

# The Role of ICT in Development Sustainability

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## ABSTRACT

Global development has been unequal, even though the trends in human development are generally positive. We live, nowadays, in a divided world: between rich and poor, healthy and sick, literate and ignorant “illiterate”, democratic and authoritarian, as well as between empowered and deprived. All the technologies that human being developed in the past centuries and all policies enacted for enhancing human development have not wiped out these disparities up to now.

Numerous organizations, governmental and non-governmental, international and local are working to remove the glaring disparities in development. Some of their efforts are already showing some results. The poverty rate for example based on the real income level has been declined from its percentage in the last two decades, also infant mortality due in large part to water borne diseases and poor hygiene has fallen. Therefore, it is unnecessary to emphasize that much more needs to be done in all areas of development sustainability, specific in some areas in Egypt for example as the rural and desert areas as well as the urban slum areas.

Over the last two decades, there have been multiple international or global conferences, seminars and workshops on the issues of development, which we focus on those sponsored by United Nations the Johannesburg World Summit on Sustainable Development (2002), The Rio de Janeiro Summit on Environment (2003), The World Summit on Information Society at Geneva (2003) and Tunis (2005) and lately the Copenhagen Summit Conference on Climate Change (December 2009), etc.

This work discusses the overview of ICT as related to development in general and development sustainability is specific: also the technology mapping to development needs in connection with its applications

for the societal scale information systems and the generalized ICT model, challenges, regulation and policy as well as economic models, markets and role for development. Basic human needs and development sustainability are explained in relation to food and agriculture, healthcare, and education. Also, Economic growth and employment in connection with poverty reduction and enabled the enhancement of employment job generation are also discussed from the point of ICT role. In the same time themes and issues such as alienation, empowerment and governance are treated focusing on the role of ICT in their enhancement. The conclusion of this work is related to linking ICT for development sustainability needs to solutions.

Keywords: development Sustainability, Sustainable Development, ICT and Development, Technology Mapping Needs, Human Development Needs, Millennium Development Goals.

## 1. Introduction:

A few technologies can be classified as all-purpose technologies as their innovations extend over many areas, and those in turn, become indispensable to economic and human portfolio development. Over a period, their contribution to economic and human development become impressively large, replacing older and less efficient methods. This ubiquity makes one wonder how it was possible to manage in the past without accessing such technologies. Electricity is often cited as a typical example of an all-purpose technology. In spite of electricity's obvious advantages, it took almost a century before electric power could become commonplace. Applications from new technologies are faster these days. The diffusion of radio and TV was faster than electricity. That of the INTERNET is particular. Within about 20 years of web existence It has more than 2 billion users and its performance has multiply manifold. The rapid diffusion of the Internet and new communication technologies such as mobile telephony suggests that innovation from Information and communication

technology (ICT) for development sustainability can also be faster than the progress shown by earlier technologies. This may provide society with targeted tools for development sustainability projects and programs> However, much of ICT research is geared towards sophisticated applications of ICT or makes assumptions about end-users and their capabilities.

Therefore, ICT is now a part of development. The debate that took place in 1990s over choosing between ICT and other development imperatives has now shifted from one tradeoffs to one of complementary. Nowadays, there are many initiatives, groups, and projects working on ICT for development sustainability. The international Telecommunication Union (ITU) has a development group and increase penetration, and the UN's ICT Task Force focuses on many aspects of ICT and development sustainability. Development Gateway Foundation, supported by the World Bank, is a clearing house and repository center for vast information on ICT and Development. The Group Summit 8 of industrial countries, instituted the Digital Opportunities Task Force (DOTF) in 2001 to strengthen efforts on ICT and development. ICT4SD's global visibility can be gauged by the public challenge that Kofi Anan, the UN former secretary general, made to Silicon Valley and ICT leaders on November 5, 2002 to make ICT relevant for global human development.

Numerous organizations, governmental and non-governmental, global and very local are already working, nowadays, to remove the glaring disparities in development. Some of their efforts are already showing some results as related to the slight decrease of poverty rate based on real income, infant mortality and poor hygiene. It is unnecessary to emphasize that much more needs to be done in some specific areas as in Egypt for example in connection with rural and desert areas.

Over the last 10 years, there have been multiple international conferences, seminars, workshops, etc. on issues of sustainable development. Among them we focus on the following conferences sponsored by UN. The Johannesburg Summit Conference (2002) resulted in the declaration of the "Millennium Development Goals", the Rio summit Conference on Environment and Development (2003) that resulted of principles for environmental sustainability and development. Also, the World summit on Information Society At (Geneva 2003) and (Tunis, 2005) stressed the utilization of ICT

to enhance sustainable development for developing countries. Lately the Copenhagen Summit Conference on Climate Change (December 2009) relates the climate change to development sustainability as well.

Therefore, this work discusses the overview of ICT as related to development in general and development sustainability is specific: also the technology mapping to development needs in connection with its applications for the societal scale information systems and the generalized ICT model, challenges, regulation and policy as well as economic models, markets and role for development. Basic human needs and development sustainability are explained in relation to food and agriculture, healthcare, and education. Also, Economic growth and employment in connection with poverty reduction and enabled the enhancement of employment job generation are also discussed from the point of ICT role. In the same time themes and issues such as alienation, empowerment and governance are treated focusing on the role of ICT in their enhancement. The conclusion of this work is related to linking ICT for development sustainability needs to solutions.

## **2. ICT and Development:**

### **2.1 Overview:**

ITU estimated in 2002 that world ICT market was almost 2.1 trillion, which they segmented as Telecom services (39%), Software and Services (31%), and Hardware (30%). This came to nearly 6.6 % of the Gross World Product in that time. In developing countries, ICT's share in GDP was not low also.

ICT can be considered to be built on the 4C's, which are: Computing, Communications, Content, and Capacity building, and less on computers. In truth, computing and other hardware, especially on price-performance basis. When considering the use of ICT for development, conventional, is that even if hardware is free, communications, software and training make ICT expensive to some extent.

