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A Decision Model for Technology Assessment to Reduce the Internal Digital Divide in Emerging Economies (case: Costa Rica)

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A DECISION MODEL FOR TECHNOLOGY ASSESSMENT TO REDUCE THE INTERNAL DIGITAL DIVIDE IN EMERGING ECONOMIES (CASE: COSTA RICA)

by

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DISERTATION APPROVAL

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ABSTRACT

An abstract of the dissertation of Audrey María Alvear Báez for the Doctor of Philosophy in Systems Science: Engineering Management presented April 8, 2005.

Title: A Decision Model for Technology Assessment to Reduce the Internal Digital Divide in Emerging Economies (Case: Costa Rica)

Information and Communication Technologies (ICTs) such as Wireless, the Internet, and e-commerce software are profoundly impacting how business and government are conducted. Digital divide (DD) refers to the gap that opens up between those who have access to, benefit and interact with ICTs and those who can not. ICTs can either accelerate change and thereby increase the DD in developing countries, or, if deployed carefully can be a tool to reduce the DD within a country. This study presents a systematic approach for doing the latter by identifying the ICTs, technology applications and key sectors that most impact the internal digital divide in developing countries. The specific case study is Costa Rica.

The methodology selected for conducting this study is the Analytic Hierarchy Process (AHP), and the model is based on the United Nations Development Program report titled "Creating a Development Dynamic: Final Report of the Digital Opportunity", concepts from the literature and expert judgments. A four level hierarchical decision model has been developed using weights provided by an expert panel. The model computes the contribution of ICTs and ICTs applications to the

reduction of the DD, through the reduction of the DD in key sectors. The model was developed for 2003 and 2010.

The study found that a reduction of the DD in the education sector would have the highest impact followed by the DD in the economic, government and health sectors. Education and government applications have the highest impact on reducing the DD, due to their focus on innovation and creativity, enhancing the education process through ICTs use as well as improving the efficiency of public administration. In 2003, the ICTs with the highest impact are: land-based devices, general- purpose software, the Internet content and infrastructure. The impact of collaborative tools increases dramatically from2003 to 2010, suggesting that the role of technology in 2010 will be distinctively oriented toward Internet mobility and collaboration.

In addition to developing a general modeling approach for prioritizing ICTs , this research provides the Costa Rican government officials with a solid basis for making important policy decisions related to reducing DD.

To my encouraging mother,
my supportive sister Ana,
and my loving husband Jacob
&
in memory of my wonderful dad

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Finally, I would like to thank all the people, colleagues, family and friends that have contributed in one way or another through this journey.

Last, but not least, I would would like to thank God for always being there.

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

" A detailed analysis of experience around the world reveals ample evidence that, used in the right way and for the right purposes, ICTs (Information and Communication Technologies) can have a dramatic impact on achieving specific social and economic development goals as well as play a key role in broader national development strategies." [1]

With the latest Information and Communication Technologies (ICTs) such as Wireless, the Internet, and e-commerce, societies have been changing dramatically. These technologies can be the engines of change, which will offer to developing countries an opportunity to leapfrog and become leaders in different markets. Investment in the proper science and technology policies will help developing countries to overcome the division that ICTs' rapid changes has created [2].

This division or Digital Divide is the gap between the people who can access, interact with and benefit from Information and Communication Technologies and those who can not. The Digital Divide can be external and between countries or internal and inside a country [3]. This research considers only the internal.

Although there are many opportunities to leapfrog, there are also many problems that each country will have to solve in order to have a secure and better way to be competitive in the digital economy [2]. Organizations such as Markle Foundation, Accenture, the Center for International Development (CIID) at Harvard University and the United Nations Development Program (UNDP) have developed case studies and introduced initiatives about fostering the use of the ICTs in the developing countries [4]. Lessons can be learned from case stories, but each country has to develop its own strategy [5-7].

This study presents a systematic approach to identify ICTs, technology applications and sectors for reducing the internal Digital Divide in developing countries; our specific case of study is Costa Rica. The methodology selected for this purpose is the Analytic Hierarchy Process (AHP) [8-17] , combined with interviews and web-based questionnaires. The respondents to the AHP instrument are members of an expert panel. This panel includes experts from academia, industry and government agencies.

1.2 RESEARCH OBJECTIVE

The objective of this study is to develop an analytical approach to evaluate the impact of Information and Communication Technologies (ICTs) on the reduction of the overall internal Digital Divide.

While ICTs could be viewed as the root cause of the Digital Divide they are also considered the enablers to bridge the gap. There are no current models to arrive at the relative impacts of each ICTs on reducing the overall internal Digital Divide. This study develops such a model. This model could be used by decision makers in government to guide ICT investments with the goal of reducing the overall internal Digital Divide.

This objective has been achieved by developing a model that operationalized the UNDP report, titled, "Creating a Development Dynamic: Final Report of the Digital Opportunity". It was done by obtaining definitions, decision criteria and subjective judgments from the expert panel members. The model was applied to Costa Rica as a case study in this research.

1.3 SYSTEMS CONTEXT

Although the use of technology is important for developing countries, technology is not the solution for all their problems. Technology should be considered within the context of interrelated systems in a country. A holistic approach should include an analysis in terms of systems. The telecommunications and information industries considered in this research are from three interrelated subsystem: the information contents subsystem (media, multimedia industries), the information processing subsystem (software, hardware industries) and the information diffusion subsystem (telecommunications, electronics industries) [18]. UNDP recommends other dimensions, including in a dynamic framework, where infrastructure, human capacity, policy, enterprise, content and applications are interrelated [1].

According to Linstone, it is important to consider technical, organizational and personal perspectives [19]. In the case of this research, the expert panel members belong to different organizations, and provide a balanced view between academia, government, and industry. The national perspective is balanced by multiple organizational perspectives. The nature of the model relies on people's judgments and represents personal perspectives including individual biases, personal views, beliefs and values. The technical perspective is involved in every stage of this research focusing on the impact of ICTs on the overall reduction of the Digital Divide in a developing country.

The model can be considered as a supra system, whose goal is the reduction of the internal Digital Divide of a country. This goal is achieved by the reduction of Digital Divide on different sectors: health, education, environmental, economic and political sectors. These sectors have diverse ICT applications that enable the reduction of the Digital Divide. The applications are made possible by different elements and technologies, in our case information and communication technologies. Figure 1 depicts these interrelationships.

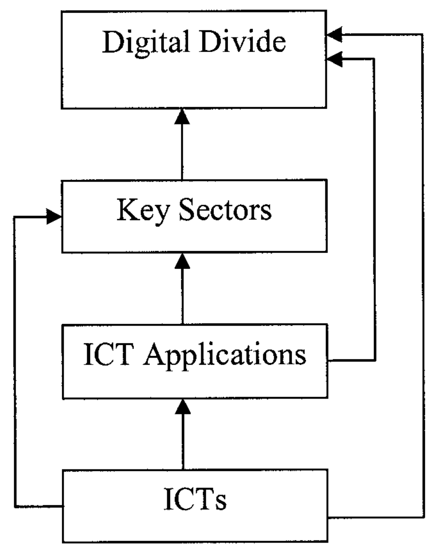

Figure 1: Interrelationships between ICTs, applications, sectors, and the digital divide.

1.4 DISSERTATION'S OUTLINE

Chapter 1 provides an introduction to the dissertation and its context from a systems perspective. Figure 2 depicts the process used to carry out this research including how the expert panel was incorporated. Following the figure each of the stages in the research is briefly described.

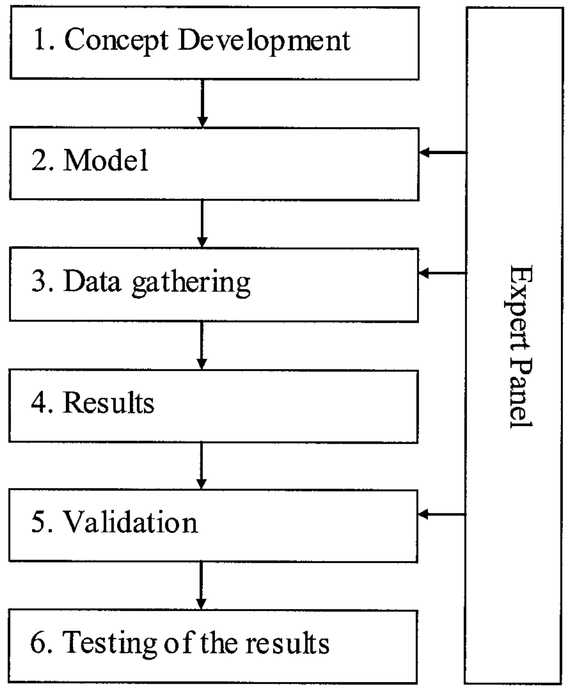

Figure 2: Research Process

1. Concept development – Chapter 2 presents the concept development based on the literature. This chapter also covers the literature in relation to ICTs and developing countries, the Digital Divide, the UNDP strategic framework, ICTs for specific development goals, AHP method, and the link between the literature and the dissertation. In addition, Chapter 3 presents the background of Costa Rica and its technological position.
2. Model, Chapter 4, presents the research objectives, research questions, research approach, the criteria for the expert panel selection, expert panel qualifications, a description of the instruments, and the model.

3. Data gathering, Chapter 5, presents the data collection process as well as the instruments used.
4. Results are presented in Chapter 6.
5. Validation, Chapter 7, presents the validation process and validation instruments.
6. Testing of the results – sensitivity analysis using the coefficient of concordance tests to verify agreement among the experts, intraclass coefficient and test of extreme cases, is also presented in Chapter 7.

Finally, Chapter 8 presents the conclusions, contributions, key assumptions, limitations, and future work.

CHAPTER 2: LITERATURE REVIEW

2.1 INFORMATION COMMUNICATION TECHNOLOGIES AND DEVELOPING COUNTRIES

In recent years the term Digital Divide has often been used by international organizations that focus on social and economic development because if not addressed there is a risk of countries and/or social and economic groups being marginalized, excluded or left behind in terms of human development[20-23]. Reducing the Digital Divide involves providing especially for poor people more and better opportunities of education, health care, empowerment, democratic participation, and economic development.

2.1.1 Human Development

A country's development involves more than economic improvements; it involves social and economic development in a holistic approach towards human development. UNDP explains that human development is the creation of an environment where people can develop their full potential and live productive, creative lives according to their needs and interests [24]. *"A detailed analysis of experience around the world reveals ample evidence that, used in the right way and for the right purposes, ICTs (Information and Communication Technologies) can have* *a dramatic impact on achieving specific social and economic development goals as well as play a key role in broader national development strategies"* [1]. The right use of ICTs is key to human development in developing countries. Societies are changing into information societies by using ICTs. This change is happening not only in the developed world but also in the developing one.

2.1.2 Information Societies

Societies have changed not only in the economic development from primary sector (agriculture) to secondary sector (industry) to tertiary sector (services), but also developing and developed societies have been changing with the use of ICTs. According to Thierry Gaudin, the world will change from an industrial society to a knowledge society in the next century [25]. Societies have been changing to become information societies trying to improve the competitiveness or to maintain their advantage [26].

An information society has three stages. At stage - 1, information is used as an economic resource. Organizational entities recognize the impact of information on competitiveness and use it for providing better services. At stage - 2, the demand for information increases and extends into general population. People look for information in the Internet, to compare and/or chose different products. At stage - 3, the local information industry starts to emerge to meet the increased demand for information.

As a result, the software, hardware, and telecommunications industries become more developed [18].

ICTs can have significant impacts on the development of a country because they can overcome social, economic and geographical barriers, increase access to information and education, help combat poverty, and enable people to participate in more of the decisions that affect their lives [24, 27]. ICTs can contribute to the economic growth of the less developed countries by improving health systems, creating jobs, modifying business models, and raising the quality of the services [28]. Investment in the proper science and technology policies will help developing countries to overcome the division that ICTs' rapid changes has created [2]. However, ICTs can also widen this gap. This division is known as the Digital Divide, and understanding how it might be reduced is the objective of our research model.

2.1.3 Digital Divide

A large amount of research has been conducted on the Digital Divide covering a vast range of topics including the Digital Divide definition, differences, consequences, measurements, initiatives, projects, policies and recommendations. The following sections will cover the aforementioned areas of study.

2.1.3.1 Digital Divide Definition

The division between people who have access to technology and those who do not have that access is creating a gap called the "Digital Divide" [29]. "*Digital Divide ... describes situations in which there is a marked gap in access to or use of ICTs devices measured by, for example, the number of phone lines per inhabitant, or the number of Internet users, or of mobile telephones in the populations*" [3]. Furthermore, according to Lalor, the gap in the theory and practice of science and technology is the cause of the division between developing and developed countries [30].

The definition of Digital Divide is as varied as the areas that it covers [30-33] as expressed by Bridges.org: "The Digital Divide is not a single thing, but a complicated patchwork of varying levels of ICTs access, basic ICTs usage and ICT applications among countries and peoples" [7]. For other authors the Digital Divide is a political and economic problem, not a technical one [34].

Bridges.org summarizes five perspectives found in the literature about the Digital Divide and its solutions:

"1. The Digital Divide is a lack of physical connection and training...

2. The Digital Divide is a lack of computers, access and training, but the problem will solve itself in time...
3. The Digital Divide is a lack of computers, access and training, exacerbated by ineffective government policy...

4. The Digital Divide is a lost opportunity, with disadvantaged groups being unable to effectively take advantage of ICTs to improve their lives...
5. The Digital Divide is a reflection of the lack of basic literacy, poverty, health and other social issues..." [7].

The term Digital Divide in this research goes further than the previous definitions.

The Digital Divide is considered as the gap between the people who can access, interact with and benefit from ICTs and those who can not.

2.1.3.2 Types of Digital Divide

Diverse authors such as Campbell, Regenstein, and Johnson, and organizations such as Bridges.org, argue that the Digital Divide can be external and between countries or internal and inside a country [3, 7] [35] [36]. However, Pippa Norris in her book "Digital Divide?: Civic Engagement, Information Poverty, and the Internet Worldwide", adds a third type and identifies three types of Digital Divide as (1) the global divide or the external divide, which refers to the different levels of digitalization in different countries; (2) the social divide or the internal divide, which refers to the different levels of access to digital technology by different sub-populations; and, finally, (3) the democratic divide, which refers to the gap between people that use digital resources to participate in public life and those who do not [37]. This research considers only the internal or domestic Digital Divide.

There are differences in accessingr ICTs in geographic regions and in most countries. For example, according to Thomas Riley there are more internet users in Northern Europe than in the southern Europe. In the same context there are regions that have lower internet access such as jungles, mountains or desserts than the valleys within a country [34].

2.1.3.3 "Measurements" of Digital Divide

In the literature, the Digital Divide is usually measured in terms of ICTs use, accessibility, teledensity, device penetration [7, 30-33] [35]. It is also measured by Internet penetration such as the number of computers per households and Internet access, the infrastructure available [30-33], the e-readiness of a country [4, 28], and ICTs penetration especially in developing countries [38-43], including the number of Internet hosts per person in relation to the capital income, and the correlation between them [44, 45]; or the percentage of use of the Internet by children between the ages of eight to eighteen [46] on a daily basis, which has increased in comparison with previous years. Other measures are related to the adoption of the Internet and its use in business environments (rural vs. urban) [47], the language of users, size of the IT sector, bandwidth and language of the websites [7], online users by gender and social group, and trends of Internet use in Europe and America [37].

Most of the research in this area is in relation to Internet access, percentage of population online and device penetration. For example, in 2000 an article in the

Economist stated that "one in two Americans is online, compared with only one in 250 Africans" [48]. Furthermore, according to UNDP, it is estimated that of all the computers connected to the Internet, 93% are in developed countries where only 16% of the worldwide population lives. In Finland, for example, there are more computers connected to the Internet than in Latin America and the Caribbean islands combined. In the same way, New York has more computers connected to the Internet than all of Africa [49]. Much of the economic growth has been driven by industries in large cities, where the best infrastructure and educational facilities are located [50]. However, in developing countries, the majority of poor populations live in rural areas [43]. In the Human Development report by Sakiko Fukuda-Parr, the author argues that *"ICTs is truly a breakthrough technology for democracy and expansion of knowledge for poor people"* [24].

Bridges.org presents a report called "Spanning the Digital Divide: understanding and tackling the issues". This report is based on more than 50 reports measuring the Digital Divide. According to Bridges.org, most of these reports present the existence of a divide but do not present an action plan [7]. The previously mentioned reports of Digital Divide measurements are a good base to understand the breadth and depth of any pre-existing gap in any area [34].

According to Guy de Teramond, Costa Rica's former Minister of Science and Technology, we have to remember that information is not knowledge and technology is simply an instrument. Technology will not transfer human value. So, it is important to not only bring technology to as many people as possible, but also to strengthen the educational system to improve human knowledge [2, 5, 24, 32, 51].

Various models have been developed for comparing policy issues and economic issues related to Digital Divide in different countries. Norris presents a comparative study of 179 countries and analyzes the inequalities of internet access and the social causes of it as well as patterns of online civic engagement in the political system [37]. Norris claims that the lack of economic development is the root cause of the uneven global diffusion of digital technologies, and the lack of internet access depends on the socioeconomic stratification [37]. *"The model Norris develops for policies comes to the same conclusion as the one Nick Flor*[1] *has developed for business-[The] electronic infrastructure will only be effective when it supports offline activities by facilitating faster, wider, better service, not when it tries to drive a process on its own"* [34]. The Digital Divide does not only include technology infrastructure. The use of ICTs has a direct effect on the Digital Divide and its consequences.

2.1.3.4 Uses of ICTs and their consequences on the Digital Divide

There is a large amount of research on the Digital Divide and how the use of ICTs can widen the Digital Divide or close the gap. UNDP has studied the impact of ICTs in the achievement of development goals [1]. Campbell studied the diffusion

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[1] Nick. V. Flor, WEB BUSINESS ENGINEERING, Addison-Wesley, Toronto 2001

patterns of ICTs use and how it affects the Digital Divide between developing and developed countries [3]. Bridges.org presents elements to integrate ICTs effectively into society to gain real access and reduce the Digital Divide [7]. Kagami *et al* presents different opinions on how the Digital Divide can be an opportunity or threat for developing nations in different regions for example in Europe, Asia and in Latinamerica [52].

Other research has studied the role of ICTs in human development when the Digital Divide is present [30-33]. For example, The Human Development report of 2001 presented by UNDP concludes that ICTs has an important development impact; through the appropriate use of ICTs social, economic and geographic barriers can be overcome [24]. The internal Digital Divide is not limited to developing economies. For example, even though the Internet and device penetration in the US is far above the worldwide average, there is still a Digital Divide between rural and urban areas, among different ethnic groups and different income levels. The US Department of Commerce indicates that the lower income groups in the US register higher rates of growth in terms of access to Internet. *"Such a positive interpretation of Internet diffusion in the US ignores the consistent fact that only one in eight in the low income group- who are also likely to be in central cities, belong to a minority racial group and have low education – has Internet access while more than three out of four have the same privilege at the other end of the socio-economic spectrum" [53].*

There is considerable research on the existence of the Digital Divide and many success stories and initiatives regarding specific regions or countries. Keinston presents at least fifty grassroots programs to bring ICTs to the masses in India. Unfortunately there is no knowledge transfer from project to project. Keinston presents a list of preliminary hypotheses that could be used measures the effectiveness of grassroots ICTs projects [20]. Tipton presents a comparative framework of ICTs agencies in asian countries to address the Digital Divide and the public policy framework in Thailand, Malaysia, Vietnam, Philipines, China and Singapore [44]. There are several documents about the initiatives to bridge the Digital Divide in Africa trough the "Yaounde declaration" [54], and the support of private companies to do that [41]. Monge and Chacon present an assessment of the Digital Divide in terms of the ICTs access for the citizens of Costa Rica .

Another area of study is the role of specific technologies. James studied the low cost ICTs available for developing countries to overcome the Digital Divide, the lack of awareness of the existence of these technologies in developing economies, and the absence of a specific organization to promote these technologies [55]. Morring presents the use of satellites as bridges to reduce the Digital Divide [39]. Lerner presents a study in Latin America and Mexico, bridging the Digital Divide and the impact of mobile data [40, 56]. Meall also presents low cost devices to overcome the ilitereacy such as the Simputer which is a "telecommunications-ready machine" with text to speech capabilities and voice mail [57].

2.1.3.5 Digital Divide Projects

There are a large number of local and international projects and possible solutions to reduce the Digital Divide at private and public levels. Not all of these initiatives identify themselves as Digital Divide initiatives, but they all fit in the definition of Digital Divide.

Bridges.org in the report "Spanning the Digital Divide, understanding and tackling the issues" reviewed 100 national and international initiatives to bridge the Digital Divide [57]. These projects were selected from the World Economic Forum, OneWorld.net, the Digital Divide Network's database and many other individual organizations. This organization classified the projects in 13 major types: Infrastructure providers, physical access providers, training programs, telecenters, school computer programs and distance learning programs, online information resources- relevant content, E-government, E-commerce, healthcare, agriculture, other applications of ICTs, technology development, *laissez faire*. The last one refers to authors who believe that the Digital Divide will be solved with the decrease in prices and diffusion of technology in the future. Their analysis indicates that there is a vast numbers of initiatives focusing on providing access to ICTs, but these initiatives frequently ignore factors that limit the sustainability of the projects and also that the Digital Divide is not only access technology but also the knowledge to use it.

Many studies focus on specific areas such as health, education, government, and so on. However, the Digital Divide is a very comprehensive problem and it requires a holistic and comprehensive approach. The findings of Bridges.Org and Venal support this assessment. Different organizations should work together to address all the issues involved in the Digital Divide at a national level [7, 58].

The Digital Opportunity Initiative (DOI) is one of the most significant initiatives that addresses the importance of ICTs in social and economic development [7]. This initiative provides a strong conceptual framework of Digital Divide issues. However, the conceptual framework has not been operationalized for decision-making at the strategic level. This research builds on these concepts and operationalizes the framework.

