic and international dimensions, and keep it under regular assessment, and track global progress in the use of ICTs to achieve internationally agreed development goals and objectives, including the Millennium Development Goals.

114. The development of ICT indicators is important for measuring the digital divide. We note the launch, in June 2004, of the *Partnership on Measuring ICT for Development*, and its efforts:

a.to develop a common set of core ICT indicators; to increase the availability of internationally comparable ICT statistics as well as to establish a mutually agreed framework for their elaboration, for further consideration and decision by the UN Statistical Commission.

b.to promote capacity building in developing countries for monitoring the Information Society.

c.To assess the current and potential impact of ICTs on development and poverty reduction.

d.to develop specific gender-disaggregated indicators to measure the digital divide in its various dimensions.

115. We also note the launch of the *ICT Opportunity Index* and the *Digital Opportunity Index*, which will build upon the common set of core ICT indicators as they were defined within the *Partnership on Measuring ICT for Development*.

116. We stress that all indices and indicators must take into account different levels of development and national circumstances.

117. The further development of these indicators should be undertaken in a collaborative, cost-effective and non-duplicative fashion.

118. We invite the international community to strengthen the statistical capacity of developing countries by giving appropriate support at national and regional levels.

119. We commit ourselves to review and follow up progress in bridging the digital divide, taking into account the different levels of development among nations, so as to achieve the internationally agreed development goals and objectives, including the Millennium Development Goals, assessing the effectiveness of investment and international cooperation efforts in building the Information Society, identifying gaps as well as deficits in investment and devising strategies to address them.

120. The sharing of information related to the implementation of WSIS outcomes is an important element of evaluation. We note with appreciation the Report on the Stocktaking of WSIS-related activities, which will serve as one of the valuable tools for assisting with the follow-up, beyond the conclusion of the Tunis phase of the Summit, as well as the “Golden Book” of initiatives launched during the Tunis phase. We encourage all WSIS stakeholders to continue to contribute information on their activities to the public WSIS stocktaking database maintained by ITU. In this regard, we invite all countries to gather information at the national level with the involvement of all stakeholders, to contribute to the stocktaking.

1.2 Overview of ITU indices

The two indices used by ITU, the DOI and the ICT-OI, were created in response to the framework of the WSIS resolution to "…develop and launch a composite ICT Development (Digital Opportunity) Index."[5] As the *2007 World Information Society Report* (WISR) observes, there is a correlation coefficient between the two indices of 0.94, with only minor variations in country rankings. Yet, they employ very different methodologies and only have one indicator in common.

This section compares and contrasts the two methodologies and the individual indicators that are drawn upon to comprise the respective indices, with a view to making recommendations for establishing a single (ITU) ICT index for the future. The 2007 WISR includes a section dedicated to this issue of moving towards a single composite index, referencing both WSIS and the ITU Antalya Resolution 131 which calls for the same. While both remain neutral – neither recommending the DOI or the ICT-OI in this capacity, Resolution 131 references Resolution 8 of the WTDC-06, which mentions only the ICT-OI.

This paper negotiates terrain between the two methodologies and their intentions, and provides arguments for reconciling issues around the two sets of ITU indicators, positioning considerations and recommendations for a future single index. It also takes into account the work of the "Partnership on Measuring ICT for Development[6]," of which ITU is a lead member. The Partnership on Measuring ICT for Development, which was also recognized by the Tunis Agenda for the Information Society (see Box 2, para 114 and 115), is a multi-stakeholder partnership to coordinate ongoing and future ICT indicator activities. It also aims to develop a coherent and structured approach to advancing the development of ICT indicators globally, and in particular, in developing countries. The Partnership includes all major regional and international players in involved in ICT measurement. While the Partnership's work is entirely separate from the work ITU is carrying out in terms of international benchmarking and index creation, the Partnership's Core List of Indicators – which was (and continues to be) developed to help guide countries in their data collection efforts – are taken into consideration. Both, the DOI and the ICT-OI draw from the Partnership's Core List in their choice of indicators.

This document is also concerned with the nexus of MDG and WSIS targets for 2015. The definitive path forward recognises the urgent need for action as well as the imperative for a framework to monitor and ensure progress toward 2015.

This discussion also considers the ITU's earlier index, the Digital Access Index (DAI), and the Digital Divide Index (DDI, or InfoStates – developed by Orbicom) as important precursors to the indices under consideration.

1.2.1 THE EMERGENCE OF THE DOI AND ICT-OI

ITU publishes about 80 individual ICT indicators[7] and collects a much wider range of data, dedicating much work over the years to maintaining the *Yearbook of Public Telecommunication Statistics*, presenting data[8] in different formats, from databases to the ICT Eye,[9] and the numerous reports

[5] DOI – WSIS Geneva Plan of Action (para 28).
http://www.itu.int/wsis/docs/geneva/official/poa.html

[6] For more information on the Partnership on Measuring ICT for Development, see http://www.itu.int/ITU-D/ict/partnership/index.html

[7] There are 105 different statistics in the ITU database, some of which are per capita derivations of the absolute values which are also listed.

[8] See: http://www.itu.int/ITU-D/ict/publications/world/material/handbook.html for a complete list of indicators collected by the ITU and their definitions.

[9] See: http://www.itu.int/ITU-D/icteye/Default.aspx

providing analysis of these indicators – especially the World Telecommunication Development Reports (WTDR) beginning in 1994, and the World Summit on the Information Society Reports (WISR) in 2006 and 2007.

ITU has also played a key role in high level initiatives to achieve consensus on which indicators should be collected, as well as to build better indicators to improve understanding of their impact on society, and to measure their diffusion and absorption across the world. It was also a founding member of the Partnership on Measuring ICT for Development.[10] Although ITU's work in the area of indices predates the WSIS, both the ICT-OI and the DOI were specifically conceived to fulfil the mandate of the Summit and both indices reference the internationally agreed core list of indicators identified by the Partnership on Measuring ICT for Development.[11] The selection of the individual indicators is covered in more detail in Chapter 2.

Table 1 – **Index characteristics**

Index	**Main stake-holders**	**Number of Indicators**	**Number of Countries**	**Data years**	**Sub indices**
Mobile / Internet Index	ITU	26	200	2001	1) **Infrastructure** 2) **Network usage** 3) **Market conditions**
DAI - Digital Accessibility Index	ITU	8	178 40 for 98-2002	2002	1) **Infrastructure** 2) **Affordability** 3) **Knowledge** 4) **Quality** 5) **Usage**
DOI – Digital Opportunity Index	ITU	11	181	2000-2005	**1) Opportunity 2) Infrastructure 3) Usage**
Orbicom's DDI - Digital Divide Project Index (also referred to as InfoStates)	Orbicom	17	139	2003	**1) Infodensity** – the sum of all ICT stocks (capital and labour) (networks and skills) and **2) Info-Use** – consumption flows of ICT over a set period (uptake and intensity) **Infostate** is the aggregation of infodensity and info-use.
ICT-OI – ICT Opportunity Index	ITU	10	183	2001-2005	**1) Infodensity** (networks and skills) and **2) Info-Use** (uptake and intensity)

1.2.2 STATED OBJECTIVES OF THE INDICES

The stated objectives of the ITU indices in Table 2 below give a general idea of the intended range of focus and the overarching categories used to frame the data for each index. Not surprisingly, as all have at different times been adopted and/or used by ITU, there is a similar core focus, which is to measure access to ICTs and to help understand differences between countries. This is further grounded in the availability of data collected – since these indices are all based primarily on ITU data. However, there is also an institutional focus on infrastructure and its effective deployment, as a precursor to other forms of social and economic development.

[10] See: http://www.itu.int/ITU-D/ict/partnership/

[11] The Partnership on Measuring ICT for Development's core list of indicators is available at: http://www.itu.int/ITU-D/ict/partnership/material/set_core_ICT_indicators.pdf

A further ITU index is the Mobile / Internet Index which was published in the 2002 ITU Internet report, which attempted "to gauge the likelihood of adoption of the mobile Internet in different economies".[12] Because of this more focused objective, it does not measure overall access to and use of ICTs and is not considered further here.

Table 2 – **Statements of purpose**

Digital Access Index (DAI) The DAI is the ITU's precursor to the DOI and was used in conjunction with the Orbicom InfoStates index to devise the ICT-OI. Launched at the 2003 WSIS.	The Digital Access Index (DAI) measures the overall ability of individuals in a country to access and use Information and Communication Technology.[13]
Orbicom InfoStates Developed by Orbicom; also used by UNCTAD Launched at the 2003 WSIS.	[M]akes possible the systematic measurement of the state and the evolution of the Digital Divide internationally. Monitors the Digital Divide across economies at a given point in time; and within economies over time. Places emphasis on developing economies; relies on a modeling approach that yields policy-relevant results; focuses on ICT, but is broader in scope than pure connectivity measures (Sciadas 2003: 2).
Digital Opportunity Index (DOI) Follows a similar methodology as used in the DAI. First published in 2005.	The Digital Opportunity Index (DOI) is a composite index that measures "digital opportunity", or the possibility for the citizens of a particular country to benefit from access to information that is "universal, ubiquitous, equitable and affordable" (WSIS Tunis Commitment, para 10). As such, it is a measure of each countries' performance and prospects for progress in building an Information Society (DOP 2006:7).[14]
ICT Opportunity Index (ICT-OI) The result of the merger of the Digital Access Index (DAI) and Orbicom's InfoState conceptual framework and model. First published in 2005	…to measure access to and usage of ICT by individuals and households in its inclusive sense. The fundamental principle has been to interpret the notion of ICT access and usage within the context of a global Information Society, thus recognizing ICT opportunities as an important part of social development. (ITU, WISR 2007, p. 120). The prime objective of the ICT-OI is to identify the digital divide and to help understand how it has evolved since the beginning of this century. To adequately measure differences among economies with highly developed ICT levels, more precise and qualitative indicators would be needed. (ITU, WISR 2007, p. 130).

The DOI statement of purpose above is taken from the DOI FAQ, and it also appears in the DOI User's Guide. However, the DOI is also ascribed different objectives elsewhere. As summarised by Jeffrey James:

> On the one hand, for example, the DOI is described 'as an objective measurement of individual and household access to ICT'. In another document, however, a much more general goal is adduced, namely of providing 'a comprehensive statistical framework for monitoring the digital divide'. In yet another source, the DOI is described by the ITU as a composite index that measures 'digital opportunity' (James 2007: 47).

[12] http://www.itu.int/osg/spu/publications/sales/mobileinternet/

[13] http://www.itu.int/newsarchive/press_release/2003/30.html

[14] Digital Opportunity Platform (DOP) (2006) Digital Opportunity Index: A User's Guide. Seoul: DOP. p.7. See also the ITU's DOI FAQ: http://www.itu.int/osg/spu/publications/worldinformationsociety/2006/faq.html.

These varying accounts of what the DOI measures could be in response to the wide range of terrain covered in the WSIS statements and the aspiration to meet the full gamut of requirements and different needs for the index, as listed in the DOI FAQ. But, more critically, there is a potential signalling of one of the fundamental differences that sets the ICT-OI apart (and InfoStates, upon which it is based) – its theoretical grounding and a conceptual starting point. The importance of this is that it serves to inform choices of indicators and their weighting[15] in the index, and assists choices which need to be determined by consensus of the designers and their stakeholders.

As shown more fully in Chapter 2, devising an index is not a trivial task, especially when it is necessary to take into account different perspectives on what is useful to measure and to negotiate methodologies for capturing the desired information or ranking.

Of all the ITU indices, the ICT-OI has the most explicit, detailed and complex conceptual framework. This framework is based on the perspective that ICTs have a dual nature, being both a consumable and a productive asset and hence the framework is grounded in economic theory.

> Infodensity refers to the slice of a country's overall capital and labour stocks, which are ICT productive capital and ICT labour stocks and indicative of productive capacity. Info-use refers to the consumption flows of ICT. Technically, it is possible to aggregate the two and arrive at the degree of a country's ICTisation, or infostate (ITU – Measuring the IS – 2007: 2).

The focus of the ICT-OI on the conceptual framework does not imply that the other ITU indices have produced unreliable results. In fact, there is very little variance in the rankings between the ICT-OI and the DOI. This is particularly notable, because the two indices measure different aspects of progress towards information societies. As is discussed further, they also have different intentions, with the ICT-OI focussed on growth of ICT stocks (with ranking being only a by-product of this process) and the relative evolution of the digital divide over time, while the DOI is more focussed on countries' absolute Index value and ranking. Clearly, transparency, clarity and a solid theoretical framework are critical for the use of the indicator to inform policy processes and for explaining results.

1.2.3 INDEX METHODOLOGIES

Because the different indices are designed to shed light on different angles of the digital divide and ICT diffusion, a certain divergence between them is to be expected. The high correlation between the DOI and ICT-OI is explained in the 2007 WISR as arising "because both indices are, in turn, related to underlying variations in wealth and income" (WISR/ITU 2007: 17). This correlation also holds true for the DAI and DOI which use similar methodologies.

There are two overarching methodological strategies employed across the indices being considered here. The DOI[16] and DAI[17] use a similar system of establishing goal posts, with the indicators expressing progress towards meeting these goals. This is a similar approach to that used in the UNDP

[15] Although there is no explicit weighting of individual indicators in the ICT-OI or the DOI, the varying number of indicators in each sub-Index creates the effect of weighting. For example the ICT-OI Skills sub-Index has four indicators and is averaged with Networks which has three indicators, so the individual Network indicators are effectively given more weight than each of the individual Skills indicators.

[16] "Indicators in various data series are standardised on a scale relative to a reference value […]. For most indicators, this is 100 per cent, making the DOI simple and straightforward to calculate […]. Index scores in the three clusters are then averaged by simple average to give the overall DOI score for a country, between zero to one […] (ITU, WISR 2007: 35).

[17] "Each variable in the DAI is converted to a variable index with a value between zero and one by dividing it by a maximum value or "goalpost". Each variable index is then weighted within its category to give the category index. The DAI is obtained by averaging the category indices" (DAI).

Human Development Index (HDI). The variables are made comparable before they are combined – for instance by dividing them by population, by the number of households or, in the case of tariff measures, by expressing them in terms of GNI per capita, with a reciprocal then being used. They are then 'normalised' into a value between 'goalposts' (minimum and maximum values that may be achieved – such as 100 percent mobile density). If the goalpost is surpassed (such as mobile density surpassing 100 percent – as is happening in certain countries), the value of the upper goalpost (1) is assigned, as it might be assumed that universal service has been achieved for this particular variable. If, for any reason, the theoretical basis for a particular goalpost has to be changed, previous years' data would have to be recalculated incorporating the new value for the goalpost to allow for changes over time. However, this has not happened to-date in the development of the DOI.

In contrast, the ICT-OI methodology takes an open-ended approach, which makes possible the expression of continued growth from one year to the next. This allows for comparisons to be made of real progress, as well as relative progress over time. The ICT-OI value for each country is calculated based on the overall average (of all countries considered) of the indicator value for the ICT-OI reference year (2001 – the earliest year for which there is sufficient data for most countries). This reference year and value provide the benchmark to quantify and monitor changes in the digital divide in a systematic manner over time and between countries. The reference value will change if the Index is restricted to a specific subgroup of countries, since the average for the entire group will change. This reflects the idea that the digital divide is a relative concept and whether a country is making progress or not, depends on what other country (or group of countries, regions etc) it is compared to.

In some senses, both of the methodologies used are relatively complex and somewhat difficult to replicate. Users wishing to analyse the data will need to unbundle the different categories and understand their implicit weighting systems.[18] The ICT-OI is perhaps even more difficult to reproduce and understand because a country's ICT-OI value is calculated based on the average of all values that it should be compared to, and because of the use of the reference value, reference year, and the use of the geometric mean.

Like the arithmetic mean and the median, the geometric mean is another form of averaging results. In the same way that the median favours the very middle value in the spread, the geometric mean favours balance between the different values. For example, an average of two values, say, mobile and Internet subscribers will be higher with a geometric mean if the values being averaged are in balance. For example, if one country had 20% Internet subscribers and 40% mobile subscribers, the arithmetic mean would be 30, but the geometric mean would be 28, while for a country with 10% Internet subscribers and 50% mobile subscribers, the arithmetic mean would still be 30 but the geometric mean would be 22.

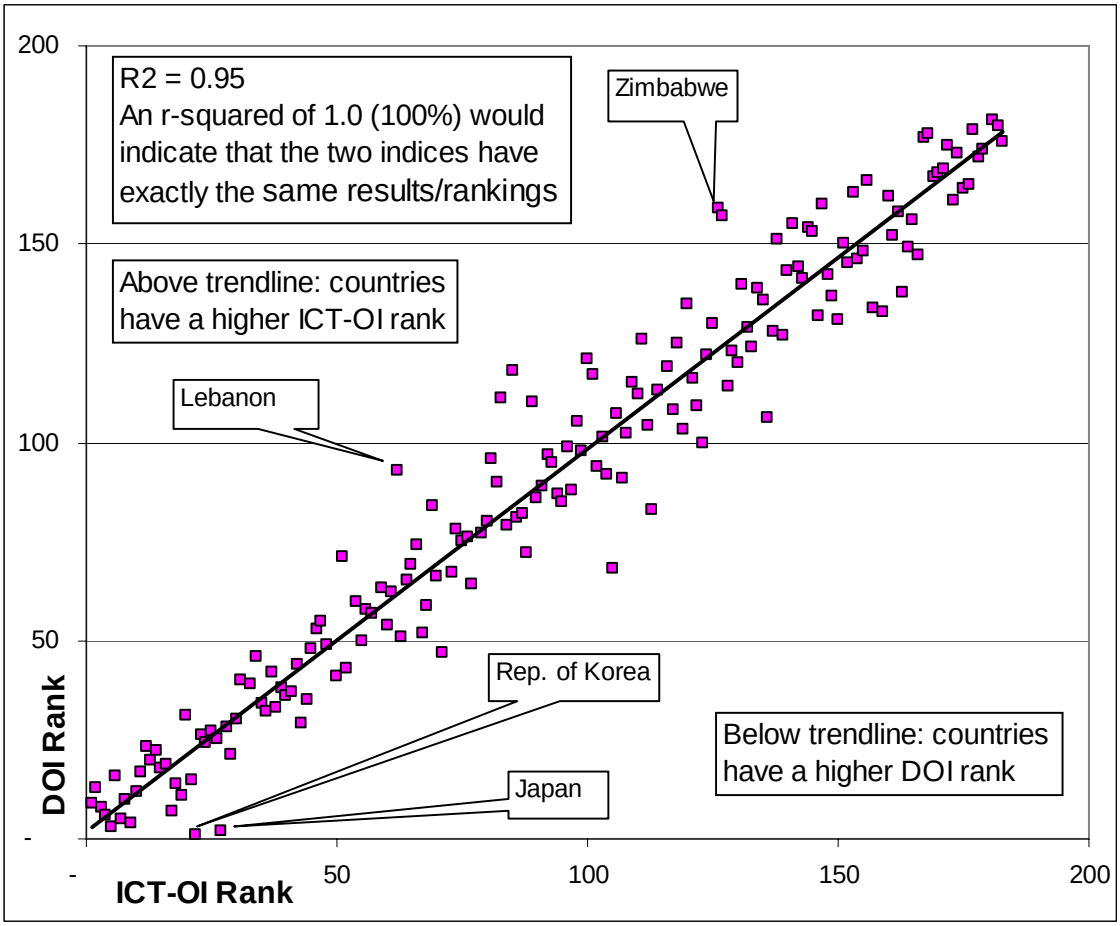
Further, since both the ICT-OI and the DOI use a number of indicators for which there is inadequate reporting to the ITU, special procedures have been used for constructing or approximating the data, as well as using alternate data sources and proxies. In this respect, the DOI makes use of a much greater variety of data sources, in particular national market research, to flesh out data that is reported directly to the ITU, thus mitigating the data gaps. It is unclear how much effort would be required to continue the sourcing of data in this way on a regular basis.

Further, the household data used by the DOI are not available for the majority of countries. While household data in an ideal situation may be a more appropriate way to measure the information society, most developing countries do not yet gather a useful set of household ICT indicators, and even in the cases where this data is available, aside from the mobile phone, very few people have access to ICTs at home. In this respect household indicators at this point in time are more of a developed, rather

[18] As mentioned earlier, neither of the indices explicitly weights indicators differently, but there is a degree of weighting inherent in the way indicators are selected and grouped, so that, for instance the multiple number of Internet or Skills related indicators used gives these types of factors additional weight in the final index.

than a developing country indicator and community access measures may be more appropriate for a global index at the moment.

Figure 1: ICT-OI and DOI rankings compared



1.2.3.1 The use of Subindices in the Index

Composite indexes present a complex of factors that are all deemed to have a bearing on the object of measurement. Information society development and bridging digital divides are contingent on a number of different areas such as access to infrastructure, and ability to use services and applications productively. In turn, these areas can be examined in terms of surveying conditions depicted by groups of indicators – to help answer questions such as, how much and what kinds of basic infrastructure is available? is it affordable? is most of the population literate enough to effectively use ICTs?, and so forth. These groupings are often used to separate out infrastructure indicators from uptake and usage ones. This type of modular design also allows for additional data clusters to be added to the Index in future for further analysis (such as for age, gender, rural / urban).