ICT is much more than computers and the Internet or even telephony, even though the digital divide and issues of Internet governance were much the focus of the World Summit on Information Society (WSIS). Applications of ICT can be divided under two broad categories. The first category concerns those largely dependent on traditional telecommunications networks (including

the Internet) that enable on-demand communications to provide information tailored to convenience and needs. How that information is processed whether it is used at all, and whether it is transformed into knowledge is left to human user who asked for that information in the first place. The 2nd category of ICT applications, that is appropriate also to human independent, is where information is processed and decisions are arrived on the basis of present criteria without human intervention at the time of decision-making. These can be nearly passive systems, pr part of a larger system (embedded ICT). Examples include sensor-based networks that determine automated climate control for buildings today, or in the near future, sensor networks for material larvae detection. Many of the more discussed applications of ICT for development sustainability are of the first category ranging from distance education programs, e-commerce, or e-governance, while the 2nd class of applications remains largely unrealized. A major challenge is how to design both ICT and other complex engineering or societal systems such that the two can be integrated.

## 2.2 ICT and Development:

ICT is viewed as both a means and an end in development. With roughly two-third of the world economy based on services, and the rise of some developing countries as India and China, and other nations as global IT players, many developing countries have accepted ICT as a national mission as in Egypt. Even within manufacturing and industry, ICT has an increasing important role to play. During the period from 1995-2002, when the United States economy posted impressive overall growth, nearly one-third of this growth in productivity was attributed to ICT [U.S. President. 2003 Economy Report of the President: Washington, DC.], while the growth rate of ICT even in developing countries are impressive, the base upon which there apply is very low.

Therefore, ICT is considered as a fundamental part of economic growth for the newly emerging knowledge economy.

John Dally, in a series of articles[<http://www.developmentgateway.org>] discussed point by point how ICT can work to meet the eight goals identified with the 18 target set by the Millennium Development Goals (MDG). Similarly options are indicated in the World Bank publication and the World Telecommunication

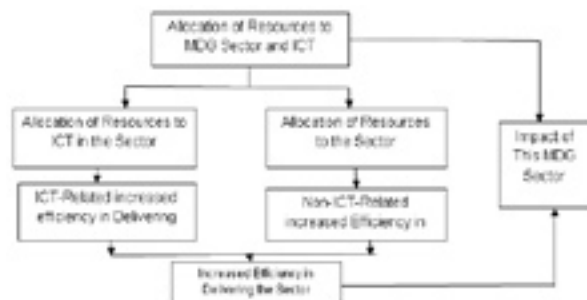
Development Report of 2003as indicated in the following table No. 1 of how ICTs can help MDG.

**Table No. 1: How ICTs Can Help MDG**

Goal/Target	Role of ICTs
<b>1. Eradicate extreme poverty and hunger</b> -Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day -Halve between 1990 and 2015, the proportion of people who suffer from hunger.	- Increase access to market information and reduce transaction costs for poor farmers and traders. - Increase efficiency, competitiveness and market access of developing country firms. - Enhance ability of developing countries to participate in global economy and to exploit comparative advantages in factor costs (particular skilled labor).
<b>3. Achieve universal primary education.</b> -Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary education.	- Increase supply of trained teacher through ICT-enabled and distance training of teachers and networks that link teachers to their colleagues. - Improve the efficiency and effectiveness of education ministries and related bodies through strategic application of technologies and ICT-enabled e-Learning development. - Broaden availability of quality educational materials, resources through ICTs.
<b>3. Promote gender equity and empower women.</b>	- Deliver educational and literacy programs specifically targeted to poor girls and women using appropriate technologies. - Influence public opinion on gender equity through information or communication programs using a range of ICTs.
<b>4. Reduce child mortality</b> <b>5. Improve maternal health</b> <b>6. Combat HIV/AIDS/HTLVI, malaria and other diseases.</b> - Reduce in fact and child mortality rates by two-thirds between 2000 and 2015.	- Enhance delivery of basic and in-service training for health workers. - Increase monitoring and information sharing support on disease and families. - Increase access of rural care gives to specialist support and remote diagnosis. - Increase access to reproductive health information including information on disease prevention through locally appropriate content in local language.
<b>7. Ensure environmental sustainability.</b> - Implement national strategies for sustainable development by 2015 so as to reverse the loss of environmental resources by 2015. - Halve, by 2015 the proportion of people without sustainable access to safe drinking water. - Have achieved by 2015, a significant improvement in lives of at least 100 million slum dwellers.	- Remote sensing technologies and communications networks permit more effective monitoring, resource management, mitigation risks. - Increase access to awareness of sustainable development strategies in areas such as agriculture, sanitation, and water management, mining, etc. - Greater transparency and monitoring of environmental abuses reinforcement of environmental regulations. - Facilitate knowledge exchange and networking among policy makers, practitioners and advocacy groups.

**Source: ITU. World Telecommunications Development Report (2005)**

In addition to this table, the following figure No. 1 shows the ICT and development in connection with resource allocation and impact of the Millennium Development Goals (MDG).



**Fig. No. 1: ICT and Development: Resource Allocation and Impact in MDG Sector**

[Source: Lavin and Qiang (2003). "Poverty E-Read-

ness: Using ICT to Meet MDGs: Direct and Indirect Roles of E-Marketing” In: Dutta, Lanvin Pula, ed. Global IT Report 2003-04. Oxford: Oxford University Press]

The above table and figure show ICT will not directly realize the MDGs. Rather its role should be seen best as an enabler and primary spanning several dimensions.

The discussion above shows that ICT can help achieve the MDGs by:

- Efficiency and competitiveness,
- New business models and opening new opportunities, and
- Transparency and empowerment of citizens.