2.1.3.5.1 UNDP Strategic Framework

The Digital Opportunity Initiative (DOI) was formed by United Nations Development Programme (UNDP), Accenture and Markle Foundation with the aim *"to help mobilize, focus and coordinate action by developing a strategic approach to harness the benefits of ICTs for sustainable development"* [1].

The DOI, based on an analysis of the different approaches taken at the ICTs policy level and results, has developed a conceptual framework to help implement strategies which will help accelerate social and economic development through the use of ICTs [1]. In July 2001, the DOI presented a framework of action, a development dynamic composed of human capacity, infrastructure, enterprise, policy, content and applications.

As this research builds on DOI findings, a list of characteristics that define each key sector for the reduction of the Digital Divide was developed. This list was presented to the expert panel members. The experts modified the sectors and came up with the final list of key sectors for the reduction of the Digital Divide. Section 2.1.3.6.1 summarizes the combined UNDP report findings and the expert modifications for the "key sectors" of the model. Similarly, the list of applications presented to the expert panel members to review was based on the UNDP report. Each application was reviewed and modified by the expert panel. The final list of ICT applications is introduced in section 4.3.2.3 which corresponds to the "ICT applications" used in the model of this research.

According to the UNDP, *"In order to reap the benefits of ICTs for development, it is necessary to involve the full range of actors in the public and private sector in a process that is inclusive, open and participatory"* [1]. It is key to involve the main players in the design and implementation of the strategies for ICTs development; to assure the future of the project it is necessary to involve the receivers of the technology. This new form of involvement, collaboration and coordination between the different actors, public and private as well as national or international, is referred to as the strategic compact [1]. The characteristics of the strategic compact are: vision and leadership, strategic alignment, coordinated actions and collaborative partnerships [1].

UNDP identifies five key components of the strategic compact:

1. Infrastructure
2. Enterprise
3. Human capacity
4. Policy
5. Content and applications

The five components are all tightly interrelated, with each impacting the other four. An action in any one of the components results in impacts in all components. The components are explained below:

1. Infrastructure

The development of ICTs network infrastructure should involve the following:

a) **Strategically Focused Capacity:** The ICTs infrastructure should have a level of global connectivity, and the infrastructure should focus on areas or applications for key sectors for the development of the specific country, so the leverage is bigger [1, 5, 59] [54].

b) **Relative Ubiquity**: The infrastructure should help the support of universal access, community networks and public access points [1]. Universal access varies from country to country. In some countries privatization has helped the country's public telecommunications industry to improve the network infrastructure. In India, for example, for Grameen Telecom, the short-term goal will be to have at least one phone in every village [60]. However, in the case of Costa Rica, the people are opposed to the privatization of the National Institute of Electricity and Telecommunications (ICE), the country's agency in charge of ICTs. Therefore, in this case, the government is in charge of finding other solutions to provide universal access for citizens. In Costa Rica, the government is promoting public access to the internet through a new fiber-optic network infrastructure as well as providing free e-mail accounts to all Costa Ricans residents or nationals. One of the objectives of these e-mail accounts is to utilize them as a mean of communication between government and citizens. E-government applications also offer other means to provide universal access to diverse government services as well as transparency and efficiency in government.

A proper infrastructure will influence the other four areas, for example, infrastructure will support the actions in enterprises, health, and education. Distance learning, telemedicine or even e-commerce will need the ICTs network infrastructure [1, 2].

2. Human Capacity

"In order to deploy ICTs for development, it is important for countries to develop a critical mass of knowledge workers, technology users, and motivated entrepreneurs" [1].

Human capacity involves knowledge workers, intermediary and technology users, and motivated entrepreneurs. These areas are described below.

Knowledge Workers: There is no doubt that education has a primary role in this area to develop the required ICTs skills [32, 41]. The countries need to educate and retain their professionals [5, 28, 33, 54]. With knowledgeable workers, the ICTs systems can be maintained and modified according to the country's specific needs [61]. Local innovations in ICTs can take place only with the relevant educational curricula and the creation of facilities oriented to the development of ICTs skills to train the new workforce and to re-train the old one [1, 2, 5, 62]. It is necessary to popularize the sciences in developing countries to foster innovation and research [2, 33, 63]. There are some initiatives to implement new models of non-formal education to promote creative thought through the use of interactive scientific centers. For example, the Maloka center in Bogotá, Colombia, has the mission "*to contribute to the creation of a culture based on knowledge, incorporating technology into everyday lives and in production process, within a framework of sustainable development*" [64].

Another important factor to consider is the amount of research done in a country. The research that was conducted in the developing countries in 1990 was only 4% of the total research conducted worldwide, according to UNESCO. This research is generally applied research or fundamental research. Applied research has little impact on science; this research is basically for modifying the same product for different industries. Therefore, even if there may be a quantitative growth, there is no qualitative growth of research.

On the other hand, the fundamental research is done by people from developing countries working in developed countries. The problem with this research is the lack of appropriate logistic support for their research in the developing country. The researchers generally are dependent on their mother institute, and there is not a real linkage between that research and the country of origin. If proper research structures were in place, they would act as a means to link the fundamental and subsistence research to development policies in developing countries and avoid the brain drain from those countries to convert it into a brain gain [30-33, 65].

Intermediary and Technology Users: Technology per se is not useful; it needs to have a linkage with the real users, companies or individuals [1]. According to Kofi Annan, many of the initiatives for reducing the Digital Divide have failed because of a lack of long-term commitment between the sponsors of the programs and the receivers of it [27]. The creation of an ICTs awareness should involve all the players, users and providers [27, 33]. In this area is it also important to reduce the "brain drain"[2] and to develop policies to improve the market and social conditions [1, 30-33, 65].

Motivated Entrepreneurs: *"The development dynamic is also accelerated by the creation of a critical mass of motivated entrepreneurs, people with business expertise to leverage new opportunities*" [1]. Bringing technology to rural areas or areas without enough infrastructure and knowledge can foster entrepreneurship. With a variety of tools entrepreneurship can also help to reduce the Digital Divide [5]. That's the case of the "El Encuentro" project in Chile, where the telecenters provide the opportunity for young people to become IT trainers, radio conductors or even to establish an online business [66]. A country does not necessarily need to develop a high literacy level to have access to technology applications and generate new initiatives. For example, Grameen Telecom in Bangladesh has a project to provide telecommunications services to rural areas through the use of village pay phones. These phones are provided to selected members, borrowers of the Grameen Bank, who will charge users for the phone calls, and they will also deliver messages to the people in the village. Even though people probably do not have a superior education, the technology that they are using is friendly enough to help them make a profit and improve the economy of the area [60].

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[2] "According to the UNDP, it is estimated that more than 50 percent of the tertiary education students from developing countries that study abroad never return" [1] M. F. Accenture, UNDP, "Creating a Development Dynamic Final Report of the Digital Opportunity Initiative," 2001.

3. Policy

Eckaus, in his book *Appropriate Technologies for Developing Countries*, indicates that the available qualitative and verbal descriptions of technologies are not enough nor are they adequate for policy formation. He also states that although technological decisions will affect the development process in political, social and economic areas and vice-versa, usually technology selection will depend not only on the technologies' benefit but also on political and economic motivations [44]. These policies are frequently affected by short-term considerations based on political gains, not on a systematic decision process. Policy decisions must help to achieve coherent technological decisions compatible with a set of goals specific for each country and sector [30, 67]. Additionally, in the literature review for economic development there are recommendations for the economists and their influence on policy makers. Fox stated that economists should get involved in the non-economists policymaking roles, concentrating on a specific problem and consequences in a specific country, economy, and the social and cultural impacts [68, 69]. Eckaus takes into consideration not only the particular characteristics of each sector seeking development but also the influence of the policies' mechanisms [67, 68].

There are three types of technology policies: first, the ones which promote incentives for using a type of technology [2]; second, the ones to expand knowledge about alternatives available; and third, the ones that focus on disseminating technical information [67].

There is also research on econometric models in the Digital Divide. Dasgupta *et al.* presents and econometric analysis where the authors determined that the intensity of Internet use does not depend on the country's economic development, and the access to ICTs depends on the income differences between high and low income countries [70]. Adelman and Taft, on the other hand, present an econometric model for socio-economic and political change in developing countries. These authors analyze the interaction of social, political and economic forces that affect developing countries, and the importance of the political stability in their economic development [71, 72]; Badram and Foster *et al.* [33, 73] study the role of technology and education in developing countries and the return of investment. The authors indicate that policies promoting greater technology changes go hand in hand with the investments in education. The role of science, invention and innovation in developing countries as well as the policy contributions to developing countries is presented in the following studies [2, 32, 33, 74-78]. Haddad, for example, states that technological progess is the engine of economic growth and development and therefore investment in science and technology can bring substantial benefits for a developing country, not only improving productivity but also quality of life; additionally, the government should play a major role in the development of science and technology in a country, not only in the infrastructure but also at the educational level [37]. Furthermore, Norris states that *"Given the lower information and communication costs via the Internet, it is hoped that new technology will allow people to be far more knowledgeable about public* *policy issues, articulate in expressing their opinions, and active in casting their votes"* [37].

ICTs's impact on economic development is presented in the following studies [2] [79] [5] [80] [6] [81] [82] [83] [53]. For example, Steinmueller not only studied countries that have narrowed the economic divide through ICTs exports but also the difficulties to apply a technological leapfrogging, such as market conditions, acquisition of skills and adaptation of equipment, complementary technologies and capabilities, and the integration requirements [6]. However, none of these studies propose a systematic approach for the reduction of the Digital Divide.

The UNDP framework tackles two aspects of policy: transparency and inclusion and the institutional capacity. *"The overall policy environment, the degree of transparency and inclusion, and, more specifically, the regulatory environment, can all have a major impact on the development dynamic "* [1]. [3]

a) **Transparency and Inclusion:** *"Transparent and inclusive government processes are useful for both the expansion of ICTs, and also an area that the use of ICTs can facilitate"* [1]. E-applications will give remote districts access to diverse services such as e-government. Universal access also covers an important role here [1, 6, 33, 78, 84].

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[3] Although the regulatory framework and laws related to property rights are not part of the scope of this dissertation, the government sector is included in this dissertation.

b) **Regulatory Framework:** involves deregulation issues and the positive and negative consequences of liberalization policies[3]

c) **Institutional Capacity:** *"For an ICTs as enabler strategy and synergies among the components to be achieved, a basic level of institutional capacity is required"* [1]. Better education systems will help improve institutional capacity [1, 84].

4. Enterprise

The private sector has an important impact on the economy and the support of ICTs. The private sector is a major source of jobs, and it promotes the development of telecommunication infrastructure as well as education infrastructure [1].

According to UNDP, the following are the critical factors for enterprise development:

a) **Finance and credit** [2, 5] [4]

b) **Property rights and commercial law** [32] [5]

c) **Fair tax regime**[6]

d) **Access to relevant global and local markets:** One of the advantages of ICTs networks is the worldwide access that they provide. It reduces the country's borders and provides global market information.

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[4] This area is outside the scope of this dissertation.
[5] This area is outside the scope of this dissertation.
[6] This area is outside the scope of this dissertation.

e) **Increasing efficiency and reach of local business:** *"Examples given in ... suggest that it is crucial that ICTs be used to improve the efficiency and reach of local business to make the entire local economy more productive, globally competitive, and better connected to local and global markets"* [1]. Depending on the market characteristics, ICTs can be used for business to business transactions or more traditional means of exchange. The ICTs can provide market information systems, efficiency and productivity improvements [6, 78], enhancing rural and economic opportunities throughout the ICTs infrastructure [1, 28] and effective partnerships [5].

f) **Demand Stimulus:** Each sector of the economy has its own requirements of ICTs infrastructure and services [1, 5, 6]. For example, in developed countries there is a high demand for ICTs infrastructure, especially for the financial sector, in contrast to developing economies, where the high demand will come from the government [1]. Private and public sectors can generate a demand for ICTs's applications. In Chile, for example, the government has in place applications where it can automatically generate the tax declaration of each citizen to be accepted or rejected electronically by the citizen.

5. Content and Applications

In this area there are four aspects to consider:

a) **Relevance and Usability:** The use of ICTs by the end-users will depend on the user's interests, ease of use of the technology, the language, the equipment characteristics and the working environment [1, 41, 54, 61, 78].

b) **Language compatibility:** In some countries the level of ICTs use will depend on the introduction of the specific characters or fonts for the language being used [1, 6, 61].

c) **Affordability:** *"Unaffordable access is probably the most important reason for low use of ICTs in developing countries"* [1]. Low-cost computers and telecenters are among the initiatives to solve this. Cost constraints are still an important factor in the adoption and use of ICTs [32, 41].

d) **Development Applications:** The ICT applications need to focus on development goals. These development goals cover education, health, the economy, environment, empowerment and political issues [1]. These applications vary from market information systems, e-government applications, distance learning, virtual research groups, to remote consulting and so on. *"The programs that are implemented at the local level must be thoroughly researched and carefully* *planned while leaving enough flexibility to adapt to special conditions"* [41].

2.1.3.6 The role of ICTs for specific development goals

Five areas have been identified by the UN Millennium Summit as development imperatives: heath, education, economic opportunity, empowerment and participation, and the environment [1]. These development imperatives are the base of the key sectors used in this research. All the sectors remain the same with the exception of empowerment and participation which is considered as the government sector. All these areas are present in the research of the Digital Divide and the ICTs role in the society.

There is a large amount of research of ICTs and its impact in society. For example the OECD in the report "OECD Information Technology Outlook 2000" presents an analysis of ICTs production by region, by product and so on. As well as the employment trend in 14 OECD countries in High-tech companies. This report also presents the ICTs markets by segment and ICTs expenditures as percentage of GDP, where telecommunications is the area of major expenditure [30-33]. Other research presents the role of ICTs in specific areas such as the government sector, specially in terms of e-government[34]; or ICTs in the educational sector [2, 7, 28, 73, 85-89]. For example, Hoyos states the urgent necessity to develop integrated programs to create a culture based on knowledge and incorporating everyday technology in it [64].

2.1.3.6.1 ICTs for Specific Development Goals

The following section describes the uses of ICTs in the key sectors: heath, education, economic, government and environmental sectors.

ICTs for Health

Health is one of the areas that has experienced the benefits of ICTs [1, 2] [7, 30-33]. The applications vary from remote consultation and diagnosis to disease prevention and epidemic response efforts [1] as well as decentralized health systems management [62].

There are many examples in this area. In Argentina, for example, there is a project to provide medical support to rural hospitals and populations located in not easily accessible areas via tele-consultation and vital signs monitoring. There are also telemedicine projects to link more than one country, as is the case of the Afro-Arab Telemedicine Network (ArtNet), which will connect Egypt, a country that has a national telemedicine network of eight nodes, with Ethiopia, Morocco, Uganda and others as well as medical centers in Europe and the US [90].

ICTs for Education

Distance education is probably the most evident use of ICTs in this area. ICTs enable the enhancement of the learning process as well as helping to empower indigenous research and development [91]. Virtual research groups, technical and vocational training [2, 61], simulations and even improvements in the efficiency of the education administration are examples of ICTs use in this area [1]. In Costa Rica, one of "Little Intelligent Communities" (LINCOS) objectives is to provide a set of educational tools to foster the creativity of inhabitants of communities with low possibilities of development. They also offer technological community centers for education [92].

Another of the ICT applications is the use of technology to enhance the learning process. Computers and multimedia software are tools for creating knowledge and helping students to learn. [33]

ICTs for Economic Opportunity

ICTs can contribute to the generation of new economic opportunities [1]. ICTs can help to improve the efficiency in the process of an organization as well as provide access to the rest of the world [2]. New ways of doing business and delivering services will be influenced by ICTs, for example, telecenters [56] [7] [93] equipped with enough infrastructure where individuals or small enterprises can share IT resources. People can go to telecenters instead of the main organizations and reduce commuting time. Telecenters can also help reduce the cost of technological infrastructure. ICTs facilitate global connectivity, providing access to new markets.

As an example, *"Consider the two young 14-year old girls from a slum in Hyderabad who received training from Stayam Computers and now have their own small company designing websites and doing data-entry work"* [50].

ICTs for Government

"ICTs can contribute to fostering empowerment and participation and making government processes more efficient and transparent by encouraging communication and information-sharing among people and organizations, and within government" [1].

Through the use of ICTs, governments can expand their services to citizens in remote areas as well as improve the quality and response of their services [1]. ICTs can also be used to foster freedom of expression, human rights and democratic processes [33], for example, to get the citizens involved in public discussions or even voting [1].

The e-government's applications have been used by some governments to provide better communications and services to poor communities [2]. This is the case in India where the Gyandoot Project in Dhar has developed a system to collect complaints from 30 village communities in India. Complaints range from the lack of a teacher at school to the need for a veterinarian. The rising number of complaints has put pressure on the offices to improve their systems and keep up with the demand [50].

Other applications are, for example, the initiatives to computerize land records across states. Examples of this are the "Bhoomi" (www.revdept.kar.nic.in) in India [50] and the automatization registration office of Lima and Callao cities (ORLC). The www.orlc.gob.pe is the first automated public registry in Latin America. Another project is a website (www.minjus.gob.pe) in Peru where they have posted the current laws of the country [94].

ICTs for the Environment

"ICTs can make a valuable contribution to sustainable environmental management by improving monitoring and response systems, facilitating environmental activism and enabling more efficient resources use" [1]. ICTs has been used to obtain a better understanding of biodiversity issues for the management of natural scarce resources, for fighting against pollution, for monitoring environmental disasters [1], and for meteorology [2].

These five areas identified by the UN Millennium Summit as development imperatives are the key sectors represented in our model. ICTs can modify the Digital Divide in each one of these key sectors in any country.

2.2 ANALYTIC HIERARCHY PROCESS

In order to achieve the research objectives, it is necessary to use a method which systematically measures the impacts of strategic decisions on the reduction of Digital Divide in a developing country. The method selected for this purpose is the Analytic Hierarchy Process (AHP).

AHP has been developed by Saaty (1980). It is a tool to help make decisions through the quantification of subjective judgment of individuals or groups of people. The decision process is modeled as a hierarchy with the decision criteria and sub-criteria being at the top levels and the decision alternatives at the lower level. Using a ratio scale in each hierarchical level, pairwise comparisons are made by the decision makers. At the end of the process, AHP determines the relative priorities of the decision alternatives [8].

" AHP provides the framework to view the problems in an organized but complex framework that allows for interaction and interdependence among factors and still enables the decision-maker to think about them in a simple way" [9].

2.2.1 Elements

The main elements in AHP can be represented in the following hierarchy:

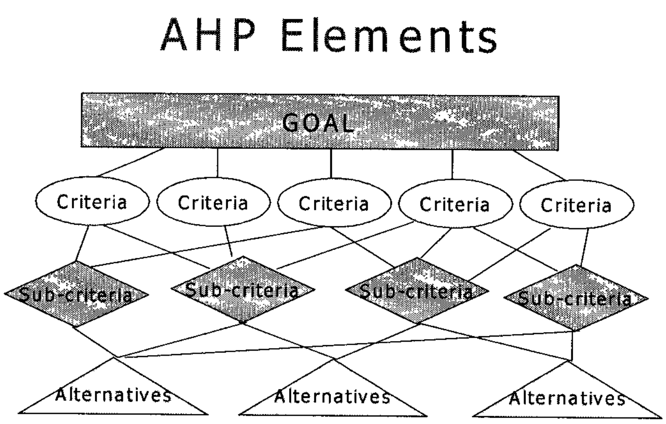

Figure 3: AHP Hierarchy

Level 1 – Goal / Objective: What needs to be accomplished.

Level 2 – Criteria: The elements of the goal, in some cases also called objectives.

Level 3 – Sub-criteria: The elements that conform the criteria. They are also called strategies.

Level 4 – Alternatives: These are also called actions, which will contribute to the upper-level criteria [8-10].

2.2.2 Axiomatic Foundation of AHP

AHP has 4 major axioms as its theoretical basis:

Axiom 1 (reciprocal): Consider the preference matrix A, which is constructed throughout the pairwise comparison of n alternatives or criteria; this matrix has the property that for all a_{ij} elements there is a reciprocal element. In other words, for $a_{ij} = 1/a_{ji}$. [8-10].

Axiom 2 (homogeneity): For all $a_{ij} \neq \infty \quad i, j \in A$. When comparing any two alternatives or criteria, one of them cannot be infinitely preferred over the other. If that is the case, the elements should be placed in different comparable clusters [10].

Axiom 3 (independence): When comparing any two criteria, it is assumed that they are independent of the properties of the alternatives [10].

Axiom 4 (expectation): The hierarchical model must be complete, adequately representing the ideas of the decision-makers so the results will match these expectations [9, 10].

2.2.3 Process

There are three main steps of AHP:

1) The decomposition of the problem in a hierarchical structure, where the first level will be the mission or goal and the following lower levels are the attributes of the superior level. The last level contains the possible actions, alternatives or decisions.

2) The collection of the data. At each level of the hierarchy, the decision-makers state the preference for each alternative's contribution to the next higher level throughout the use of pairwise comparison. The decision maker will establish the preference between alternatives. Saaty uses a scale of 1,3,5,6 with intermediate levels of 2,4,5,8. The experts then have to express the judgment criteria in terms of how many times one element of the pair has more impact than the other element. This research uses the constant sum method because it gives a more refined measurement, especially when the elements being compared are close to each other. The constant sum method allows the expert to distribute 100 points between every pair in the same level. The analyzed data will result in a series of matrices, which will indicate if the alternatives are equally preferred, less preferred or highly preferred.

3) The relative weights are determined at each level for each alternative. This gives ratings for the relative impact values as each alternative's contribution to the system's goals and mission. [8-10].

2.2.4 Applications

AHP has been used for a wide range of applications. Most common applications are in the areas of strategic decision making [95], resource planning [96], resource allocation [11], prioritization of resources such as energy resources [97] or customer demands [98], risk analysis, conflict resolution [12], project management [12-14, 99, 100], project/resource selection [12, 13, 15-17, 99, 100], forecasting [101], technology transfer [102] performance evaluation of systems such as the shipping performance of an organization [103], Metal die stamping for complex layouts " The proposed strip-layout index helps to evaluate and rank any given set of strip-layout alternatives" [104]. AHP has also been used in agriculture for quantitative evaluation of soil [105]. Furthermore, AHP has been used in regenerative medicine and evaluation of human tissues [106] among other areas.