Thus, each of the indices have groups of subindices into which different indicators are organised (see Tables 1 and 3). The different subindices may also permit more clarity on particular policy decisions that might improve rankings and hence progress towards information society goals.

The DOI has a distinct property here, which is to view the subindices in sequence, and as interdependent. "In order to have access to infrastructure, users must have the opportunity to be covered by the service and be able to afford it. Usage depends on having infrastructure and a device. This progression is in fact reflected in the DOI results, where the Opportunity Index is consistently higher than the Infrastructure Index, which in turn is higher than the actual Usage Index."[19]

For the ICT-OI, indicators are transformed by dividing the country value by the average for all countries, to obtain category scores which give an indication of the country's performance relative to the world average. The categories/subindices are then averaged together to obtain the overall score. As mentioned earlier, the key distinction compared to the DOI here is that the index compiles each country's index value in relation to the average of all of the other countries' indicators rather than to a maximum value as is the case of the DOI.

1.2.3.2 Weighting

Weighting the different indicators in the index is often used to assign more or less importance to the constituent factors. Although there is a degree of weighting inherent in the way indicators are grouped, especially in the ICT-OI, in general ITU indices have avoided used any explicit weighting. For example, the DOI uses equal weighting for each component "due to the lack of any objective or theoretical basis for alternative weights and a desire to keep the index as simple as possible so that it can be replicated and used as a policy tool by as broad an audience as possible" (Kelly & Biggs 2007: 1327).

An Index can also carry an implicit weighting in the choice and number of indicators used. Comparing the ICT-OI with the DOI, it can be seen that the DOI has more Internet and broadband indicators, while the ICT-OI has more emphasis on basic infrastructure and skills in its choice of Indicators.

It has been observed that the DOI's approach of using equal weighting within and between the three clusters, with particular regard to the mobile coverage indicator, and the equal weighting of opportunity has been said to give more emphasis to *potential* rather than *actual* use (James 2007). When the DOI indicators listed in Table 3 are considered, there is already an implicit weighting skewed towards internet and mobile relative to other indicators because of the large number of internet and mobile related measures used in the index. Of the eleven DOI indicators, only two are not related to mobile or internet (households with a fixed phone line and households with a computer).

Table 3 below also shows which of the Indicators used in the DOI and the ICT-OI are part of the Partnerships' agreed list of twelve basic indicators (A1-A12, marked in bold). As can be seen, the two indices use roughly half each of the Partnership indicators (5 vs 6, respectively).

[19] Frequently Asked Questions about the Digital Opportunity Index (DOI): http://www.itu.int/osg/spu/publications/worldinformationsociety/2006/faq.html

Table 3 – **Comparison of the indicators included in the DOI and the ICT-OI**

Digital Opportunity Index (DOI)	***ICT Opportunity Index (ICT-OI)***
Opportunity	**Infodensity: Networks**
1. Percentage of population covered by mobile telephony (A7) **2. Internet access tariffs as a percentage of per capita income (A8)** 3. **Mobile cellular tariffs as a percentage of per capita income (A9)**	**1. Main telephone lines per 100 inhabitants (A1)** **2. Mobile cellular subscribers per 100 inhabitants (A2)** 3. **International Internet bandwidth (kbit/s per inhabitant) (A6)**
Infrastructure	**Infodensity: Skills**
4. Proportion of households with a fixed-line telephone 5. Proportion of households with a computer 6. Proportion of households with Internet access at home **7. Mobile cellular subscribers per 100 inhabitants (A2)** 8. Mobile Internet subscribers per 100 inhabitants	4. Adult literacy rates 5. Gross enrolment rates (primary, secondary and tertiary)
	Info-use: Uptake
	6. Internet users per 100 inhabitants **7. Proportion of households with a TV (A11)** **8. Computers per 100 inhabitants (A3)**
Utilisation	**Info-use: Intensity**
9. Proportion of individuals that have used the Internet **10. Ratio of fixed broadband subscribers to total Internet subscribers (A5:A4)** 11. Ratio of mobile broadband subscribers to total mobile subscribers	**9. Total broadband Internet subscribers per 100 inhabitants (A5)** 10. International outgoing international traffic (minutes) per capita

Source: ITU 2007.

1.3 WSIS Targets and MDGs

As noted at the beginning of this chapter, there is a need for both a robust framework *and* concerted action to extend infrastructure networks. When new ICT networks were first being integrated into societies, there was much discussion around setting clear priorities (food, sanitation and healthcare over spending on ICT), and a subsequent understanding of the need to distinguish between urgent needs and important needs. There is now recognition that ICT networks offer opportunities for promoting well-being on different levels – and this is implicit in the targets and goals that have been set for achievement by 2015.

The ICT terrain, and indicators used to assess its growth, have evolved substantially from the more straightforward rankings achieved under the POTS (plain old telephone service) framework. Information must now be obtained from different service providers and must cover a range of different types of network technologies. Further, the indicator mandate has diversified from just counting infrastructure to obtaining information on literacy, audiences, governance and other less tangible elements of information society participation.

This new complexity is illustrated in the WSIS targets for 2015 (See Box 3). ICTs are covered by Goal 8, objective 18 of the Millennium Development Goals (MDGs) and it is clearly important to align Information Society goals with overarching development goals. The WSIS targets provide some substance for this.

Box 3 – WSIS Objectives, goals and targets

6. Based on internationally agreed development goals, including those in the Millennium Declaration, which are premised on international cooperation, indicative targets may serve as global references for improving connectivity and access in the use of ICTs in promoting the objectives of the Plan of Action, to be achieved by 2015. These targets may be taken into account in the establishment of the national targets, considering the different national circumstances:

   1. to connect villages with ICTs and establish community access points;
   2. to connect universities, colleges, secondary schools and primary schools with ICTs;
   3. to connect scientific and research centres with ICTs;
   4. to connect public libraries, cultural centres, museums, post offices and archives with ICTs;
   5. to connect health centres and hospitals with ICTs;
   6. to connect all local and central government departments and establish websites and email addresses;
   7. to adapt all primary and secondary school curricula to meet the challenges of the Information Society, taking into account national circumstances;
   8. to ensure that all of the world's population have access to television and radio services;
   9. to encourage the development of content and to put in place technical conditions in order to facilitate the presence and use of all world languages on the Internet;
   10. to ensure that more than half the world's inhabitants have access to ICTs within their reach.

Source: WSIS Plan of Action (2003) <http://www.itu.int/wsis/docs/geneva/official/poa.html>.

Further, as documented by Minges (2006) there are significant definitional issues around interpreting these targets for the purpose of identifying accurate indicators to measure progress on their attainment. Once real progress is made in these areas, in a post 2015 world there will likely be a shift to more experientially based indicators – those which reflect convergence and institutional change and networked society existence. Until then, the task at hand is to deploy ICT network infrastructure and monitor progress in this goal.

1.4 Conclusions

During the course of the past decade, the ITU has showcased different and promising indices to measure the world's access to ICT. As technology and the ICT terrain in many countries has evolved

rapidly, this became reflected in the different instruments designed to capture the incidence of this growth. With unexpected developments, such as the extremely rapid uptake of mobile networks, especially in developing countries, and shocks such as the burst of the dotcom bubble, along with a growing awareness that ICT is a key to accelerated socio-economic development, the target of assessment has shifted purely from infrastructure availability to more to include more demand side indicators.

Simultaneously, there have been changes in who is concerned with monitoring the ubiquity and use of ICT, as is evidenced by the participation of civil society in WSIS and the creation of the Partnership on Measuring ICT for Development. Whereas very few developing countries were collecting ICT indicators at the outset of the ITU's composite index initiatives, the Partnership has been driving efforts to increase consistent data stocks across a core set of internationally agreed indicators. These are the cornerstones of building an internationally comparable index and their use is testimony to the ITU's commitment to align its single index with its own institutional objectives and partnerships.

In terms of this agenda, and in the need to provide an assessment of ICT progress, the ICT-OI methodology is theoretically grounded and draws upon an economic framework which guides the selection of indicators. This is a particular concern in terms of having a framework to interpret and be able to explain and defend future results. Second, the ICT-OI provides a measure of relative progress over time which is particularly useful for developing countries needing to track their progress toward the Information Society.

Because there is no theory to predict how opportunity will be transformed in to use, and at what pace this might be expected to happen, for now it is important to focus on measuring actual usage – especially in developing country contexts. More will be said about this in the following chapters, with particular reference to indicator selection for a single index.

Table 4 **- Comparison of DOI and ICT-OI Methodologies**

Feature	**DOI**	**ICT-OI**
Number of indicators used	11	10
Number of Partnership core indicators used	5	6
Framework used	No explicit framework, but category hierarchy is used	Economic model framework (see Measuring Information society, page 3)
Sub-Index category hierarchy levels	1	2
How Digital Divide is measured	Absolute	Relative
Index formula	Arithmetic mean	Geometric mean
Index computation	Can be done easily by the country, since based on absolute values	Depends on average of values included in the study.
Indicator selection focus	Mobile & internet	Skills, basic infrastructure and utilisation
Indicator type emphasis	Household	Individual
Treatment of outliers and large values	Goalposts	Maximum value adjustments/Scalars

2. Assessment of existing indices: An overview of the state of the art of ICT indices

We feel that information societies' metrology deserves a higher profile, especially in the information research community, and should constitute a unique and coherent research front. Its recognition as a coherent academic field with an interdisciplinary core would facilitate the setting up of research teams and formulation of projects.
Menou & Taylor, A "Grand Challenge": Measuring Information Societies, 2006

It is time to stop identifying gaps and setting priorities at a high level. Anyone working in ICT and development in the country will already know these things and it is a waste of time and money to keep writing papers and holding conferences that do these same things over and over again. If e-readiness assessment is going to remain useful as a tool it needs to become far more focused and action-oriented.
Bridges, e-Ready for What? 2005

2.1 Introduction

Al Gore's *Inconvenient Truth*[20] and Hans Rosling's enthusiastic presentations using his Gapminder software[21] are two recent and vital examples of mobilising indicators in service of awareness raising around climate change and world health issues. Both present complex data that effectively communicates to lay persons. Gore's film achieved what years of debate and discussion failed to do: to put environmental issues on the popular public agenda in the United States. The key device legitimising Gore's discourse was his use of indicators – many different indicators expressed in different ways; and conversely, Gore's persona lent credence to the indicators he was presenting.

Indicators are effective devices for moving ahead agendas because their simplified presentation can be used to cut through the swathe of competing discourses. But which indicators present perspectives on the world most accurately? The week that Al Gore won the Nobel Peace prize for his work on climate change, the validity of his findings was being challenged in British courts. Indicators can contribute to accuracy in policy decisions, and can ward off white elephant projects in support of effective implementation plans. Or, as asserted by Bridges.org, endless negotiations over monitoring frameworks risk inhibition of progress.

However there is no doubt that indicators are extremely useful and that there is value to their concerted formulation into composite Indices. It is also widely recognised that access to information and communication technologies and services offers a wide range of benefits for individuals, communities, business, and governments across different social sectors and the economy. An evolving recognition of this new opportunity and its reach is reflected in the composite indices that have been devised to attempt to capture changes in the nexus between ICT diffusion, access and usage.

During the mid-1990s governments around the world produced information society statements. These were formulated in recognition of the potential of the Information Superhighway and many echoed the vision put forth in Gore's *Building the Information Superhighway*. The process of transforming countries into information societies is inherently complex and involves a large number of variables – from infrastructure deployment, to skill levels within a country, to regulatory terrain and market conditions, to political will and sustained commitment to policy objectives. The latter is demonstrated

[20] http://www.climatecrisis.net/

[21] http://www.ted.com/index.php/speakers/view/id/90

by the practical monitoring of other variables to capture progress and bottlenecks in order to further inform and evolve policies and strategies for achieving the goal of societies benefiting from ICT.

By the beginning of the new century, more concrete information society goals were being developed at national and international levels, with ICT connectivity targets being set alongside more traditional measures of economic wealth and well-being. Yet how many countries were achieving these goals? Was progress being made? Not surprisingly, many initiatives were undertaken to take the pulse of different aspects of ICT deployment. As mentioned above, this preoccupation has been echoed at a global level with the formulation of the Millennium Development Goals (MDGs) and the World Summit on the Information Society (WSIS) Action Plan's set of targets.

2.2 The emergence of ICT indicators

Prior to the beginning of telecom privatisations around the world there was a common sector model worldwide. Telecom was viewed as critical infrastructure and was accordingly provided by state operators. The indicators that were collected to provide feedback on the sector were primarily concerned with the efficient of provision of fixed lines to residential and business customers. There was not much concern with *how* telephones were used and the economic growth corresponding to access to the infrastructure was not necessarily reflected in pricing, with business and long distance use subsidising household subscriptions.

Nevertheless there were some spikes of interest in qualitative-use issues during the history of telecom – for example, around the introduction of new technology, such as SS7 signalling[22]. But overall, the measurement of telecom diffusion was assessed and ranked at a national level in terms of concrete infrastructure levels and the supply of services.

Technological evolution resulted in new items being added to the list of statistical scrutiny. Not only were internet infrastructure indicators now of interest but also were new telecom indicators to reflect different kinds of use (such as prepaid telephony). And inevitably, content, cost and quality of use issues began to complement connectivity issues. Privatisation and new ownership models resulted in information asymmetry issues, and also in new information becoming important with regards to regulation and ensuring level playing fields in the telecom and emerging ICT markets.

With technological change and integration of ICT into societal sectors such as government, health and education, and with its increased impact on employment, other actors also became interested in ICT measurement and metrics to assess impact. And today, the extent of dependence on ICT in modern economies and societies means that they could barely function without them.

At the same time, as underlined by the WSIS, ICT is seen as a critical component in improving quality of life and accelerating development, not only in less wealthy countries but also in poorer, more isolated regions of the North. As a result, indicators of ICT uptake have become as important as measures of wealth in helping to determine policy strategies to improve well-being.

A critical mass of indicators intended to measure ICT and the different facets of the so-called information society and its corresponding digital divide began to emerge in the late 1990s. Beginning mainly at the turn of the century, a number of e-readiness indices were designed with the intention of obtaining an initial grasp on the changes that were happening in the emerging ICT sector and what this could mean for economies, cultures and societies. Were governments and their respective ICT sectors willing and able to deploy new technologies and services to the benefit of their peoples and economies?

[22] Which raised concerns around privacy of individuals and the possibility that this would open the door to a host of annoying and controversial applications such as businesses being able to target or red-line individuals for marketing campaigns

Beyond the early e-readiness studies, many of which are still kept current, a number of composite indices have also been developed to provide perspectives on the positive effects that were accompanying ICT deployment and uptake – and conversely to document the chasm of lost opportunities which further marginalised people without recourse to such resources. While there is consensus about the positive effects of ICT on social and economic development, there are nonetheless varying perspectives on how best to measure these effects.

2.2.1 PARTNERSHIP ON MEASURING ICT FOR DEVELOPMENT

The international multi-stakeholder Partnership on Measuring ICT for Development was launched in June 2004 during the 11th United Nations Conference on Trade and Development (UNCTAD).[23] The work of the Partnership is of particular importance in evolving indicators, as ITU developments in this area will have bearing on the trajectory of decisions around indicator collection, analysis and use. The *Measuring ICT* website housed by UNCTAD, and the WSIS thematic meetings on different aspects of ICT indicators and measurement are the direct results of the WSIS emphasis on indicators spearheaded by ITU efforts.

The Partnership's objectives are:

> 1. To achieve a common set of core ICT indicators, to be harmonised and agreed upon internationally, which will constitute the basis for a database on ICT statistics.
>
> 2. To enhance the capacities of national statistical offices in developing countries and build competence to develop statistical compilation programmes on the information society, based on internationally agreed upon indicators.
>
> 3. To develop a global database on ICT indicators and to make it available on the Internet. Work towards agreeing to a set of standardised ICT indicators to measure the information society that would be collected across all countries and allow for benchmarking and comparison.

The members of the Partnership work with national level statistical agencies to obtain data, to arrive at consensus on which indicators should be collected and the methodology for their collection. An extensive (and perhaps exhaustive) list of national statistical agencies is maintained on the Measuring the Information Society website.[24]

The Partnership has developed two essential texts: *Measuring ICT: The Global Status of ICT Indicators*,[25] and *Core ICT Indicators.*[26] The *Measuring ICT: The Global Status of ICT Indicators,* is the report of a global stocktaking exercise on the availability of ICT indicators. The intention of the survey was to obtain a snapshot of mechanisms to collect indicators around the world; and secondly to ascertain the availability of concrete ICT indicators. The 47 percent response rate to this concerted effort underlines problems in access to indicators – especially with particularly low response rates for

[23] The Partnership for Measuring ICT Development comprises the International Telecommunication Union (ITU), the UN Conference on Trade and Development (UNCTAD), the Organisation for Economic Co-operation and Development (OECD), UNESCO Institute for Statistics, UN Economic Commission for Africa (UNECA), UN Economic Commission for Latin America and the Caribbean (ECLAC), UN Economic and Social Commission for Asia and the Pacific (UNESCAP), UN Economic and Social Commission for Western Asia (UNESCWA), and the World Bank.

[24] Under "Country Information": http://measuring-ict.unctad.org/QuickPlace/measuring-ict/Main.nsf/h_Toc/1F6843B23A7F136CC1257110005302AF/?OpenDocument

[25] http://www.itu.int/ITU-D/ict/partnership/material/05-42742%20GLOBAL%20ICT.pdf

[26] Partnership on Measuring ICT for Development (2005) *Core ICT Indicators*. http://www.itu.int/ITU-D/ict/partnership/material/CoreICTIndicators.pdf

Africa and the Asia Pacific countries.[27] The second work, *Core ICT Indicators*, describes a range of core indicators identified during the stocktaking exercise. For each indicator, methodologies or strategies for obtaining accurate data are also provided. This list of indicators does not claim to be complete and identifies the process as continuous and subject to periodic review.

2.3 From indicators to index

A key moment in devising an index begins with identifying the theory that will guide and ground the framework, methodology and indicator selection, and then determining how the indicators will be transformed and assembled in the final index. The latter mainly relates to the structuring or weighting of each indicator in the index, but it also relates to how the variables are derived. Most often the final value is given in per capita or per household terms, but it can also be a ratio, such as broadband users as a percentage of total internet users.

As the analysis of the different indices above shows, an index can be expressed as a simple global rank, or further derived as some expression of distance from an average, or hypothetical target. Another strategy is to use a logarithmic scale, such as in UNDP's TAI Index, to capture the importance of an indicator at the earlier stages of technological advance but not at the most advanced stages. The TAI report points out: "Thus while it is important for India to focus on diffusing electricity and telephones so that all its people can participate in the technological revolution, Japan and Sweden have passed that stage. Expressing the measure in logarithms ensures that as the level increases, it contributes less to the index."

As noted in Chapter 1, choosing the right weighting for each indicator is often a matter for intense debate, largely because there are no clear rules to how to apply weighting. In developing the African Governance Index,[28] the Mo Ibrahim Foundation did a series of different weighting trials in order to determine the optimum weighting, such as weighting the Human Development indicator twice as much as the other categories.[29] However this is still not underpinned by a theoretical framework that can be used to justify a particular weighting value.

2.4 Use by date: 2015

A corollary to weighting issues is the need to capture the *urgency* of extending the information society to all regions and countries. This urgency is implicit in the 2015 deadline for meeting the Millennium Development Goals and the WSIS targets. It is not just that it is important to meet these goals, it is important to meet them urgently.

Indeed, for developing countries it is important to stop conceiving of e-readiness and ICT adoption as something to be achieved at an incremental pace. John Daly discusses the widening gap, with high income countries spending about 120 times more per capita on ICT than low income countries and points out that there are lost opportunity costs that accumulate over time.

> It should be recognised that the rich are buying different things than the poor. It is not simply that people in high-income countries have hundreds of times as many radios, televisions, phones, and other appliances than their counterparts in low-income countries. As the demands for the basic devices and services are satiated, other demands start to be filled. Countries begin to develop ICT-intensive industries and to intensify the ICT inputs to other, more traditional industries. It is not coincidental that high-income countries have the most ICT-intensive militaries, nor that they

[27] Not to mention the absence of some major economies which did not respond to the survey, such as China, Nigeria and South Africa.

[28] http://www.moibrahimfoundation.org

[29] Also noteworthy is the Foundation's expression of the Index at different confidence levels (75% and 90%).

dominate the development and profits from ICT industries, nor that the best universities in the world are in the North (Daly 2004).

None of the existing ICT indices or indicators provides a measure of the velocity of change or any other time factor as part of their constituents. If there is enough time series data, it is possible to look at rates of change between countries or regions and determine how long it would take for one to catch up with another at present rates of development. However if some more direct indicator of the rate of change was included in an index, such a factor could more clearly illustrate the real ICT disparities between countries.

Another aspect of the rate-of-change issue is that because of rapidly changing technologies and hopefully, changing priorities, it will be necessary to revisit the categories used in a composite index. With the range of different network technologies bringing information society benefits to communities, and increased recognition of the importance of intermediaries and shared use of devices, indicators will need to shift to more experiential-based evidence.