### **2.3 ICT Relevance in the Infrastructure Development Targets:**

The world Summit on Information Society (WSIS) phase 1 (Geneva, 2003) brought to the front the role of ICT for development. The Conference emphasized the growing relevance of ICT in the global domain of development. A summary of the development targets for 2015 margining out of WSIS are as follows:

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 centers to ICTs.
4. To connect public libraries, cultural centers, museums, post offices and archives with ICTs.
5. To connect health centers and hospitals with ICTs.
6. To connect all local and central government departments and establish Web sites and e-mail addresses.
7. To adopt 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 has access to TV 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.

### **2.4 Measuring ICT:**

Data and statistics on ICT abound, but some of these lack transparency and standardization. Most popular metrics are based on weighted sub-metrics spanning various facets of ICT, and very few are global (often due to data limitations). The Global Information Technology Report (GITR) ranks 82 economies according to Networked Readiness Index (NRI) which measures the degree of population of a nation on community to participate in and benefit from ICT development [Dutta and Paura, eds., 2003] and [Global IT Report 2003-04]. The UNCTAD’s ICT Development Index (2003) uses a Gini coefficient equivalent to measure ICT inequality.

Gini coefficient is a metric of income inequality based on the distribution of income by households or individuals. Its computation is based on shape of Lorenz curve, which plots the cumulative income by individuals and households from 0 to 100% of the population.

To provide updated and standardized data, ITU published World Telecommunication Development Report 2003 in December 2003. However, like most reports, the emphasis in it is on connectivity. It is difficult to measure some aspects of ICT, such as content, let alone its quality and relevance. This report proposes a new Digital Access Index (DAI) a transparent metrics encompassing numerous factors including infrastructure, affordability, knowledge use, and quality. It establishes explicit benchmarks, such as literacy rates, as part of the components, and computes the Digital Access Index (DAI) number for a country, based on which, these can be ranked high, upper, medium and low DAI.

However, most measures of user capacity as literacy also, content is especially difficult to measure. Therefore, it is required new ICT measurements that capture the relationship to the thematic areas of development sustainability.

### **2.5 Technology Mapping and Development Needs:**

There are a number of hypotheses as to why ICT is not yet unequally relevant for development. This may relate that most of ICT for development comes from the West or the developed countries which is considered as a problematic for a number of reasons:

- The products are expensive as the intended market in the developed countries and those who assume non-

trivial user capabilities (literacy if not illiteracy),

- The almost requirement of Networks support,
- Electricity for operating devices may not be available to a significant fraction in some locations in developing countries as in Egypt's rural and desert areas Egypt

Therefore, any viable solution for Egypt as an example will involve sizeable investment I research and development, ranging from enabling technologies to applications as shown in the following figure:



Figure No. 2: Components of Societal –Scale Information Systems

The above figure presents a generalized model of ICT and the research and development (R&D) needs to making ICT relevant for development, as shown also in the following table. This is different from the overall 4C framework of ICT (Computing, Communications, Content, and human Capacity) as this is entirely within the technology domain.

Table No. 2: Generalized ICT Model

Sensors (S)	Acquire and correct observations into information in digital formats.
Communications (C)	Reach and richness of networks.
Databases/Information Systems (DBIS)	Global databases of information spanning all media. Availability of information in appropriate formats, languages and specifications. Creating knowledge and control bases and algorithms for processes and decision making.
Controllers/Actuators/Effectors (CTRL)	Effecting change (feedback) in nature and the operating domain.
Human-Computer Interface (HCI)	Managing and interface with ICT (includes new devices for ICT based field all in our devices, etc.)

The domains of ICT span different functionality and segments of any solution.

Also, the following figure No. 3 shows examples where ICT could make major impact on various human

and economic developments.

Incorporates issues of: Protocols, Robustness, Software, Power Management, Control, Regulation, Security, etc.

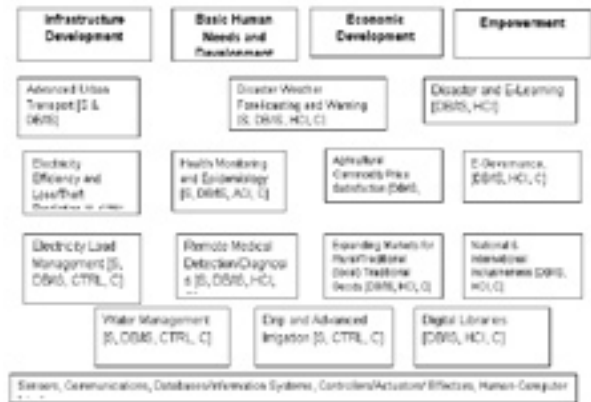


Fig. No. 3: Selected Examples of End-Users Needs Driving ICT

### 2.6 ICT Challenges:

The simplest model of ICT as shown in the above table masks the challenges that require extensive research and development, both in technology and in the social sciences as well. Several issues that determine the validity of ICT for development sustainability, primarily focused on traditional computing and connectivity that are listed below. Some of these issues are common to the needs of developed or advanced countries, but they often have institutions and mechanisms to address some of these issues.

**Digital Divide:** Is actually a manifestation of other under-lying divides, spanning economic, social, geographic, gender and other divides. Attempting to address the digital divide as a cause instead of a symptom of the other divides has led to many failures of ICT driven development projects. Therefore, the digital divide is more than differences in the availability of hardware and connectivity.

In this connection, there are 4 interrelated features determine the value of ICT for the user is as follows:

1. Awareness: People must know what can be done with ICT, they must also be open to using ICT.

2. **Availability:** ICT must be offered within reasonable proximity with appropriate hardware and software.

3. **Accessibility:** Relates to the ability to use the ICT (Spanning literacy, e-literacy, language, interfaces, etc.)

4. **Affordability:** All ICT usage together should, ideally, be only a few percent of one's income that cover also life-cycle costs that is termed as total costs of ownership (TCO) which spanning hardware, software, connectivity, education, etc.

Therefore, reducing the divides requires improvements across all dimensions of ICT (doubled the 4Cs Framework as is discussed below).