2.3 LINKING THE LITERATURE REVIEW TO THE DISSERTATION

The literature presents different gaps. In relation to the Digital Divide the literature presents:

1. Definition of the Digital Divide and importance of closing this gap.
2. Recommendations only at a policy level
3. Situational studies of a specific country and/or region.
4. Measurements of accessibility and device penetration classified by region, gender, economic class and so forth.
5. Studies of the different existent projects in the Digital Divide.

These studies do not present an operationalized model according to the concepts presented in the UNDP model, measuring the impacts that each ICTs has in the reduction of the Digital Divide in a specific country as well as the impact of the applications applicable to the reality of the country. Finally, these studies do not address the impacts of reducing the Digital Divide on the health, education, economic, government and health sectors in a developing economy.

In relation to AHP, even though there are many studies at a tactical and strategic levels in diverse areas related with ICTs and technology selection, they are not related to the Digital Divide.

In relation to Costa Rica, the majority of studies on the Digital Divide are in relation to the accessibility and infrastructure. There are also studies of assessment of the current technology infrastructure and readiness. In addition, there are different governmental programs that try to attack one area of the Digital Divide, but these programs are not comprehensive. For example, the access program focuses, as the name indicates, only on Internet access and equipment. It does not focus on the health, education, economic, government and environmental sectors. It covers the access to technology, but if these initiatives are not integrated with the right content and the human capacity to interact with those technologies, the gap is going to be still a problem. Closing the Digital Divide will require a holistic approach covering the key sectors of the country, and a model built according to the country's needs. The diverse areas that the Digital Divide covers should be studied using a systematic and comprehensive approach.

CHAPTER 3: COSTA RICA

This chapter presents a brief description of Costa Rica, the country selected for this dissertation. Costa Rica was selected because of its interest in technology issues, the internal Digital Divide, and the availability and willingness of participation from high level decision makers.

Costa Rica is a developing economy where the Digital Divide is present and has been measured in terms of accessibility, device penetration and other measurements. During the last decade, the Costa Rican government as well as academic and public sectors have focused on information technologies as a means of achieving social and economic development and the reduction of the Digital Divide [107].

Costa Rica is geographically located in Central America between Nicaragua and Panama and has both Pacific and Atlantic Coast lines. It has an area of 50,900 square kilometers, and a population of four million inhabitants. With a literacy rate of 90 %, *"The population, one in three are under 14, is well educated and hard currency earnings flow in from tourism, business services and electronic exports*" [108].

Education in Costa Rica has been always a high priority. Jose Maria Castro Madrid, founder of the Republic of Costa Rica, said *"Liberty without education is almost illusory"* [109]. Education has received special attention after the abolition of the army more than fifty years ago [107, 108, 110]. Education is free at all levels and mandatory up to middle school. Health has also been important for Costa Ricans. This is reflected in the fact that hospital and medical services are available for low cost to the entire population. The United Nations ranked Costa Rica in the group of first-tier nations on its human development index group in their United Nations Human Development Report [24, 84, 108, 109, 111].

In its commitment to the environment, Costa Rica was ranked ninth of 142 countries studied [108]. Ecotourism is one of the major sources of income, with a rich biodiversity and a population committed to the environment. Costa Rica has more than a quarter of its territory occupied by over 50 natural reserves and national parks.

Among the most productive activities in Costa Rica are the industries based on ICTs. They are forecasted to have large growth in the near future [112]. During the last seven years, the Costa Rican government as well as academic and public sectors have focused on information technologies as a means of achieving social and economic development and the reduction of the Digital Divide [107].

In relation to the technological development of Costa Rica, it is important to note the following ICTs policies and initiatives that have an impact on the key sectors in the country:

1) A decade ago, the taxes on computer imports were eliminated, making them more accessible to the population.

2) The Omar Dengo Foundation was created with the main objective of bringing computers to primary schools, and giving technology access to the students from kindergarten on.

3) The University of Costa Rica created the Academic and Research Network known as CRNet. All of these things have helped the software development industry to flourish in the country [109, 113, 114] .

4) Costa Rica's technological advance index has ranked the country in the group of Potential Leaders in the United Nations Human Development Report [84].

5) The Costa Rican Investment Board (CINDE) assists foreign investors to establish operations in Costa Rica. CINDE also has a program to attract foreign direct investments in three main sectors: medical equipment, electronic and business services. In addition, it also has other areas of interest such as textiles and tourism. In part due to CINDE there is a group of foreign enterprises investing in Costa Rica such as Intel, Abbott, Baxter and Procter & Gamble.

6) Intel arrived in Costa Rica in 1998 [115]. *"We believe that the arrival of Intel to the country has been crucial, not only because of the employment opportunities for Costa Rican engineers and technicians and the opportunities for linkages with the rest of the economy, but also because this stands as a recognition of our skilled work force"* [109].

Although coffee and bananas are still important to the economy, Costa Rica is transforming its agricultural economy to a technology oriented one with computer chips and software [108, 110, 116].

In 1999, Costa Rica's GNP grew 8%, however, the effect on the national income was reduced. The positive effect on the GNP number was caused by the exports in high-technology products, but these products required for their creation large quantities of imported products. Local industry does not yet provide all the supplies needed for the high-tech companies investing in Costa Rica [117].

7) Software Industry: There are at least 137 enterprises dedicated to software production; 70% of these enterprises have been created in the last 10 years. The products are either generic software, tailored software and / or services for software development in other businesses. More than 80% of these enterprises use Costa Rican capital [118, 119].

It has been estimated that in 1998; the annual amount of this sector's export had grown by $30 million. There are also some local software companies that report growth rates of up to 300%.

8) In relation to human resources, industry, academia, research institutions and government agencies are studying current needs and future trends in labor market demands [107, 109]. The use and development of ICT applications require human resources with the right qualifications. The lack of personnel limits organizations in their development and focus on change. However, in studies of the productivity of its human resources and speed of learning, Costa Rica has ranked even better than countries such as Chile, Mexico and Argentina [84, 110].

The software industry is requiring more quantity and quality of developers as well as other technical professions to keep growing and compete in an international market that is more and more demanding. According to the Center of Formation of

Technology (CENFOTEC), there is a continuing growth of salaries in the software industry due to the lack of personnel and the quality required. Since the local software industry has been growing in recent years, the demand of product and IT services has grown too, which has provoked a high demand for knowledge workers. The public universities, which are the most preferred to hire from, do not offer enough places to accommodate the demand of students who wish to study for technological careers. Industry has started to put more emphasis on the quality and requirements of human resources and to support the different educational institutes. CENFOTEC, for example, is a technology center founded by local software industries (Exactus, CODISA and Art in Soft), investors and the academic sector to train or retrain professionals in the technological areas of interest of the current technology market in the country.

The public sector is also interested in generating new training in ICTs technologies. For example, the National Institute of Learning (INA) is expanding its programs in technical education such as providing training in Internet and telecommunications [115].

According to Dr. Guy de Téramond, the former Minister of the MICIT, what Costa Rica needs in terms of human resources is to improve the quality [114]. The MICIT has started a scholarship program to provide high-level human capital at masters, and PhD levels in new areas of knowledge such as telecommunications, software engineering and computer science [109, 114, 120].

9) Finally, it is important to make reference to the National Institute of Electricity and Telecommunications (ICE). This is the regulator body of telecommunications in Costa Rica and is fully owned by the government. Although there have been efforts to open the telecommunications market, public opinion has been against it, so the telecommunications industry in Costa Rica is a monopoly. However, with the current legislation, it is possible to have free competition in the layers close to the end users. In any case, if in the future the markets open, ICE will have a competitive position with the "Internet Advanced Network" ("Red de Internet Avanzada"), a powerful Internet infrastructure provided to the public[7] [109].

It is important to recognize that the ICE was created to develop energy resources, and it has been quite successful with 97% electric coverage of the population. It also has 95% coverage of telephone lines at the national level and has one of the most developed telephone systems on the American continent [109]. However, the ICE has not fulfilled the demand for cellular telephones. ICE has provided this service since 1994, and the demand surpassed the projections. There is a new project in process, to acquire 400,000 lines to cover this gap [110].

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[7] Fore more information in the Internet Advanced Network " Red Avanzada de Internet" please refer to section.3.1.1.1

3.1 DIGITAL AGENDA

In the government of Miguel Angel Rodriguez, a Digital Agenda, which contained ICTs policies and projects, was created to focus government's actions on five important pillars for the technological development of Costa Rica. These pillars are the development of telecommunications infrastructure, the reduction of the Digital Divide, the reform of the regulatory framework, support of the private sector with the changes and challenges of the new economy, and the digital government [114, 121].

There is at least one major project related to each one of these areas.

- Infrastructure: Internet Advanced Network ("Red Avanzada Internet") and "Internet 2" projects
- Private Sector Support: "MarketPlaceCostaRica.com", and the Enterprise Information Systems of Costa Rica ("Sistema de Información Empresarial Costarricense") projects
- Digital Divide: Communication without frontiers ("Comunicación sin fronteras") and Costarricense.cr projects
- Regulatory Framework: "Intellectual Property Law" and "Digital Signature" projects[8]
- Government: Digital Government "Gobierno Digital" project [114, 121]

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[8] The regulatory framework is outside the boundaries of this dissertation.

3.1.1 Infrastructure

3.1.1.1 Internet Advanced Network ("Red Avanzada de Internet")

Internet Advanced Network ("Red Avanzada de Internet") is a telecommunications infrastructure project. This is a joint project of the MICIT and the ICE. Its objective is to provide to all Costa Ricans, included those living in rural areas, access to a high-level infrastructure of telecommunication based on Internet protocols to transmit the data, to provide content, information and services to the government portal, the diverse institutions of Costa Rica, as well as high speed access to networks around the world.

The National Institute of Electricity and Telecommunications (ICE) had already installed fiber optic rings during the previous decade covering 90 % of the country's population [122]. Costa Rica's telephone coverage is 95% of the country in fixed lines. The Internet Advanced Network ("Red de Internet Avanzada") project took advantage of the fiber optics and the copper networks installed as well as the electric lines. The project foresees covering 240 telephone districts nationwide. The objective of the "Red de Internet Avanzada" project is to have 100,000 Digital Subscriber Line (DSL) lines, and with a national population of four million inhabitants, the coverage will be 2.5%, which will put Costa Rica in fifth place worldwide for broadband coverage [113, 114, 122].

The main technology for the connection will be DSL, which provides a range of 5 or 6 kilometers around each central station. In locations where DSL is not an option due to the distance, the ICE will use the Integrated Services Digital Network (ISDN), "Red Digital de Servicios Integrados (RDSI)" and / or wireless systems. The following map shows locations and distribution points.

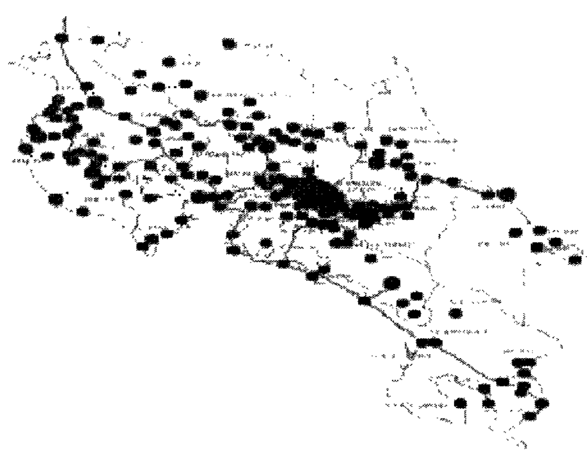


Figure 4: National Coverage [123]

With this project the MICIT expects an exponential increase in access and use of the Internet. Additionally, the connectivity to the rest of the world using transoceanic fiber optics will be increased by a factor of 50.

There are other complementary projects such as border to border or "Frontera a frontera" to connect the country north and south and east and west with other fiber optic networks [113] [114] [124].

3.1.1.2 Internet 2 ("Red Nacional de Investigación Avanzada")

The National Research Advanced Network, "Red Nacional de Investigación Avanzada" or "Internet 2", is a complementary network created for advanced scientific applications in all areas of knowledge and superior education. The objectives are to promote the development of research networks, Internet 2 and 3, to generate new research and technologies, provide researchers with tools to keep them up to date and let them know and utilize the latest advances available, and provide the infrastructure needed for areas such as telemedicine and distance learning [114].

Throughout the Internet Advanced Network ("Red Avanzada de Internet") and Internet 2 program, the cost of Internet connections can be reduced by a factor of 20 from the current rates [114, 122, 124].

3.1.2 Private Sector Support

There are different projects from the government to support the private sector, which try to take advantage of technology such as MarketplaceCostRica.com and Enterprise Information System of Costa Rica, "Costa Rica Provee" and Tourism on line.

The "Promotora del Comercio Exterior de Costa Rica- PROCOMER" is the institution in charge of promoting Costa Rican products to the world. MarketPlaceCostaRica.com is a project of PROCOMER. This web site's objective is to promote the exportable products of Costa Rica, making the products and enterprises well known throughout the most important search engines on the Internet such as Yahoo, Google, AltaVista, Lycos, Excite and MSN. MarketPlaceCostaRica.com offers search options by sector and products. The web site has general information about each enterprise, a description of the products as well as links to the enterprise home page.

The Enterprise Information System of Costa Rica's objective is to provide all the information necessary to establish and operate businesses in Costa Rica. This information system also permits the selection of a list of enterprises by productive sector, geographic location, and type of supply offered by the enterprises as well as demand [125, 126].

3.1.3 Costa Rica's Digital Divide

There is a clear existence of the Digital Divide in Costa Rica between geographical zones, between children and adults as well as between groups of different levels of income and education. This divide is related to Internet access as well as the access to other ICTs. According to the Costa Rican Advisory Commission in High Technology (CAATEC), only 3.4% of the homes in Costa Rica have access to the Internet. Although this is a low percentage, the Internet has a high percentage of use thanks to access through Internet cafes, schools and / or in work places. E-commerce in Costa Rica is still in its early stages. There is a lack of content in

Spanish, which causes another divide in terms of language since the majority of content on the Internet is in English [43].

Although there is a Digital Divide according to CAATEC, the digital literacy rate is high (84% of youth and 41% of adults have used the Internet at least once). And the zero tax policies for computers as well as the importance of the technological sector in the country are becoming motivators to have access to ICTs's. The Internet Advanced Network ("Red de Internet Avanzada") project will also help reduce this gap [43].

3.1.3.1 Communication without Frontiers ("Comunicación sin fronteras")

Communication without Frontiers is a national program to promote the access of ICTs's to all Costa Ricans, especially those who have limitations due to their geographical location or social condition.

The objectives are to develop a public policy to promote the importance of the ICTs, to foment a national culture which values and utilizes the opportunities that ICTs offers to promote education of the project's population to warrant the use of ICTs and the involvement of it in useful issues according to the population's needs as well to use them in a democratic way, to support the creation of telecenters for daily activities of the citizens, to exchange information, to make operations with the digital banks, and to foment culture and democratization of the Internet. In summary, the objective is to consolidate a national culture for the use of e-commerce and the Internet as a social and a democratic tool.

3.1.3.2 "Costarricense.cr" program

The "Costarricense.cr" program is now part of Communication without Frontiers. The program provides free e-mail accounts to all Costa Ricans and residents in Costa Rica. The e-mail accounts can be checked for free at some post offices or government agencies centrally located in different towns or neighborhoods [124].

3.1.4 Costa Rica Digital Government Program "Programa de Gobierno Digital: Republica de Costa Rica"

During the government of Miguel Angel Rodriguez (1998-2002), president of Costa Rica, the role of technology in the government was highly emphasized. The government of Costa Rica started a process to change the public institutions in order to make them more efficient, transparent and effective. This implies qualitative and quantitative changes in diverse areas such as human resources, and in the processes and the means by which the government manages governmental processes [108, 121].

The mission is to convert Costa Rica's government to a better government incorporating a new generation of services that includes three key elements: human resources, technology and processes. The central portal of the government (http://www.go.cr) is designed to be the entry point of the citizens to establish a communication channel between them and the public institutions. The idea of this portal is to have the best practices in the design of web sites of the government, and in this way be a model to be imitated by other public institutions. The intention is to make digital government an integrated application with all the public institutions. The portal provides a general interface, where each institution will link their own website. Each one of these institutions is in charge of their own web site; however, the technical, security and integration issues are dictated by the central portal and checked by the Agency of National Digitalization (ADN).

Some of the services that the portal offers are services related to electronic tax reports, the acquisitions of the states, promotion of international commerce, e-bulletins, e-forums, as well as a platform to pay for public services [113, 121].

3.1.5 Accessibility Program "Programa Acceso"

This is a new project of the Ministery of Science and Technology. The objective of this project is to reduce the Digital Divide by providing better options for acquisition of computers with access to the Internet. The project will provide 100,000 computers, which will help to improve the penetration rate of computers in Costa Rican homes and improve the rate of access to the Internet, information and knowledge. This project is coordinated by the MICIT, and there are different organizations participating such as Dell, Microsoft, Lanix Costa Rica, DHL, Intel and some Costa Rican banks[127].

3.1.6 Other initiatives

Public Internet Terminals: The ICE started a pilot project in 2002 to install public touch screen terminals in public places such as ports, touristic places, airports and public agencies. This will enable clients to access Internet using the same phone cards widely available in the country. The ICE also has mobile units in remote areas with public phones and computers that have access to the Internet [128].

However, the majority of these initiatives have the same problem as the ones presented in the literature search, the main focus is one area of the Digital Divide, for example access of technology but not integrated with the right content or the human capacity to interact with those technologies. The Digital Divide needs a holistic approach covering the key sectors of the country, and a model according to the country's needs.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 RESEARCH OBJECTIVE

The Digital Divide and the use of ICTs have been widely studied. The majority of the research analyzes the current infrastructure development or the device penetration. It also covers case studies and gives recommendations at a policy level; one of these studies is the Digital Opportunity Initiative report from UNDP. Although quite comprehensive, this report has not being operationalized with a systematic approach.

The model presented in this dissertation considers the five specific development goals defined by UNDP as key sectors. These sectors will have ICT applications that will have an impact on the reduction of the Digital Divide in each sector. In turn the reduction of the Digital Divide of each sector may impact the reduction of the internal Digital Divide in a developing country such as Costa Rica. The research objective is the identification of ICTs, technology applications and sectors and their impact on the reduction of the internal Digital Divide in a developing country.

4.2 RESEARCH QUESTIONS

There are five research questions in this dissertation:

1. What is the relative impact of the reduction of the Digital Divide of each one of the five key sectors on the overall reduction of the internal Digital Divide in a developing economy?
2. What critical ICT applications contribute to the reduction of the Digital Divide in a developing economy?
3. What are the relative impacts of the ICT applications on the reduction of the Digital Divide of each of the five key sectors?
4. What are the relative contributions of the available ICTs on each of the ICT applications?
5. To what degree does each ICTs impact the reduction of the Digital Divide in a developing economy?

4.3 RESEARCH APPROACH

The dissertation utilizes the Analytical Hierarchy Process (AHP) for creating a developing technology selection model to reduce the Digital Divide in a developing economy. An expert panel provided subjective values to determine the relative impact relationships among the decision elements at all levels of the hierarchy.

4.3.1 The Expert Panel

An expert panel was formed to help develop the hierarchy, to provide the data for the relative impacts, and to interpret the results. The experts were selected from academia, industry and government agencies in Costa Rica. Many of them are members of the Advisory Council of the Ministry of Science and Technology of Costa Rica.

The selection of the members of the expert panel is based on their in-depth knowledge and experience at a high level of decision making in health, education, economic, environmental and political sectors impacting strategic development and policy making in Costa Rica. This panel included at least three experts for each sector. The experts had to fulfill the following criteria:

1. Decision-maker role, or expertise in advising decision makers in Costa Rica.
2. Representation of industry, government or academic institutions in a balanced mix.
3. Expertise in at least one of the sectors considered in the study.
4. Expertise in developing, acquiring or implementing technology at a strategic level for improving one or more of the sectors under consideration.

A total of 15 experts agreed to participate with at least four experts for each key sector defined as ICTs for specific development goals by the United Nations Development Program (UNDP) [1]. The following table presents the areas of expertise of the experts.

Table 1 Experts' area of expertise

Experts/ area of expertise	Health	Education	Economic	Government	Environment
Expert 1			X	X	
Expert 2		X			
Expert 3		X			X
Expert 4	X				
Expert 5			X	X	
Expert 6				X	
Expert 7			X	X	
Expert 8	X	X			
Expert 9		X			
Expert 10			X	X	X
Expert 11			X	X	
Expert 12					X
Expert 13		X			
Expert 14	X				
Expert 15	X	X	X		X
Total per area	4	6	6	6	4

The experts identified the strategies for each dimension of the study and provided quantified values for their subjective judgments about the impact of each decision element on the next level of the decision hierarchy. Finally, they provided assistance in evaluating, validating and interpreting the results.

4.3.2 Model Definition

The use of ICTs for specific development goals has been studied by the United Nations Development Program (UNDP). The UNDP has identified 5 key areas: health, education, economic opportunity, empowerment and participation, and environment [1].

The model developed in this dissertation considers these five areas as key sectors which by reducing the Digital Divide in each sector may impact the reduction of the Digital Divide in a developing country such as Costa Rica. This part presents the definitions of the reduction of the Digital Divide in each sector and the respective ICT applications. In this research the ICT applications are mechanisms to help the sectors to reduce the Digital Divide using ICTs. The initial set of ICT applications were taken from the final report of the Digital Opportunity Initiative elaborated by the United Nations, Markle Foundation and Accenture Foundation in July 2001. However, the final ICTs list of applications used in this model had some modifications coming from and approved by the expert panel.