Ideally, an ICT index would be refined steadily over time, to take these factors into account as they emerge, or as more countries begin monitoring the relevant metrics. This is the approach that has been taken by the Economist Intelligence Unit (EIU) and some other indices, however this creates a major problem in that data is not comparable from one year to the next, and a clear idea of progress over time cannot be observed. For these reasons it is recommended that the components of the single index remain static for an agreed period of time. Given the 2015 deadline for the MDGs and the WSIS goals, this timeframe would provide at least seven years of data for analysis, and at this point the index could be reviewed.

2.5 Gender and exclusion

Gendered indicators ostensibly continue to be at the top of everyone's agendas. There are three main areas of gender issues, and each of these points has been repeatedly affirmed, not least by the ITU or the Geneva Plan of Action:[30]

- A commitment to promoting women's use of ICT – and thus ensuring opportunities for women's benefiting from ICT;

[30] ITU Resolutions on Gender, http://www.itu.int/ITU-D/gender/background/

Plenipotentiary Conference of the International Telecommunication Union - Resolution 70 (Rev. Antalya 2006) - Gender mainstreaming in ITU and promotion of gender equality towards all-inclusive information societies

World Telecommunication Development Conference - Resolution 55 (Doha, 2006)- Promoting gender equality towards all-inclusive information societies

Resolution 55 - Mainstreaming Gender in ITU-T Activities - Florianópolis, 2004

Resolution 70 rev - Gender Mainstreaming in ITU - Marrakech, 2002

Resolution 44 - Mainstreaming Gender in ITU-D Programmes - Istanbul, 2002

Resolution 70 - Inclusion of Gender Perspective in the Work of ITU - Minneapolis, 1998

Resolution 7 - Gender and Telecommunication Policy in Developing Countries - Valletta, 1998

Geneva Plan of Action: 12. We affirm that development of ICTs provides enormous opportunities for women, who should be an integral part of, and key actors, in the Information Society. We are committed to ensuring that the Information Society enables women's empowerment and their full participation on the basis on equality in all spheres of society and in all decision-making processes. To this end, we should mainstream a gender equality perspective and use ICTs as a tool to that end.

- Recognition that particular programmes and strategies will need to be adopted to encourage women's adoption and use of ICT – which may be different from mainstream practices;
- Gendered indicators are needed for ongoing monitoring and policy development.

There is little dispute that gender disaggregated indicators are needed to provide feedback on progress, to demonstrate results of programmes and to ensure that commitment to women and girls stays on the agenda. However, until 2003, the only sex-disaggregated ICT data that the ITU was able to collect was the percentage of female employees in telecom administrations, and since 2003 it has only been able to add two new sex-disaggregated indicators – female internet users as a percentage of total users; and female internet users as a percentage of females. Only the first of these has been included in the ITU indicator database, and even this has only a fraction of the surveyed countries providing this data.

Mostly due to lack of resources, but also perhaps due to the lack of perceived importance of the information, the statistical agencies in countries for which this data would be the most useful, are not collecting this information. And where it is being collected – at community or project levels, there is likely to be a range of methodologies for data collection and lack of significant coverage – for example to be able to extrapolate the data to a national level or to be able to compare between countries.

The DOI discusses the gender issue without incorporating it into the index: [31]

> *How can the DOI be adjusted for gender differences?*
> Paragraph 28a of the Geneva Plan of Action calls for performance evaluation and benchmarking, including gender analysis. The DOI can be used to assess and monitor differences in access to ICTs by gender. Household and tariff data cannot be disaggregated by gender (it is assumed that all members of the household can access the telephone, whether male or female, and tariffs are the same for all). However, studies in some countries have shown different levels of access for male and female Internet users and mobile phone users. The DOI can be compared for different groups within society to take into account and evaluate differences in access.[32]

However, it is also important to question the premise of equal access to technology at the household level. A study on the gender digital divide in Francophone Africa, *A Harsh Reality*, asserts that components for a gender digital divide indicator should comprise: *control*, *content relevance*, *capacities* and *connectivity* (Mottin-Sylla 2005: 34). The first of these, control, relates directly to issues around who is allowed to use the technology at a community or household level – which may not be equal at all. While a gender sensitive ICT indicator will collect information on access, use and impact in a disaggregated gender format, the gender digital divide indicator devised for this Francophone Africa study is prescriptive, providing information with the intention of targeting women's additional unequal conditions (including domestic conditions) for correction.

Unless there are concerted efforts to measure women and girls' access to ICT, this project will fail to be adequately measured for progress and will risk continually slipping off the policy agenda before equity goals are met.

Although the DOI does not contain a gender indicator, in the 2006 World Information Society Report, a gender-disaggregated DOI was produced for the Czech Republic where the relevant data had been

[31] While there is no specific gender indicator used in either the ICT-OI or the DOI, the latter has been used to incorporate a gender module. See the gender-based DOI scores for the Czech Republic (Figure 4.6 at: http://www.itu.int/osg/spu/publications/worldinformationsociety/2006/wisr-chapter4.pdf). In the same vein, it is also possible to use other breakdowns by age, or by region, etc. However, to do so systematically of course requires sufficient data.

[32] http://www.itu.int/osg/spu/publications/worldinformationsociety/2006/faq.html#What%20are %20the%20sub-indexes,%20and%20what%20are%20they%20used%20for

collected for both sexes. The findings show a not very large difference of 0.56 for men and 0.53 for women (ITU 2006: 64-65). While the report takes the opportunity to highlight that there is still a measurable difference to be bridged, a different conclusion could have been made. For countries that do measure women and girls' access to ICT, it is likely that the difference between the sexes will be small because monitoring the gender divide is evidence that there is a policy priority in this area and also because the more wealthy countries are able to conduct this sort of monitoring – countries where the gender divide is likely to be smaller.

Finally, clearly there are other forms of equity measures which provide an indication of exclusion to ICT access that also need to be assessed, documented and addressed. For example, different age groups might benefit disproportionately from ICTs. An age-disaggregated DOI was prepared for Singapore in the 2007 edition of the WISR (ITU 2007) which examines this. Furthermore, the Global Alliance for ICT for Development (GAID) is working on developing a composite index for measuring the provision of ICTs for persons with disability.[33] Network coverage and public access facility indicators might also go some way to providing some measure of the extent to which rural populations are excluded from access.

2.6 Prescriptive ranking – some underlying assumptions

Ranking and benchmarking can generate a lot of media attention. Countries like to know that they are considered to be one of the nicest places to live, that they have had the biggest growth rate in the region, that their math students rank first in the world – and it can be useful to promote this information widely. Similarly, 'naming and shaming' to highlight laggards can be especially effective.

ICT indicator rankings are no different. Penetration of infrastructure, prevalence of networks and uptake of technologies confers information about the national economy, its level of technological sophistication and also provides a window on available skill levels.

This section discusses some of the critiques of international comparisons and ranking exercises, and questions their utility and accuracy. As illustrated in the section on gender, indices proffer a vision of how things should be. If the number of women who have internet access is recorded, then there is an expectation that there will be women using the internet. The exercise of indicator formulation is inherently prescriptive. If an indicator counts the number of telephones per households, then there is an implicit assumption that households have telephones. By way of example: "While the explosion of public facilities offering Internet access is admirable […] policy-makers should focus on the benefits of each household having its own, regular Internet access" (WISR 2007: 51). What is implied when these (or other items) are not included in indices and other things are?

Studies that investigate how the poor use and value ICT[34] identify different modes of use and different forms of technology adoption and appropriation.[35] Thus, if the methodology for assessing adoption does not take practical or cultural differences into account, then it risks failing to capture the real extent of ICT penetration and use. In the same vein, intermediaries are a key factor in network extension and they can also serve to promote social cohesion more generally – but it is difficult to capture instances statistically. Radios and TVs, or a measure of audiences will go towards this, but generally radios and TVs are counted to demonstrate technology penetration rather than anything more sociological. Further, promoting community-based facilities such as telecentres creates direct

[33] See the GAID flagship initiative, Global Initiative For Inclusive Information and Communication Technologies, at http://www.un-gaid.org/en/advocacy/g3ict.

[34] See LIRNE*asia*'s "Teleuse at the Bottom of the Pyramid" at http://www.lirneasia.net and DIRSI's "Mobile Opportunities" project at http://www.dirsi.net.

[35] See e.g. the "Abaporu" project at http://abaporu.net.

employment opportunities and also has important downstream spill-over effects in terms of creating other employment opportunities in the local economy.[36]

Because ranking is inherently contingent on what can be counted, it is predisposed to favour countries that already have much physical infrastructure, rather than countries with regulatory environments that promote innovative approaches for extending and broadening access to network infrastructure. In the same vein, prioritising ICT investments as a measure could also be misleading for international comparisons as it would fail to capture a proactive environment supporting use of lower cost, more efficient solutions, or conversely, the spread of piracy or the arbitrary value of donated hardware and software (Menou & Taylor 2006: 265).

Further if the goal is for each country to have many things to count, we perhaps really need to consider what this will look like in terms of the mountains of technology junk that will accrue – most likely in developing countries.[37] Just as the term *the digital divide* implies a digital solution, each ICT development indicator choice implies a better reality by an increase in factor *x*.

Most recently, mobile phones have been targeted as the most important ICT device. But, for mobile phones to be widely deployed amongst the poor, they need to be relatively inexpensive devices. Much work has gone into making the cheap laptops for the One Laptop Per Child project childproof and indestructible, and some efforts are made to produce ultra-low-cost handsets. Industry strategies to build in obsolescence, or natural obsolescence as technology evolves rapidly also need consideration here. And of course, the issue at hand is not whether poor people in developing countries should have phones or not – but rather to question our world view and trajectories implied by the inherent vision in indicators.

> Information Society criteria are often determined by developed nations to measure progress in all countries of the world. However, intentionally or not, these criteria may indeed reflect an inherent bias that promotes the goals of developed nations, sometimes negatively impacting those in developing countries. Current measurements that determine an information society must be transformed in order to be able to represent the diverse aspects of the nation-states of the world and guarantee a more equitable examination of issues of quality of life for all (Hyder 2005: 26-27).

Continuing to rank in this manner could imply a destructive trajectory that does not acknowledge real advances being made in developing countries where information society access is extended by using intermediaries – in communities, schools, and the media, or through other innovative strategies. Ranking high on an information society indicator measure thus may not indicate actual diffusion, but rather simply purchasing power and ability to pursue developed country traditions of ownership by individuals, rather than by household, or community (or other models).

The point of these critiques is to not imply that ICT indicators are a worthless exercise, nor to take a Luddite stance on development goals. Rather, we need to anticipate criticisms and indeed flaws in index design to ensure that the indicators used and the methodology accurately reflects real progress and to also ensure the validity of any identification of failure to progress. The Partnership on

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[36] Policy lesson: Access to the Internet on a communal basis can provide access for technically disadvantaged local groups, enable improvements in the business skills of the informal sector, and have positive externalities in the local economy (ILO 2001: 318); see also the experience of the Hungarian Telecottage as documented by UNDP-CIS (2006).

[37] For a discussion of this, see for example, Rolf Widmera, Heidi Oswald-Krapf, Deepali Sinha-Khetriwal, Max Schnellmann, Heinz Böni (2005) Global perspectives on e-waste, *Environmental Impact Assessment Review* 25, pp.436–458; or see Basel Action Network – BAN, International e-waste watchdog organisation at http://ban.org; for a visual depiction of the volume of e-waste, see Inside the Digital Dump, *Foreign Policy*, photo essay at: http://www.foreignpolicy.com/story/cms.php?story_id=3807.

Measuring ICT for Development is a useful forum for exploring these definitions, methodologies and implied best practices across all countries.

Clearly ICT index rankings have both positive and negative aspects. The increased recognition of the fundamental importance of ICT to societies and economies imply different stakeholders with different visions. Naturally some of these visions compete or conflict with each other. The objective here is to assert a single index model in service of development goals – and to identify the information needed to make effective policy decisions to pursue these goals.

2.7 Indicators used in existing indices

The indicators adopted by the major ICT indices are summarised in Table 5. Across the 21 different ICT indices surveyed (see Annex 1), over 200 different indicators have been used. Because some of these are composite indicators, the actual total is even higher. Some of the indices provide data for a large sample of countries (14 of the indices sample 140 or more countries), while some target only a few countries. Across our sample, at least 120 countries are indexed.

Table 5 – **Incidence of indicators across surveyed indices***

Indicator	Incidence
Mobile subscribers per 100 inhabitants	13
Main lines per 100 inhabitants	12
Internet users per 100 inhabitants	9
PCs per 100 inhabitants	9
Adult literacy	8
TV equipped households per 100 households	5
Broadband [internet] subscribers per 100	5
10 individual indicators[38]	4
17 individual indicators	3
44 individual indicators	2
135 individual indicators	1

* See Annex 1.

From this analysis it is possible to draw a number of conclusions about the various indices:

- There are a wide range of categories (groups or subindices) and the different indices are not consistent in their use of these categories, i.e. in one index the same indicator may be in a very different category to another;
- A large number of different indicators (over 200) have been adopted in the various indices used around the world;
- Not all are pure ICT indicators;
- Many indices make use of composite indicators which are in themselves indices and may complicate diagnostic analysis;

[38] 1) Cost of local call, 2) Secure Internet Servers, 3) School Life Expectancy, 4) Secondary school enrolment, 5) All school enrolment, 5) Patents registered, 7) International bandwidth, 8) Laws relating to ICT, 9) International outgoing telephone minutes 10) Internet hosts.

- Some indices use similar indicators but these may be expressed very differently, e.g. TVs per capita vs. TVs per household;
- Some indices make use of survey-based data on perceptions, which may hard to reproduce;
- All of the top seven indicators noted in Table 5 are used in the ICT-OI, whereas only two are used by the DOI (allowing for a range of methodologies for the internet usage metric).
- The indicators which re-occurred at least four times included three different variants of measures of levels of education – School Life Expectancy, Secondary School Enrolment and All School Enrolment. Clearly there is a general interest in including an educational measure, but little consensus on what it should be.

These observations underline the fact that ICTs are still relatively new and that there is no universally recognised methodology for establishing an ICT index. In many cases, indicators have been pulled together and aggregated into categories without an explicit theoretical framework, and the relationship between indicators, categories and causal effects often do not have a rigorous theoretical underpinning. This is not because the indices have neglected to do this, but because the field is still in its infancy.

An obvious conclusion that may also be drawn from this data is that the indicators used in the indices reflect the particular constituency of the organisation that developed the index. The EIU and WEF Indices for instance, have a strong focus on the private sector. Others that focus on knowledge more generally are likely to include a number of other soft indicators of information flow, such as newspapers or patents. This is to be expected, but furthermore, each of these indices makes use of different core ICT indicators and methodologies for calculating the final index. The development and widespread adoption of a universally accepted single index for core ICT indicators would simplify the work of those developing more specialised Indices and improve their comparability.

Comparability and consistency of indicators is clearly a general problem which affects the accuracy of all indices, as well as their level of country representation. Aside from the difficulties of ensuring uniform reporting from countries, different global agencies have responsibility for the collection of indicators and each have their own standards and schedules for updates. Even the World Bank, which tries to maintain a comprehensive dataset consistent with the UN agencies admits[39] that differences remain because of timing of updates, differences in sources, and definitions of regional groupings.

Most of the widely available indicators are broad brushes using data that is largely available from operators, historically developed from national reporting by incumbent state-owned monopolies. The adoption of these indicators is necessary due to the lack of availability of more useful or informative data from the majority of countries.

Ideally in the future, policy-makers will not have to rely on these indicators when national survey data becomes more widely and consistently available. The optimal data would comprise levels of ICT utilisation disaggregated at a personal, household, government and business levels, as well as by gender, age, geographic location and personal income. Examples of figures that should eventually be available across all countries would include:

- How many women have access to broadband at home, and at work.
- How many people over 40 have used the internet in the last month/week
- How many hours a month do secondary school children spend on the internet, watching TV, listening to the radio
- How much does the average household spend on communications, spend online on goods, services
- How many people outside the major urban areas have any form of internet access

[39] http://ddp-ext.worldbank.org/ext/GMIS/gdmis.do?siteId=2&menuId=LNAV01HOME3

- How many minutes a month does a pensioner spend on voice calls
- How many annual transactions do businesses conduct online with government services

Since the majority of countries are still a long way from gathering this level of information, indicators need to be based on the more widely available proxy measures. But even amongst the traditionally used proxy measures (such as network subscribers and voice traffic), as shown below, many have wide variations in their degree of country representation, and even those that are widely available have some significant limitations.

Table 6 – **Indicators used in surveyed indices**	**DAI**	**DOI**	**Info-states**	**ICT-OI**
FIXED LINE				
Infrastructure / Infodensity – main telephone lines per 100 inhabitants	X		X	X
Infrastructure – proportion of households with a fixed line telephone / Info-use – residential phone lines per 100 households		X	X	
Infodensity – waiting lines/mainlines			X	
Infodensity – digital lines/mainlines			X	
MOBILE				
Infrastructure – Mobile subscribers per 100 inhabitants	X	X	X	X
Opportunity – Percentage of population covered by mobile cellular telephony		X		
Infodensity – Cell phones per 100 inhabitants			X	
TARIFFS				
Affordability – internet tariff as % of GNI	X			
Opportunity – internet access tariffs as a percentage of per capita income		X		
Opportunity – mobile cellular tariffs as a percentage of per capita income		X		
HUMAN CAPITAL SKILLS				
Knowledge / Infodensity – adult literacy	X		X	X
Knowledge / Infodensity – school enrolment	X		X	X
COMPUTERS				
Infrastructure – Proportion of households with a computer		X		
Info-use – PCs per 100 inhabitants			X	X
TV / RADIO				
Infodensity – Cable TV subscriptions per 100 households			X	
Info-use – TV equipped households per 100 households			X	X
USE / INTERNET METRICS				
Usage / Info-use – Broadband [internet] subscribers per 100 inhabitants	X			X
Usage – internet users per 100 inhabitants	X		X	X
Utilisation – Proportion of individuals that used the internet		X		
Utilisation – Ratio of fixed broadband subscribers to total internet subscribers		X		
Utilisation – Ratio of mobile broadband subscribers to total mobile subscribers		X		
Info-use – Broadband users/internet users			X	
Info-use – International outgoing telephone traffic minutes per capita			X	X
Info-use – International incoming telephone traffic minutes per capita			X	
Infrastructure – proportion of households with internet access At home		X		
Infrastructure – Mobile internet subscribers per 100 inhabitants		X		
Infodensity – internet hosts per 1,000 inhabitants			X	
Infodensity – Secure servers / internet hosts			X	
Infodensity – International bandwidth (Kbs per inhabitant)			X	X
Quality – International bandwidth per 100 inhabitants	X		X	

Table 7 – **Number of countries with ITU data for selected indicators**

Indicator	2005	2004
Main telephone lines per 100 inhabitants	189	193
Mobile cellular subscribers per 100 inhabitants	191	202
International Internet bandwidth (kbit/s per inhabitant)	186	188
Estimated internet users per 100 inhabitants	192	195
Proportion of households with a TV	45	44
Computers per 100 inhabitants	182	186
Total fixed broadband Internet subscribers per 100 inhabitants	180	183
International outgoing telephone traffic (minutes) per inhabitant	187	183
Percentage of the population covered by mobile telephony	130	121
Internet access tariffs as a percentage of per capita income	174	188
Mobile cellular tariffs as a percentage of per capita income	161	140
Proportion of households with a fixed-line telephone	25	41
Proportion of households with a computer	50	69
Proportion of households with Internet access at home	45	51
Mobile Internet subscribers per 100 inhabitants	34	33
Ratio of fixed broadband subscribers to total Internet subscribers	149	150
Ratio of mobile broadband subscribers to total mobile subscribers	44	35

Table 7 illustrates most clearly the fundamental challenge impeding the construction of an ICT index: the simple lack of data, and that relatively few indicators are collected using a common methodology across the majority of countries. To be sure, the indicators that are the most collected are likely to be the most well represented, and are highly valued important measures. These indicators are also closely correlated with the economy and GDP. So, although there is little overlap in indicator choice between the DOI and the ICT-OI, there is a high correlation between their results and with economic indicators such as GDP.

As discussed above, the question of the ideal number of indicators can result in precision or noise, depending on what is being measured and how the indicators are combined in the composite index. The DOI and ICT-OI have 11 and 10 indicators respectively. According to Minges' survey (2005), a handful of indices have as few as eight indicators – including the ITU's DAI[40], with other indices exceeding 50, for example, the Economist Intelligence Unit has more than 100, the Knowledge Economy Index has 80, and the Network Readiness Index has 51. In contrast, the World Bank Knowledge Index (KI) tracks only three ICT indicators: telephones, computers and internet users.

[40] See Digital Access Index, at: http://www.itu.int/ITU-D/ict/dai/index.html.

For internationally comparable rankings, country coverage will be increased by surveying a smaller set of core indicators, increasing the likelihood of multiple data points across countries. If these data points are not collected directly, they will need to be inferred. "While admissible imputation techniques can be used in cases of missing observations, the issue of 'the lowest common denominator' results in country exclusions and is very difficult to escape - with the existing know-how. Alternative approaches have been tried, but they are not advisable as the results are subject to biases that are statistically non-defendable" (Sciadas 2004: 30).