1. **Computing:** PCs are prohibitory expensive for most people in developing countries, and share access (e.g., community centers such as public libraries, cultural libraries, clubs, etc.) become inevitable. PCs today are very difficult to use, and even experts spend a lot of time maintaining their machines, worrying about upgrades, security, compatibility of hardware, etc. As complementary technology, non-PCs devices are important option, e.g., mobile phones.

2. **Connectivity:** While mobile telephony is improving worldwide, it remains expensive, limited in rural and desert area, and poor at providing data connectivity.

3. **Content:** Meaning content is lacking in many languages, and most content is locally relevant. Today's systems tend to make people passive consumers of information, instead of enabling regeneration of local information. In addition, rich content demands multimedia that is useful to overcome literacy issues, which in turn, required broadband connectivity.

4. **(Human) Capacity:** Users need to be aware, literate, and innovative to harness the value of ICT. They also should be empowered to use ICT, both by society and by governorates.

Of course, ICT usage does not occur in vacuum, rather within social and cultural norms, that also shape the divide. In addition, ICT usage is based on policy and business models, especially regulation. In the long

run, ICT must provide value and be sustainable from both a user and a provider perspective.

Affordability is a limiting factor, since we have seen that many people could avail ICT for development states. Therefore, digital divides are not just the result of economic differences in access to technologies, but also in cultural capacity and political will to apply these technologies for development impact.

Access is a sever bottleneck for increased ICT use. For many human development projects using ICT, telecommunications access costs are the largest component. As for the UN Global E-Government Readiness Report 2004: Towards Access for Opportunity points out, we need access to reach opportunity, as indicated in the following:



In linkages between these steps which are not linear or unidirectional. Knowledge is interpreted information that captures relevance and content is tightly coupled with opportunities.

### **3. Basic Human Needs and Development:**

#### **3.1 Food and Agriculture:**

Overview: Food supplies have grown with population, but local and regional shortages remain a concern. Food is a basic human need, and agriculture that is including fisheries, farming, livestock, etc. employs the bulk of the Egypt's population. Technological improvements have kept pace with population growth, averting the shortage of food, but regional and local imbalances and lags remain especial in many parts of local as well as urban areas as well. Therefore, agriculture needs to be sustainable-environmentally and economically, i.e., sustainability is a fundamental part of long-term agriculture, which is based on:

- Presenting the natural resource base
- Maintaining the soil's productivity
- Maintaining environmental quality
- Alleviating human drudgery and suffering – making agriculture a viable and respected live hood.

#### Challenges:

1. Increase the rate of reduction in number of hungry individuals,
2. Improve food production on for enhanced nutrition and health care,
3. Preserve natural resources including water.
4. Prevent land erosion and stabilize land quality,
5. Increase access to markets,
6. Value-addition through agro-products and food processing,
7. Enhance and make available education about best practices for improved outputs and incomes,
8. Improve agricultural practices, including appropriate use of biotechnology,
9. Increase livelihood options in rural areas, taking out a substantial fraction from sole dependence on agriculture,
10. Help to minimize suffering from catastrophic failures in agriculture, which causes human suffering as well as increases pressure for urbanization. Establish adequate safety nets (public and/or private) to protect the rural population affected by crop failures,
11. Reduce wastage and spoilage of products,
12. Development of hygienic and non-perishable storage and packaging systems, while maintaining environmental compatibility.

The Role of ICT: ICT can help with both the physical production of foods, as well as improving agriculture as a livelihood through the following apparatus:

- Sensors and information systems to optimize inputs based on soil, water, crop, and environmental conditions.
- Interconnections with specialists, two way audio visual communications for best management, e.g., diagnosis of diseases through digital images and expert advice through Expert Systems,
- Marketing and logistic enhancement, price discov-

ery, bargaining power, and supply chain efficiency.

#### Examples of Needed Research and Development:

- Drip and advanced irrigation systems that will impact sustainability and reduce water needs,
- Sustains to match inputs and effort (fertilizer, pestilence, swing timing, etc.) with soil, crop, weather, and other conditions, which can also be limited to advanced irrigation systems.
- Determine role and potential for ICT vis-à-vis physical inputs required for productivity.
- Making agriculture related information available and compatible with available hardware and communications technologies (e.g., cell-phones as a hardware platform and communications means).

One major issue with increased use of ICT (common to many aspects of development) is the asymmetric ability of stakeholders to benefit from ICT.

### 3.2 Healthcare:

Overview: Successful healthcare, like other areas of development requires improvements outside the domain, such as in energy, water and sanitation, etc. It is recognized, that there is a well-established inverse relationships between overall development and burden of disease. However, even for a given level of income; indicators such as malnutrition vary significantly amongst countries. This suggests that there is more to health than mere economic well being. Therefore, globally healthcare is an enormous sector of economy.

#### Challenges:

1. Increase longevity and survival statistics.
2. Reach the entire population and educate them in a persuasive manner on health issues.
3. Ensure that disease such as: tuberculosis, H1N1, etc. are eradicated and the affected cured.
4. Make educational information universally available on how to prevent the spread of some disease such as H1N1 or AIDS help the victims from being ostracized.
5. Provide healthcare and health information

to people in difficult-to-reach rural areas, including through outreach programs.

6. Make telemedicine systems routinely available in all remote areas.

7. Minimize deaths from water-born diseases and poor sanitation.

8. Provide education on pre-natal and post-natal care.

9. Improve healthy life styles (diet) exercise, etc.

10. Incorporate traditional and so-called alternative medicine in a scientific manner.

**The Role of ICT:** ICT can play an important role in healthcare everywhere. Healthcare can be 10+% of the Gross Domestic Product (GDP) in some countries, and simply using ICT for stream-linking logistics and operations alone can lead to significant returns. Telemedicine can extend the availability of medical specialists to rural and other underserved areas. ICT can also play a role in societal health issues, including diseases that are communicable or that affect a segment of population.