A four-level hierarchical model has been developed as shown in Figure 5:

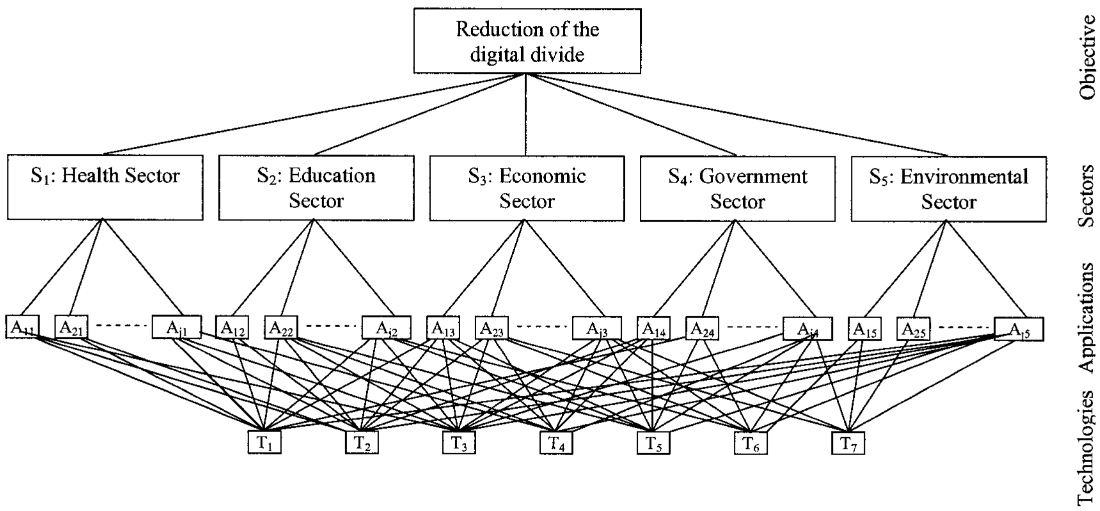


Figure 5: The Decision Hierarchy

The following sections present each level of the hierarchy and its definitions. The definitions presented here are the compiled and finalized version of what was identified first by gathering information from the literature and then modified by the expert panel members. Appendix L has a list of the references used for the definitions of the model.

4.3.2.1 First level

This level represents the objective of this study: the reduction of the internal Digital Divide.

4.3.2.2 Second level

The second level consists of five key sectors: health, education, economic, government and environmental sectors. The reduction of the Digital Divide in each of these sectors will have an impact on the overall goal of reducing of the Digital Divide in the country, but what is the reduction of the Digital Divide in each sector?

The reduction of the Digital Divide on the health sector in terms of this research is bringing hospitals, clinics, health centers and health professionals in rural and urban areas to a level where they can utilize ICTs capabilities; and by providing the community with the tools that are required for access to good medical service.

The reduction of the Digital Divide on the education sector is bringing all the education institutions and professionals in the country to a level where they can benefit from the use of ICTs; and by providing the community with the tools that are required for access to good education no matter where the individuals are or what education degree they pursue.

The reduction of the Digital Divide on the economic sector is improving business efficiency and productivity throughout the country to become competitive in a global economy through the use of ICTs; and by providing businesses, professionals, farmers, and the general population with ideas and solutions to create and/or capture markets and economic opportunities.

The reduction of the Digital Divide on the government sector is fostering empowerment and participation of the people through the use of ICTs; and by making government processes more efficient and transparent by sharing information among individuals, business and government.

The reduction of the Digital Divide on the environmental sector is managing information about biodiversity and creating sustainable development through the use of ICTs with a focus not only on the research community but also on the public in general.

4.3.2.3 Third level

The third level consists of a diverse range of information technology applications. Each technology application has an impact on the reduction of the Digital Divide in the sector with which it is associated. Following is a comprehensive list of the applications used in this model described sector by sector.

4.3.2.3.1 Applications in the health sector:

A.1.1. Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population: telemedicine, remote consultation, diagnosis and treatment that take place without having the patient in the same physical location as the physician; the information is gathered and then sent through digital means to the respective physicians[62, 90].

A.1.2. Preventing diseases and improving epidemic response: capturing information about cases of contagious diseases, monitoring them and disseminating information by broadcast media or other ICTs means; creating DRGs (diagnosis related groups).

A.1.3. Providing on-line medical libraries: making medical libraries accessible to health professionals, especially in remote areas, to keep up-to-date on medical knowledge and related literature; and providing the general population with the means to learn more about certain illnesses or health issues.

A.1.4. Facilitating diagnosis in distant medical labs: using ICTs technologies to get data for clinical trials locally to be evaluated in distant labs. Standardizing the processes used in the labs for consistency and effectiveness of illness identification.

A.1.5. Improving the efficiency of the health system in every geographic area: using e-applications which provide low-cost healthcare information and facilitate consultation, referrals, scheduling, unique medical records e-procurement; developing a data base of medical records with Internet access for use by public and private healthcare providers; improving the efficiency in procurement and resource management in health systems according to the geographic areas' needs.

A.1.6. Creating awareness of health issues in the population through the use of ICTs: disseminating information about infant to old age health problems to the population through the use of ICTs.

4.3.2.3.2 Applications in the education sector:

A.2.1. Enhancing the learning process through the use of ICTs: providing access to knowledge and facilitating collaborative and interactive learning, thus enhancing the traditional education system[129, 130]. It includes on-line communities for students, teachers and/or professors; instructor support through multimedia learning materials, bulletin boards and e-mails; collaborative projects among instructors and students; student tracking systems to evaluate the student's progress; chat rooms, email, bulletin boards, conceptual maps, and home pages; special programs for educating teachers about how to utilize computer technologies as a teaching tool, promoting education with IT use in K-12; and creating new instruments for evaluation and appraisal.

A.2.2. Improving the education system administration: using technology applications, with the objective of making them available to the entire population, and providing a transparent and efficient management of resources at schools and in the Ministry of Education.

A.2.3. Expanding distance learning: delivering education by ICTs where professors and students do not have to be in the same physical location, but can access the same virtual space where they interact or find the necessary information to acquire knowledge and the necessary tools to test the on-line acquired knowledge.

A.2.4. Providing technical and vocational training to the entire population: developing specific skills for technology use including hardware / software systems, as well as skills needed in various fields including health-related professions, agriculture, mechanical repair, etc. through the use of technological applications, internet and web-based classes.

A.2.5. Making programs that foster innovation, creativity and research available throughout the country: creating programs where academics and students can freely interact with the computer in an open environment according to their interests; encouraging shared research efforts among researchers.

4.3.2.3.3 Applications in the economic sector:

A.3.1. Improving market intelligence available to every business in the country: providing timely access to market information such as the status of a crop, fluctuations in the tourism industry, changes in the software industry, pricing structures and supply/demand relationships; facilitating data mining to identify predictive patterns in the market behavior (this is also a tool for information dissemination).

A.3.2. Enhancing rural economic opportunities: enabling people to work anywhere, so local communities are integrated into the global economy. For example, the use of telecenters, which are community resource centers equipped with the latest technology such as computers, faxes, and Internet connections.

A.3.3. Improving business efficiency and productivity of small –to-medium-sized enterprises (SMEs) through information and communication technologies:

using ICTs to reduce operational cost by decreasing material, procurement and transaction costs; and enabling SMEs throughout the country to use more and better information to improve the value of their output.

A.3.4. Sharing ICT resources among enterprises: enabling small –to-medium-sized enterprises to share resources for reducing the cost of access to technology; developing data centers and centralized computer systems for computing on demand: for example, two SMEs can share a computer to work on business accounting.

A.3.5. Creating new business models based on information networks: using ICTs to create and deliver products and services on a global scale, and to give developing countries access to new markets for competitive advantage; improving direct marketing and data acquisition for import/export of specific products; identifying the vendors, buyers and suppliers. These new business models include applications such as e-trading, marketplaces, business-to-business, and portals.

A.3.6. Creating a database to match the available human resources and job offerings: matching the skills of the available man power with the needs that exist in the economic sector.

4.3.2.3.4 Applications in the government sector:

A.4.1. Facilitating participation of the public in democratic processes: encouraging the public's participation in the democratic process via elections, forums, discussions, establishment of criteria about specific topics, enforcement of accountability of public officials, and voting in elections through the use of ICTs.

A.4.2. Providing universal access to information and on-line services to empower people: developing hardware and software infrastructure that interconnects computers and provides free Internet access, free e-mail accounts and information to citizens nationwide; making information accessible through citizen service centers; providing the citizens with technological access to government agencies; promoting the use of applications that permits the citizens to have an equitable/fair access to the services of the government so they can make educated choices and political decisions at local, regional, and national levels.

A.4.3. Improving public administration throughout the country: developing applications to improve the quality of service and the level of responsiveness of government institutions everywhere in the country; increasing the efficiency and transparency of government processes for the entire population; bringing hardware/software and technological platforms of the governmental agencies up to date in all provinces; improving the capabilities of the personnel by providing education in the IT field and access to the information networks; improving the capability for equitable public spending and tax collection.

4.3.2.3.5 Applications in the environmental sector:

A.5.1. Monitoring and disseminating information on ecological conditions: using technology applications to improve efficient use of resources to fight contamination and to set prevention and mitigation measures. Technology applications can collect data and forecast pest problems and pesticide use. Weather information and soil monitoring are also parts of ecological monitoring.

A.5.2. Promoting public awareness of environmental issues throughout the country: using ICTs to disseminate information about environmental and bio-diversity related issues, impacts on environmental quality, farming sustainability, marine management and energy sources. It includes a national computer database to contribute to bio-diversity and environmental knowledge and awareness.

A.5.3. Monitoring environmental conditions to facilitate decision making: using ICTs to send information, including images of environmental disasters, on a timely basis, so the decision makers can have the information they need when they need it; incorporating satellite information in environmental decision making (examples include fire emergencies, oil spills, as well as developing strategies to protect the environment).

A.5.4. Promoting biodiversity and sustainable development: Using ICTs to disseminate information about biodiversity and the impact on society; encouraging the society to put a higher value on natural resources and to conserve them.

A.5.5. Dissemination of information about best practices: Making information available about successful approaches to environmental management; describing best practices to establish benchmarks for comparison.

4.3.2.4 Fourth level

The fourth level is a set of information and communication technologies. A large list of ICTs was presented to a panel of experts, and through various iterations the technologies were grouped into seven categories:

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

4.3.3 The Outputs and Information Sources.

The model provides six main outputs:

1. Identification of:

a. Sk: Sector (k) for k =1 , … , 5

b. Aj: ICTs Application (j) for j= 1, …,J

c. Ti: Information & Communication Technologies (i) for i= 1, … , I

2. t_{ij}: Relative impact of ICTs(i) on application (j)
3. a_{jk}: Relative impact of ICTs application (j) on sector (k)
4. s_k: Relative impact of reducing the Digital Divide on sector (k) on objective (reducing the Digital Divide)
5. $a_j = \sum_{k=1}^{k} a_{jk} * s_k$: Relative impact of ICTs application (j) on reducing the

   Digital Divide
6. $t_i = \sum_{k=1}^{k} \sum_{j=1}^{j} t_{ij} * a_{jk} * s_k$: Relative impact of ICTs(i) on reducing the Digital Divide.

The following figure depicts the information sources and outputs of the model.

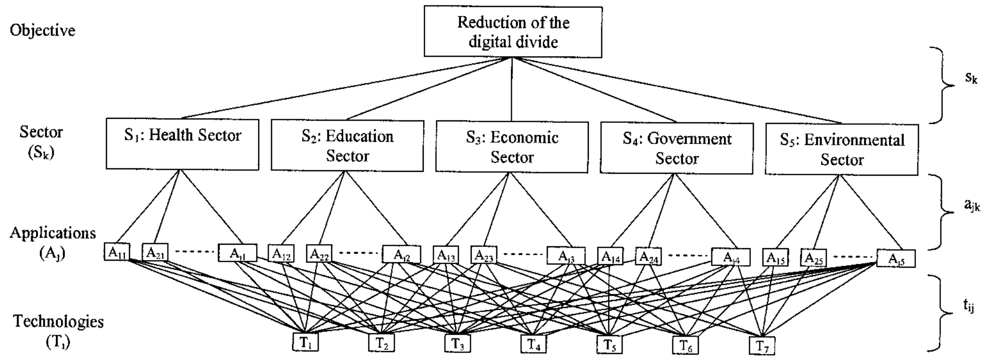


Figure 6: Output and information sources of the model

The sectors, ICT applications and ICTs were identified by gathering information from the literature, and having it modified and validated by the expert panel. For outputs 2-4, the source of information was the expert panel. Outputs 5-6 were obtained based on the analysis of the experts' quantified judgments.

CHAPTER 5: DATA COLLECTION

5.1 PROCESS

This research has four main steps for the data collection process.

1. Obtain the consent of expert panel members for participation in the study.
2. Develop the model and the applications through interviews and the web instrument.
3. Create, distribute, and collect the judgment quantification instruments for pair-wise comparison by the experts.
4. Present the results to the expert panel members for validation.

5.2 FIRST STEP: HUMAN SUBJECTS

The Human Subjects form for obtaining consent of expert panel members for participation in the study was translated into Spanish and sent to each participant via e-mail. Appendix J is a copy of this form. The forms were received with a digital signature before the data collection started. The original signatures were also collected when the pairwise comparison instrument was subsequently personally presented to each expert panel member.

5.3 SECOND STEP: MODEL DEFINITION

A framework model was constructed based on the UNDP concepts presented in "Creating a Development Dynamic: Final Report of the Digital Opportunity" [1] in addition to the concepts of the literature search. Detailed information about the process and the methodology used for this study was provided to the expert panel in person. A preliminary list of suggested sectors and ICT applications was also presented to the expert panel members. See Appendix A for the preliminary and final lists of applications and technologies. Each expert panel member was asked to analyze this information and determine if he/she believed it necessary, adding, deleting or modifying the list of applications and the sectors.

In order to prevent any bias that the experts might have had toward their own additions to the model, additions from multiple experts were combined and reworded such that no addition was solely based on the exact words of one expert.

The expert panel members with technological backgrounds were asked to identify all the ICTs that will impact the reduction of the Digital Divide and / or ICTs needed for the ICT applications and to group these technologies under a more generic classification. The compiled list of 42 technologies was reviewed, modified, finalized and consolidated into a list of seven ICTs described in section 4.3.2.4

5.3.1 WEB Instruments

After these first interactions with the expert panel members, the complete hierarchical model was presented to the expert panel via a web instrument for a final review and approval. The complete expert panel was asked to review the model and the definitions of each item in the hierarchy to identify and propose any suitable modification for the proposed model.

The web instrument has eight parts as follows:

- Part I: registration, introduction and presentation of the model.
- Part II: the instructions, the definition of the objective "the reduction of the Digital Divide in Costa Rica," and the definitions of reduction of the Digital Divide of each sector.
- Parts III to VII: the instructions, the objective of each instrument, the definition of the reduction of the Digital Divide in each sector, the definition of the ICT applications of the sector, and an open part to make changes and/or comments if needed.
- Part VIII: the instructions for the ICTs, the definition of each ICTs, and an open section for changes and comments, as needed.

Please refer to Appendix B for the web instrument.

5.4 THIRD STEP: JUDGMENT QUANTIFICATION INSTRUMENT

Once the model was finalized, the expert panel members were asked to fill out a series of pairwise comparison instruments with two time frames of reference: the year 2003 and 2010. The judgment quantification instrument is a set of 31 pairwise comparison instruments. Instrument 1 includes the pairwise comparison of the relative impact of the reduction of the Digital Divide on each key sector on the overall reduction of the Digital Divide in the country. Instruments 2 - 6 include comparisons of the relative impact of the ICT applications on the reduction of the Digital Divide of the appropriate sector. Instruments 7 to 31 are the instruments to evaluate the relative impacts of the ICTs in each ICTs application. Please refer to Appendix C for the pairwise comparison instruments.

The entire expert panel filled out instrument 1. Instruments 2 to 6 were assigned according to the area of expertise of the expert panel members. Each instrument had at least three respondents. The remaining instruments were assigned to the panel members with technical expertise to compare the information and communication technologies in pairs and then express their judgments about each technology's relative impact on each application. Appendix D presents a table with the distribution of the instruments to the expert panel members.

In an effort to prevent fatigue of the experts the instruments were distributed in phases. Instruments 1 to 6 were sent by mail and collected in person. A subset of instruments 7 to 31 were then handed to and completed by the expert according to their area of expertise, and collected for analysis.

5.5 FOURTH STEP: VALIDATION INSTRUMENTS

After all the data of the pairwise comparison instruments were collected and analyzed, the results were presented to the expert panel using the validation instruments, see Appendix E These results had a confidentiality agreement that the experts had to sign before opening the envelope. At this time one of the experts preferred not to sign the confidentiality agreement and withdrew from this research. Please refer to Appendix J for the copy of the confidentiality agreement.

The validation instrument consists of 31 instruments with the results for this research described as follows:

- Instrument 1 presents the impacts of the reduction of the Digital Divide of each sector for the year 2003
- Instrument 2 presents the impacts of the reduction of the Digital Divide of each sector for the year 2010.
- Instrument 3 - 7 present the impact of the ICT applications on the reduction of the Digital Divide for each sector for the years 2003 and 2010.

The following instruments are divided according to the sector in which they belong:

- Instruments 1h to 6h present the impact of the ICTs on each ICTs application in the health sector.
- Instruments 1e to 5e present the impact of the ICTs on each ICTs application in the education sector.
- Instruments ec1 to ec6 present the impact of the ICTs on each ICTs application in the economic sector.
- Instruments gov1 to gov3 present the impact of the ICTs on each ICTs application in the government sector.
- Instrument env1 to env6 present the impact of the ICTs on each ICTs application in the environmental sector.

Each instrument has 3 parts. The first part presents a figure with the respective values of the impact of the sectors, ICT applications or ICTs on the reduction of the Digital Divide. The second part presents the ICTs or ICT applications according to the level of impact on the reduction of the Digital Divide on the next level. The third part of the instruments contains a discussion part and a validation part. Please refer to appendix E for the instruments.

CHAPTER 6: RESULTS

6.1 RESULTS

The following are the results of this research. Sections 6.1.1 and 6.1.2 represent the impacts of the reduction of the Digital Divide in each sector on the internal Digital Divide of the country for the years 2003 and 2010. Sections 6.1.3 to 6.1.7 summarize the impacts of the different ICT applications on the reduction of the Digital Divide in each sector for the years 2003 and 2010. Finally, section 6.1.8 shows the overall impact of the technologies on the reduction of the internal Digital Divide in the country for the years 2003 and 2010. In addition, result 8 shows the ranking of the impact of the technologies for both years.

6.2 IMPACT OF KEY SECTORS ON THE REDUCTION OF THE DIGITAL DIVIDE IN 2003

Figure 7 represents the impacts of the key sectors on the reduction of the Digital Divide in Costa Rica for 2003 according to the judgment of the experts.

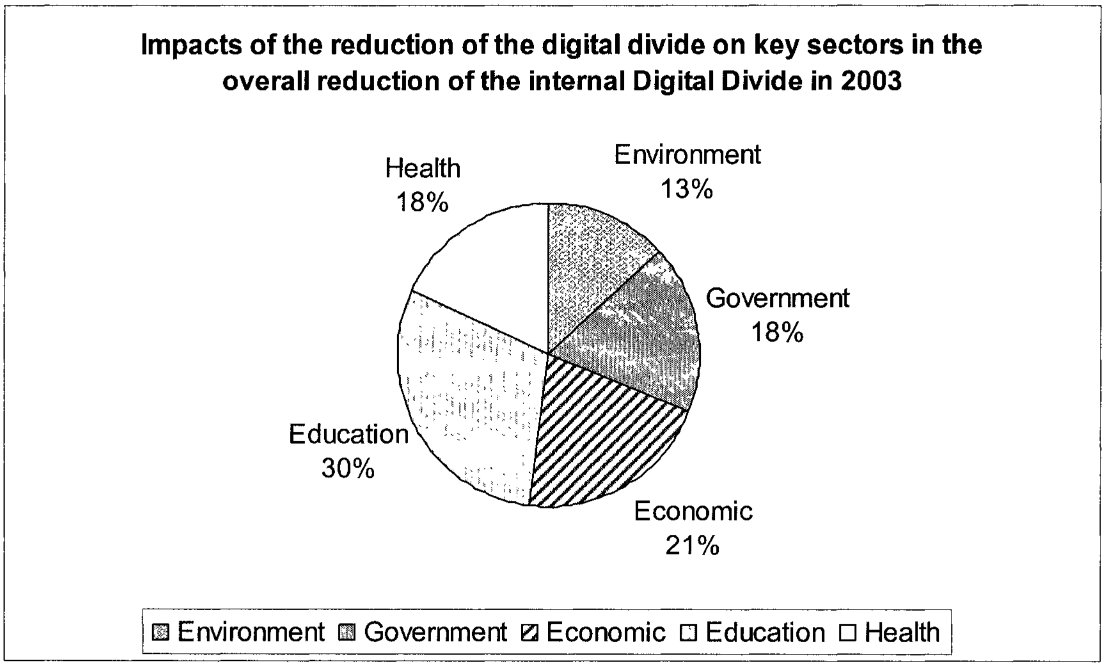


Figure 7: Impacts of the reduction of the digital divide on key sectors in the overall reduction of the internal Digital Divide in 2003

In 2003 the sector with the highest impact on the reduction of the Digital Divide is the education sector. If we group the sectors by high, medium and low impact on the reduction of the Digital Divide, the groups will be as follows:

- High impact: education

- Medium impact: economic, government and health sectors
- Low impact: environmental sector

6.3 IMPACT OF KEY SECTORS ON THE REDUCTION OF THE DIGITAL DIVIDE IN 2010

Figure 8 represents the impacts of the reduction of the Digital Divide key sectors on the overall reduction of the Digital Divide in Costa Rica for 2010 according to the judgment of the experts.