But it is not entirely clear that this common denominator approach sufficiently addresses the problem. The perennially missing disaggregated by gender indicators are routinely passed over because they are not available in a reliable fashion. Hence we find ourselves in a world where we count things simply because they have been traditionally counted.

Prepaid was only offered as a payment option in the late 1990s and is already being well-documented. This in part, is evidence of it being easier to obtain supply-side rather than demand-side indicators. Further it is evidence that there is importance accorded to this segment of the market. But the rapidity with which prepaid indicators were incorporated into ITU reporting also indicates that it is possible to alter the agenda.

Given a theoretically sound framework, qualitative information combined with a wide range of indicators can provide much needed information for sound policy analysis. This kind of information may not result in a ranking, but given the choice of knowing where one's country stands vis-à-vis the top country, or having sound advice about particular trends upon which to base policy decisions, it is likely that national policy makers will opt for the latter.

2.8 Issues for the DOI and ICT-OI indicators

Both the DOI and ICT-OI indices draw from the Partnership's collection of agreed upon ICT Indicators, but use a different selection of the Partnership's core indicators. Table 3 in Chapter 1 lists the two collections, for which there is only one indicator in common: mobile subscribers per 100 inhabitants.

The DOI groups indicators across the areas of Opportunity, Infrastructure and Utilisation. The DOI selection of indicators also emphasises newer technologies and household access, by focusing on household access to ICTs and by including mobile Internet and mobile broadband subscribers. Because they are emerging technologies, especially for developing countries, these access methods are not yet reported on in a reliable manner across a significant proportion of developing countries. This means for countries where there is no indicator, the value has to be estimated or extrapolated based on other collected information. The ICT-OI strives to reflect a higher proportion of measures for technology that is currently available to the majority of countries and concentrates on indicators which are more readily available through the regular ITU data collection. Conversely, the DOI's inclusion of newer technologies such as mobile broadband, means that their growth can be assessed from inception.

A further marked difference between the two data sets is the DOI's use of household survey data and the ICT-OI's reliance on individual use (per capita). Household survey data means that shared use of ICT and the role of (family) intermediaries do not penalise developing countries where these practices are common. But this may become less significant with trends towards cheaper devices and individual ownership, even for bottom of the pyramid users. Generally, household surveys can provide much richer data and are also more accurate for measuring differences across rural and urban areas. However, household survey data simply is not yet available for many developing countries.

Measuring uptake per capita provides a more widespread sample which "does not mean that per capita measurements are necessarily the best way of measuring ICT access and use. They are rather the easiest way of measurement" (ITU WTDR 2006:11). Also, using individuals as a unit of measure

means that it is possible to also assess other important factors such as age, gender, education (Beroggi 2005:101). In addition, individual measures may also be a better reflection of the developing country environment where few people have access to ICTs in at home, and are more likely to obtain access through public facilities.

Given the increasingly pervasive nature of networks today, both the OI and the DOI could be said to have insufficient usage indicators. The DOI has no usage level indicators at all, and the ICT-OI only measures international bandwidth, and international outgoing minutes. This raises the question of focussing on *opportunity* instead of *achievement* or *usage.* The *opportunity* potential maybe an important policy input at national level, but it does not provide a practical indicator on use.

The usage indicators selected for the ICT-OI may also introduce some significant biases. For example, by including only outgoing international minutes of traffic (and not incoming), this may underestimate the real level of international traffic in those countries where, for reasons of demography, tariff structures or monopolistic supply structures, incoming traffic is much greater in volume than outgoing. Considering that these situations are more prevalent in developing countries, this may provide a more inaccurate picture for these countries. The measure of outgoing minutes of international traffic also under-reports the significance of mobile traffic, which often passes outside the accounting rate system or which is treated as roaming traffic rather than international traffic. Finally, the international internet bandwidth indicator may not properly assess countries such as the US with a large and content-rich internal market or others, like Japan or the Republic of Korea, whose languages are not spoken widely outside the country and who consequently will have a much higher level of national Internet bandwidth.

The incorporation of traditional media devices in indices, such as TV and/or radio, may also need to be re-examined for the future. The broadcast model is far different from the collaborative, communicative and content creating characteristics that define emerging networked individuals. Are these traditional technologies really relevant to measuring ICT-uptake when they are so different to the new technologies? And in the long run they are unlikely to be future-proof given moves to IPTV, streaming audio, podcasts etc. Furthermore the figures used for technologies that are not tied to a regular payment are not thought to be sufficiently accurate in developing countries.

2.9 Issues with specific indicators

2.9.1 FIXED LINE INDICATORS

Mainlines are the historical legacy of government-run telecom monopolies and there has been much written on the inefficiency of the telecom sector under monopoly conditions. This was a universal phenomenon, although to varying degrees. In developed economies there were adequately functioning networks in urban areas however they did have gaps in their reach to rural areas. The drop in pricing with the advent of competition suggests pricing inefficiencies and similarly there were lack of incentives for any real innovation in the sector. In developing countries, prior to liberalisation there was massive pent-up demand for the very small proportion of people who could afford a telephone service, and very little reach beyond cities of the telecommunications infrastructure. Liberalisation of telecom markets, it was argued, would allow market mechanisms to correct these inefficiencies, pent-up demand and high prices – and putting telecom sectors on the road to recovery would create healthy conditions for social improvements and economic growth.

With the advent of the Information Superhighway in the early 1990s fixed-line infrastructure was understood to be a key component of internet access and thus was an important indicator. However, as is now well-known, the possibilities and promises of information societies has engendered innovation around mobile and fixed wireless networks. There has also been the unprecedented uptake of mobile services – most importantly in developing countries.

Thus, from the vantage point of the early 21st century, due to convergence in mature markets and the growth of mobile networks in developing economies, fixed line indicators tell us more about the history of the national telecom sector than about its future. In developing economies in particular, there has been a pronounced stagnation in fixed line infrastructure, with mobile benefiting from the lion's share of new investment[41]. In addition, the growth of mobile means that fixed lines are an increasingly less relevant indicator of personal communication access. For many countries, the incidence of mainlines encompasses payphones, and for some countries, ISDN channels are also included in mainline calculations. Further, a major bias of this indicator is the large preponderance of lines in business premises, especially in developing countries which renders per capita averages much less meaningful.

Although it can be argued that a fixed line in every home is not necessarily a useful policy ideal for many countries, nonetheless, the presence of fixed line infrastructure does have an influence on the average cost of calls[42] and availability of broadband.[43] Thus, fixed line penetration can still confer an indication of the potential for broadband uptake[44] and general network development, and so it is not surprising that all of the indices under consideration include a measure of the availability of fixed line infrastructure. The InfoStates methodology most prominently addresses this component in terms of reporting on existing potential, household up-take, pent-up demand and the increased capacity of digital lines. The ICT-OI and the DOI use the number of *mainlines* which, as per the report's technical notes, refers to the telephone lines connecting a customer's equipment to the PSTN and which have a dedicated port on a telephone exchange (ITU 2007: A-73).[45]

Waiting lists for mainlines has often been used as an indicator in various indices, but due to the much easier availability of mobile phones, especially via prepaid, waiting lists for main lines are an increasingly inaccurate indicator of demand for voice services. Waiting list measures also suffer from under-reporting, especially in developing countries, because many people simply do not even bother to put their names on the waiting list when it is known that obtaining a fixed line may take years.

2.9.2 MOBILE NETWORK INDICATORS

The *1999 World Telecommunication Development Report* proclaimed, "The future is bright; the future is mobile" (ITU, 1999: 96).[46] At that point in time, mobile network use had already surpassed fixed line use for many African countries; this happened at a global level a few years later. Clearly this is an important indicator, yet there is still debate as to what constitutes a mobile network user in an age of prepaid and personal interconnection and roaming strategies that involve multiple SIM cards (if not

[41] In fact across the world fixed line infrastructure is barely growing – the global average fixed line teledensity was virtually unchanged between 2001 and 2005, at just under 20%

[42] Due to the normally lower cost of local fixed line calls.

[43] High levels of fixed line infrastructure were correlated with early internet adoption - ADSL's higher speed access to the Internet can be made widely available over twisted pairs at affordable prices. However with recent advances in fixed wireless technologies, this is increasingly less the case.

[44] Although in future this may be less relevant as broadband is increasingly substituted by mobile networks (3G/Edge) and Fixed Wireless Access (FWA).

[45] International Telecommunication Union (ITU) (2007), *Measuring the Information Society: ICT Opportunity Index and World Telecommunication / ICT Indicators*, ITU, Geneva. This is the definition also used by the Partnership on Measuring ICT for Development (see *Core ICT Indicators*, 2005: 7).

[46] International Telecommunication Union (ITU) (1999), *World Telecommunication Development Report 1999: Mobile Cellular*, ITU, Geneva.

multiple handsets as these become more disposable). The *Core ICT Indicators* booklet places some parameters on this definition. It states:

> *Mobile cellular subscribers* refer to users of portable telephones subscribing to an automatic public mobile telephone service using cellular technology, which provides access to the PSTN. Users of both post-paid subscriptions and pre-paid accounts are included. *Mobile cellular subscribers per 100 inhabitants* is obtained by dividing the number of mobile cellular subscribers by the population and multiplying by 100 (Core ICT Indicators p. 7).

In using this methodology it can be observed that the overall number of mobile subscriptions in developing countries surpasses those in developed economies. Although factoring in per capita numbers offers a more accurate picture of actual penetration levels, this indicator provides a useful gauge for policy formulation.

The method of computation for mobile subscribers does not take into account business use, but due to the mode of mobile use, where the same personal phone is used in business and at home, this indicator much more closely reflects personal access. It should be noted that in countries with poor interconnection regimes and expensive roaming, a number of mobile subscribers may have two or more phones, and travellers may have SIM cards for many countries. While there have not been any detailed surveys of the extent of this type of usage, it is assumed that the effect on overall numbers of mobile subscribers is small. Perhaps a more important problem is comparability of data between operators, because not all of them use the same measure to define a subscriber.

The mobile coverage indicator used by the DOI assesses opportunity to connect to a mobile network. Like measures of the availability of fixed / main lines, it observes a potential for which uptake will be contingent on other factors such as pricing and ability to use (both of which are addressed by complementary indicators within the DOI framework). The use of skills indicators in the ICT-OI can also be seen to be addressing measures of the potential for use of ICTs.

Given the pronounced importance of mobile networks in developing countries, a more useful measure could be effective teledensity, which is the higher value of either main telephone lines per 100 inhabitants or mobile cellular subscribers per 100 inhabitants. However, the extent to which the mobile network is dependent on fixed infrastructure needs to be kept in mind in terms of sector policy priorities.

In addition, the emergence of various new wireless technologies which provide a range of fixed and mobile broadband services also needs to be taken into account here. While ‘2G’ GSM has by far the highest penetration levels worldwide at the moment, advances to 2.5G, 3G and 3.5G in the mobile networks are now being increasingly deployed, even in some less developed countries.

Furthermore, WiMax, WiBro, CDMA and various other fixed, mobile and semi-mobile data services are also rapidly becoming available. Even in countries with relatively well-developed fixed line networks, such as South Africa, there are now more wireless Internet users than copper network users. As a result, indicators for tracking the use of these services will become increasingly important and could either be included in the index, (as is the case with the DOI) or could comprise part of a ‘two speed’ index for countries tracking this measure. Taking the second approach may provide a more broadly accurate picture of current ICT-use across a majority of countries, but if these technologies continue to gain ground so rapidly, it will become increasingly important to include them in indices. In this respect, the ITU index will need to be developed based on the statistical work carried out within ITU and be limited to indicators collected through the World Telecommunication/ICT indicators database.

2.9.3 TARIFFS

Because of the huge number of variables associated with ICT tariff regimes, it is challenging to arrive at an averaged or basket approach that has any international comparability. As a result meaningful assessment of mobile and internet tariffs usually occurs at national and regional levels. However, pricing is an important area of regulation, and indeed it is precisely this opacity across packages and bundling of services options which makes it difficult for consumers to make informed pricing decisions and also makes it difficult for regulators to regulate tariffs in markets where this is still a necessary function.

Tariff indicators while useful for national or regional level analysis may seem too difficult for attempting international comparability or benchmarking, however, it is a critical factor influencing use and hence is built into many indices – the DOI included. From a policy perspective, this is important in terms of information about the point at which service uptake transforms into a mass market. Tariff indicators are also a useful way of building information about the conditions of supply into the indicator. The price of a service reveals indirect information about the level of competition for example. Finally, pricing information is critical for investment decisions in the sector.

In some senses price information can be seen as an explanatory variable which would not warrant its inclusion in the set of core measures of uptake, however, as a measure of affordability it fits well with other measures of access equity such as network coverage and literacy.

Nevertheless, while it is true that mobile access tariffs are a key measure of affordability, in adopting the use of tariff measures in an index it should be noted that they may not correlate fully with use. For example, studies have shown that poor people spend a much higher proportion of their income on communication costs.[47] Obviously this is not because the poor can afford to spend more, but because they deem a certain threshold of communication as required for their life strategies. Also, the poor may be required to pay more for basic calls because prepaid packages typically priced higher than post-paid, or there may be a premium for making calls to a different local network.

Another issue is that prices and pricing are in a state of transition and are likely to fluctuate widely between countries (especially between developing and developed countries), and over time. Evolving technologies and market dynamics are forcing operators to change their business plans. New content and service provision models will increasingly provide new ways of financing networks as call charges eventually drop to zero and are financed by higher bandwidth use, flat rate charges, advertising or some other arrangement.

Because of these issues and the avoidance of explanatory variables, the ICT-OI does not use tariff measures, while the DOI's approach for dealing with the wide fluctuation in prices is to index the variable to 100 with no data point allowed to exceed 100 (the price index is also inverted so that a price which is equal to or above 100% of average monthly income scores 0 in the DOI).

2.9.4 INTERNATIONAL VOICE TRAFFIC MINUTES

The volume of international voice traffic is one of the more available measures of network usage-intensity, although international voice traffic data is only available for just over half the countries for outgoing minutes in 2005 (123), while less than a quarter have data for incoming minutes in 2005 (and only about a third of the countries for 2004). These measures also suffer from the problems around emphasising business-use.

[47] See LIRNE*asia*'s Teleuse at the Bottom of the Pyramid research and DIRSI's Mobile Opportunities survey results.

The DOI does not use voice or data traffic measures, while the ICT-OI only uses Total Outgoing Minutes for its voice traffic measure. This tends to penalise less developed countries since they will likely have more restricted markets resulting in a larger differentials in cost between incoming and outgoing international calls, and also biases against those countries with a large diaspora. In both these cases there is a tendency for outgoing calls to be replaced with incoming calls. This indicator should ideally be coupled with the same information for internal calls within the country, however data is severely lacking on national voice traffic and with so few countries represented, it cannot usefully be included in indices.

2.9.5 PERSONAL COMPUTER PENETRATION

Computer equipment data is based largely on responses to a questionnaire that the ITU sends to government telecommunication agencies which often do not have the resources to gather this information. In the absence of data from many countries, the number of PCs is estimated using industry sales data or PC imports data. For some small developing economies, neither sales nor import data are available. Donated computers or reconstructed/recycled computers would also not be included in this estimate, and per-capita measures would also obscure the fact that the vast majority of PCs are likely to be located in businesses rather than households, especially in developing countries.

Additionally, the definition of a PC is becoming increasingly blurred given the vast range in devices with capabilities from 16bit monochrome machines to high-end 64bit multimedia workstations and the emergence of smartphones, thin-clients, interactive television and stripped down school PCs, as well as the embedding of computer devices in many other appliances. Finally, there is a limited number of countries for which recent data is available.

In spite of these shortcomings, PC penetration is nonetheless an important Information Society measure and underlies other indicators such as internet access, fixed line broadband, and so forth. Thus it is not unexpected that PC penetration is measured in both the DOI and the ICT-OI, although in the case of the DOI this is measured at the household level, while in the ICT-OI it is measured at the individual level (although as with many of the other indicators, this may again over-emphasise business-use).

2.9.6 BROADCAST MEDIA

Television or radio penetration as ICT measures suffer from similar problems to PCs as indicators, but because they are such important media for developing countries, they could offer valuable data worth including in indices. In these countries they can act as intermediaries in delivering information derived from interactive ICTs, and as such they are a key means of extending information into communities with low penetration of ‘new’ ICTs, i.e, particularly developing countries. It is notable therefore, that the ICT-OI uses a measure of TV penetration, while the DOI does not.

Although no measure of radio penetration is included in any of the indices under consideration, radio has a traditional role in providing access to information in rural and urban communities, delivering locally important content in the local language.

As noted by Minges, some indicators designed to capture the prevalence of radios simply ask the wrong questions about stand-alone devices and fail to capture the ubiquity of radios in our phones, cars, clocks, and so forth. And with so few countries reporting data, inclusion of radio or TV penetration is unlikely to be useful as a global indicator.

Rather than measuring the total number of radios it may be more useful to have audience numbers. This is certainly information that commercial radio stations collect in order to market airtime. Public broadcasting also is likely to have an idea of audience levels – especially where there is still a radio licence fee. Community broadcasters will also be likely to have an idea of the size of their listening communities (Girard 2003).

Cable TV subscriptions as an indication of TV penetration is a poor measure because so many countries, especially developing countries, do not have a cable TV service, or it may just be present in the capital city. In some countries, Cable TV is also provided through informal markets which may not be able to provide user data. With the growth of wireless broadband, cable TV access is also becoming less indicative of broadband connectivity.

Satellite TV and other subscription television services may be a better indicator, especially as a number of low-cost satellite-based services are now being deployed.

Note should also be made of the difficulties of comparing data reported for countries which have a TV license scheme and those that do not, as this could affect accuracy of reporting.

2.9.7 HUMAN CAPITAL AND SKILLS

As observed in the 2001 World Employment report, "literacy and education cannot be leapfrogged" (ILO 2001: 201). The International Labour Office further identifies three overarching areas of information economy gains: participation in production of world demand for ICT products; gains in economic efficiency and productivity – across all sectors of the economy; and possibilities that networking opens up for poverty alleviation through improving incomes and marketable capacities of the poor as well as their quality of life (ILO 2001: 168).

However, given the role of intermediaries and the simplicity of mobile phone use (the predominant new ICT deployed in developing countries) this indicator could be argued to shed a limited perspective on the digital divide. However, literacy and school enrolment are also relevant to opportunity or equity issues and thus provide a measure of the ability to participate in the knowledge economy.

The DOI does not include any human capital measures. In the case of the ICT-OI, human capital measures of literacy and enrolment in the different levels of education (primary, secondary and tertiary), are used as proxies for skills availability in its conceptual model for the index. In this respect the skills index is combined with network density to provide the Infodensity sub-Index, which aims to provide a measure of ICT capital and labour stocks, and thus productive capacity. There are however a multitude of other factors that affect productive capacity, such as capital markets, unemployment rates, affordability and not least, the ability created by the technology to access skills remotely in another country. So giving skills an equal weighting to network density and using only these two factors to describe ICT productive capacity is open to question.

2.9.8 INTERNET USERS

For most developed and larger developing countries, internet user data is based on user surveys conducted by national statistical agencies or industry associations. This data is either provided directly to the ITU by each country, or the ITU does the necessary research to obtain it. For countries where internet user surveys are not available, it is common to estimate the number of users based on a multiple of the numbers of actual paying internet subscribers. As a result, the actual number of users is usually less accurately measured in developing economies where fewer surveys exist. In future, measures of the numbers of public access facilities will help improve this picture as the public is likely to be more dependent on these for access.

The ratio of broadband users to internet users is another commonly used indicator here, notably in the DOI and not in the ICT-OI. But having access to broadband may not be a particularly solid indicator of intensity of use, and may simply reflect affordability, pervasion and availability of broadband. In addition it needs to be recognised that there is a very wide range of national definitions of 'broadband', from 256Kbps links (which might actually only be 64Kbps or 32Kbps upstream), to 100Mbps links. As a result internet bandwidth may be a better measure of intensity of use.

Mobile internet subscribers and mobile broadband subscribers have also been used as indicators and are likely to become increasingly important in the future. However as discussed above under mobile indicators in section 2.9.2, including them in an index at this point in time is likely to heavily weight the rankings in favour of the few countries that have currently adopted these technologies. In this sense, this indicator may be too 'young' to be included in a universally agreed single index, but may find more use in a 'second speed' index measuring more advanced states of ICT development. It should also be noted that the definition for mobile broadband and mobile Internet users is still under discussion within (and outside) ITU, making international comparisons difficult. Alternatively, it can be argued that due to the increasingly rapid uptake of these technologies, it will be important to include them as a measure in order to future-proof the index in the short-to-medium term.

2.9.9 SECURE SERVERS, INTERNET HOSTS AND BANDWIDTH

Secure servers are usually established to host content with a financial transaction component. Since so few developing countries have adjusted their legal frameworks to accommodate online transactions, and so few of the population in these countries have credit cards or other forms of online payment systems, including this indicator in a core set for an index could give too much weight to advanced economies. Thus it is not unexpected that neither the DOI or the ICT-OI include secure servers as a measure in their indices.

International bandwidth is a relatively good proxy measure for internet use, but, like mainlines per capita, it suffers from inaccuracy created by much greater business use in most countries, as well as residential power-users who have access to cheap broadband and can stream multimedia or download large quantities of data. It also emphasises international use over local use which, given the lower levels of local content and applications in developing countries, may under-emphasise developed country use. International bandwidth is also likely to be harder to measure in developed economies where the number of different international links is much greater.