One of the primary role of ICT can play in Egypt is on education. Questions for stakeholders who aim to integrate ICT into modern healthcare systems include the following:

- Is there a functioning information system that would gain in performance with new ICT?

- Are there growing operational needs, e.g., logistics, finance, personnel, services, that ICT systems could more easily manage?

- Are there new data gathering and analytical needs that ICT systems could simplify?

- Are there knowledge and skill building needs that can be efficiently facilitated by ICT?

- Are there international, regional, national and local interaction needs that would be best met by ICT systems?

Therefore, ICT's impact has been easier to find within modern healthcare systems, which is often beyond the

reach of a large fraction of population.

**Examples of Needed Research and Development:** ICT is already being into modern healthcare systems, but ICT needs to be appropriately scaled for the provider at hand (who might be a semi-literate midwife).

- Making healthcare information available and compatible with available knowledge and communication technologies (e.g., cell-phones, as a hardware platform and communication mean at the same time).

- ICT solutions that are user-centric and user-driven, and do not acquire ICT specialists to operate or maintain.

### **3.3 Education:**

**Overview:** ICT can enhance education at all levels but there is also a need for improved education for developing and improving ICT skills. Therefore, education has two components: basic education (literacy) and advanced (which may or may not include specialized or ICT training). Education highlights a number of divides, including gender. Much of the deliberations in many workshops and conferences are centered on basic education and eradicating illiteracy.

**Challenges:**

1. Universal literacy, including adult literacy.

2. Increasing female education levels to parity just literacy concerns.

3. Establishing vocational and technical education programs, with curriculum relevance for employability.

4. Make content rich, affordable and available at all levels of learning, including a universal digital library.

5. Make contents available in different languages.

6. Develop computer simulated experiments in sciences for students to perform and learn.

7. Develop and disseminate programs to help children with learning difficulties or physical disabilities.

8. Assist and empower teachers and provide them with tools for providing quality education.

9. Modernize curricula to be relevant and worthwhile



for students.

10. Establish standards and certification procedures for education.

**Measures for Success and Failure:**

1. Universal literacy, especially with meaningful measures (functional literacy).

2. Increasing employment for women

3. Well-trained workforce with hands-on (learning by doing) experience.

4. Increase in teachers and funding for education.

5. Ability for anyone to access any educational content at very little or no cost.

6. Reflection of increased education through overall economic growth.

7. Increased patenting and innovation from developing countries as Egypt.

**The Role of ICT:** ICT can help education and literacy, as if it has the technological prowess of extensive reach, and provides options to tailor the output to meet individual needs at anytime of his or her choosing. More than such conveniences, ICT can overcome some of the major handicaps inherent in conventional education. For instance, it can provide quality education with appropriate graphics and experimental presentations that are today available only in a few selected urban schools; it does not discriminate on the basis of gender or income, and can be made available in any language. These characteristics of ICT enabled education are available at any level including for courses in practical training, adult education or continuing education, government programs are often required to bring ICT to under-funded schools. Therefore, ICT should enhance or supplement traditional education, not replace it.

Also, ICT can be used to enhance education and supplement it in the same time. ICT for education need not to be real-time intensive or online: television, radio, and post have all played a major role in education in many countries including Egypt, i.e., ICT should not become an additional burden for teachers.

One of the major issues relates to capacity building for educators, ICT should not become another burden in fact, another divide, upon teachers. They need hardware, software, training and connectivity. One special potential for ICT is to allow easier customization and specialization of content especially geared towards special classes of underserved or disadvantaged users (gender, age, disabilities, etc). In addition, ICT can help reach those outside formal schools systems, such as through TV, radio and videos. One challenge is incorporating such non-traditional delivery, mechanisms into funded and certified educational programs.

**Examples of Needed Research and Development:**

1. National and international coordination on education perhaps through an international liaison committee.

2. Solutions for easy scalability of ICT, especially teaching for teachers.

3. Development of appropriate content, with access and availability (this includes digital libraries).

4. Efficient feedback systems that make expert teachers and advanced learning available to all students.

### **3.4 General Observations of Human Needs and Development:**

In their daily life, people recognize the need for information. Today, they mainly seek information as facts (prices, weather, etc.). From data we can extract information, and this can be analyzed and synthesized and ultimately, we can achieve knowledge. Humans today perform these tasks using various modes of communication. In future, some of these tasks can be done by machines, or at least human aided by expert systems.

To foster such collaboration (and achieve knowledge for future use) requires appropriately designed ICT that is available, accessible, and affordable. Across all the domains for human development, appropriate content (content customization for cultural context) requires innovations in ICT to make contents more inclusive for local stakeholders. Given infrastructural constraints, this might require solutions such as local cashing and

distributed storage. Even with governmental support, these activities would require, new business models and creative financing to help sustain them. In addition to traditional participants (government, business, individual end-users, and philanthropists), collective ownership models (co-ops), or community systems were suggested as attractive models. These can also help empower women if they are targeted as stakeholders.

The following table presents an action plan and activities concerning ICT for human development:

Time Frame	Activities
2 years Plan	<ul style="list-style-type: none"> <li>- Initiate several projects on customization.</li> <li>- Foster courses targeted at ICT facilitators, etc.</li> <li>- Educate technologists about actual potential users and their behavior.</li> <li>- Educate potential users about the possibilities.</li> <li>- Start to build the database of recent successful and failed case studies.</li> <li>- Stimulate policy makers to assess.</li> <li>- Initiate several projects on customization.</li> </ul>
5 years plan	<ul style="list-style-type: none"> <li>- Reports on existing deployment.</li> <li>- Have graduated several advanced degrees in ICT for sustainability development.</li> <li>- Have established forums, where these issues are dealt with.</li> <li>- Replication to other developing localities.</li> <li>- Influence worldwide design processes.</li> </ul>
10 years	<ul style="list-style-type: none"> <li>- Products originate from developing communities (used to be developed).</li> <li>- Customized content ubiquitous.</li> <li>- Access to remote (geo and socially) facilities.</li> <li>- Government / private partnerships facilities equity.</li> <li>- Government needs new ICT initializations.</li> </ul>

Table No. 3: Action Plan and Activities (ICT for Human Development)

#### 4. Economic Growth and Employment:

Overview: Economic growth is recognized as one of the key factors to improve quality of life, through the Human Development Index (HDI) does not perfectly correlate with Gross Domestic Product (GDP). The differences become striking when we compare the variance within a community, but communities as a whole tend to follow the trend.