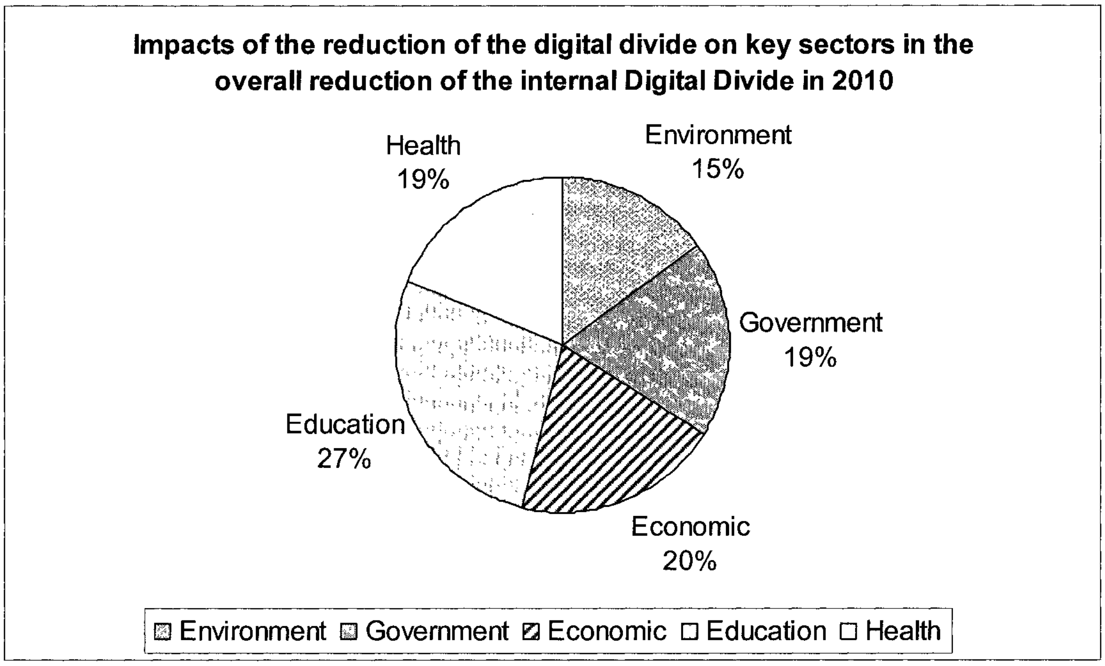


Figure 8: Impacts of the reduction of the digital divide on key sectors in the overall reduction of the internal Digital Divide in 2010

For the year 2010, the sector with the highest impact on the reduction of the Digital Divide is again the education sector. By grouping the sectors by their impact on the reduction of Digital Divide we will obtain:

- High impact: education
- Medium impact: economic, government and health sectors
- Low impact: environmental sector

The relative impact rankings on the reduction of the Digital Divide for the sectors remain the same. However, the values have a slight change. The education sector is lower than in 2003 and the other sectors are higher. There was a heavy emphasis on the reduction of the Digital Divide on the education sector in 2003. For the year 2010, the emphasis on the education sector will continue, but the impact of the other sectors will gain a higher relative importance than in 2003.

6.4 IMPACT OF APPLICATIONS ON THE REDUCTION OF THE DIGITAL DIVIDE IN THE HEALTH SECTOR

Figure 9 represents the impacts of the ICT applications on the reduction of the Digital Divide in the health sector for the years 2003 and 2010.

Grouping the applications by the level of impact, we will have:

- High impact: A13: Providing on-line medical libraries
- Medium impact: A11: Making health services widely available & identifying appropriate level or medical response

according to the population's needs

A15: Improving the efficiency of the public health system in every geographic area

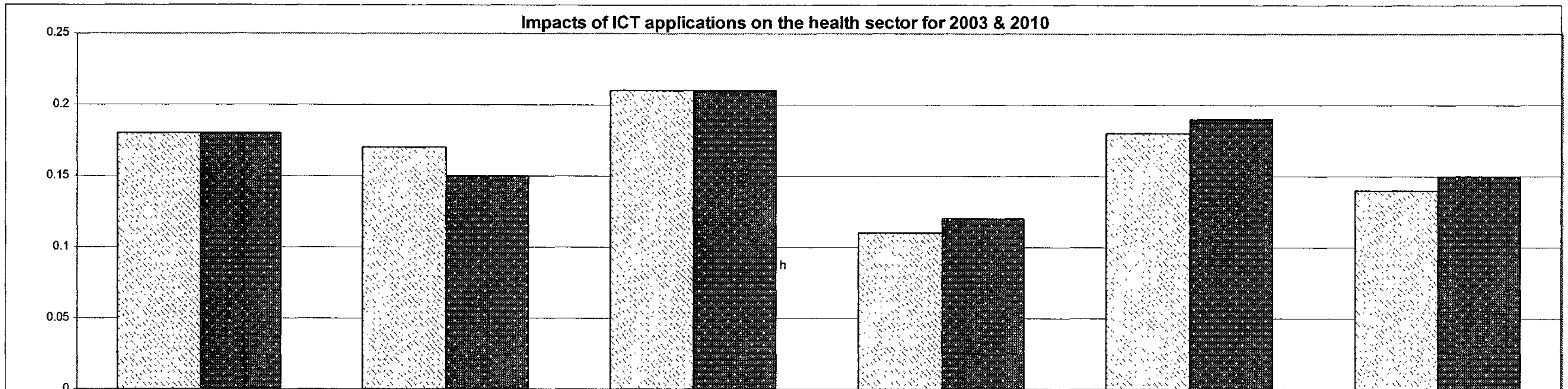
A12: Preventing diseases and improving epidemic responses

- Low impact:

A16: Creating awareness of health issues in the population through the use of ICTs

A14: Facilitating medical research in distant research facilities

Providing on-line medical libraries, making medical libraries accessible to health professionals, especially in remote areas to keep up-to-date on medical knowledge, and providing the general population with the means to learn more about certain illnesses or health issues are the applications with the highest relative impact in both 2003 and 2010. The second group relates to improving the current health system. Finally, the third group relates to general awareness and medical research.



	A.1.1. Widely available health services	A.1.2. Disease prevention & epidemic response	A.1.3. Providing on-line medical libraries	A.1.4. Medical research in distant facilities	A.1.5. Improving efficiency of the public health system	A.1.6. Creating awareness of health issues
2003	0.18	0.17	0.21	0.11	0.18	0.14
2010	0.18	0.15	0.21	0.12	0.19	0.15

Figure 9: Impacts of ICT applications on the health sector for 2003 & 2010

6.5 IMPACT OF APPLICATIONS ON THE REDUCTION OF THE DIGITAL DIVIDE IN THE EDUCATION SECTOR

Figure 10 represents the impacts of the ICT applications on the reduction of the Digital Divide in the education sector for the years 2003 and 2010.

Grouping the applications by the level of impact on the reduction of the Digital Divide in the education sector in 2003, we have:

- High impact: A21: Enhancing the learning process through the use of ICTs
  A25: Making programs that foster innovation, creativity and research throughout the country
- Medium impact: A24: Providing technical and vocational training to the entire population
- Low impact: A23: Expanding distance learning
  A22: Improving the education system administration

On the other hand, we see the following groupings of applications by the level of their impact in the year 2010.

- High impact: A25: Making programs that foster innovation, creativity and research throughout the country
- Medium impact: A24: Providing technical and vocational training to the

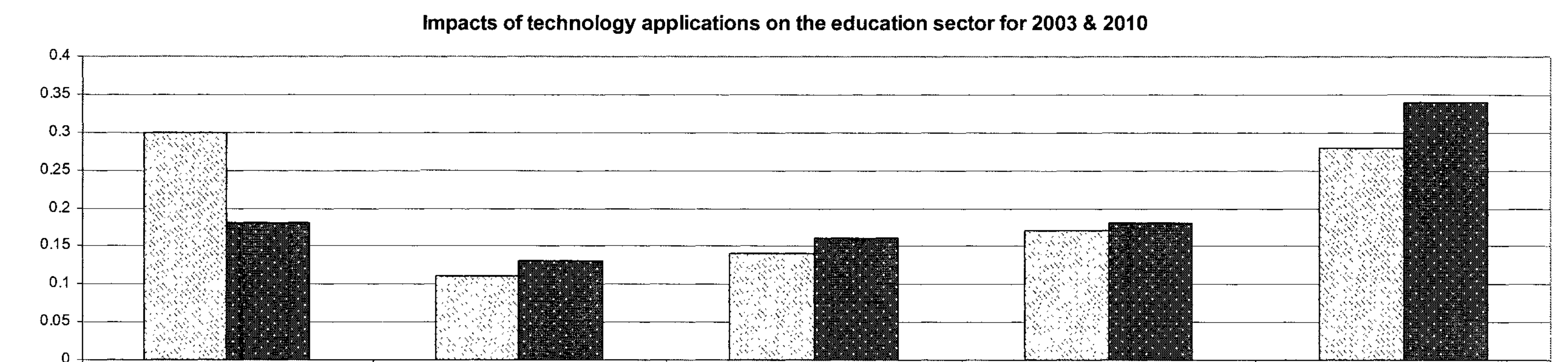
entire population

A21: Enhancing the learning process through the use of ICTs

A23: Expanding distance learning

- Low impact: A22: Improving the education system administration

There is an emphasis on enhancing education through the use of ICTs, enhancing the traditional education system, facilitating collaborative and interactive learning as well as fostering innovation and research in 2003. However, in 2010, the innovation and creativity factor become more and more important in a country where the population is already familiar with ICTs in the education sector. This application helps to generate new / in-house technologies to help to reduce the Digital Divide according to the country's own needs. It also reduces technology dependency on other countries for their human capital and technologies.



	A.2.1. Enhancing the learning process	A.2.2. Improving education system administration	A.2.3. Expanding distance learning	A.2.4. Technical & vocational training	A.2.5 Programs that foster innovation, creativity & research
2003	0.3	0.11	0.14	0.17	0.28
2010	0.18	0.13	0.16	0.18	0.34

Figure 10: Impacts of technology applications on the education sector for 2003 & 2010

6.6 IMPACT OF APPLICATIONS ON THE REDUCTION OF THE DIGITAL DIVIDE IN THE ECONOMIC SECTOR

Figure 11 represents the impacts of the ICT applications on the reduction of the Digital Divide in the economic sector for the years 2003 and 2010.

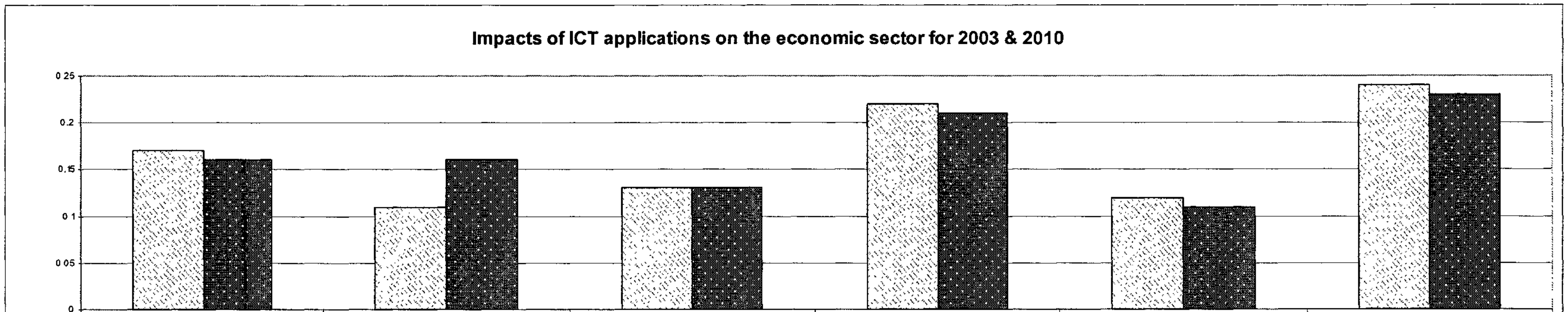
Grouping the applications in the economic sector by the level of impact on the reduction of the Digital Divide in the economic sector in 2003, the groups are as follows:

- High impact:
  - A36: Creating a database to match the availability of human resources with job opportunities
  - A34: Sharing ICT resources among enterprises
- Medium impact:
  - A31: Improving market intelligence available to every business in the country
- Low impact:
  - A33: Improving business efficiency and productivity of SMEs through ICTs
  - A35: Creating new business models based on information networks
  - A32: Enhancing rural economic opportunities

In 2010 the application of enhancing rural economic opportunities becomes part of the group with medium impact on the reduction of the Digital Divide of the economic sector as shown below:

- High impact: A36: Creating a database to match the availability of human resources with job opportunities
  A34: Sharing ICT resources among enterprises
- Medium impact: A31: Improving market intelligence available to every business in the country
  A32: Enhancing rural economic opportunities
- Low impact: A33: Improving business efficiency and productivity of SMEs through ICTs
  A35: Creating new business models based on information networks

Costa Rica should use its existing human & ICT resources effectively in 2003. In 2010 the focus should be on improving the economic opportunities and the available market intelligence.



	A.3.1. Improving market intelligence	A.3.2. Enhancing rural economic opportunities	A.3.3. Improving business eficiency & productivity of SMEs	A.3.4. Sharing ICT resources among enterprises	A.3.5. Creating new business models	A.3.6. Matching human resources w/job opportunities
□ 2003	0.17	0.11	0.13	0.22	0.12	0.24
■ 2010	0.16	0.16	0.13	0.21	0.11	0.23

Figure 11: Impacts of ICT applications on the economic sector for 2003 & 2010

6.7 IMPACT OF APPLICATIONS ON THE REDUCTION OF THE DIGITAL DIVIDE IN THE GOVERNMENT SECTOR

Figure 12 represents the impacts of the ICT applications on the reduction of the Digital Divide in the government sector for the years 2003 and 2010.

Grouping these applications according to their impact on the reduction of the Digital Divide in the government sector in 2003, we have three groups:

- High impact: A43: Improving public administration throughout the country
- Medium impact: A42: Providing universal access to information and on-line services to empower people
- Low impact: A41: Facilitating participation of the public in democratic processes

For the year 2010 we have two groups:

- High impact: A43: Improving public administration throughout the country
- Medium impact: A42: Providing universal access to information and on-line services to empower people

  A41: Facilitating participation of the public in democratic processes

Improving public administration is the key area that needs major improvements to reduce the Digital Divide in the government sector. It is expected that the public administration will improve by 2010, and the other applications related to empowering the people and providing universal access will gain more weight. Basically, we have the same pattern in 2003 and 2010, but the relative impact of the applications in the medium and low impact groups will be higher in 2010.

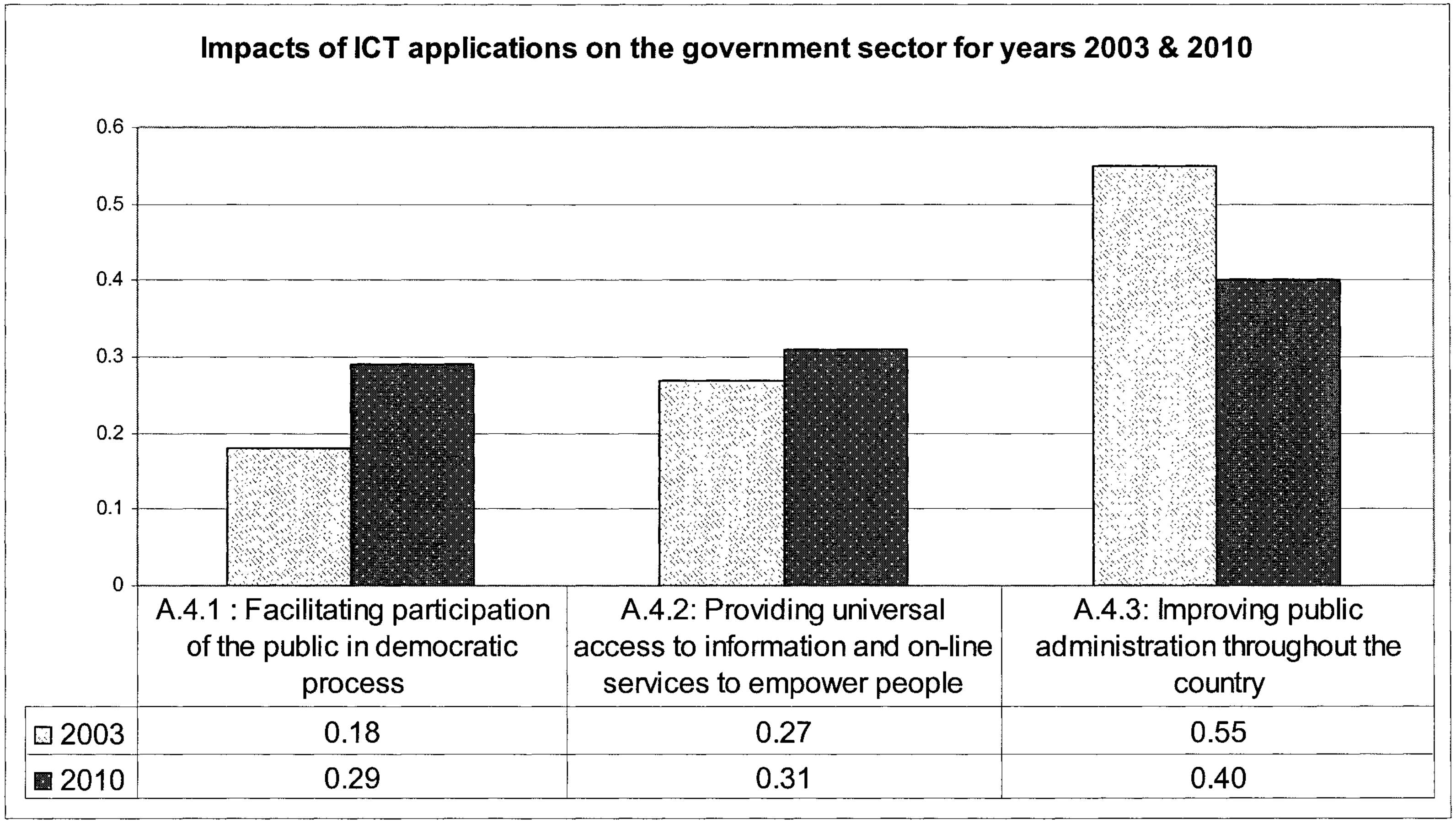


Figure 12: Impacts of ICT applications on the government sector for years 2003 & 2010

6.8 IMPACT OF APPLICATION ON THE REDUCTION OF THE DIGITAL DIVIDE IN THE ENVIRONMENTAL SECTOR

Figure 13 represents the impacts of the ICTs application on the reduction of the Digital Divide in the environmental sector for the years 2003 and 2010.

Grouping the applications in the environmental sector by their impacts on the reduction of the Digital Divide on that sector in 2003, we have:

- High impact: A54: Promoting biodiversity and sustainable development
  A52: Promoting public awareness of environmental issues throughout the country
- Medium impact: A55: Disseminating information about the best practices
- Low impact: A53: Monitoring and responding to environmental disasters
  A51: Monitoring and disseminating information on ecological conditions

For the year 2010, the groups are as follows:

- High impact: A54: Promoting biodiversity and sustainable development
  A55: Disseminating information about the best practices
  A52: Promoting public awareness of environmental issues throughout the country

- Medium impact: A53: Monitoring and responding to environmental disasters
- Low impact: A51: Monitoring and disseminating information on ecological conditions

It is important for Costa Rica to promote awareness of environmental issues, biodiversity and sustainable development; in time, disseminating information about best practices becomes more and more important.

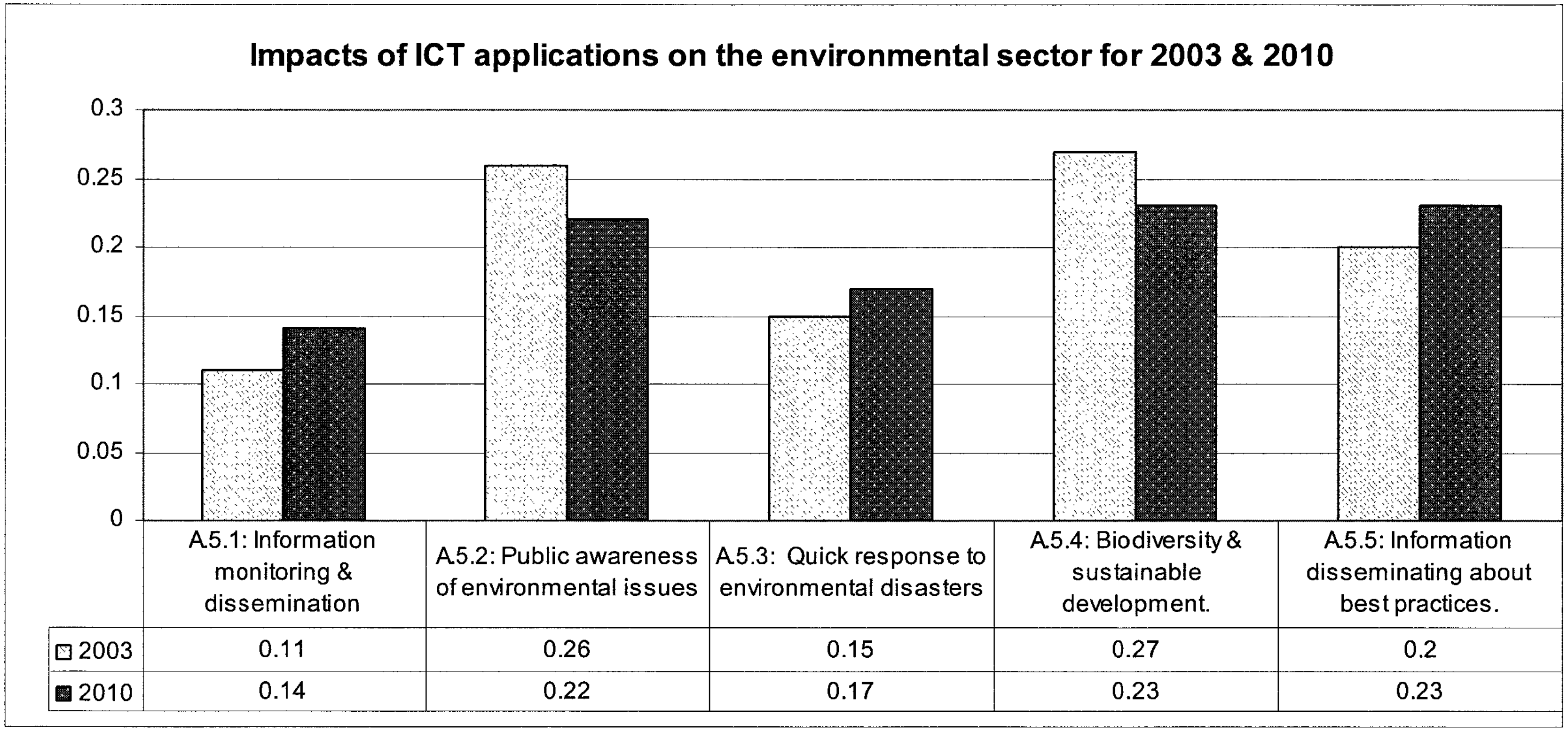


Figure 13: Impacts of ICT applications on the environmental sector for 2003 & 2010

6.9 IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON THE REDUCTION OF THE INTERNAL DIGITAL DIVIDE

Figure 14 represents the impacts of ICTs on the reduction of the Digital Divide in Costa Rica for the years 2003 and 2010.