Internet hosts per 1,000 inhabitants is another measure of internet penetration that has often been used in indices, but the number of actual internet hosts in a country is hard to measure using public IP numbers because so many machines linked to the internet are behind firewalls and use private IP numbers with Network Address Translation (NAT), or use IP space that is allocated to other countries. Furthermore IP networks are in transition to IPV6 infrastructure, which currently creates a mixed environment that makes comparisons difficult, although in the future, IPV6 will likely eliminate issues with NAT. However, increasingly sophisticated analysis of the IP space is being undertaken by organisations such as Ipligence.com and this may still a relatively valuable indicator considering that it is widely available.

2.10 Conclusions

As discussed in Chapter 1, the ICT-OI and the DOI are apparently dissimilar indices in terms of indicator selection and their resulting ranking of countries. This is not surprising given that their intent, methodologies and indicators (except for one) all differ. Yet, their rankings ostensibly arrive at much the same conclusions for the majority of countries. The close correlation between the two indices has been explained in terms of a common underlying relationship with wealth and income. Minges argues that there "is often a tendency to link ICT indices to economic frameworks because of the importance of ICT for development. However, ICT has wide-ranging impacts from better governance to improved health care delivery that a purely economic framework will not capture. Any framework that does not consider the large scope of ICT is bound to be limiting" (Minges 2005: 49).

In this respect, given their very similar results despite the wide variation in indicators used, both the ICT-OI and the DOI may be suitable candidates for the single ITU index. The indices also fulfill the need to be able to evolve and accommodate modification. The DOI has been designed in a modular fashion so as to permit bringing in new data elements for deeper analysis – to further examine rural

and urban divides, gender imbalances or for regional benchmarking. In this manner, it is flexible and useful for supporting national level policymaking processes. The ICT-OI can also accommodate new data sets as these become available, and as discussed in Chapter 1, offers a good framework for measuring the digital divide over time and between countries, including through the index's sub-rankings.

Nevertheless, as described above, a variety of issues in the choice of indicators and methodologies of the two indices have been pointed out, which suggests that with small adjustments, a new Index could be developed which addresses these problems. This could consist of simply removing or changing the selection of indicators in either of the two indices, or it could aim to strike a middle ground between the two, and merge the best of the methodologies and indicator selections.

In considering these various options, the key questions that need to be answered are:

1. Is there a conceptual framework to inform indicator selection?
2. Are the indicators needed available and up-to-date for most countries? (a particular consideration with household data).
3. Do the indicators selected measure ICTs that are presently used in the majority of countries? (an issue for fixed lines and mobile broadband indicators)
4. How easy is the index to understand and unpack? (an issue for more complex methodologies)
5. How useful is the index in benchmarking progress toward achieving MDG and WSIS targets by 2015?

In assessing the different ITU indices, the first observation is that a small number of indicators are needed and that the choice of indicators makes relatively little difference to the country rankings. This was shown by the high correlation between the DAI and the DOI in Figure 1 (Chapter 1).

Given that a key concern for an ITU index is to provide a useful perspective for developing countries, the fewer indicators that are used increases the likelihood of higher country representation across most of the categories, and given the greater difficulties of obtaining data from developing countries, fewer indicators will likely improve representation from these countries.

In terms of network infrastructure development, it is arguable whether it is still essential to include a fixed line indicator. A decision not to include this is likely to require substantial discussion, however, all indicators and industry information show stagnation in fixed line investment and roll-out; with mobile becoming increasingly important both for telephony and advanced services and applications. Using effective teledensity as a measure for weighing both mobile and fixed line is attractive, but this would result in a lessening of statistical recognition that the mobile telecom sector has fundamentally changed the landscape in this respect, especially for developing countries. Thus, the teledensity and effective teledensity issue could be flagged for the future, and for now, including fixed line measures is necessary as it is still a critical component in too many economies to exclude.

More simply, mobile broadband has not yet been widely deployed in many countries, and where it has, this has usually been in the much larger and more developed markets. In addition there is lack of clarity over what exactly constitutes mobile broadband, given the rapid adoption of semi-fixed wireless broadband solutions with wide ranges in data speeds (54Mbps to 14Kbps - from WiMax to CDMA to GPRS).

The question of the inclusion of tariff measures has also been questioned. As explanatory variables, indicators such as tariffs will already be reflected in uptake and usage. And the same case could also be made for human resource indicators such as literacy and education. These, along with a host of other factors clearly affect uptake, but may not be the most effective measures for measurement at an international level. However, if carefully managed, the benefit of this kind of information may outweigh the disadvantages of including it. Also, in line with the needs of developing countries, these

kinds of indicators provide real access to needed information on the levels of equity in universalising access to ICT and give clear signs to policy makers.

Broadcast ICTs are important for their role in further diffusion role of information. Ideally a measure of radio uptake should be included in the index, as it is one of the most prevalent forms of ICT, playing a key intermediary role for local communities and also offering a much higher proportion of local content than television. This is an important developing country indicator, but the data is simply not available in a sufficiently consistent, accurate or widespread manner.

In the absence of disaggregated indicators generally, neither is there an accepted gender related ICT indicator that could inform the index on gender.

Usage intensity metrics for voice and data traffic also have their limitations, finally, as illustrated by the different internet metrics across the different indices, an effective measure of internet uptake is still lacking. Adequate internet metrics still need to be developed and refined.

In terms of methodologies, there is the age-old tension between sophistication and simplicity exemplified by the differences between the ICT-OI and the DOI methodologies. While the ICT-OI uses a variety of innovative ways of treating the data, (such the geometric mean, and measures which are relative to the world average rather than a set of fixed goal posts), this may be harder to grasp by non-specialists than the simpler approach of the DOI.

Building on the observations of Chapters 1 and 2, Chapter 3 maps out the various scenarios for a single index, focussing on indicator choices and methodological approaches to guide decisions in formulating a single ITU index.

Chapter 3 – Choices for a single index

3.1 The context and goals for the development of a new index

Taking into account the analysis and conclusions from the previous chapters, to further help in choosing a single index for ICTs, the overall purpose and needs for such an index are re-considered below.

ITU's responsibility to produce statistics covering the ICT sector is well recognised and forms part of the global statistical system of the United Nations. As such, the ITU tracks global, regional and country trends through various statistical indicators in keeping with a variety of mandates. Many of these relate to support for the building of an information society, most recently through the WSIS goals and its call for a composite index to measure progress.

Of particular note is the need to adopt a set of indicators which can demonstrate the extent of the digital divide to further improve existing benchmarking efforts, and to unify the information that is available in one place. Having a single index will clearly be a more efficient use of resources in terms of encouraging more up-to-date reporting of the core-indicator constituents of the index by individual countries, and also helping to reduce any lack of clarity about which index to use. In addition, it would encourage all countries to use the same set of benchmarks, and thereby help in the development of common strategies to improve the uptake of ICTs, while increasing the visibility of both the achievers and the laggards.

ITU's mandate also indicates that any new index should ensure that measures can be made of the progress in developing countries where policy makers are especially keen to ensure that the digital divide is narrowed. In addition, there are notable digital divides within countries that also need addressing. However to measure progress in this area most developing countries will require much more extensive survey work and production of relevant statistics by national organisations. Capacity building in this area is being addressed elsewhere by ITU and particularly through the Partnership on Measuring ICT for Development.

At the same time, ITU has an obligation to all of its members, including the developed countries. Because they are generally at later stages in the S-curve of ICT adoption (and have much bigger legacy networks of older technologies), the developed countries have different concerns to those of the developing countries. The difficulty of providing useful information relevant to all countries within one index has been noted a number of times, and the idea that developed countries may require an index based on different indicators, persists.

Perhaps related to this is the observation that the ICT-OI may be more suitable for developing countries, while the DOI is more suited to developed countries, but the hard evidence for this is somewhat unclear, especially as the two indices are so closely correlated. In some respects the lack of goalposts and the unbounded nature of the ICT-OI would indicate that it is also suitable for measuring progress in developed countries. Perhaps more important is the choice of indicators in the ICT-OI which suggest an implicit weighting for factors of more relevance to developing countries than the DOI (for example literacy and education levels), and the exclusion of mobile internet and mobile broadband indicators, which are currently either not available or not tracked in most developing countries.

As a result there may be a need to structure the single index in a manner that allows it to be more easily unpacked in ways that are relevant to both developing and developed countries. This, along with strategies for accommodating the requirements for 'two-speed' indexing are covered in more detail further below.

3.2 Additional considerations in the design of a single index

Taking into account the above and the discussion in the previous chapters, in considering options for choosing the single index, the key considerations and assumptions for the scope of such an index can be summarised as follows:

1. The aim of the index is to provide a universally accepted measure of access to, and use of, ICTs. Accordingly, the goal of establishing the index is to achieve a general measure of ICT-adoption at a national level that encompasses as many nations as possible.
2. The index should be transparent in its formulation, easy to understand and use, and effective in informing policy decisions. In this respect it should be easy to replicate, allowing use of the tool without any special training;
3. The index should be able to stand on its own, and its components should be easily unpacked for more detailed analysis or to be integrated into other indices;
4. The scope of the time period for the utility of the index would be until 2015. This corresponds to the MDG and WSIS goals, and as there will be a major stock-taking at this time and there will have been significant changes in technologies and the abilities of NSOs to report more useful data, the index would likely need to be extensively reformulated at that time;
5. Due to the general lack of available up-to-date data, an index with the smallest number of component indicators is likely to be the most inclusive and comparable across countries. Many of the most desirable indicators are currently not available in a consistent manner, especially for developing countries. While this is likely to change in future as national information gathering reaches higher levels of sophistication and NSOs improve their capacities, in the interim pragmatic choices need to be made about the selection of indicators based on their levels of country representation.
6. Indicators that measure levels of users and usage provide the clearest measures of the degree of access to ICTs and their level of adoption. Thus the index should be based on a solid conceptual framework and aim to measure actual uptake and use. In this respect the use of subjective factors that attempt to ascribe the potential for access are likely to find less wide acceptance. Similarly, supply-side indicators also tend to reflect potential use rather than actual use;
7. Given the framing of the WSIS and MDG goals, the focus of the index should be on personal rather than business-use (although ideally in future when more data is available, household use and other types of disaggregation would also be more explicitly included in the indicators);
8. To maximise the validity of the index while technologies evolve and new infrastructure and services are adopted, the indicators need to anticipate the future evolution of ICT infrastructure and services.[48] In this respect it is expected that networks will steadily evolve away from a circuit-switched infrastructure to packet-switched/internet protocol based networks, commonly known as next generation networks (NGNs), which will also increasingly comprise larger numbers of wireless Internet users.
9. Indicator data used should be compiled by credible organisations and should be issued on a regular basis to allow for longitudinal studies (over time);
10. The indicators used in the index should be as up-to-date and as accurate across as many countries as possible, using consistent data definitions and timing for data reporting;

[48] Given that ICTs are subject to such rapid technology change, it is not surprising that the ITU has recognised that "indicators to measure access to, use and impact of ICTs need to be regularly redefined and new indicators must be developed to reflect changes in the technological and regulatory environment. These changes must also reflect the ways people are accessing and using telecommunication/ICTs" (ITU 2006d).

11. The index should complement the ICT indicators adopted for measuring the achievement of the MDGs and the WSIS goals.

3.3 The Three Scenarios for the Single Index

As discussed briefly at the end of Chapter 2, these considerations suggest three possible scenarios for the single index:

1. Adopting one of the two indices already in use – either the ICT-OI or the DOI. This approach has the advantage that the two indices are already well known and extensively analysed. The disadvantage is that the different problems which have been identified with each of the indices suggests that choosing one over the other may be difficult or could lead to even more protracted debate with an unclear outcome.
2. Adopting a slightly modified version of one of either of the two existing Indices involving adding or removing some of the indicators currently used, and retaining the same methodology of either the ICT-OI or the DOI. This option has some of the advantages of Scenario 1 but due to the inherent differences between the ICT-OI and DOI, it may be difficult to make changes to sufficiently address the issues. The conceptual framework and intricate methodology which is imbedded in the ICT-OI makes it less appropriate for piecemeal modification, while in the DOI it may be possible to simply change, remove or add indicators with little additional effort. Removing the 'mobile internet subscriber 'indicator and the ratio of 'mobile broadband to total mobile subscribers' indicators from the DOI could be one way of making the index less focused on developed countries (with their much higher utilisation of advanced broadband technologies). Removing the tariff indicators could focus the index more closely on actual uptake. But even removing both of these types of measures would still not address the other concerns that have been identified, especially the use of household indicators, which are not available through household surveys (but rather estimated) for the majority of developing countries.
3. Adopting an index that merges the most desirable features of the two existing indices. This 'revised' version of the index would build on the body of work already carried out in developing the ICT-OI and the DOI. The index would use a combination of the existing indicators and mix the methodology of the ICT-OI and the DOI. A further permutation of this scenario would be to also incorporate some new indicators such as internet metrics and equity factors such as gender. The drawback of this approach (and to some extent the approach of scenario 2) is that it would create yet another (third) index, which has not been tested yet.

If Scenario 1. is chosen, little further discussion is necessary, as the issues affecting the ICT-OI and the DOI are covered in detail above. All that would be needed is acceptance of the disadvantages and advantages of either of the two indices, and a decision on which one to use.

Similarly, a fairly straightforward choice can be made regarding Scenario 2., with the provisions for adopting or rejecting the indicators used in each index covered above, and further below in considerations for Scenario 3., which is described in more detail below.

3.4 Toward a conceptual framework for a 'Revised' index

The number and range of ICTs available today has never been greater, and the interrelationships between them and their indicators are many and diverse. In order to effectively evaluate the choice of indicators for a single index which merges the best features of the ICT-OI and the DOI, it is essential to have a clear conceptual framework on which to base it. Selecting indicators and formulating an index with them is to some extent an art rather than a science, as well as requiring pragmatic compromises to deal with the lack of available data. The choice of indicators is likely to be the most controversial and important question to be addressed in formulating a revised index. A good

conceptual framework makes it possible be much more systematic about this process and makes the overall methodology more open to rigorous critique.

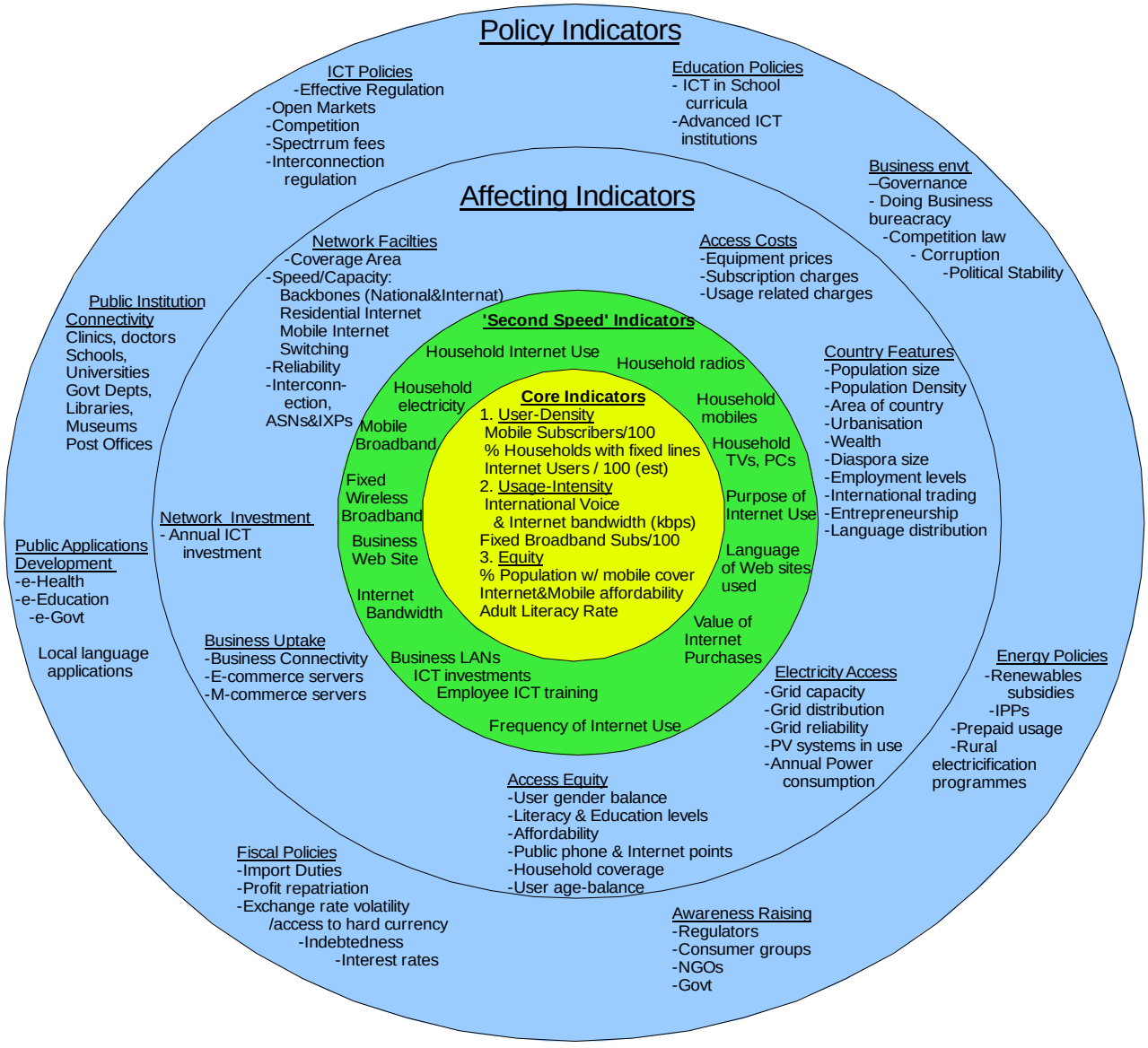
The ICT-OI is the index with the most explicit conceptual framework. As mentioned above, the ICT-OI conceptual model (derived from Orbicom's Digital Divide Index) is closely linked to economic theory, focusing on the dual nature of ICTs as a productive asset as well as a consumable. In this respect it groups indicators into two categories – Infodensity, which refers to the ICT slice of a country's overall capital and labour stocks (indicative of productive capacity), and Info-use, which refers to the consumption flows of ICTs. Thus it can be said that Infodensity also gives a measure of the potential for ICT uptake, while Info-use aims to measure actual uptake and intensity of use.

Considering that the ICT-OI yields very similar results to the DOI, and that the conceptual framework of the ICT-OI creates a less apparent weighting of indicators,[49] it may be more beneficial to policy makers and non-experts to use a less complex conceptual model that focuses on measuring actual uptake and ICT-use, while acknowledging the large number and wide variety of factors that underpin the results.

An example of such a simplified analytical model is shown in the schematic diagram below depicting the various factors and indicators (see Figure 2). The diagram presents a view of the revised index as a set of Core Indicators which are nested within the much larger number of diagnostic indicators (explanatory variables). These are measures of the factors that can have a direct or indirect impact on the Core Indicators, and can be used to better explain the variations between countries to inform policy making. In general, each of the diagnostic indicators provide part of the picture, which, when combined, can describe the potential for improving access to and utilisation of ICTs.

[49] Because they are grouped behind a hierarchy of subindices which are merged to create the final index.

Figure 2 – **The single index schematic of indicators**



The diagnostic indicators (the blue area) can be broken down into two groups of indicators: those in the inner circle (the Affecting Indicators), which comprise the explanatory variables that have a direct affect on the Core Indicators, which in turn are influenced by Policy Level explanatory variables in the outer circle. All these diagnostic measures would ideally be gathered and analysed by national statistical offices or other stakeholders who can contribute data from their particular area of focus, many of which, as can be seen from the diagram, are not necessarily in the ICT field directly.

In the yellow area, the Core Indicators at the centre are those that could comprise a revised single index, taking into account the aim of the index and the availability of data, rather than being a theoretically ideal set of indicators. The proposed indicators for the index are discussed in more detail further below. The outer green circle comprises additional measures which could become part of a two speed index approach using the more sophisticated indicators and technologies that are present in some countries.

This conceptual framework relegates many of the indicators adopted by other indices to the level of diagnostic indicators and focusing the core indicators on the most widely represented and most accurate set of indicators available. The validity of using these indicators (and the validity of the entire conceptual model) could also be tested by measuring the correlation of the index with the diagnostic indicators, assuming enough of them are available.

The ICT-OI framework's indicators fall into the following categories or subindices: Infodensity – networks and skills; and Info-use – uptake and intensity. Within the conceptual framework proposed above, the ICT-OI's network indicators fall more into the category of Info-use indicators which would, in an ideal world, comprise all general demand-side measures of network and equipment uptake such as fixed, mobile and internet subscribers, PCs, TVs and radios per capita. For various reasons described below, it may be more appropriate to restrict the Info-use indicators to fixed lines, mobile subscribers and internet users. To better describe the sub-index, it could be called User-Density.