Distribution of wealth, captured by the inequality based on the distribution of income by Gini coefficient. [Gini Coefficient is a metric of income inequality based on the distribution of income by households or individuals. Its computation is based on shape of Lorenz Curve, which plots the cumulative income by individual on household, from 0 to 100% of the population]. Therefore Gini Coefficient provides one view of inequality, but such data as published rarely incorporate sub-regional granularity, or breakdowns paralleling other

divides (gender, age, community, rural / urban, etc).

There are several studies that indicate the correlation between economic development and ICT or networking penetration. However, if a group cannot pay for a certain ICT, the facilities either require continuous subsidiary, or fall into disuse.

ICT and economic development can be categorized into two categories:

1. Servicing and development of ICT technologies and industries, hardware, software and process development.
2. Using ICT enabled processes and services to enhance efficiency, create new opportunities and generate new paths for employment.

It is noticeable nowadays, that the services sector is almost of the world

economy, and is increasingly dependent on ICT.

#### 4.1 Economic Growth and Poverty Reduction Through Servicing ICT Industries:

Challenges:

1. Develop human resources with appropriate skill sets for technology needs.
2. Targeted training to use ICT to meet different cultural and social needs.
3. Create appropriate organizational structures and business processes to benefit from ICT created opportunities.
4. Develop appropriate governmental policies for transparent commercial practices and for creating fiscal incentives to enhance ICT opportunities.

Measures for Success and Failures:

1. Increase in share and growth of ICT and related services in the economy.
2. Creation of governmental programs and incentives for ICT education and other relevant areas for ICT enabled growth such as e-commerce.
3. 3. Increased use of appropriate standards for ICT enabled services.
4. Establishing a number of training as well as collabora-

tive programs in ICT both within a country or its provinces.

5. Bottom-up demand for ICT based services for local and domestic needs.

**ICT Enabled of Enhanced Employment Generation and Poverty Reduction:**

**Challenges:**

1. Identify areas to utilize if not sustainable ICTs in business and government processes to improve the reach, volume and quality of services, and minimize transactions' costs. This especially applies to agriculture, which employ7s the largest population in the Egyptian rural areas.

2. Develop new opportunities for meeting local needs.

3. Identify new ways or paths for ICT that substitute mass production by catering to individually customized needs.

4. Develop new business models and processes to harness the opportunities in the international market-place.

5. Identify opportunities that substitute labor-intensive production by computer controlled technology based processes, taking into consideration the local genius of the people. This extends to reduced use of natural resources.

6. Provide appropriate financial services and tax incentives to promote entrepreneurs focused on the local or domestic economy.

7. Eliminate gender and other disparities in training, employment and opportunities.

8. Improve transparency in economic transactions and culture of awareness for the need for transparency.

**Measures for Success and Failures:**

1. Increase the number of areas and organizations using ICT enabled services in all areas of human development and economy.

2. Greater universal competitiveness of Egypt and improved economic and human development.

3. Scalability and transferability of ICT enabled sustainable development projects.

4. Increase number of people in the formal sector of economy.

5. Improving the quality of education at all levels from primary to tertiary with attention paid to local contexts and needs.

6. Increased capital generation for development and infrastructure from the economy.

7. Increased level of credit availability across socio-economic classes, expanding to foreign direct investment as required.

8. Increased access of modern amenities and infrastructure.

9. Increased use of transparent services and increase in level of use and types transparent transactions

10. Increase in intellectual property rights (IPR) filing from developing economy.

11. Economic intelligence shaping in Egypt with available data.

**Role of ICT for the Above: Economic Growth and Poverty Reduction Through Servicing ICT Industries & ICT Enabled of Enhanced Employment Generation and Poverty Reduction:**

- Creation of new hitherto new industries and sources of employment.

- Increasing the competitiveness of existing and traditional industries.

- Providing an equitable balance to globalization. them to undertake productive activities.

**Examples of Needed Research and Development:**

1. Training packages for ICT education, for all levels of users.

2. Increasing interconnectivity to and within developing countries (through new technologies such as wireless), to allow ICT and ICT enabled and enhanced services to flourish.

3. Improving software, hardware and their integration so that solutions are robust, easy to use and maintain, as well as have low total costs of ownership.

4. Solutions for low-cost and secure money transfer corresponding systems for financial and risk management.

**5. Alienation, Empowerment and Governance:**

**5.1 Alienation Issues and Empowerment:**

**Overview:**

The 20th century had witnessed dramatic changes in social institutions and hierarchies, as technologies that shrank distances were cited as a major factor. While in the past this was transportation, it is now instantaneous communication

technologies driving such changes. This means that ICT has been described as a great equalizer if not a democratizer.

Therefore, ICT can be a powerful means for employment. Earlier technologies for information dissemination, such as the radio, were extensions of traditional information networks, with centralized authority spreading information. The Internet can fundamentally alter this balance of power, allowing new and multiple layers of interactions between individuals and groups. Giving stakeholders a voice is more than a manifestation of empowerment. It also relates to participation and efficiency, many people are outside modern service delivery systems, and they often do not know their rights or what is meant to be available from public and private providers.

Lack of empowerment and opportunities can be a driver for alienation, which might result in increased anti-societal tendencies. This is a particular challenge considering most developing countries who have a population pyramid with a very large number of youths, who can learn of and perceive greater disparity than ever before due to ICT and the media.