Grouping the ICTs by their impacts on the reduction of the Digital Divide in 2003, we have:

- High impact: T1: General purpose software
  T3: Internet content & infrastructure
  T5: Land-based devices & infrastructure
- Medium impact: T2: Mobile devices & infrastructure
  T6: Country specific software
- Low impact: T4: Collaborative tools
  T7: Mass communication systems

For the year 2010, the groups are as follows:

- High impact: T4: Collaborative tools
  T3: Internet content & infrastructure
- Medium impact: T2: Mobile devices & infrastructure
  T5: Land-based devices & infrastructure
  T1: General purpose software

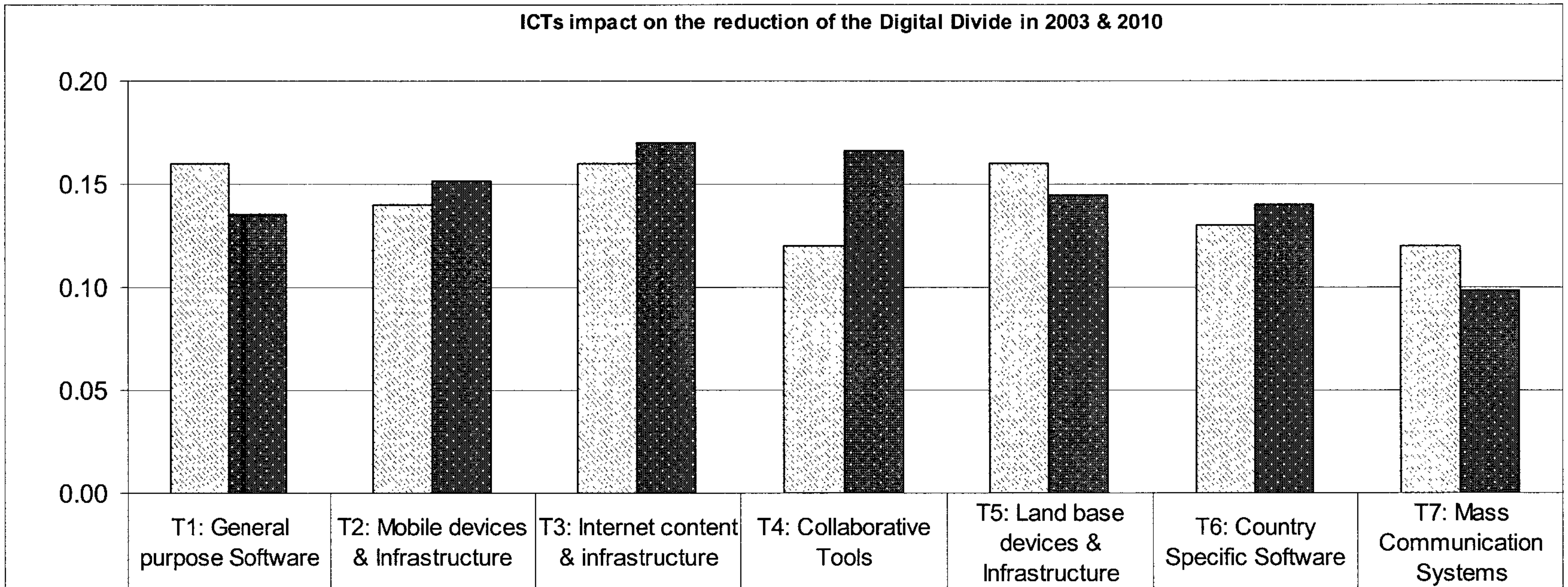
T6: Country specific software

- Low impact: T7: Mass communication systems

Land-based devices, general purpose software, the Internet content and infrastructure have the highest impact on the overall reduction of the internal Digital Divide in 2003. It is expected that by 2010 the installed based of land-based devices, such as PCs, general purpose software and mass commucation systems will have arrived at a level where continued investment in these ICTs will not yield as significant reduction on the internal Digitial Divide as investments in other ICTs.

The impact of collaborative tools increases dramatically from the 2003 to the 2010. Whilst collaborative tools were very important for applications in the education sector in both 2003 and 2010, there is a significant increase of importance of the technology in the economic sector in 2010.

The Internet content and infrastruct as well as mobile devices increase their impact in 2010, leading us to conclude the role of technology in the year 2010 will be distinctively oriented toward Internet, mobile and collaboration.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.16	0.14	0.16	0.12	0.16	0.13	0.12
2010	0.14	0.15	0.17	0.17	0.14	0.14	0.10

Figure 14: ICTs impact on the reduction of the Digital Divide in 2003 & 2010

6.10 SUMMARY OF RESULTS

The key results can be summarized at three levels:

1. Relative impacts of the reduction of Digital Divide in key sectors on the overall reduction of the internal Digital Divide
2. Relative impacts of ICT applications on the reduction of the Digital Divide in the key sectors
3. Relative impacts of ICTs on the overall reduction of the internal Digital Divide

Each result is discussed below.

6.10.1.1 Relative impacts of the reduction on Digital Divide in key sectors on the overall reduction of the internal Digital Divide

The reduction of the Digital Divide in the education sector has a major impact followed by the reduction of the Digital Divide in the economic, government and health sectors in both 2003 and 2010. In both years, the reduction of the Digital Divide in the environmental sector has the lowest impact on the reduction of the internal Digital Divide, but it is nevertheless a significant impact, representing 13% of the total in 2003 and 15% in 2010.

For the year 2003, it is perceived by some of the experts that the reduction of the Digital Divide on the education sector is in some way at a different level than the other sectors. It is a necessary condition that will impact the reduction of the Digital Divide in other sectors. According to those expert panel members:

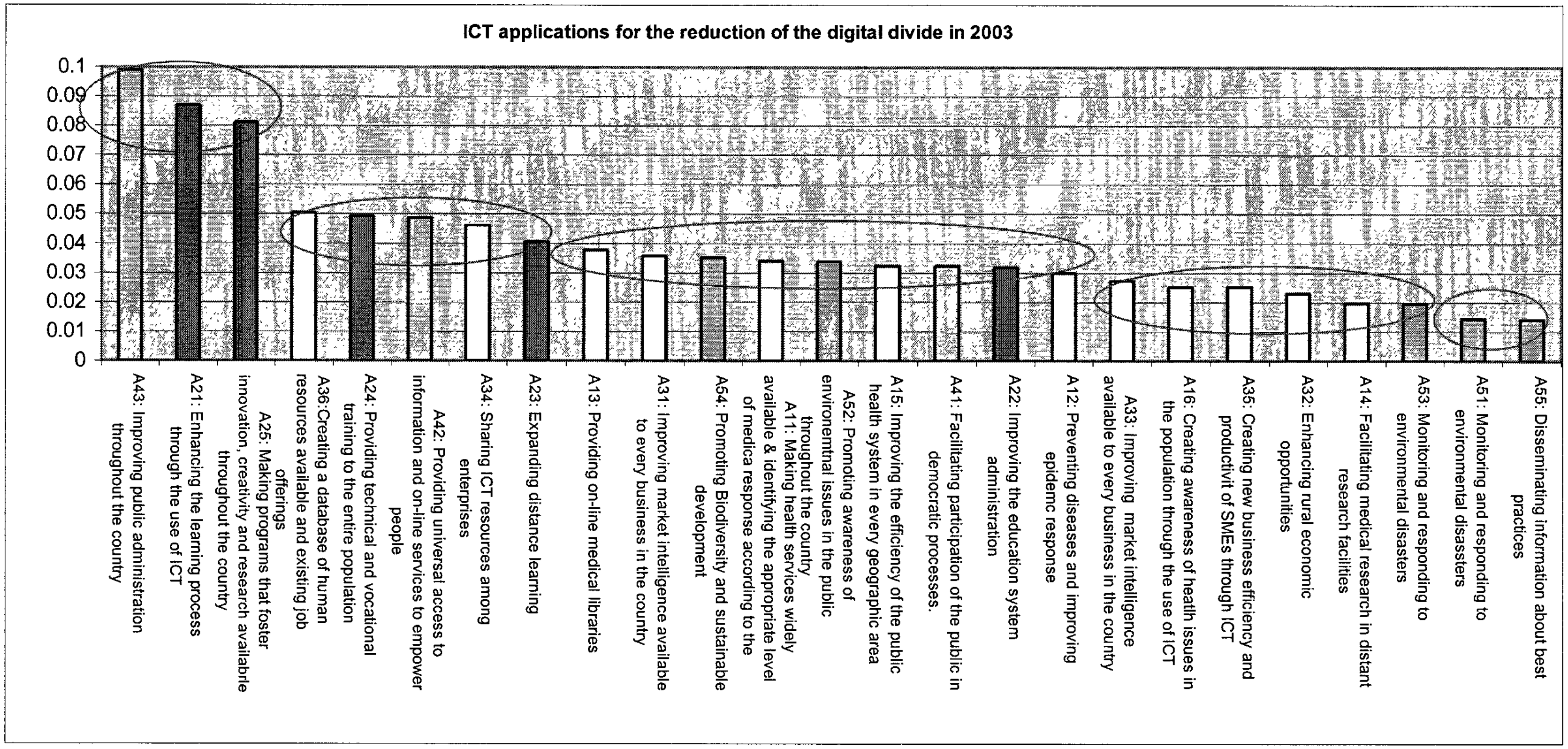
a. The education sector in Costa Rica is one of the most expensive among all sectors, not only for the equipment but also for the number of people working in that sector.

b. The reduction of the Digital Divide in the education sector has a multiplying effect on other sectors' future. For example, re-training professionals from other disciplines in the use of ICTs will lead to innovative applications in all sectors.

The results obtained for the year 2010 generated questions and comments in the expert panel. The panel members indicated that any policies implemented in 2003 to reduce the Digital Divide would have dramatic impacts on the reduction of the Digital Divide in several sectors by 2010. In fact, even if the impacts are not very high, the experts believe that many people will have to jump into the technology boat sooner or later.

6.10.1.2 Relative impacts of ICT applications on the reduction of the Digital Divide in the key sectors

Figure 15 represents the relative impact of all the applications of all the sectors on the reduction of the internal Digitial Divide for the year 2003.



Health Education Economic Government Environment

Figure 15: ICT applications on the reduction of the Digital Divide 2003

Grouping the applications by the level of impact on each sector, we have five groups for the year 2003:

- Very high impact: This group consists of three applications, one from the government and two from the education sectors. Those applications are: improving public administration, enhancing the education process through ICTs, and fostering innovation and creativity.
- High impact: This group consists of a mix of applications in economic, education and government sector. Applications that focus on making effective use of human resources and ICT resources.
- Medium impact: This group has a mix of applications from all the groups with a focus on diffusion of information of different topics in different sectors. Most of the health applications are in the medium impact group.
- Low impact: This group is focused on applications on new businesses and rural areas. The applications are mainly from the health and economic sectors.
- Very low: This group consists of applications in the environmental sector with a focus on dissemination of information and prevention in environmental problems.

This can be interpreted as a gradual approach. First, focus on what will have a major impact now and in the future. Then, as second priority, focus on what resources we have now and what our current needs are, matching them together to generate economic and social empowerment. As third priority, grow more horizontally and focus on the health and well being of the people, and other areas of knowledge. As fourth priority extend the area of action to access rural areas and to reduce the gap in the economic and health sectors. Finally as the fifth priority, consider the environmental applications in the country.

Figure 16 represents the impact of the applications of all the sectors on the reduction of the internal Digital Divide for the year 2010.

Grouping the applications according to their impact on the reduction of the Digital Divide in 2010, we will have five groups as follows:

- Very High impact: This group consists of one application from the government and one from the education sectors. Innovation and creativity become more and more important as well as improving the efficiency of public administration.
- High impact: This group consists of 2 applications of the government sector. Applications that focus on the empowerment if the citizens.
- Medium impact: This is a mix of applications in education, economic and health sectors, focused on making effective use of human resources and ICT resources as well as expanding education.
- Low impact: This group is a mix of applications in various sectors. They are primarily related to improving efficiency in education and health systems administration, improving rural and economic opportunities and creating

biodiversity awareness. The medium impact level is where the environmental application first appears.

- Very low impact: This group includes applications in health, economic and environmental sectors with a focus on dissemination of economic, health and environmental information. In addition to applications on medical research, new business models, and environmental issues.

Fostering innovation and creativity is the leading application followed by improving the public administration through the use of ICTs. It is expected that if the public administration is improved in 2003, then in 2010 it will have a lesser impact. However, fostering creativity and innovation will have a larger impact in 2010 than in 2003, with a society more dependent on technology, the need for innovation and creativity increases. After that, applications that look for empowerment of the population to participate in public and government processes, followed by improving the public services in health and education. The next group of applications focus on improving the situation in rural areas, and finally applications of awareness and prevention in environmental sector and health.

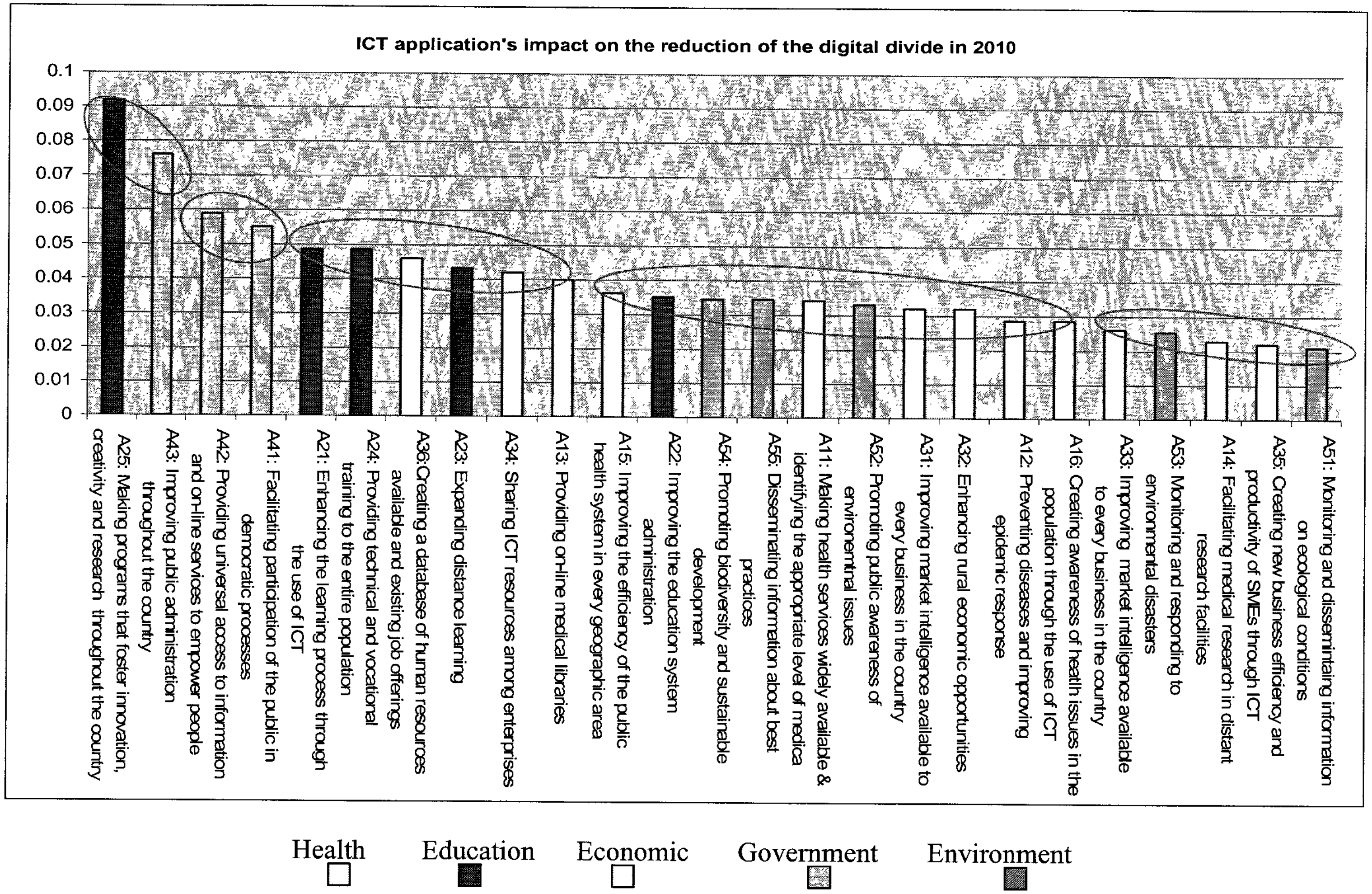


Figure 16: ICT applications on the reduction of the Digital Divide 2010

6.10.1.3 Impacts of ICTs on the reduction of the Digital Divide

Table 2 presents a comparison of the impact of information and communication technologies on the overall reduction of the Digital Divide in 2003 and 2010.

Table 2 Ranking of relative impacts of ICTs on reducing the internal Digital Divide in Costa Rica

2003		2010	
ICTs	Rank	Rank	ICTs
T1: General purpose Software	1	1	T3: Internet content & infrastructure
T3: Internet Content & Infrastructure	1	1	T4: Collaborative tools
T5:Land-based devices & Infrastructure	1	3	T2: Wireless devices & infrastructure
T2: Wireless devices & Infrastructure	4	4	T1: General purpose software
T6: Country specific software	5	4	T5:Land-based devices & infrastructure
T4: Collaborative tools	6	4	T6: Country specific software
T7: Mass communication systems	6	7	T7: Mass communication systems

The ICTs with the highest relative impacts in 2003 are land-based devices, Internet content and infrastructure, and general purpose software. As we move toward 2010, the role of technology becomes distinctively oriented towards the Internet, mobility and collaboration. The difference between the impact of wireless devices and land- based devices is small by 2010. In both cases the mass communication systems are the last group. They have an impact on the reduction of the Digital Divide, but their relative impact does not grow from 2003 to 2010; in fact it is slightly reduced.

CHAPTER 7: VALIDATION & SENSITIVITY ANALYSIS

7.1 VALIDATION

The validation process covers three areas: content validation, construct validation and criteria-related validation as described below:

7.1.1 Content validation and Construct validation

The objective of the content validation is to check if the questions are right, necessary and sufficient. On the other hand, the objective of the construct validation is to verify if the structure of the model is correct and appropriate.

The content and construct validation were done in three steps. First the definitions and model structure were presented in a graduate level class in Engineering and Technology Management. The students evaluated the definitions and model to assure that they understood the concepts and the model structure. The students checked that the elements in the model were preferentially independent at each level and that they were able to do comparisons.

Second, the instruments were evaluated in the quarterly meeting of the PhD by professors and PhD students of Engineering Management Department. The group evaluated each definition and the structure of the model. Finally, the instruments were presented to the expert panel via web. The web instruments were designed to verify that the content of the model was appropriate and complete in each level as well as to verify the structure of the model. All the experts reviewed each instrument. The definitions were modified, combined, and also applications were added as needed. Thus, the model was considered finalized.

7.1.2 Criterion-related validation

The objective of the criterion-related validation is to verify if the model has sufficient power to make an impact. The expert panel verified the predictions of the model through the validation instruments. These instruments were presented to the experts with the final results. Space was provided for experts' comments. The instruments where distributed with a confidentiality agreement. At this point, fourteen out of the fifteen experts accepted keeping the information confidential; one expert withdrew from this research.

First, the complete panel received the validation instruments for the relative impact of the reduction of the Digital Divide on each sector for the years 2003 and 2010. Second, the validation instrument for the relative impact of ICTs application on each sector was reviewed by at least three experts per sector. Third, the validation instrument for the relative impact of ICTs on each ICTs application was reviewed by two experts in each case.

The complete table of the distribution of the validation instrument is located in Section F. A copy of this set of instruments is located in section E.

The expert panel members validated the results of the impact of the key sectors on the reduction of the Digital Divide for the year 2003. At this step the expert panel provided their overall impressions. For example, some experts expected to see a more significant change between 2003 and 2010 than what was identified in the study. The expert panel members made several comments about the impact of education or the acquisition of knowledge on the reduction of the Digital Divide in the other sectors. The acquisition of knowledge in a specific area will have an impact on a different sector. Furthermore, one of the experts stated that if he had the power to reduce the digital divide, he will focus on reducing the digital divide on the education sector, focusing on the children more than the adults, because by doing so one can hope to see bigger impacts in the future[9].