The ICT-OI Intensity sub-index, comprises voice and internet traffic, and broadband subscribers. However instead of combining these into the Info-use sub-index which also includes PCs, TVs and internet users, these two categories could be kept at the top level of the sub-index hierarchy, and thus could be weighted more equally in the revised index. The sub-index could be called Usage-Intensity, to better imply measures of the extent to which ICT is actually used.

The User-Density and Usage-Intensity sub-indexes could be combined *as-is*, to provide a workable index of ICT uptake and levels of use, but this would not take into account the skills and opportunity components that are also important parts of the picture. The ICT-OI only uses the skills component, while the DOI only looks at opportunity. In the ICT-OI, the skills indicators are seen as part of the productive ICT assets within the economic conceptual model used by the ICT-OI index. However, due to the lack of available data, these measures are a proxy measure of ICT labour assets and may be insufficient to provide a real measure of productive ICT-specific labour assets.

Therefore in order to keep the focus on clear measures of uptake, while retaining the DOIs concept of *opportunity*, skills can instead be treated as one of the key measures of the breadth of the public's ability to access ICTs. This concept could be refined in a revised index with a third and final sub-index to more broadly measure the Equity factor.

In this respect the Opportunity sub-index in the DOI can be seen as a way of providing a measure of access equity – i.e. the extent to which some people are excluded from access to or the use of ICT. Average per capita measures of ICT use obscure the fact that, for example, in many countries women do not have as much access to technology, or do not have the education to effectively use ICT, and neither do the illiterate. Similarly the poor may not be able to afford access to broadband, and networks often do not extend uniformly across the country. Thus the Equity/Opportunity sub-index

would aim to highlight these problems and create a composite proxy measure of the equitability of access and use of ICT in any given country.

Given commitments to gender disaggregation in measures of ICT adoption, ideally the Opportunity category should include some measure of gender access. However, as mentioned above, no gender measure directly related to ICTs exists across the majority of countries. The UNDP's Gender Development Index (GDI) could be used as a generic proxy for gender related access to ICTs, but this has not been sufficiently discussed among the stakeholders, so the Opportunity sub-index at this stage would likely be restricted to mobile population coverage, internet plus mobile affordability, and adult literacy.

Using this simple three-part sub-category/sub-index system for a revised index also allows for easy comparisons to be made between countries in the three factors, or over time for an individual country. This works well visually, in the form of wheel and spoke diagrams, as shown in Figure 3.

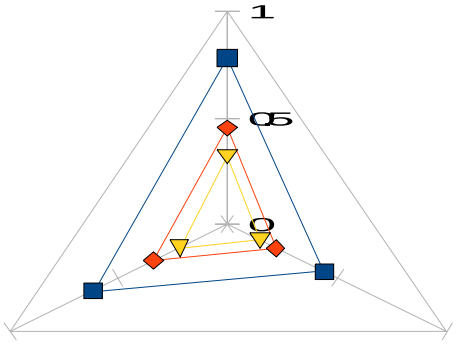


Figure 3 – **Comparison of three countries, or one country over time, (blue, orange and red) along the three axes of the subindices**

3.5 An index at two speeds

As some countries have better data availability for the more useful survey-based ICT indicators identified by the Partnership on Measuring ICT for Development, especially usage at the household level, this has led to the idea that an additional index using these indicators could be developed for these countries. The saturation of uptake in some parts of the world also forms part of the rationale for devising a two-speed element to indexing.

To some extent, a revised index as described above could address some of these concerns, for which User-density would be of key concern to developing countries, while Usage-Intensity would be more important to developed countries. However, as increasing numbers of countries are now able to report more useful ICT indicators, this process should be encouraged, while making available the tools and indexing methodology needed to make use of these indicators, and to allow tracking of the adoption of more advanced technologies.

The 'second speed' index would thus be likely to include a set of indicators drawn from those identified by the Partnership. Using the conceptual model described above to formulate criteria for their selection, the 'second-speed' index would be likely to comprise some of the indicators from the revised index core indicators, and/or mobile and wireless internet users, frequency of use and household use.

In designing such an index a number of difficulties will need to be addressed. One is determining how the countries are to be selected for the index. If it is to be for developed countries, the OECD already

collects many ICT indicators[50] for its member countries, (and has also identified 15 key ICT indicators that could be used in an index). If such an index is not to be just for the most developed countries (which have less need to measure progress, in particular in bridging the digital divide), a framework would be needed to determine which countries should be included. Further analysis, beyond the scope of this report, may be able to determine an inflexion point in ICT uptake from basic indicator data that could be used to determine if a country should move to the next rank. However, there is little guarantee that there would be a match between reaching this point and the availability of improved ICT indicators in that country.

This problem could be addressed by allowing countries to self-select their participation in the Index, based on their ability to supply the needed indicators. Since it is expected that increasing numbers of National Statistical Offices will be able to consistently provide better indicators derived from improved survey work, the members of the group are likely to increase steadily over time, and this will make year-on-year comparisons much more difficult (a country might be 18th this year, and 24th next year, even although its ICT uptake performance has improved, simply because new countries were added to the index).

Nevertheless the logic for creating a more in-depth and accurate index is attractive, but it is only likely to carry much weight once more countries have improved data availability – in 2005 only about 40 countries worldwide collected ten or more household ICT indicators.[51] So although it is desirable to have a clearer picture of ICT uptake by making use of improved indicators, this is unlikely to be feasible for a sufficiently large number of countries in the short-term. Therefore it may be necessary to rely on a revised index and its two-speed elements to measure ICT uptake and use until 2015.

At this time there will be a major stocktaking of progress which could provide an opportunity to refine measures based on national survey progress, the emergence of new technologies and other changes that will have occurred within the ICT sector. Ideally, by 2015 almost all countries will have reached affordable nationwide broadband coverage and User-density measures will reach saturation. As a result there would no longer be of as much value in measuring this aspect of national level progress with the focus shifting toward usage. This situation is already getting closer in some of the more developed countries especially for mobile uptake, whereas there is still a long way to go in most developing countries.

3.6 Indicator selection considerations for a revised index

3.6.1 FOCUSSING ON ACTUAL USE

A key feature of a revised index would be its emphasis on measuring actual uptake, rather than more nebulous indicators of potential for uptake which are open to different interpretations of their relative importance. As illustrated in the indicator schematic diagram (see Figure 2), there are actually many more of these such factors than included in any index (partly due to the lack of data availability).

In other words, the optimal practical measure of the extent to which ICTs are accessible to a particular country's residents is in their uptake and use, not in more general and subjective measures of potential for uptake. In this respect, a revised index would focus less on explanatory measures and supply-side indicators and more on actuality.

[50] See for example, http://www.oecd.org/sti/ict/broadband. It could be beneficial to compare the use of these indicators with others proposed for a 'second speed' index.

[51] See: Partnership on Measuring ICT for Development (2005).

3.6.2 DATA AVAILABILITY

As discussed in Chapter 2, very few of the indicators available are up-to-date and cover the majority of countries. Although an increasing amount of year-end 2006 data is becoming available, overall, 2005 is the most recent year for data in the ITU database. However, in general there is more data available for 2004. For example, while an equal number of countries in 2004 and 2005 record data in the ITU database for fixed lines, due to delayed reporting, mobile subscriber information is available for 210 countries in 2004, but only 179 countries in 2005.

This highlights a key problem in selecting a meaningful set of core indicators and also means that for policy makers there is at least a two year lag in seeing the results of policy decisions. While more up-to-date information may be available for some indicators, if it is not available for all indicators, the index decreases substantially in value and is only really accurate for those years where data is most widely available. These observations underscore the need to focus on the indicators that are the most current and most prevalent.

3.6.3 AVERAGES OBSCURE IMPORTANT DIFFERENCES

In choosing indicators, it also needs to be recognised that an issue with most of the measures available at national levels is that the derivation of indicators based on dividing national totals by the total population can obscure massive variations between urban and rural, men and women, and between business and private use.

This issue is likely to be more prevalent in countries at lower levels of infrastructure development. For example, dividing the number of fixed line subscribers in the country by the total population to derive a measure of lines/capita (or per 100 people) will obscure that fact in many of the least developed countries, by far the majority of fixed lines are located in businesses and amongst the most wealthy households. Similarly, in most of these countries, the majority of lines are located in the top two or three urban centres, while most of the people live outside these areas. For example, in 2001, the overall fixed line teledensity for Malawi was about 0.5% (55 000 lines for 10.5 million people). However if the population and lines in the four largest cities are taken out of the equation, there remains only 8,000 lines for the remaining 10 million people, giving them a teledensity of only 0.08%,[52] which is almost a factor of 10 different to the national average.

A different aspect of this problem is that in some countries, especially some Middle East nations, only citizens (not the full resident population) is used for measuring density, thereby inflating the actual levels of the measure.

Other indicators suffering from this issue are internet subscribers/capita, PCs/capita and most usage indicators, for which averages can obscure even more extreme variations between different users in the country. For example, a commonly used rule of thumb among internet service providers (ISPs) is the 90/10 rule (derived from the 80/20 rule[53]), which says that 10% of the users will consume 90% of the bandwidth. Similarly, less developed countries are likely to have a much higher proportion of international voice traffic emanating from business-use than from private users.

Nevertheless, these indicators are among the few that are available for most countries and so would still be likely to be included in a revised index because they at least allow some measure to be made of these factors. Since the availability of indicators with broad representation across countries is so small, these considerations also underline a key tension in the construction of any index – the playoff between accuracy and country representation.

[52] Jensen research while seconded to the Malawi national telecom regulator on behalf of the ITU.

[53] This is the Pareto principle which states that for many events, 80% of the effects comes from 20% of the causes; or for business, that 80% of sales derive from 20% of clients.

In the case of fixed lines, the DOI gathered substantial additional survey data and estimates of numbers of residential lines which allows for the use of households with fixed lines as an indicator. Although the methodology simply uses proxies on household size and percentage of residential lines where household data is missing, the accuracy of this approach has not been verified and it is unclear if this effort can be sustained in an ongoing basis. Nevertheless, these issues may be outweighed by the methodological limitations of using national fixed teledensity figures described above, and it at this time it appears that each have similar validities in being used in a revised index .

3.6 Subindices and indicator options for a revised Index

This section provides further details on the subindices and individual indicators that would most likely be selected for a revised index, based on the conceptual model described above.

3.6.1 USER-DENSITY SUB-INDEX

A User-Density sub-index would be expected to measure the per capita penetration of ICT among the public. Ideally, such density indicators would consist of all measures of network users and equipment penetration such as fixed, mobile and internet subscribers, PCs, TVs and radios per capita. Phone numbers in use and email addresses would also be desirable if available.

However, because of data accuracy and availability limitations, most of these indicators can be eliminated from the selection. In particular, while most other indices have used PCs/capita, very few countries have a precise measure of the number of PCs, especially for many developing economies, where sales or import data are generally not available or are out-of-date. In addition, as described in the previous chapter, the definition of what actually constitutes a PC is becoming increasingly blurred because of mobile PC convergence and the embedding of computing devices in other equipment such as TVs and fridges.

TV penetration was also rejected as an indicator for similar reasons. Again, as mentioned above, data for TV sales is not up-to-date for many countries, is likely to be inaccurate due to grey market importing and is currently only available for 85 countries. Similar to concerns around using PCs as an indicator, TV penetration is not future-proof, considering rapid moves toward IPTV and mobile phone TV, so that using traditional TV measures would bias against those countries that have already adopted these technologies. This bias is likely to increase as these technologies are adopted in more countries. Including a measure of traditional TV adoption would also reduce focus on the factors that are of more interest in the networked economy – the uptake of new ICT.

Radio penetration data suffers from the same sort of problems as PC and TV data, and can also rejected on this basis.

Fixed line penetration measures may also be considered for rejection from the index considering that little new cable is being laid and many nations (especially developing countries) are skipping the use of fixed-line infrastructure and moving directly to wireless technologies. As a result, including a fixed-line measure would be likely to bias against most developing countries. But overall, given the need to take into account the use of fixed lines for delivering broadband in developed countries, it is probably necessary to include this indicator in a revised index.

In contrast to fixed lines, mobile phone access is becoming the de facto measure of basic access and this indicator is of particular concern to developing countries where growth is still rapid and has not come close to reaching saturation. In addition mobile phones are now being more used for internet access than PCs in some countries.[54] Mobile subscribers are accurately monitored in 220 countries by

[54] See: http://communities-dominate.blogs.com/brands/2007/01/putting_27_bill.html

Wireless Intelligence,[55] the partnership between the GSM Association and Ovum. Quarterly data is even available a few months after the end of the quarter[56] and the data spans mobile network operators across all technologies, including: GSM; W-CDMA; TDMA; PDC; cdmaOne; CDMA 2000 1x; CDMA 2000 1xEV-DO; Analog; and iDEN.

Similarly, a measure of the total number of internet users is probably the second most important indicator in this category. There are some limitations to the data because there is no clear relationship between internet subscribers (relatively easily obtained) and internet *users*, many of whom may share the subscriber's connection. As a result much of the available data is based on estimates, for which the level of accuracy is unclear.

Nevertheless, given the importance and interest in measuring the uptake of the internet, and considering that national survey data is likely to become increasingly available in the future, this indicator is likely to be included in the index.

Since broadband users and in particular, wireless and mobile internet users, are also becoming an increasingly important component of the internet user base, it may also make logical sense to include measures of these users in this sub-index category, especially as there is now a well accepted understanding of the importance of broadband for full access to the information society. For example, the Pew Internet Project points out in its report, *The Broadband Difference*, that broadband users are far more likely than dial-up internet users to create or post content to the internet (Horrigan and Rainie 2002). The need for affordable pervasive access to broadband thus extends beyond access to information and into active participation as people with shared interests or problems become significantly active on the web only when broadband is available.

3.6.2 USAGE-INTENSITY SUB-INDEX

A Usage-Intensity sub-index would be expected to measure the levels of activity of ICT users by including the indicators for international internet bandwidth, international voice traffic, and broadband-use. The Usage-Intensity sub-index would also aim to provide a sufficient level of detail to allow the more developed countries at the top end of the User-Density scale to make effective national comparisons.

While these indicators do not give an ideal picture of usage intensity, until more widespread national data is available, the use of these simple proxy indicators is necessary. The main deficiency with use of these indicators is a tendency to over-emphasise international usage. Also, ideally they would include more measures of national usage. However, there is very little national internet traffic data currently available, and although there is some national voice-traffic data, the level of country representation is poor. Therefore it should be noted that any index using these measures would bias in favour of countries with low international call/bandwidth costs (indicating a deregulated environment), and relatively high levels of diaspora. Inclusion of broadband subscribers in the index would partly help to compensate for these factors, and also provide a better indication of the extent of high-volume users.

Although these indicators would appear to only measure usage, they also provide some indication of production of data, although ideally this aspect would be augmented in future by other measures such as numbers of local web sites and domain names. These measures are however difficult to gather due

[55] See: https://www.wirelessintelligence.com

[56] See: http://www.gsmworld.com/news/statistics/index.shtml.

to the use of generic Top Level Domains (gTLDs) by many in-country web site operators, which choose not to use the country Top Level Domains (ccTLDs)[57].

Using both voice traffic and internet bandwidth helps to create balance in the move toward NGN infrastructure which implies that voice minutes will decrease while internet bandwidth will increase. Until the more general adoption of NGN infrastructure, measurement of voice calls separate to internet bandwidth will continue to be necessary.

Voice traffic is usually measured in minutes, however for the purposes of a composite index this could be converted to bandwidth equivalents. This transformation[58] can be made to allow a more direct comparison with internet bandwidth, and to allow contributions from operators who may only wish to record data circuits rather than call minutes. In the longer term, as networks move toward an NGN infrastructure the indicator is future-proofed as growth in internet bandwidth will compensate for decreases in switched voice minutes (as users increasingly adopt VoIP, voice minutes are likely to become increasingly less measurable, and simply become part of total internet traffic).

Although the availability of international voice traffic data is patchy, this can be partially addressed by adding incoming and outgoing minutes together, which is also logically necessary because there is a tendency for outgoing calls to be replaced with incoming calls. Then by combining this with internet bandwidth, the impact of these deficiencies in data availability can be to some extent reduced.

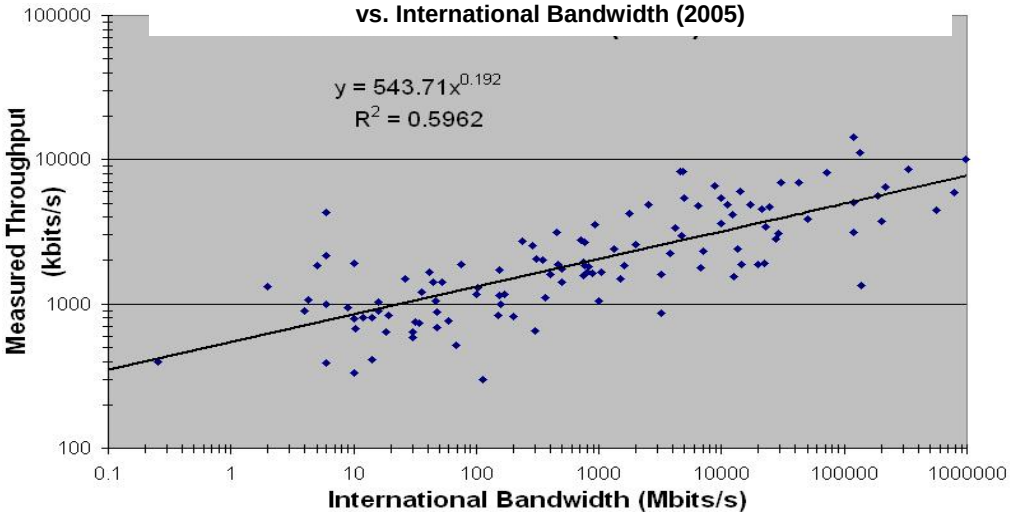
International internet bandwidth per capita has become an increasingly well-recognised statistic following its use at the G8 Dot-Force meeting in Kananaskis in 2002. It is fairly easy to obtain because there are a relatively small number of international internet service providers, especially for developing countries. Because of the high costs of international bandwidth, it is likely to reflect actual usage rather than being a supply-side indicator based on the size of the pipe. Ideally this measure should also include some indicator for congestion on the links.

[57] As discussed earlier, the penetration of secure internet servers in the population has been commonly used in other indices as another usage indicator of the extent to which reliable digital transactions are made. However this indicator does not reflect the fact that many of the most popular online services requiring secure servers are global brands and not specific to any particular country (Amazon, eBay, etc.).

[58] Various methods have been used to estimate bandwidth requirements from traffic measured in minutes, the most commonly used way is to take the number of minutes, multiply to cope with maximum flow during busy hour, divide by compression ratio, add in network overhead for packet headers, and multiply by the number of 64kbps equivalent circuits required.

There are also other ways of measuring international bandwidth using internet-based applications. For example, international bandwidth data is gathered by the Stanford University SLAC PingER project.[59] This type of data could also be used to confirm the extent to which the internet pipe is actually in use. The Pinger project also measures derived throughput and this measure confirms that international bandwidth records are broadly in line with measured performance, as shown in Figure 4.

Figure 4 – **PingER Normalised Derived Throughput (Jan-Sept '07) vs. International Bandwidth (2005)**



Including the measure for broadband subscribers as an indicator in this sub-index category would be based on its contribution to the intensity of use. A case could also be made to include it in the User-Density measure. Since internet users are already measured, using a measure of broadband subscribers could also be seen as a form of double-counting. Ideally, if total national and international internet bandwidth could be measured, this figure, combined with the total number of internet users, would give the best composite measure of the extent of internet use, and distinguishing between broadband and non-broadband users would not be necessary. Thus, including measures of broadband users vs. total internet users is likely to be an area for continued discussion.

3.6.3 EQUITY SUB-INDEX

As described above, the Equity sub-index would aim to group indicators to measure the level of exclusion from ICTs amongst the public. Of note is that the World Bank's *World Development Report 2006* advocates taking equity into account when determining development priorities. While this has not been the direct focus of the other indices, they do use some of the indicators would be included here and the DOI focuses on the related concept of opportunity. The sub-index would thus comprises mobile coverage, mobile and internet affordability, and literacy levels. This would also likely to be the place to bring in the public access measures that are currently being developed by the ITU.

Ideally the Equity sub-index would also include a measure of gender disaggregated access, but as yet the measure for this has not been agreed on and currently, gender disaggregated data availability is minimal; for example only 39 countries feature on the ITU's STAT page for female internet users.[60] Inclusion of the appropriate gender indicators in future would also help to ensure that data gathering commitments around equity issues will be prioritised.

[59] See: http://www.slac.stanford.edu/xorg/icfa/icfa-net-paper-jan07/

[60] http://www.itu.int/ITU-D/ict/statistics/at_glance/f_inet.html

The network coverage indicator should include national broadband coverage but as this figure is not available, the index would need to use the proportion of population covered by mobile networks, which may also give some general indication of broadband coverage.

Ideally the affordability component could measure the prices of broadband subscriptions calculated pro-rata for 1Mbps/month (data for which is already available since 2003). This would allow comparison of countries with different speeds available and could also be expressed as a percentage of average monthly household income. As this data is not yet available, as adopted in the DOI, the OECD defined basket of costs for low-end mobile usage combined with the estimated costs for 20 hours of dial-up internet access per month could be used. Because of the complexity and variety of available mobile tariff packages, and the lack of identical packages in different countries, it should be noted that there may be some inherent variation in the data that does not reflect actual costs. In addition, a case could be made for using the medium basket, rather than the low end user basket which was defined in the early 1990s when mobile usage was relatively low.