However, the more economic issue than extreme alienations is the subtle alienation of many segments of population, especially as relates to issues of identity and diversity. There are many cultural divides, such as gender, rural/urban, religion, age, etc. Exacerbating this is the very large increase of migration, both within and across countries, especially from Egypt to European and rich Arab countries.

## **5.2 Governance and e-Governance:**

### **Overview:**

Governance occurs within a framework that is both formal (legislated/statutory) and implicit (socio-cultural norms). In addition to good governance, citizens require complementary support from an independent judiciary, a free press, land reform, etc., and also seek a greater say in their future (democracy).

E-government is a much talked about application of ICT and it holds great promise. One aspect of e-government is the computerization of governance activities, both for internal efficiency and for increasing ability of citizens to receive information, especially under single window.

Computerized land records could reduce the costs of transactions down. A second and related aspect is the establishment of linkages and connections between citizens-government, as well as citizens to citizens. This means not only that they can receive a particular form or document with ease, they can also participate in decision-making and provide feedback to government.

Therefore, the government should continue with appropriate e-governance programs and initiatives even if the citizens have limited ICT access. Also, there exists some indicators related to E-governance Readiness Index (that is spanning users infrastructure, and government's online activities), Web Measure Index (that excludes access measures 'more a fraction of government actions') and E-Participation Index (which measure of usefulness of e-government services and how frequently they are available).

## **5.3 Challenges of Both Issues and Empowerment, and Governance and e-Governance:**

1. Increase transparency in governance, reduce transaction costs.
2. Enhance citizens participation (local and national policy making, elections and polls), reducing vagaries of process and opportunities for manipulation or biasing.
3. Reduce the digital divide (geographic, socio-economic status, age and gender, etc.)
4. Allow for open discussion of government goals, strategies, policies, targets and processes.
5. Foster free, fair and enlightened media.
6. Increase coordination among local, national government agencies.
7. Develop appropriate legal systems to legitimize ICT enhanced services.
8. Allow migration paths and hybrid systems that maintain consistency between electronic and physical information.
9. Ensure security and privacy of information.

## **5.4 Measures for Success and Failures of Both Issues and Empowerment, and Governance and e-Governance:**

1. Democratization of information dissemination.
2. Increased voter registration/participation in polls and reduction in voter fraud.
3. Increased participation of women in all sectors of

human and economic development.

4. Inclusiveness of persons with disabilities and functional illiterates.

5. Increased involvement of youth in education and services.

6. Increased delivery of government services online (local and national services).

7. Increased efficiency (time and quality) of government services.

8. Greater availability and use of ombudsman to all sectors of society to ensure good and fair governance.

9. Increased level of ICT education among bureaucrats.

10. Enhanced number of communities connected by knowledge networks for economic and human development.

**5.5 Role of ICT For Both Issues and Empowerment, and Governance and e-Governance:**

- o Increasing connections between citizens and citizens to institutions (including e-government).

- o Improving governance through stream lines, free interactions, with transparency in decision-making.

- o Providing a voice for the underrepresented and alienated.

- o ICT can be an equalizer, making more people producers of content and information than mere consumers. With a little effort, this can include other underrepresented segments of society. This fundamental shift in terms who can impart information requires building awareness among the population, who are in many localities today receive their information from limited sources (because of media consolidation and/or governmental control).

- o ICT can also help in rapid dissemination of information (warning) under emergency or disaster conditions, such as probable earthquakes, storms, or floods.

**5.6 Examples of Needed Research and Development For Both Issues and Empowerment, and Governance and e-Governance:**

1. IT solutions that can facilitate and integrate all levels of data collections, storage, analysis and dissemination-ranging from large (governmental) to micro (grassroots) systems.

2. Technologies to maintain and enhance privacy and

control over personal information.

**6. Conclusions:**

**6.1 Results Relating Linking Needs of Development Sustainability for ICT:**

The integration of ICT into all aspects of human activity is inexorable. Governments, services providers and companies are adopting such technologies, often unbeknownst to their end-users or clients. What was decades ago the wondrous act of listening to voices from miles away (radio) has become replaced by even children accepting and demanding instantaneous interaction at almost any location (mobile telephony). This challenge for professional is to link ICT to specific human and economic needs.

The following table summarizes the needed ICT research and development as linked to development needs.

Table No. 4: Mapping of Development Needs to R&D Requirements

Thematic Area	Group/ Subgroups	Development Needs	Key Recommended R&D	Primary ICT Mapping*
Infrastructure	Water	Better models and assessment of supply and quality	Low cost sensors; GIS models; data dissemination solutions; and integration into water flow models.	S, C, DEIS, HCI
	Energy	Improved measurement, theft control, and control (including demand side management).	Longer-lived digital electricity meters with control and communication, with integration into efficient end use appliances for load control.	S, C, DEIS, CTRL
	Transportation	Optimization of public and private transport along with enhanced safety	Integration of sensors, GIS, GPS, and other technologies	S, C, DEIS, HCI
Basic Human Development	Food and Agriculture	Optimize input to the soil and improve productivity; improve farmers' stake in the supply-chain.	Sensors and information systems for optimizing irrigation (e.g., drip irrigation), fertilizers, pesticides, etc.; developing accessible and affordable solutions for access to markets, weather, and other information.	S, C, DEIS, CTRL, HCI
	Healthcare	Improve delivery of healthcare services; make systems more participatory	ICT solutions integrated with existing systems; develop easy-to-use and robust interfaces and platforms.	C, DEIS, HCI
	Education	Improve literacy and create at different levels of needs (age, gender, specialization, etc.)	Easy-to-use and scalable solutions for education; customized content and delivery systems with feedback.	C, DEIS, HCI
	Economic Growth and Employment	ICT-based and ICT-enabled job creation and poverty reduction	Easy-to-use and scalable solutions for education; easy to implement standards for ICT integration; secure flexible and integrative systems to manage and move money.	C, DEIS, HCI
Alienation, Empowerment and E-governance	Alienation issues, empowerment and e-governance	Understanding of information policies norms of privacy and individual control	Solutions that make it easy to create, monitor, search and apply information while maintaining end user privacy and control.	C, DEIS, HCI

Sensors (S), Communications (C), Database/Information Systems (DB/IS), Controllers, Actuators/Effectors (CTRL), Human-Computer-Interface (HCI).