Most of the experts agree about the impact of the reduction of the Digital Divide on the key sectors in 2010 most of the experts agreed. The expert panel members had different opinions in terms of what they would have expected to see as a result of the expert panel opinions combined. The panel saw a need of a more proactive attitude of Costa Rica in front of the rapid development of the technology's impact in our lives; and in terms of the role of the government.

Below are some extracts of comments from the expert panel members:

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[9] Due to confidentiality reasons the expert's name cannot be disclosed.

"If we have a passive attitude the situation can be the same in 2010 [as in 2003,] but I think technology is developing fast, and sooner or later many people will have to jump into the [technology] boat ... " Expert X[10].

"The results seem to reflect that the group considers that the impact of diverse sectors' reduction of Digital Divide will start to be seen in 7 years. My question is if strategic actions and public policies can start to show and impact in shorter terms... " Expert Y[11].

Analyzing the comments of the applications of the health sector to reduce the Digital Divide in this sector the opinions were divided. However, in the cases where there was disagreement, it was because of a contradiction or change of opinion of the expert.

For the education applications, there is high agreement on the impact of the applications in 2003 with some level of expectation on greater impact of distance learning for the year 2010. Furthermore, one of the experts commented on the need to re-train the high quality professionals from other disciplines in technology, so these professionals can develop innovative applications in non technical domains.

The applications of the economic sector are the ones with higher contradiction between the original values collected in the pair wise comparison and what they expressed later on when the results were presented to them.

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[10] Due to confidentiality reasons the expert's name cannot be disclosed.
[11] Due to confidentiality reasons the expert's name cannot be disclosed.

In the case of governmental applications, the experts agreed on the impacts of the applications for 2003. However, there were different opinions in relation to 2010. The following is a comment of one of the expert panel members: *"I consider that A42 (universal access & empowerment) should have a high impact in 2010. The transparency in the acts of the government should create an engine to push A43 (improve the public administration".*

The environmental applications presented a high level of agreement for the majority of the experts.

Finally, analyzing the impact of each technology on the different applications, the majority of the experts agreed, especially for the year 2003, but there is some uncertainty for 2010 results.

The expert panel validated the results of the impact of the reduction of the Digital Divide in the key sectors for the year 2003. At this step the expert panel members provided their overall impressions of the results. In some cases, the expert panel members changed their opinion in relation to their previous answers. The comprehensive sensitivity analysis presented in the next section addresses the impacts of the changes on the experts' opinions and expectations.

7.2 SENSITIVITY ANALYSIS

This section has three main parts. The first two parts use non parametric tests. The first part analyzes the concordance between the rankings of the technologies using different methods of Kendall's' coefficient of concordance. The second part utilizes the intraclass correlation coefficient to measure the interjudge reliability. Both tests are used to evaluate the interval/ratio ratings of the technologies by the experts. The third part presents a series of analysis of situations when there is a variation of the weights of: a) the reduction of the Digital Divide on sectors; b) the relative impact of the ICT applications on the sectors; c) the relative impact of each ICTs on the applications.

7.2.1 COMPARISON OF TECHNOLOGY RANKINGS USING KENDALL'S COEFFICIENT OF CONCORDANCE

Kendall's coefficient of concordance is used to measure the concordance between sample rankings, or dependence of the samples [131, 132]. This measure considers n objects (ICTs) and m rankings (experts), where Rij denotes the rank given by the "i^{th}" expert to the "j^{th}" ICTs, using the individual expert judgement values for the sectors and keeping the means of the subjective judgmental values for the evaluations below the sector level. The null hypothesis is H_0: The rankings are independent (i.e. there is a significant difference in the rankings by different experts) [131-133].

We can measure the significant differences of the rankings in our research using the S, W and Q values. The last one is used for larger values of m and n.

According to Kendall and Gibbons the ranking of fifteen experts to seven technologies can be considered as a large value [140] [134].

7.2.1.1 Using S for Kendall's coefficient of concordance

Kendall coefficient of concordance is a measure of relative agreement. This measurement " *is a ratio of the variance of the sums of the ranks of the subjects (i.e., the variance of* $\sum R_j$ *values) divided by the maximum possible values that can be computed for the variance of the sums of the ranks for the relevant values of m [experts] and n [technologies]*" [133]. The variance of the $\sum R_j$ values is represented by S.

$$S = \frac{nU - (T)^2}{n} \qquad \textbf{Equation 1}$$

To analyze our data, the first step is to rank the relative impact values of the ICTs into ranking values. In the case where an expert gives the same value to two or more technologies, they are considered tied and the rank value is assigned by the mid-rank method. This method averages the ranks of the technologies that they would posses if the technologies where not tied [132]. For example, if expert 1 gives the highest impact value to technologies 1, and 3, and if that value is the same for both, these two technologies will not be ranked as first and second. Instead, the rank will be 1.5 as shown in Table 3.

- The following table represents the rankings of the ICTs by the 15 experts for the year 2003 and the computation of the U and T values.

Table 3 ICT rankings by Experts for 2003

	ICTs						
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Expert 1	1.5	4	1.5	7	3	6	5
Expert 2	2.5	4	1	5.5	2.5	5.5	7
Expert 3	2.5	4	1	7	2.5	5.5	5.5
Expert 4	3	4	1.5	5.5	1.5	5.5	7
Expert 5	3	4.5	1.5	4.5	1.5	6	7
Expert 6	2	4.5	1	7	3	6	4.5
Expert 7	2.5	4	1	5.5	2.5	5.5	7
Expert 8	2.5	4	1	6	2.5	6	6
Expert 9	2.5	4	2.5	6	1	5	7
Expert 10	2.5	4	2.5	6	1	5	7
Expert 11	1.5	4	3	6	1.5	5	7
Expert 12	2	4	2	6.5	2	5	6.5
Expert 13	2.5	4	1	5.5	2.5	5.5	7
Expert 14	2	4	2	7	2	5	6
Expert 15	2.5	4	1	5.5	2.5	5.5	7
Total	**35**	**61**	**23.5**	**90.5**	**31.5**	**82**	**96.5**
$(\text{Total})^2$	**1225**	**3,721**	**552.25**	**8,190.25**	**992.25**	**6724**	**9,312.25**

To test the null hypothesis H_0: The rankings are independent (i.e. there is a statistically significant difference in the rankings of the technologies by different experts). The appropriate values are substituted in Equation 1, as

$$T = \sum_{i=1}^{n}\sum_{j=1}^{m} R_{ij} = 420$$ **Equation 2**

Where R_{ij} is expert j's ranking of technology i.

$$U = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} R_{ij}\right)^2 = 30{,}717$$ **Equation 3**

Then

$$S = \frac{7(30{,}717) - (420)^2}{7} = 5{,}517$$ **Equation 4**

Note that $S_{critical} = 1{,}129.5$ at 0.01 level of significance [132]

The observed value of $S_{observed} > S_{critical}$

$\therefore$ 5517 > 1129.5, therefore reject Ho

Hence, there is significant association in the ICTs rankings by the fifteen experts for the year 2003 at the sector level.

- The following table represents the rankings of the ICTs by the 15 experts for the year 2010 and the computation of the U and T values.

Table 4 ICT rankings by Experts for 2010

	ICTs						
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Expert 1	5	3	1	2	5	5	7
Expert 2	6	3	1	2	4.5	4.5	7
Expert 3	5	3	1.5	1.5	5	5	7
Expert 4	5.5	3.5	1.5	1.5	3.5	5.5	7
Expert 5	5.5	3.5	1	2	3.5	5.5	7
Expert 6	6	3	1	2	4.5	4.5	7
Expert 7	5.5	3	1.5	1.5	4	5.5	7
Expert 8	5	3	1	2	5	5	7
Expert 9	6	3	1	2	4.5	4.5	7
Expert 10	6	3.5	1.5	1.5	3.5	5	7
Expert 11	5.5	3.5	1.5	1.5	3.5	5.5	7
Expert 12	5	3	1	2	5	5	7
Expert 13	5	3	1.5	1.5	5	5	7
Expert 14	5.5	3	1.5	1.5	4	5.5	7
Expert 15	5	3	1.5	1.5	5	5	7
Total	**81.5**	**47**	**19**	**26**	**65.5**	**76**	**105**
$(\text{Total})^2$	**6642.25**	**2209**	**361**	**676**	**4290.25**	**5776**	**11025**

To test the null hypothesis H_0: **The rankings are independent (i.e. there is a statistically significant difference in the rankings of technologies by different experts).** The appropriate values are substituted in Equation 1, as

$$T = \sum_{i=1}^{n}\sum_{j=1}^{m} R_{ij} = 420$$ **Equation 5**

Where R_{ij} is expert j's ranking of technology i.

$$U = \sum_{i=1}^{n}(\sum_{j=1}^{m} R_{ij})^2 = 30{,}979.5$$ **Equation 6**

$$S = \frac{7(30{,}979.5) - (420)^2}{7} = 5{,}779.5$$ **Equation 7**

Note that $S_{critical} = 1{,}129.5$ at 0.01 level of significance [132]

The observed value of $S_{observed} > S_{critical}$

$\therefore$ 5,779.5 > 1,129.5, therefore reject H_0

Hence, there is significant association in the ICTs rankings by the fifteen experts for the year 2010 at the sector level.

7.2.1.2 Using W for Kendall's coefficient of concordance

Another way to express "the coefficient of concordance" is as a ratio of the sums of the ranks for the subjects divided by the maximum possible value that can be computed for the variance of the sums of the ranks (for the relevant values of m and n) [133]. This coefficient is noted by "W". If the variables are independent, there is no association and W =0. On the other hand, for a complete dependence there is perfect agreement and W=1.

$$W = \frac{S}{\left[\frac{m^2 n(n^2 - 1)}{12}\right]} \qquad \textbf{Equation 8}$$

Substituting the values for the year 2003 as S=5,517, m=15, and n=7:

$$W_{2003} = \frac{5{,}517}{\left[\frac{15^2 7(7^2 - 1)}{12}\right]} = 0.86 \qquad \textbf{Equation 9}$$

In this case the W value is close to one, which indicates that there is a high agreement among the ICTs rankings of the expert panel members for the year 2003.

- Following the same procedure for the year 2010, substituting the value of S=5,779.5, m = 15 and n=7 the value of W is:

$$W_{2010} = \frac{5{,}779.5}{\left[\frac{15^2 7(7^2 - 1)}{12}\right]} = 0.92 \qquad \textbf{Equation 10}$$

In this case the W value is even closer to one. This indicates that there is high agreement between the rankings of the ICTs done by each expert for the year 2010.

However, we can see in this analysis that there are ties in the rankings of the technologies. There is an additional analytical procedure for Kendall's coefficient of concordance when ties are present. The quantity $\frac{1}{12} m \sum_{a=1}^{s_{ties}} (u_a^3 - u_a)$ is calculated for each expert to make the adjustment for ties S_{ties} indicate the number of set of ties in each ranking and u_a indicates the number of ties in each set of ties within each ranking.

The following equation includes the tie correction

$$\widetilde{W} = \frac{S}{\frac{1}{12}m^2\left(n^3 - n\right) - \frac{1}{12}m\sum_{a=1}^{s_{ties}}\left(u_a^{\ 3} - u_a\right)}$$ **Equation 11**

The following table shows the ICTs rankings by experts for the year 2003 and the number of sets with tied values. For example, for the ranking of expert 1 there is only one set of technologies with tied values. T1 and T3 for expert 1 should have the same ranking position. In the same way the ranking expressed by expert 12 has two sets of technologies with tied values: technologies one, three and five in one set and technologies four and seven in another set.

Table 5 Tied ICT ranks for 2003 per Expert

	ICTs							Number of sets of tied ranks
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	
Expert 1	1.5	4	1.5	7	3	6	5	1
Expert 2	2.5	4	1	5.5	2.5	5.5	7	2
Expert 3	2.5	4	1	7	2.5	5.5	5.5	2
Expert 4	3	4	1.5	5.5	1.5	5.5	7	2
Expert 5	3	4.5	1.5	4.5	1.5	6	7	2
Expert 6	2	4.5	1	7	3	6	4.5	1
Expert 7	2.5	4	1	5.5	2.5	5.5	7	2
Expert 8	2.5	4	1	6	2.5	6	6	1
Expert 9	2.5	4	2.5	6	1	5	7	1
Expert 10	2.5	4	2.5	6	1	5	7	1
Expert 11	1.5	4	3	6	1.5	5	7	1
Expert 12	2	4	2	6.5	2	5	6.5	2

Expert 13	2.5	4	1	5.5	2.5	5.5	7	2
Expert 14	2	4	2	7	2	5	6	1
Expert 15	2.5	4	1	5.5	2.5	5.5	7	2

The quantity $\frac{1}{12}m\sum_{i=1}^{m}\left(u^3-u\right)$ is calculated for each expert to make the adjustment for ties for the year 2003 as follows:

Expert 1 $= (2^3-2) = 6$

Expert 2 $= 2(2^3-2) = 12$

Expert 3 $= 2(2^3-2) = 12$

Expert 4 $= 2(2^3-2) = 12$

Expert 5 $= 2(2^3-2) = 12$

Expert 6 $= (2^3-2) = 6$

Expert 7 $= 2(2^3-2) = 12$

Expert 8 $= (2^3-2)+(3^3-3) = 30$

Expert 9 $= (2^3-2) = 6$

Expert 10 $= (2^3-2) = 6$

Expert 11 $= (2^3-2) = 6$

Expert 12 $= (2^3-2)+(3^3-3) = 30$

Expert 13 $= 2(2^3-2) = 12$

Expert 14 $= \left(3^3-3\right) = 24$

Expert 15 $= (2^3-2) = 12$

TOTAL Correction $= \frac{1}{12}15\left(198\right) = 247.5$

Substituting the appropriate values for the year 2003 S=5,517, m=15, n=7, and 198 as the value of the tied correction:

$$\widetilde{W}_{2003} = \frac{5{,}517}{\frac{1}{12}15^2\left(7^3-7\right)-247.5} = 0.91$$ **Equation 12**

The tied correction gives us a value of $\widetilde{W}$ even closer to one than the previous analysis. Furthermore, according to Sheskin an interjudge reliability coefficient of .9 or greater indicates extremely high interjudge agreement.

Following the same procedure for the year 2010, the value of $\widetilde{W}_{2010}$=0.97 achieves a higher agreement for the year 2010.

In both cases there is a high interjudge agreement within the rankings of information & Communication Technologies in the year 2003 and the year 2010 respectively at the sector level. Therefore, the mean values obtained in this research are a good representation of the collective judgement of the experts.

7.2.1.3 Other considerations

Kendall and Gibson suggest the use of the following approximation when the values of m and n are large:

$$Q = \frac{12S}{mn(n+1)} = m(n-1)W$$ **Equation 13**

Which can be approximated by the Chi-square distribution with $n-1$ degrees of freedom [132]. In our research we have ($n \geq 7$)which is considered a large values [132]. Following the equation, we obtained an observed value of Q_{2003}= 82.04. Using the chi-square distribution at a 0.01 level of significance the critical value of Q is equal to 16.81. The $Q_{observed} > Q_{critical}$, therefore the null hypothesis is rejected. Thus,

there is a significant association in the ICTs rankings by experts for the year 2003 at 0.01 level of confidence at the sector level.

Following the same procedure for the rankings of the year 2010, the observed value of Q for 2010 is 87.13, and the critical value of Q is 16.81 at a 0.01 level of confidence. The observed value of $Q_{observed} > Q_{critical}$ therefore the null hypothesis is rejected.

Thus, there is a significant association in the ICTs rankings by experts for the year 2010 at 0.01 level of confidence at the sector level.

In all these cases the Kendall's coefficient of concordance indicates that there is a high degree of agreement among the 15 experts with respect to how they rank the ICTs for years, 2003 and 2010.

7.2.2 FACTOR WITHIN-SUBJECTS ANALYSIS OF VARIANCE AND THE INTERCLASS CORRELATION COEFFICIENT

The intraclass correlation coefficient r_{IC} indicates the inter-judge reliability with respect of k judges (experts) rating n objects (ICTs), using the individual expert judgement values for the sectors and the means of the expert judgments fpr the evaluattions below the sector level. The values to calculate r_{IC} are obtained by the single factor within subject analysis of variance of the data. The value will be of 0.7 or greater if there is a high agreement between the judges or experts [141].

The following equation represents the r_{IC}:

$$r_{IC} = \frac{MS_{BS} - MS_{res}}{MS_{BS} + (k-1)MS_{res} + \frac{k}{n}(MS_{BJ} - MS_{res})}$$ **Equation 14**

where MS_{BS} = mean square between subjects (ICTs)

MS_{BJ} = mean square between judges (experts)

MS_{res} = mean square residual

Table 6 presents the impact of ICTs on the reduction of the Digital Divide according to the 15 experts followed by the calculations necessary to obtain the factor within analysis of variance. For the year 2003 with n = 7 technologies and m = 15 experts.

Table 6 Impact of ICTs on the reduction of the Digital Divide for 2003

	Expert 1		Expert 2		Expert 3		Expert 4		Expert 5		Expert 6		Expert 7		Expert 8	
	X_1	X_1^2	X_2	X_2^2	X_3	X_3^2	X_4	X_4^2	X_5	X_5^2	X_6	X_6^2	X_7	X_7^2	X_8	X_8^2
T1	0.17	0.03	0.16	0.03	0.16	0.03	0.16	0.03	0.16	0.02	0.16	0.03	0.16	0.02	0.16	0.02
T2	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02	0.14	0.02
T3	0.17	0.03	0.17	0.03	0.17	0.03	0.17	0.03	0.17	0.03	0.17	0.03	0.17	0.03	0.17	0.03
T4	0.11	0.01	0.13	0.02	0.12	0.01	0.13	0.02	0.14	0.02	0.11	0.01	0.13	0.02	0.13	0.02
T5	0.16	0.03	0.16	0.03	0.16	0.02	0.17	0.03	0.17	0.03	0.15	0.02	0.16	0.03	0.16	0.03
T6	0.12	0.02	0.13	0.02	0.13	0.02	0.13	0.02	0.13	0.02	0.12	0.02	0.13	0.02	0.13	0.02
T7	0.13	0.02	0.12	0.01	0.13	0.02	0.11	0.01	0.11	0.01	0.14	0.02	0.11	0.01	0.13	0.02
	$\Sigma X_1= 1.01$ $\Sigma X_1^2= 0.15$		$\Sigma X_2= 1.0$ $\Sigma X_2^2= 0.15$		$\Sigma X_3= 1.0$ $\Sigma X_3^2= 0.15$		$\Sigma X_4= 1.0$ $\Sigma X_4^2= 0.15$		$\Sigma X_5= 1.02$ $\Sigma X_5^2= 0.15$		$\Sigma X_6= 1.0$ $\Sigma X_6^2= 0.15$		$\Sigma X_7= 0.99$ $\Sigma X_7^2= 0.14$		$\Sigma X_8= 1.01$ $\Sigma X_8^2= 0.15$	

	Expert 9		Expert 10		Expert 11		Expert 12		Expert 13		Expert 14		Expert 15		ΣS_i
	X_9	X_9^2	X_{10}	X_{10}^2	X_{11}	X_{11}^2	X_{12}	X_{12}^2	X_{13}	X_{13}^2	X_{14}	X_{14}^2	X_{15}	X_{15}^2	
T1	0.16	0.03	0.17	0.03	0.17	0.03	0.16	0.03	0.16	0.02	0.17	0.03	0.16	0.02	2.43
T2	0.14	0.02	0.15	0.02	0.15	0.02	0.14	0.02	0.14	0.02	0.15	0.02	0.14	0.02	2.13
T3	0.16	0.03	0.17	0.03	0.16	0.03	0.16	0.03	0.17	0.03	0.17	0.03	0.17	0.03	2.50
T4	0.12	0.01	0.12	0.02	0.12	0.01	0.12	0.01	0.13	0.02	0.11	0.01	0.13	0.02	1.86
T5	0.17	0.03	0.18	0.03	0.17	0.03	0.16	0.02	0.16	0.03	0.17	0.03	0.16	0.03	2.45
T6	0.13	0.02	0.13	0.02	0.13	0.02	0.13	0.02	0.13	0.02	0.13	0.02	0.13	0.02	1.92
T7	0.11	0.01	0.11	0.01	0.10	0.01	0.12	0.02	0.12	0.02	0.12	0.01	0.12	0.01	1.78
	$\Sigma X_9= 1.01$ $\Sigma X_9^2= 0.15$		$\Sigma X_{10}= 1.0$ $\Sigma X_{10}^2= 0.15$		$\Sigma X_{11}= 1.00$ $\Sigma X_{11}^2= 0.15$		$\Sigma X_{12}= 0.99$ $\Sigma X_{12}^2= 0.14$		$\Sigma X_{13}= 1.0$ $\Sigma X_{13}^2= 0.15$		$\Sigma X_{14}= 1.01$ $\Sigma X_{14}^2= 0.15$		$\Sigma X_{15}= 1.01$ $\Sigma X_{15}^2= 0.15$		ΣX_T=15.08

To compute this test the data have been divided in to different components as follows:

- The total number of scores is represented by $N=n*k$ where n represents the number of ICTs and k the number of rankings for each technology. For this case $N = n*k = 7*15 = 105$

- $\sum X_T$ is the sum of the 105 scores and is represented as follows:

  $\sum X_T = \sum X_1 + \sum X_2 + ... + \sum X_k = 15.08$

- The total sum of the 105 squared scores is represented by $\sum X_T^2$. For this case the values is : $\sum X_T^2 = \sum X_1^2 + \sum X_2^2 + \sum X_3^2 + ... + \sum X_k^2 = 2.21$

- SS_T: total sum of squares

  Where $SS_T = SS_{BJ} + SS_{BS} + SS_{res}$. Replacing the values for this case the total sum of squares is $SS_T = \sum X_T^2 - \frac{\left(\sum X_T\right)^2}{N} = 0.0412$

- SS_{BJ} : between-judges sum of squares. Replacing the respective values we have:

  $$SS_{BC} = \sum_{j=1}^{k} \left[\frac{\left(\sum X_j\right)^2}{n} \right] - \frac{\left(\sum X_T\right)^2}{N} = 0.0001$$

- SS_{BS} : between-subjects sum of squares. Replacing the values for this case the sum between-subjects is $SS_{BS} = \sum \left[\frac{\left(\sum S_i\right)^2}{k} \right] - \frac{\left(\sum X_T\right)^2}{N} = 0.0377$

- SS_{res}: residual sum of squares. Replacing the appropriate values

  $SS_{res} = SS_T - SS_{BJ} - SS_{BS} = 0.0033$

  At this point the variance between subjects, judges and residual can be calculated as indicated:

$$MS_{BJ} = \frac{SS_{BJ}}{df_{BJ}} = 0.000008$$
$$MS_{BS} = \frac{SS_{BS}}{df_{Bs}} = 0.006281$$
$$MS_{res} = \frac{SS_{res}}{df_{res}} = 0.000040$$

The intraclass correlation coefficient r_{IC} indicates the inter-judge reliability; replacing the respective values in equation 8 we have:

$$r_{IC} = \frac{MS_{BS} - MS_{res}}{MS_{BS} + (k-1)MS_{res} + \frac{k}{n}(MS_{BJ} - MS_{res})}$$

For the year 2003 the $r_{ic} = \frac{0.0062}{0.0068} = 0.92$. An interjudge reliability coefficient of 0.9 or greater indicates extremely high interjudgment agreement at the sector level [133].