It should also be noted that while the ICT access costs aim to measure affordability, when compared against country wealth they may not correlate fully with use. As pointed out in the previous chapter, the poor may spend a much higher proportion of their income on communication costs. Flat rate subscriptions with monthly minute packages also tend to skew this assessment.

Adult literacy levels are an obvious and well-represented indicator for the degree to which the public can use the internet, but the measure does suffer from some biases. Mobile phone users do not necessarily have to be literate to use this technology, and intermediaries are often used by the non-literate to obtain information from the internet or to send messages. More granular measures of education levels and literacy could be also incorporated in the index, but as they are unlikely to make a significant difference to the overall values, to maintain the simplicity of the index, it may be better to avoid them.

3.7 Statistical methodologies for a revised index

Performance in each indicator is normally expressed as a value, first by compensating for population size by dividing it by the total population of the country. At this point the number can then be adjusted to a value within fixed goal posts (such as 0-100), as in the DOI methodology, or as in the ICT-OI methodology, expressed as the value's variation from the average for the indicator across all countries. Using the average value as the reference point results in the following general formula:

(ActualValue/AverageValue)*100

Multiplication by 100 gives the indicator value as a degree of variance from the world average, expressed in whole numbers or as a percentage. Thus the indicator value is 100 for a country that has the same indicator value as the world average.

This key difference between the two methodologies (the DOI being based on absolute values vs. the ICT-OI being based on relative values) results in an important difference between the two in measuring the digital divide. The main argument to tracking *relative* movements over time is that the digital divide is understood as a relative concept i.e. when looking at the divide, the performance of a country or region is measured relative to the performance of another country or region. For this reason the absolute values tracked by the DOI may not be as appropriate in measuring the digital divide. However this concept not entirely easy to grasp and the benefits of the simpler approach in the DOI could outweigh the advantages of a relative approach.

In the case of unbounded indicators with no theoretical maximum (such as international traffic), these require further processing to give them a range that is comparable with the other indicators. In the case of the DOI, such values are capped at the top value of the goal post, while in the ICT-OI methodology,

this involves choosing a scalar value (usually related to a multiple of the average value) to the indicator value to bring it in line with the other indicators. The formula used is:

((ActualValue + ScalarValue)/(ScalarValue+AverageValue))*100

For the purposes of illustration, this formula could be used in the revised index to accommodate the very wide variation in bandwidth per capita in the Usage-Intensity Index, where the scalar value chosen might be half the average value. However the use of scalars introduces an element of arbitrariness into the calculation, the precise value of which may be hard to justify and adds a level of complexity that may not be well understood by policy makers.

Finally, in the case of Affordability, a high value for usage cost, expressed as a proportion of GNI/capita, represents a negative outcome. Therefore, using the process adopted for the DOI for this measure, this indicator value could be reversed by subtracting it from 100 to make the interpretation of the value the same as that of the other indicators.

Once the individual indicators are standardised according to one of the formulas described above, the three subindices (User-Density, Usage-Intensity and Equity) could be created by averaging together their component indices. Again, this could use the Arithmetic Mean, as in the DOI, or the Geometric Mean, as in the ICT-OI, as described above.

Since the Geometric Mean emphasises balance among appropriately selected indicators (such as internet and mobile users, or literacy and affordability), it may be a more favourable approach than using the more standard Arithmetic Mean. In the same way, the final index can be created by taking either the Geometric or the Arithmetic Means of each of the three sub-index values. Again, the Geometric Mean may be more appropriate because it favours balance (symmetry) among the values, but sacrifices some of the simplicity of the Arithmetic Mean.

Explicit weightings are unlikely to be necessary for any of the chosen indicators or indices, partly due to the difficulties of arriving at an objective method for determining any such weightings. This problem with the use of weighting has been recognised in earlier work and critiques of indices which use weightings, such as Jeffrey James (2007). And as observed by Sciadas: “weights are used extensively in index measures, but they are chiefly based on objective data sets from external sources. In Information Society, no such outside intelligence exists. Therefore, any use of weights will be inevitably subjective” (Sciadas 2004: 30).

Finally, as an alternative benchmark, the innovative concept of Planetia,[61] could be included in the calculations and might be a better alternative to the average country (Hypothetica) for use as the reference point. Planetia values are those of the planet as a whole, viewed as one country and may be more accurate in describing the reference point since countries with large populations are not treated equally with those countries with small populations. I.e. the Planetia value will tend to give much more importance to China vs. the Seychelles, whereas Hypothetica treats them equally.

3.8 Making the single index more useful

This section looks at ways the index can be made more useful to lay policy makers by using computer-based tools, rather than just relying on static documents describing index rankings.

The use of software tools and online web-based database systems can help address a variety of issues around making the index more accessible and understandable by tailoring it to the needs of the particular user. The flexibility that software tools provide means that the index can go well-beyond the static analysis that is required for a print-form index. For example, by allowing the index user to pick

[61] See Sciadas 2003.

countries according to many more categories – neighbouring countries, specific economic union (for example ECOWAS states, or APEC states), varying levels of indebtedness, small islands, small populations etc, the user is not restricted to using pre-packaged categories which may be of less relevance to their particular interests.

In the same way, a very useful method for analysing the index outputs are the use of special ranking categories, for example, countries that grew the most, countries that grew the least, countries furthest from Hypothetica or Planetia, or countries furthest from the GNI benchmark. Grouping countries by rank is also important in measuring and highlighting progress – for example, the top 10 adopters, low adopters, most rapid adopters. This latter could be measured by change the size of the change in index since last year, or the last five years.

Similarly the same tools can be used to combine different indicators and essentially allow the user to create their own index, which makes reaching consensus on the use of specific indicators far less necessary. In this way, software tools can allow for the creation of a reference set of indicators and then provide tools and methodologies to combine and aggregate indicators into indices that meet specific needs (e.g. measuring progress toward MDGs). In summary, with tools that are available today, there is less need for a single index, just a uniform methodology and toolset.

There are many examples of existing software tools for aiding in the analysis of the implications of the index outputs, combining indicators in different ways and making conclusions more transparent. Tools that could be considered include:

1) The Doing Business project which provides objective measures of business regulations and their enforcement across 178 countries. The project allows a user to understand how a country's ranking would change if it reformed by using a ranking simulator based on a spreadsheet which can be used to change indicator values.

2) Mapping the data – for example, the DOI's world and regional maps, the IFC's Doing Business Map, which uses Google Maps and the HDI Ranking to create an interactive world map.

3) The UNDP's HDI allows a variety of customisation options such as Build your own table flexibility where users choose the countries and indicators of interest and download formatted tables, either on-screen or to Excel. In addition, the website provides 'Human development in animation' in which the data can be explored with animated charts highlighting important trends in development.

4) Among the most sophisticated of these types of tools is that developed by the Trendalyser project which has recently been purchased by Google and is now renamed GapMinder.org. GapMinder will shortly allow data to be uploaded to for personalised index analysis and Trendalyser software has already been used for the Millennium Goals Indicator[62].

5) DevInfo – a sophisticated tool for combining and analysing development indicators.[63]

Generally much more analysis and interpretation could be done on the index if these tools are easily available. This is especially important for any 'second speed' index that might be developed as these tools would make it practicable for countries to enter their own data, choose their preferred methodologies and make their own comparisons.

Therefore it is may be desirable that an online ICT Indicator Toolkit be developed by the ITU which:

1. Provides an online interface to the ITU Database for the full range of accepted core and second-speed indicators.

[62] Go to the project at: http://millenniumindicators.un.org

[63] Available at: http://www.devinfo.info/mdginfo2007/devinfoapp.aspx?cl=DAT

2. Provides a wide range of categories to allow countries to group themselves by such areas as geographic region, country wealth, indebtedness, distance relative to GDP benchmark, distance moved in last 2 years, last 1 year.
3. Makes use of interactive mapping tools, in particular a facility similar to the one developed by Gapminder.org for the UN Millennium Development Goals database.
4. Generates additional visualisation tools such as wheel and spoke diagrams, charts and graphs.
5. Generates web and excel spreadsheet tables
6. Allows the creation of the above outputs based on 'what-if' scenarios – i.e. mobile increases 25%, or literacy is improved 20%.

3.9 Naming the index

A variety of names for the single index have been informally proposed in consultation with peers, including:

- The Integrated ICT Opportunity Index (IIOI)
- The Digital Inclusion Index (DII)
- The Interactive ICT Index (III)
- The Digital Equity Index (DEI)
- The New Information Opportunity Index (NIOI)
- The Digital Adoption and Usage Index (DAUI)
- The ITU ICT Index (ICT-I)

Our proposal is that the index either be called the Digital Inclusion Index or the Digital Equity Index, to reflect a new start to the universal acceptance of the index, and to emphasise the focus on uptake and universal access reflected by the MDG and WSIS targets.

3.10 The future of the single index

This final section of this paper provides further observations and suggestions for improving single index for the future, as outlined in the refinement to Scenario 3 above. While it may be possible to accommodate most outstanding concerns regarding the existing indices into the recommended architecture for a proposed single index for the ITU, there are four remaining areas that could be examined further for incorporation if it is decided to adopt a revised index.

The first two of these areas are internet metrics, and gender equity indicators, neither of which are adequately captured in the existing Core ICT Indicators used in the existing indices. Given current technology trends and long-stated gender concerns, it is becoming increasingly essential to have a clear picture of how the internet and women's access to ICT is evolving in developing countries, and indeed throughout the world.

The third area of concern is apparent around discussions as to whether or not to include fixed lines in the index (see discussion above). Developing countries need indicators which help them formulate regulatory and policy decisions around how to best extend the network using constrained resources. Shared use, community networks, telecentres – and so forth are strategies that are not fully reflected or measured in the legacy indicators agreed to by the Partnership on Measuring ICT for Development – although the intention to use household survey data does take some steps towards accuracy in this regard.

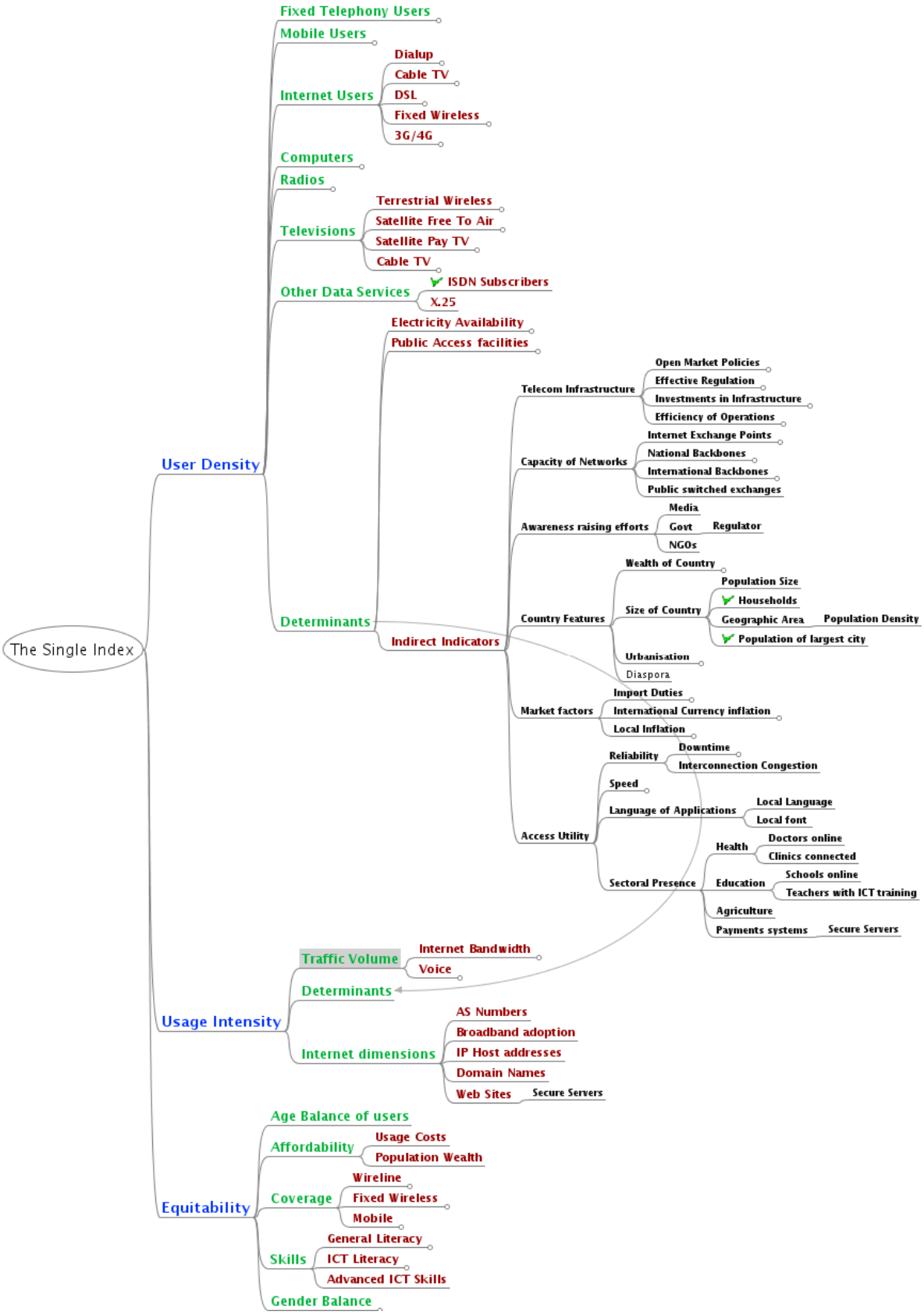
Finally, as stressed in Chapter 2, there is an urgency to extending infrastructure to places and people with no or inadequate access. Incremental change is no longer a sufficient strategy. Failure to make progress

towards information society goals will have cumulative implications for society, the economy and development agendas for health, education and democratic governance.

While the conceptual model described above serves to promote more qualitative assessments, its application is constrained by the very few globally representative indicators that can help to accurately describe ICT's national productive capacity across a range of countries at different stages of development.

To further analyse these needs, the tree diagram below shows another view of the analytical model adopted to understand the range of ICTs and their relationships, along with the qualities that could be or are being monitored in order to contribute to a better picture of the extent of ICT uptake and use. For the sake of brevity and clarity this map of the ICT space is not exhaustive, and does not show the many indirect links between the various elements. Instead it builds on the existing body of work on ICT benchmarking, aiming to provide a structure in which to link cause with effect, and to most logically group potential indicators together. From this a few key areas can be identified that are discussed in more detail below.

Figure 5 – **Tree Diagram of ICTs and the Determinants of Adoption**



3.11.1 IMPROVING THE USE OF INTERNET METRICS

Given the growing importance of networks based on internet protocols and the decreasing use of switched voice circuits in the universal move toward NGN infrastructure, it will be increasingly important to incorporate better measures of internet use than previous indexes have done (most of these have only used reported international bandwidth and numbers of internet users).

A few indices have also used internet protocol (IP) host numbers. This is a superficially attractive measure as it is easily available for every country and is relatively up-to-date, however due to the prevalent use of private IP numbers behind firewalls, and allocations of numbers not in actual use, this measure is quite misleading. In addition, the transition from IPV4 to IPV6 is changing the entire numbering system and some countries are more advanced in this process. In the future this will ultimately yield IP host numbers as a better measure by eliminating the need for Network Address Translation (NAT) and host address masquerading.

New approaches are also being developed; one of the most attractive of these is a metric based on Autonomous System Numbers (AS numbers or ASNs). Unique ASNs are allocated to internet network operators by the regional registries (RIRs) for use in multi-path (BGP) routing (the protocol standard used to ensure that there is more than one route to the Internet provider's network). The use of ASNs as an internet metric was pioneered by OECD researcher Tom Vest, and based on his work, the OECD's Committee for Information, Computer and Communications Policy (ICCP) has now proposed the use of ASNs for measuring internet uptake in their member countries.[64]

An ASN is only issued when an institution demonstrates the means to maintain an independent routing policy. This generally entails having direct interconnections with at least two other, similarly independent external network entities. In principle, every AS is associated with a specific country via the regional registries. This association generally corresponds to the provider's country of administration. Since few ISPs in developing countries are international in scope, this association can also indicate the AS's country of operation/service delivery. According to Vest[65] (2007) an ASN can be seen as the protocol glue used to integrate diverse elements (network equipment, servers, telecom capacity products and services of various kinds) into a single entity.

Raw ASN information is available on a daily basis via automated ftp download and is thus the most up-to-date ICT indicator available in the world. The data is hosted by the University of Oregon Route Views Project[66] where the daily updated data goes back to 1997. Associating the raw data with country information has been undertaken by Vest whose database now encompasses about 37 600ASNs, with about 24 000 visible during the most recent measurement.

Because of the scaling properties of hardware and infrastructure usage, as well as ASN and IP address allocation policies themselves, the ASN count does cause some distortions for the smaller economies (especially the small but wealthy ones). Also, about 0.5% of the ASNs are listed by region (e.g. AP or EU) rather than by country. ASNs for the former Yugoslavia are a split between YU and successor entities. About 180 countries are present in the records, including countries which have zero ASNs.

Another very clear advantage to the ASN metric is that it does not rely upon country reporting and thus does not further burden developing country national statistical offices (or the national regulator) with further indicator collection responsibilities.

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[64] http://www.oecd.org/dataoecd/25/54/36462170.pdf

[65] Personal communication, October 2007, tvest@ripe.net. See also Vest's CAID presentation http://www.caida.org/publications/presentations/2006/wealthofnetworks/wealthofnetworks.pdf

[66] http://archive.routeviews.org/oix-route-views/

3.11.2 IMPROVING GENDER METRICS

Clearly there is no further need here to make a case for the inclusion of gendered indicators. The question is how to accurately incorporate this into the design of the index. Given the poor performance overall for developing countries reporting on ICT indicators in general, it is unlikely that resources will be allocated in this direction in the short to medium term.

While there is no doubt that as national-level information-society policies prioritise women and girls' access to and ability to use ICT, there will be efforts to measure these in order to document progress towards policy goals. But this is only just beginning to happen and it will be a long time before there is a critical mass of gendered ICT indicators available.

However, other data sets can shed light on the opportunity aspect of women's and girls' adoption of ICT: whether girls receive education to levels that are equal to boys; literacy rates; health indicators; and women in government – all of these provide a snapshot of women's equity within society and hence the likelihood of their full participation as citizens in society. As discussed in Chapter 2, there are many different inter-related divides and forms of exclusion. If women are excluded from education attainment, it is unlikely that they will fully benefit from mainstream technology adoption.

Thus, one solution for building a gender equity component into the index is via the use of an indicator devised specifically to assess this, such as the UNDP's Gender Development Index (GDI). The GDI is one of the five indicators used by UNDP in the annual Human Development Report, and provides a perspective on inequalities between men and women in terms of having a long and healthy life, knowledge, and a decent standard of living. The GDI has broad representation across countries with the 2006 index ranking 175 countries.

Although it is agreed that gender imbalance needs to be addressed and represented in indices, there are differing views here too as to the best way to proceed. As for other indices, there is the problem of accuracy with the indicator and the breadth of how many countries can be covered. While the UNDP GDI aims for breadth of coverage, the Economic Commission for Africa has promoted development of the African Gender and Development Index (ADGI). This a composite index consisting of two subindices: a Gender Status Index (GSI) and the African Women's Progress Scoreboard (AWPS). The ADGI 2004 report argues that UNDP's GDI is closely tied to a country's GDP and further:

> [T]he international database used by the UNDP is not always adequate to capture African realities … by focusing on quantitative issues the GDI and the GEM ignore qualitative issues such as women's rights. The AGDI takes the arguments that the UNDP initiated a step further by separating the gender status from a country's GDP by making use of data sets that are nationally available and by incorporating qualitative issues (ECA 2004: 5).

Finally, the Millennium Development Goal 3 – to promote gender equality and empower women – also has indicators associated with measuring progress, which are: the ratio of literate women to men 15–24 years old; the share of women in wage employment in the non-agricultural sector; and the proportion of seats held by women in national parliament.

Like all other metrics and indices, there are points of negotiation, particular perspectives on what should be measured and the need for a solid theoretical framework upon which to base decisions around indicator selection and other methodological issues. While none of these indicators are directly related to ICTs, they are indirectly related to ICTs via the likelihood of women's ability to access and use them to improve their lives and the lives of their families.

3.11.3 THE EVOLUTION OF THE INDEX

It is recognised that the indicators used in virtually all ICT indices may not be the ideal reflections of ICT uptake and are at best, proxies used in the absence of better data (such as hours per month using

the Web, number of calls, gender disaggregation, language group, age, location in country, etc.) In addition, some of the current indicators are based on specific technologies (copper, GSM, voice-minutes) with differences likely to disappear as operators move toward an NGN environment.