## 6.2 Recommended Tasks:

1. **Making ICT Universally Available, Accessible and Affordable:** Ending the digital divide should be information, primary education, programs and government services should be accessible to all citizens within convenient distance, at zero or near zero cost. In addition to connectivity, research and development are required to make ICT accessible for those who do not use the major languages (as English language) and/or have limited literacy. Besides the innovations based languages translation and speech recognition technologies, creation of localized content that will help spur the user demand for ICT that could be through:

**1.1 Village connectivity networks:** This includes the combination of wireless access with optical fibers which could be cost-effective for improving connectivity. Several clusters of villages can be targeted for such connectivity.

**1.2 Advanced Wireless Technologies:** Regulatory hurdles of ten limit the potential of new wireless technologies. There is a need to develop software defined radios, which can operate in any frequency, or even cognitive radios. This veracity would help reduce the global volume required for dramatically lower costs as all countries could use the same equipment.

2. **Making ICT Usable and Applicable:** Complex systems like trucks and cars demand very little advanced skills from their users. On the other hand, end-users ICT is complex, user-unfriendly and difficult to operate and maintain.

3. **Integrate ICT into Development Issues and Economic Growth:** Research and development are needed to identify how much of difference ICT can make in a particular field, and how much investment and other inputs are required for the field itself.

3.1 **Knowledge Networks:** many information net-

works are geared to benefit the end-users, are designed only to be used by professionals. This is in part due to difficulties at the end-user's end, his or her illiteracy combined with lack of connectivity. Advances in connectivity and creation of specialized knowledge networks that reach up to end-users are therefore necessary.

**3.2 Remote and Field Diagnosis:** these can lead to a "laboratory on Chip". They could give the endemic nature of a number of diseases (H1N1, HIV, Malaria, etc.) and health conditions. Therefore, it is important to inexpensive diagnose and monitor the vulnerable population, which is considered the first step to improved healthcare.

**3.3 Micro Irrigation for Agriculture:** Agriculture is the primary consumer of fresh water that is in short supply in many areas of the Egyptian villages as well as in severe shortage in the desert areas in Egypt. The utilization of technological simulation models could assist in solving the aroused problems.

**3.4 Smart Meters for Energy and Electricity:** Energy is a critical input to economic growth, especially in the form of electricity. Unfortunately, many areas in Egypt face very high transmission and distribution losses and theft especially at urban and remote areas, this is affecting the economic viability of utilities. ICT can help reduce theft significantly with smart meters that can communicate and be controlled remotely.

**2.5 Sensor Networks:** This technology spans the range of sensors covering environmental monitoring to equipment operating conditions. There is a clearly defined need to make sensors relevant for development sustainability in all sectors.

**4. Defining the Scope of ICT for Enterprises' Development Sustainability:** ICT for development sustainability requires universal collaboration, specialized R&D, and test beds perhaps using a network of centers and institutions. This is to be implemented through the followings;

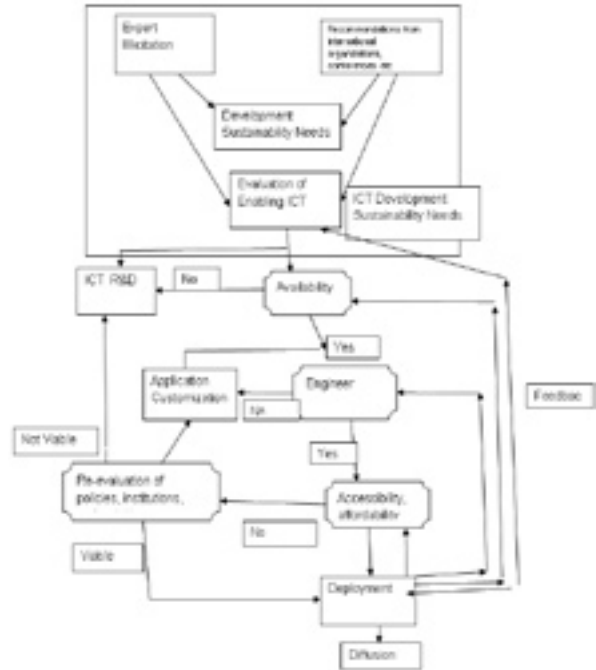
**4.1 Metrics and Rigorous Analysis:** ICT for development sustainability requires formalization of measures for success, standardization of evaluation and rigorous critical analysis. Metrics is standardization of information and its quality.

**4.2 Role of Stakeholders:** The pantheon of stakeholders in ICT for development sustainability networks is vast and their linkages are many. In this connection, end-users need to integrate ICT into their personal and professional life to harness its development process. Also ICT companies and service providers must continue to invest and innovate in ICT development for it to be applicable to development sustainability. The challenge is one of matching investments and efforts along sustainability paths, avoiding booms and busts. Companies, corporations and industry are natural consumers of ICT and their use provides the volume for spreading ICT further into market supply chain. Government have an enormous role in ICT for development sustainability, just as they have an overarching presence in most facets of development services, including ICT services, they also set policies that lay the ground rules for deployments. therefore, the government is also the regulator of ICT and other services and shape innovation and R&D.

**5. the Need for R&D and Administration to New ICT Development Sustainability Model:**

at the business end, new models, with appropriate regulatory clearances, will be required for innovators and entrepreneurs. Flexible (micro) financing and micro-franchising models will also be imported for achieving scalability.

The following figure shows the process flow for ICT for development sustainability. Issues of appropriateness affordability and impact are central to ICT research and design, instead of merely affecting penetration and deployment.



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