As illustrated by the emerging possibilities for internet metrics described above, what are currently accepted as accurate measures are likely to evolve in the very near future – although clearly these changes are likely to affect different countries on different time-scales and this may need to be taken into account when amending or formulating a revised index. In addition, more and more countries are steadily expanding their capabilities to collect consistent ICT information at a national level through household and individual surveys. Once this happens for a large proportion of the countries, it will be necessary to further re-consider the indicators comprising the single index.

In devising strategies to connect the next billion to the internet, it must be recognised that the next billion (and the billion after that even more so) will be significantly less well off than the first billion that began using the internet in the last century. There are different paths to internet access and there will be economies of scale, geographic and demographic logistics, and new technological possibilities which will determine which path is used.

The ITU's work in developing a public access point indicator, for example, is key in this respect. Although there is an ongoing debate and argument that mobile networks are the future – especially for bottom of the pyramid users – the jury is not yet out on that debate. Many governments (including local and community leadership) may prefer to invest in community network provision of services such has been described as Community Triple Play – where the community access point, in addition to providing mesh wireless internet access, comes from an operator or community based organisation that provides a community telephony service (usually wireless) and also a local community broadcasting (Girard 2007).

While these different paths lead to the internet, they are not equal in bandwidth, speed or even in being a two-way channel which is important for content creation. Thus, as with the discussion around whether it is still useful to include fixed lines as an indicator in a single index, there will increasingly be a need for experiential indicators about the quality and ubiquity of access and use.

3.11.4 RACE AGAINST TIME

Finally, there is the issue of urgency. There is an increasing awareness across all development fronts that there is an urgent need to eradicate poverty and that use and access to ICT can facilitate this. A single index is first and foremost an awareness raising device. It informs countries where they rank regionally and internationally. There is prestige associated with being in the top ten countries, or even the top 20, and much is made of these leaders in the media when the results of an ICT index are released.

But there is a vast technological gulf between Denmark and a small African country. With each year that the African country persists at the bottom of the ranking, Denmark pulls further away in terms of economic development and technological possibility.

At 2015 there will be an important stocktaking of progress made towards successfully achieving Millennium Development Goals and the WSIS targets. Given current growth rates at the bottom of the rankings, if an urgency factor is not built into current indices, such an indicator may be irrelevant post 2015.

3.11.5 SUMMARY OF OPTIONS FOR A REVISED INDEX

In summary, the main decisions that need to be made to formulate a revised index are:

1. The use of the more transparent arithmetic mean vs. the more prescriptive geometric mean.

2. The use of the average as the reference point to provide a better relative measure of the digital divide, or the use of static goalposts to provide a simpler measure for comparing changes over time.

3. The grouping (weighting) of indicators into subindices or categories which could either use the existing ICT-OI or DOI categories, the categories proposed for a revised index, or some other configuration based on these and other category types.

4. The choice of indicators – these can be selected from the ICT-OI indicators, the DOI indicators, the two-speed index indicators, and/or some new measures that add elements for affordability, gender and better internet metrics.

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Annex 1 – An assessment of some ICT indices

Major ICT Indices Compared

Index	Main stake holders	Number of Indicators	Number of Countries	Data years	Aim, Categories & Comments
ArCo[67]	UNDP/ UNIDO	8	162	1990 and 2000	Derived from the UNDP Technology Achievement Index (TAI) and the United Nations Industrial Development Organization's (UNIDO) Industrial Performance Scorecard. ArCo is similar to the TAI except that it has three categories rather than four: 1) **Creation of technology**, 3) T**echnological infrastructure** (combining diffusion of recent and old innovations) and 3) **Human skills**.
TAI	UNDP	8	72	2001	The Technology Achievement Index was developed for the 2001 Human Development Report and focuses on four dimensions of technological capacity: 1) **Creation of technology** - two indicators to measure the level of innovation - number of patents granted and receipts of royalty and license fees from abroad; 2) **Diffusion of recent innovations** - diffusion of the Internet and exports of high- and medium-technology products; 3) **Diffusion of old innovations** - (telephones and electricity); 4) **Human skills** - to reflect the human skills needed to create and absorb innovations.
HDI[68]	UNDP	3	177	1996-2006	While not an ICT Index, the Human Development Index is developed for the associated Human Development Report which made use of the TAI (see above) in the 2001 report.
World Bank Country at-a-Glance ICT4D	World Bank	34	144	2006	The World Bank also tracks various indicators as part of its analysis of global trends and policies. The indicators are organised into 3 main categories 1) E**conomic and Social Context**, 2) **ICT Sector Structure**, 3) **ICT sector performance** (which has 5 subcategories: Access, Quality, Affordability, Institutional Efficiency & Sustainability, and ICT Applications).
ICT Diffusion Index	UNCTAD	12	160-200	99-00, 01	In support of the UNCST, UNCTAD developed a theoretical framework in 2003 for measuring ICT diffusion. Indicators are clustered in four categories - 1) **Connectivity**; 2) **Access**, 3) **Policy**; and 4) **Usage.** However the Usage category was ultimately excluded from the Index as only one indicator was identified (incoming and outgoing minutes), and it was felt that it did not sufficiently reflect the extent of ICT uptake.
ICT-OI	ITU	21	183	2005, 2007	This index is the result of merging the ITU's Digital Access Index (DAI) and Orbicom's InfoState (DDI/Monitoring the Digital Divide). Two categories of indicators assess Infodensity and Info-Use. Notably, the index is not published with the same number of countries in each category.
IKS[69] Index Of Knowledge Societies	UNDESA	14	45		An "illustrative" and "experimental" index based on quantitative indicators organized into 3 categories: 1) **Assets**: expected schooling and proportion of people below age 15, diffusion of newspapers, the Internet, main phone lines

[67] http://ssrn.com/abstract=487344

[68] http://hdr.undp.org/statistics/

[69] http://unpan1.un.org/intradoc/groups/public/documents/UN/UNPAN020643.pdf

Index	Main stake holders	Number of Indicators	Number of Countries	Data years	Aim, Categories & Comments
					and cellular phones; 2) **Advancement**: public health expenditure, R&D expenditure, (low) military expenditure, pupil/teacher ratios in primary education, a "freedom from corruption"; 3) **Foresightedness**: child mortality rates, equality in income distribution (GINI Index), protected areas as % of surface area, and CO2 emissions per capita.
DAI - Digital Accessibility Index	ITU	8	178 40 for 98-2002	2002	The DAI uses a relatively small number of indicators (8) based around five categories. The categories include 1) **Infrastructure**; 2) **Affordability**; 3) **Knowledge**; 4) **Quality**; and 5) **Usage**. Now superseded by the DOI.
Oricom's DDI - Digital Divide Project Index (also referred to as InfoStates)	Orbicom	17	139	2003	The Digital Divide Index Project, subsequently published in a work entitled *Monitoring the Digital Divide*, is one of the projects of the Canadian based Orbicom network. Indicators are structured within the **InfoState** conceptual framework into two categories – **Info-Density** - sum of all ICT stocks (capital and labour), and **Info-Use - consumption flows of ICTs over a set period**.
DOI	ITU	11	180 40 countries for 2000-2005	2007	The DOI Uses a subset of the internationally agreed indicators approved by the Partnership for Development. Indicators are clustered into 3 categories 1) **Opportunity**; 2) **Infrastructure** and 3) **Usage** . Note: 215 countries are covered by raw ITU data. See more details below.
MOSAIC Group Index	MOSAIC Group Index	6	143	1999	An early framework for measuring the state of Internet diffusion in an economy. Six factors are rated: 1) **Pervasiveness**; 2) **Sector absorption**, 3) **Connectivity**; 4) **Organizational structure**; 5) **Geographic dispersion**; and 6) **Sophistication of use**.
EIU - Economist Intelligence Unit eReadiness Index[70]	EIU	100	69	2000-2007	An annual e-readiness ranking of the word's largest economies since 2000. The index allows "countries to compare and assess their e-business environments" and determines "the extent to which a market is conducive to Internet-based opportunities". The index uses about 100 quantitative and qualitative variables organized into six differently weighted categories: 1) **Connectivity and technology infrastructure** (20%); 2) **Business environment** (15%); 3) **Social and cultural environment (**15%); 4) **Legal and policy environment** (10%); 5) **Government policy and vision** (15%); 6) **Consumer and business adoption** (25%)
ICTforHD[71] -	UNDP /APDIP	22	9 (Asian)	2004	A recently developed Index which aims to measure five dimensions of ICT use: 1) **Availability or supply linked -- skill-independent** (Telephones, mobiles, TV and Radio); 2) **Availability or supply linked -- skill dependent** (Internet users, PCs and ICT spend/capita; 3) **Efficiency and speed** (usage costs, speed and ICT training) ; 4) **Social sectors**, (egovernment and access in schools) and 5) **Vulnerable groups** (female workers, public access points and government policies).
ISI Information Society	IDC	15	53	1995-2007	Said to be the first ICT Index, starting in the mid 1990s, combining 15 variables arranged in 4 infrastructure pillars 1) **Computer**, 2) **Internet**, 3) **Telecom** and 4) **Social**. Arranged in

[70] http://www.eiu.com/site_info.asp?info_name=eiu_2007_e_readiness_rankings

[71] http://www.apdip.net/projects/rhdr/news/08012004/indicators.pdf

[72] http://www.idc.com/groups/isi/main.html

Index	Main stake holders	Number of Indicators	Number of Countries	Data years	Aim, Categories & Comments
Index[72]					one overall index and 4 subindices.
NRI[73] - Network Readiness Index	WEF/INSEAD	47	122	2002-2006 (5)	Amongst the most sophisticated and widely accepted ICT indices, the NRI uses three indicator categories: 1) **Environment** (20 indicators analysing market, political & regulatory, and infrastructure dimensions), 2) **Readiness** (18 indicators measuring individual, business and government dimensions), and 3) **Usage** (9 indicators measuring individual, business and government dimensions). The data comprises a mix of hard data and ratings obtained from surveys. Closely related is the WEF's Global Competitiveness Report and its associated Global Information Technology Report (GITR[74]).
World Employment Report (WER)[75]	ILO	8	220	2001	Not technically an Index, but still noteworthy is the WER's use of ICT indicators in its analysis of employment. The variables analysed are Internet hosts, Internet users, PCs, telephone lines, mobile subscribers, digital cellular subscribers, television receivers and Cable TV subscribers
Government e-Readiness Index[76]	UNPAN	6	178	2004	This index assess public sector e-government initiatives according to a composite index of e- readiness based on 1) **Website assessment**, 2) **Telecommunication infrastructure** and 3) **Human resource endowment**.
MDGIs[77]	UNFPA/ UNDP/ UNSD	3 of 48	147	1999-2007	The United Nations Millennium Declaration of 2000 proposed the eight Millennium Development Goals, including 18 time-bound targets. A set of Indicators was created by the UN Statistics Division to measure progress in MDGs. In the ICT field (Target 18) these cover: 1) **Telephone Lines + Mobile subs/capita,** 2) **PCs/capita**, and 3) **Internet Users**.

[73] http://www.weforum.org/pdf/gitr/rankings2007.pdf

[74] http://www.weforum.org/en/media/Latest%20Press%20Releases/gitr_2007_press_release

[75] http://www.ilo.org/public/english/support/publ/wer/tables/tab1_e.htm

[76] http://www.unpan.org/e-government/global%20leaders%20index.htm

[77] http://mdgs.un.org/unsd/mdg/Data.aspx

Key Lessons from the Selected Indices

The indices described in Table 1 are discussed in more depth below to identify characteristics that are considered of value in forming a single index, in particular, methodological. A wide variety of ICT indices were developed during the course of the last decade, beginning with initial attempts to assess *e-readiness*.[78] As observed in an earlier assessment:

> There is significant duplication of effort in some countries, while others are devoid of useful data:
> - A total of 1506 e-readiness assessments have now been conducted.
> - A total of 188 countries have been assessed by at least one tool.
> - 68 countries have been assessed between five and ten times by different organizations, while a further 69 countries have been assessed *over ten times*.
> - Only four countries have never been assessed: North Korea, Tuvalu, Monaco and Nauru (Bridges 2005:18).

Some of these indices are still in use and others have ceased to be updated, and some indices have been developed only for a specific region.

The Network Readiness Index (NRI)

The NRI aims to assess preparedness and capacity to make use of and benefit from ICTs. It is closely related to the WEF's Global Competitiveness Report which uses the same indicators. The NRI includes a number of indicators that based on opinion surveys or are unrelated directly to ICTs, such as *state of technological readiness* and number of US utility patents.

In his review of the NRI for the World Dialogue on Regulation for Networked Economies,[79] Divakar Goswami points out that "a number of extraneous variables have been included that do not shed any light on ICT environment, readiness or usage, while others, that may have added greater robustness to the measure, are missing." Additionally, "the credibility of the NRI is called into question by the non-transparent manner in which the authors report the sources of the data and the methodology that was followed to collect the raw data."

Goswami concludes that the biggest drawback and strength of the NRI is the large number of indicators that it uses to assemble the composite index. "Because the indicators cover a wide swathe of ICT related dimensions and other dimensions that are not directly related to ICTs but may impact ICT environment, usage and readiness, the NRI is comprehensive in its coverage. However, whether the picture obtained from the NRI is an accurate representation of a country's ICT development and readiness, is another issue altogether." Given the large number of indicators it is not surprising that data for only 122 countries is available.

NRI Indicators are transformed based on the highest values; the sub-category scores are derived from factor analysis. Sub-categories are averaged to obtain categories scores which are then averaged to obtain the final score.

Economist Intelligence Unit (EIU) eReadiness Index

While the EIU index uses about 100 quantitative and qualitative variables organized across six categories, the index is notable in not considering fixed line infrastructure, while at the same time there is a preponderance of business oriented indicators which underscores the aim of this index to highlight the progress of a country toward providing new business opportunities in ICTs.

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[78] E-readiness Assessment Tools Comparison , 28 February 2005 (updated) , bridges.org

[79] http://www.regulateonline.org/content/view/827/74/

The EIU index methodology and the indicators used have changed over the years, which impacts on the ability to make historical comparisons, for example the 2007 Index measures broadband affordability for the first time.

The EIU indicators are divided into six categories which are weighted between 10% and 25%, according to their assumed importance as influencing factors. Because only the larger economies and those with good data are covered, the Index is limited to only 69 countries.

Information Society Index (ISI)

The ISI is a comprehensive index with one overall index and four subindices. Similar to other business oriented indices, it includes a number of market metrics which combines economic and IT industry supply-side factors such as the stock market, current interest rates and GDP forecasts. In this respect the index is notable for its emphasis on macro-economic and supply-side indicators, as well as its use of forecasting.

IDC combines and weights the inputs using information developed in its Leading IT Indicators program on the relationship of macroeconomic trends to IT spending. Values are based on expectations of future growth, with a value of 1000 equating to zero growth and each 10 points representing roughly 1% of expected growth. Indicators are transformed based on the highest values and the sub-category scores are derived from factor analysis. Sub-categories are averaged to obtain categories scores which are then averaged to obtain the final score.

With only 53 countries covered, the ISI is of little direct value in the quest for a global Index, but its weighting and indicator transformation methodologies are noteworthy.

Index of Knowledge Societies (IKS)

The Index of Knowledge Societies (IKS) is notable for a rather different take on an ICT related Index, focussing only minimally on pure ICTs, and comprising a much wider range of knowledge related variables from diverse areas such as equality in income distribution, freedom from corruption and public health expenditure.

Unfortunately, the IKS only covers 45 countries. Nevertheless, the IKS report is one of the more in-depth examinations of knowledge and development, and the factors influencing the emergence of smart societies.

ArCo

ArCo (named after its inventors) only includes two sector-specific indicators, and since it uses the TAI, it can be seen as a refinement of the TAI. The methodology it uses to calculate the index is to average the three categories to obtain the index score. Individual indicators are transformed using maximum values (goal posts), however the methodology does not explain how they are converted to category scores. In some cases, the indicators are based on three-year averages (e.g., 1997-2000) rather than a specific year in order to smooth out fluctuations. The paper describing the index does not include the category results or the original indicators.

Personal Informatization Index (PII)

The PII, developed by the Korea Agency for Digital Opportunity & Promotion (KADO), is a nationally oriented index and so does not need to consider indicators that may not be available outside Korea. The PII does not have an exclusive focus on access, but aims to encompass other dimensions of digital opportunity as well. Each of these dimensions is composed of multiple factors that are weighted to calculate the Index, based on the opinion of experts. Access is given 30 per cent of the total, Capacity has 20 per cent and Utilization has the highest weighting with 50 per cent. The methodology

was tested with a survey in 2004 and the results evaluated using a Gini coefficient. Based on the survey results, access was the category most equally distributed, while qualitative usage was the most unequally distributed category in Korea.

The methodology of the PII underscores the fact that different countries are likely to have varying degrees of importance attached to access vs. usage. For Korea, a 50% weighting for utilisation may make sense, but for nations with very little ICT infrastructure, this might be too high. Thus any Single Index should needs to take this into account. In addition the ability to unpack and view the individual subindices and categories of indicators will be important in aiding analysis for the widest number of nations.

Knowledge Assessment Methodology (KAM)

The World Bank's Knowledge Assessment Methodology and its associated Indices, the Knowledge Economy Index (KEI) and Knowledge Index (KI) are among the most comprehensive indices in terms of spread of Indicators and level of country representation. However both indices focus on a number of knowledge related areas that are not directly related to ICTs, such as tariff barriers and technology exports. In this respect the Indices may be a better measure of knowledge potential, than ICT uptake.

Methodologically, the KEI is constructed from the average of the four categories. Each category score is in turn calculated by averaging the normalized scores of each indicator. The indicators are normalized based on the highest value in the data set on a scale of 0 to 10 relative to other countries in the comparison group.

ICT Diffusion Index – UNCTAD

The ICT Diffusion Index was developed by UNCTAD in context of its support of the UN Commission on Science and Technology for Development (CSTD) and first published in 2003. The index is notable as the only one to include Internet Exchange Points as an indicator. It also uses a composite indicator – the HDI – and interestingly, also wealth (GDP/capita), partly as a simple proxy for affordability and to reflect that wealthier countries are likely to have higher levels of ICT penetration. The indicators are transformed based on maximum values and averaged within categories. The categories are then averaged to generate the index score.

Technology Achievement Index (TAI)

The UNDP's TAI focuses more on various aspects of innovation than on ICT uptake, however two aspects of the methodology are of interest; 1) indicators of older innovations are used – electricity and telephony – which is seen as necessary for adoption of later innovations, and 2) the variables are expressed as logarithms and capped at the average OECD level to emphasise that they are important at the earlier stages of technological advance but not at the more advanced stages. TAI indicators are transformed based on maximum values and averaged within categories. The categories are then averaged to generate the TAI score.

ICT4HD – UNDP Asia-Pacific Development Information Programme

While only constructed for a small number of Asian countries, APDIP's Index is one of the more recently formulated Indices and is notable in the use of its categories which separate skill dependent from skill independent indicators and in focussing on social sectors and vulnerable groups, by which it also attempts to measure the equity in distribution or uptake of services.

The Millennium Development Goal Indicators (MDGIs)

The MDG Indicators are notable for their broad based development and support. The United Nations system, including the World Bank and the International Monetary Fund, as well as the Development

Assistance Committee of the Organisation for Economic Co-operation and Development, came together and agreed on 48 quantitative indicators. The report, Indicators for Monitoring the Millennium Development Goals: Definitions, Rationale, Concepts and Sources[80] contains metadata on the agreed list of quantitative indicators for monitoring progress towards the eight goals and 18 targets derived from the United Nations Millennium Declaration.

The indicators were not intended to be prescriptive but are meant to take into account the country setting and the views of various stakeholders in preparing country-level reports. According to the report, five main criteria guided the selection of indicators on the basis that they:

- Provide relevant and robust measures of progress towards the targets of the Millennium Development Goals;
- Be clear and straightforward to interpret and provide a basis for international comparison
- Be broadly consistent with other global lists and avoid imposing an unnecessary burden on country teams, Governments and other partners;
- Be based to the greatest extent possible on international standards, recommendations and best practices;
- Be constructed from well-established data sources;
- Be quantifiable and;
- Be consistent to enable measurement over time.

The Bellagio Process

While not directly related to ICTs, lessons can be also learned from similar activities for assessing progress in areas of sustainable development. In 1996 the International Institute for Sustainable Development (IISD) considered the need for indicators following the World Commission on Environment and Development (1987). Their challenge was to choose and develop the correct basket of measures for the job. As a result, the Bellagio principles were developed[81] through the collaboration of researchers from five continents. The principles are "guidelines for the whole of the assessment process including the choice and design of indicators, their interpretation and communication of the result." The IISD report, *Sustainable Development Indicators: Proposals for a Way Forward* (Pintér et al. 2005) offers strategic options for future indicator development. It recommends a capital based approach to indicators (measuring the base of assets that enable the desired set of outcomes). In addition it recommended coordination of indicator efforts with underlying statistical systems. The report notes:

- Continued interest in the development of aggregate indices
- Interest in core sets of 'headline indicators'
- Emergence of goal-oriented indicators
- Emphasis on making better use of indicators in performance measurement

[80] Led by United Nations Population Fund (UNFPA), United Nations Development Programme (UNDP) and the Department of International Economic & Social Affairs Statistics Division millenniumindicators.un.org/unsd/mifre/Metadatajn30.pdf

[81] http://www.iisd.org/pdf/bellagio.pdf