Following the same procedure for the year 2010, the $r_{ic} = \frac{0.0097}{0.0100} = 0.97$ also has an extremely high inter-judgment agreement.

7.2.3 ANALYZING CASE BY CASE

7.2.3.1 ANALYSIS OF EACH SECTOR

To analyze the sensitivity of the model to changes in the judgments, a software tool was created. This tool varies the values of a sector's impact on the reduction of the Digital Divide from the minimum to the maximum values assigned by the expert panel members. The other sectors' impacts are modified accordingly so that the sum of all the impacts is equal to one. The rest of the model remains with the original values. Appendix "I" has the complete tables of this analysis case by case.

The relative values of the impacts of the ICTs on the reduction of the Digital Divide present minimal changes. The difference in the values of the technologies are insignificant between the mean values used in this dissertation and the minimum and maximum values given by the expert panel members for the impacts of the reduction of the Digital Divide on the key sector in the overall objective. Appendix I presents all the tables of this analysis.

7.2.3.1.1 Analysis for the year 2010

The same analysis was conducted for the year 2010. The differences in the values of the technologies are insignificant between the mean values used in this dissertation in the minimum to the maximum value range assigned by the experts. See Appendix I for the tables for each sector in 2010.

7.2.3.2 ANALYSIS OF EACH ICT APPLICATION

In the same way that we analyze the sensitivity of our model to changes in the sectors, we analyze the sensitivity of the model to changes in the applications. We change the values of an ICT application in increments of 0.1 from the minimum value to the maximum value that the expert panel's members have assigned to the application in this study. The rest of the applications in the sectors' impacts are modified accordingly so that the sum of all the applications' impacts is equal to one in that sector. The rest of the model remains with the original/mean values. The following sections present the results of our analysis.

7.2.3.2.1 Analysis for the year 2003

Each application was analyzed between the maximum and minimum values assigned by the experts and compared to the mean value that is used in this dissertation. Thirteen out of 25 applications present slight changes of +-0.01; the maximum change for a given ICT is 2.1%. Only 6 out of 25 applications have slight changes in the final ICT rankings. Please refer to Appendix I for the tables with all the changes.

7.2.3.2.2 Analysis for the year 2010

The same analysis was done in the ICT applications for the year 2010. Three out of 25 applications present slight changes in the final ICT ranking; with a maximum change of 2.4%. Please refer to Appendix I for the tables with all the changes.

7.2.3.3 ANALYSIS OF EACH ICT ON EACH APPLICATION

The next level to study is the fourth level, where we study the sensitivity of the model to when we change the impact of each ICT on each ICT application. We change the values of an ICT in increments of 0.01 from minimum to maximum values assigned by the expert panel members. The rest of the technologies impacts' are modified accordingly so that the sum of all the technologies' impact is equal to one for the application of study. The rest of the model remains with the original values. The following sections present the results of our analysis for each year.

7.2.3.3.1 Analysis for the year 2003

Each technology was analyzed between the maximum and minimum values assigned by the experts. Out of 175 cases studied 151 have no changes; the other 24 have slight changes in the final ICT ranking. Appendix I presents all the tables where the technologies had suffered any modifications.

7.2.3.3.2 Analysis for the year 2010

Out of 175 cases studied 168 have no change; the other 7 have slight changes in the final ICT ranking.

7.3 SUMMARY

The validation tests show that there is:

a) A high degree of agreement amont the 15 experts with respect to the ranking of ICTs for both 2003 and 2010, using the individual judgment values for the sectors.

b) High interjudge reliability among the 15 experts when ranking the technologies using the individual judgement quantification value for the impact of the reduction of the sectors on the overall reduction of the digital divide.

c) Only slight changes in the rankings when we analyze case by case in the extreme cases' range for the sectors' impact, ICT applications and ICTs.

Overall, the values used in the analysis are representative of the judgements of the entire expert panel.

CHAPTER 8: CONCLUSIONS, CONTRIBUTIONS AND FUTURE WORK

8.1 CONCLUSIONS

Four major conclusions are derived from the results of this study.

1. Reduction of the Digital Divide in the education sector will have the highest impact on reducing the overall internal Digital Divide in Costa Rica. The ICT applications with major impact on the reduction of the digital divide of this sector are "Enhancing the learning process through the use of ICTs" and "Making programs that foster innovation, creativity and research". The top ranked technologies for these applications are "Collaborative tools" and "Country specific software".
2. ICT applications in the government and education sectors have the greatest impact on the overall reduction of the internal Digital Divide in Costa Rica. These are applications focused on improving public administration and fostering innovation and creativity.
3. The relative impact of "Internet content & infrastructure" and "Collaborative tools" on reducing the internal Digital Divide will grow from 2003 to 2010. The relative impacts of the "General purpose software" and "Land-based devices" will diminish in the same time frame. Technologies can be clustered into three priority levels in terms of each

technology's impact on the overall reduction of the interal Digital Divide in 2003 and 2010.

	2003	2010
High impact	T1: General purpose software T3: Internet content & infrastructure T5: Land-based devices & infrastructure.	T3: Internet content & infrastructure T4: Collaborative tools.
Medium impact	T2: Wireless devices & infrastructure T6: Country specific software	T2: wireless devices & infrastructure T1 general purpose software T5: Land-based devices & infrastructure T6: Country specific software
Low impact	T4: Collaborative tools T7: Mass communication systems.	T7: Mass communication systems

4. The most effective ways to reduce the overall internal Digital Divide in Costa Rica are to:

   a) Enhance the learning process through the use of ICTs in the education sector.

   b) Develop ICT-enabled educational programs that foster innovation, creativity and research.

   c) Focus on using ICTs to improve public administration.

8.2 CONTRIBUTIONS TO THE STATE OF KNOWLEDGE

This research establishes a decision-making process and model for the reduction of the Digital Divide and identifies, asseses, and selects the appropriate ICTs, ICT application, and sectors for the reduction of the internal Digital Divide in a developing economy.

There is a substantial amount of information in terms of case studies and policy level recommendations about the Digital Divide. The model operationalizes UNDP concepts, providing a generalized model for developing countries to reduce the Digital Divide by using ICTs. In other words, this research provides a tool to make educated policy decisions in terms of ICTs and the Digital Divide.

This model and its methodology can be generalized to different countries to identify the ICTs, technology applications and sectors and their impacts on the reduction of the Digital Divide. The general objective is applicable in any developing country, and the sectors studied are present in any society. The results may have different relative weights in different countries. ICT applications and technologies are mostly constant for all countries at a given time but may also have different weights in different countries. The model can be applied to other technologies too.

The research presents another application of AHP at the policy-making level for the reduction of the Digital Divide. It also presents policy modeling as a series of impact relationships among technologies, applications, key sectors and the country's objective. Finally, systems perspectives can be applied to the decisions related to the Digital Divide by identifying the appropriate systems and the different perspectives.

Research in developing countries is usually done by people from abroad. A frequent problem with this research is the lack of a real link between the research and the country of origin [31]. In this research, the panel of experts is formed by people who are related to the country and have an active participation in Costa Rican society.

This research provides Costa Rica with a decision-making tool to reduce its the Digital Divide through a participative decision process using expert opinions to prioritize the reduction of the Digital Divide of the sectors, ICT application and ICTs.

8.3 CONTRIBUTIONS TO COSTA RICA

This research contributes to Costa Rica by:

1. Appliying the model to a critical policy decision involving key people at high levels of national decision making.
2. Providing an in-depth understanding of the relative impacts of reducing the Digital Divide in key sectors.
3. Identifying the top-ranked ICT applications and ICTs in each sector for both 2003 and 2010.
4. Enabling the decision makers in Costa Rica to select the areas on which to focus. Table 7 presents top-ranked sectors, ICT applications and ICTS for 2003 and 2010. This table could be used in many different

decision scenarios. For example: a) the decision maker who is responsible for reducing the Digital Divide in the country should focus on columns one and two, b) the decision maker responsible for reducing the digital divide in a specific sector should focus on the rows corresponding to the sectors respectively, or c) the decision maker who wants to determine which technologies will have the highest impact on a top-ranked application should focus on the application row and the top technologies listed in that row.

Table 7 Top ranked sectors, ICT applications and ITCs for 2003 and 2010

		2003		2010	
Priority	**Sector**	**Top ranked ICTs Applications**	**Top ranked ICTs**	**Top ranked ICTs Applications**	**Top ranked ICTs**
1	Education	A.2.1. Enhancing the learning process through the use of ICTs	T4, T6	A.2.5. Making programs that foster innovation, creativity and research	**T4**, T6, T3
		A.2.5. Making programs that foster innovation, creativity and research	**T4**, T6		
2	Economic	A.3.6: Creating a database to match the availability of human resources with job opportunities	**T1**, T2	A.3.6. Creating a database to match the availability of human resources with job opportunities	T4, T3
		A.3.4. Sharing ICT resources among enterprises	T3, T1, T5	A.3.4: Sharing ICT resources among enterprises	T4, T2
3	Government	A.4.3. Improving public administration throughout the country	**T1**, T5, T2-T3	A.4.3. Improving public administration throughout the country	T5, T3
3	Health	A.1.3. Providing on-line medical libraries	T3	A.1.3. Providing on-line medical libraries	T3
5	Environment	A.5.4. Promoting biodiversity & sustainable development	T3	A.5.5. Disseminating information about best practices	**T6**, T3
		A.5.2. Promoting public awareness of environmental issues throughout the country	T7	A.5.4. Promoting biodiversity & sustainable development	**T3**, T1
				A.5.2. Promoting public awareness of environmental issues throughout the country	T7

8.4 ASSUMPTIONS

The major assumptions in the research are:

1. The biases of the experts are balanced in the expert panel.
2. The decision elements at each level, i.e. the technologies, applications and sector levels, are preferentially independent.
3. The impact relationships considered in the model are linear and additive.

8.5 LIMITATIONS

The finance and legal framework are outside of this study, which can bring some limitations to the system.

Although investment in ICT infrastructure is not considered as an enabler, it can lead to improved access, reduced cost and extended coverage [1]. It is intrinsically considered to enhance rural economic opportunities, improve communication systems and other areas of the economic system. Simply, investing in ICT infrastructure will not reduce the Digital Divide.

The research relies on the individual judgment of the experts to evaluate the model. The experts will give their opinions based on their background and knowledge; however, their opinions are also influenced by personal preferences and values, so these could affect the validity of the model.

The research takes into consideration only ICTs in a specific country, Costa Rica.

The follow-up and implementation of the results of this research in Costa Rica will depend on how the experts use the results.

8.6 FUTURE WORK

Altfhough this research provides the relative weights of the impacts of the sectors and applications, the sectors are evaluated in a static time frame. Addressing dynamics, possibly using simulation models, is a key opportunity for future work. As a starting point, this research identifies subsets of applications and technologies that have higher impacts in each sector. One could develop different models to understand the development of the key ICTs in each sector based on the results of this research.

Other ideas for future work include:

- Inclusion of the legal and financial framework
- Generalization of the model towards the external Digitial Divide, different technologies, different countries, and/or different policy problems in a country. Table 8 shows the different levels of the model that could be reused in generalizing the model.

Table 8 Generalization of the model

	Internal Digital Divide in other countries	External Digital Divide	Other policy problems in any country
Sectors	☑	☑	☑
Application	☑	☒	☒
Technologies	☑	☑	☒

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APPENDIX A: LISTS OF ICTs APPLICATIONS PER SECTOR AND INFORMATION & COMMUNICATION TECHNOLOGIES

A1: PRELIMINARY LIST OF APPLICATIONS

Applications in the Health Sector

1. Making consultation available in remote areas
2. Bringing diagnosis to remote areas
3. Providing treatment in remote areas
4. Preventing diseases by information dissemination
5. Responding to epidemics (monitoring cases and vaccination coordination)
6. Providing on-line medical libraries to health professionals especially in remote areas
7. Facilitating medical research in distant research facilities
8. Improving the administrative efficiency in the public health system

Applications in the Education Sector

1. Participating in virtual research groups
2. Creating curricular improvements
3. Enhancing the learning process through the use of ICTs
4. Improving educations system administration
5. Promoting education with IT's use in K-12
6. Extending distance learning in remote areas
7. Providing technical training through ICTs
8. Providing vocational training through ICTs
9. Dissemintating information in education

Applications in the Economic Sector

1. Creating market information systems
2. Enhancing rural economic opportunities
3. Improving business efficiency through the use of ICTs
4. Sharing ICT resources
5. Providing global connectivity delivery
6. Creating new business models (b2b, b2c, etc)

Applications in the Government Sector

1. Facilitating the participation in democratic process
2. Providing universal access for citizens
3. Creating e-governement applications
4. Improving the public administration

Applications in the Environmental Sector

1. Monitoring ecological conditions
2. Managing biodiversity
3. Managing sustainable resources
4. Monitoring environmental disasters
5. Responding to environmental disasters
6. Disseminating environmental information

A2: PRELIMINARY LIST OF ICTS

1. Microwave including low earth satellite
2. Wireless for LAN
3. Wireless for cellphone networks
4. Fiber optic
5. DSL or cable
6. Land-based telephone system
7. Low cost computers
8. Personal computers
9. Servers
10. PDA's
11. Wireless phones
12. Digital cameras
13. Video cameras
14. Sound devices
15. Interent infrastructure (Swithcers, hubs, routers)
16. Internet protocols (HTTP, TCP/IP)
17. User interface systems
18. Databases
19. ERP systems
20. CRM
21. OLAP
22. Data analysis systems
23. Data modeling systems
24. Statistical analysis systems
25. Simulation tools
26. Security systems
27. Web services
28. Web browsers
29. Web forums
30. Chats
31. e-mails
32. Video conferencing
33. Teleconferencing
34. Voice recognition
35. Multimedia
36. Collaboraltive tools
37. Multilingual tools
38. Geographic information systems
39. Automatic computing
40. Web semantics
41. Vertical applications
42. Customization

A3: FINAL LIST OF APPLICATIONS

Applications in the Health Sector

A.1.1. Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population
A.1.2. Preventing diseases and improving epidemic response
A.1.3. Providing on-line medical libraries
A.1.4. Facilitating diagnosis in distant medical labs
A.1.5. Improving the efficiency of the health system in every geographic area
A.1.6. Creating awareness of health issues in the population through the use of ICTs

Applications in the Education Sector:

A.2.1. Enhancing the learning process through the use of
A.2.2. Improving the education system administration
A.2.3. Expanding distance learning
A.2.4. Providing technical and vocational training to the entire population
A.2.5. Making programs that foster innovation, creativity and research available throughout the country

Applications in the Economic Sector:

A.3.1. Improving market intelligence available to every business in the country
A.3.2. Enhancing rural economic opportunities
A.3.3. Improving business efficiency and productivity of small –to-medium-sized enterprises (SMEs) through information and communication technologies
A.3.4. Sharing ICT resources among enterprises
A.3.5. Creating new business models based on information networks
A.3.6. Creating a database to match the available human resources and job offerings.

Applications in the Government Sector:

A.4.1. Facilitating participation of the public in democratic processes
A.4.2. Providing universal access to information and on-line services to empower people
A.4.3. Improving public administration throughout the country

Applications in the Environmental Sector:

A.5.1. Monitoring and disseminating information on ecological conditions
A.5.2. Promoting public awareness of environmental issues throughout the country
A.5.3. Monitoring environmental conditions to facilitate decision making
A.5.4. Promoting biodiversity and sustainable development
A.5.5. Dissemination of information about best practices

A4: FINAL LIST OF TECHNOLOGIES

T1 : General purpose software

T2 : Mobile devices and infrastructure

T3 : Internet content and infrastructure

T4: Collaborative tools

T5: Land-based devices and infrastructure

T6: Country specific software

T7: Mass communication systems

APPENDIX B: WEB INSTRUMENT

The Spanish version is available upon request from the author.

Welcome to Audrey Alvear's Dissertation Site

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Expert Panel Registration

Thank you for joining the expert panel. Please provide the e-mail address and password you will use in this study. This will ensure confidentiality of your responses by preventing access by anyone else.

The first time you log in to our study web site, you'll be asked to confirm your password and some personal information. If you have already registered, a personalized menu will appear.

Fields with * mark are required.

* E-mail:	
* Password:	

Submit Reset

Contact us : *ww@xx.yy.zz*[12]

A Decision Model for Technology Policies to Reduce the Digital Divide by Using ICTs

New User Password Confirmation:

To participate in the study, please confirm your password

Fields with * mark are required.

First Name: *	Audrey

---

[12] For confindetiality reasons e-mail address not displayed.

Last Name: *	Alvear
E-mail:	ww@xx.yy.zz
Password:	
Confirm Password: *	

Submit Reset

Contact us : *ww@xx.yy.zz*

A Decision Model for Technology Policies to Reduce the Digital Divide by Using ICTs

Main Menu

Welcome Expert's Name,

You can partially submit your responses at any time by clicking the "RETURN TO MENU" button at the bottom of each survey page. Then, you can come back to finish it or edit your previous responses before the expiration of accessibility period.

If you have any questions, please contact ww@xx.yy.zz.

Please select an option:

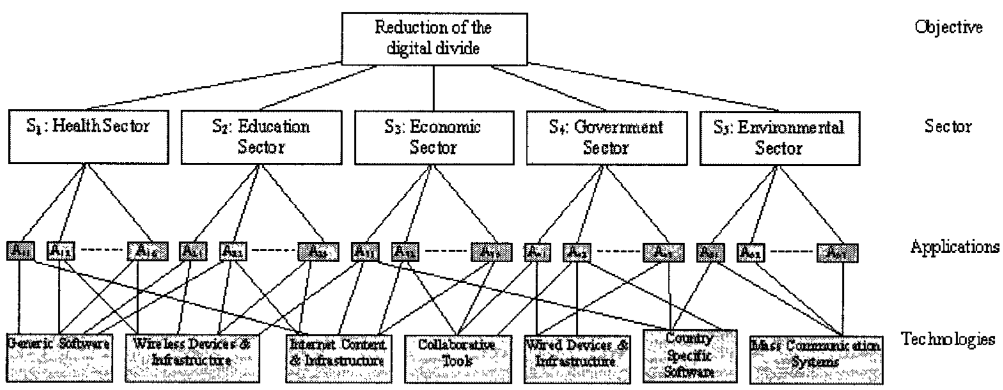
You can start responding now by clicking this button:	Start
Sign out	Sign Out

Contact us : *ww@xx.yy.zz*

Digital Divide

Is the gap between the people who can access, interact with and benefit from the use of Information and Communication Technologies (ICTs) and those who cannot.

You are part of an expert panel whose objective is to help develop an analytical approach to reducing the Digital Divide in developing countries. This objective will be achieved by determining the relative impacts of the Reduction of the Digital Divide in the key sectors of the country, assessing various applications of ICTs in each sector, and selecting specific technologies for the application areas. A four-level hierarchical model has been developed for this purpose as shown below:



The elements at each level have been identified as follows:

Level – 1:	Reduction of the Digital Divide in the country.
Level – 2:	Reduction of Digital Divide of the five key sectors by improving access, availability and usability of that sector.
Level – 3:	Applications of ICTs (6 in health, 5 in education, 5 in economic, 3 in government, and 6 in environmental sectors)
Level – 4:	7 Information and Communication Technologies

All of the applications at level 3 and technologies at level 4^{th} have been identified from the literature and finalized by incorporating all the comments received from the expert panel.

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A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Level 1: Digital Divide

Is the gap between the people who can access, interact with and benefit from the use of Information and Communication Technologies (ICTs) and those who cannot

Level 2: Reduction of the Digital Divide in Key Sectors

S1: Reduction of the Digital Divide in the health sector by bringing hospitals, clinics, health centers, and health professionals in rural and urban areas to a level where they can utilize ICTs capabilities; and providing the community with the tools that are required for access to good medical services.

S2: Reduction of the Digital Divide in the educational sector by bringing all the educational institutions and professionals in the country to a level where they can benefit from the use of ICTs; and providing the community with the tools that are required for access to good education no matter where the individuals are or what educational degree they pursue.

S3: Reduction of the Digital Divide in the economic sector by improving business efficiency and productivity throughout the country to become competitive in a global economy through the use of ICTs; and providing businesses, professionals, farmers, and the general population with ideas and solutions to create and/or capture markets and economic opportunities.

S4: Reduction of the Digital Divide in the government sector by fostering empowerment and participation of the people through the use of ICTs; and making government processes more efficient and transparent by sharing information among people, business and government.

S5: Reduction of the Digital Divide in the environmental sector by managing information about biodiversity, and sustainable development through the use of ICTs, with a focus not only on the research community but also on the public in general.

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A Decision Model for Technology Policies to Reduce the Digital Divide by Using Information and Communication Technologies

Instructions:

The following is a list of technology oriented applications in the health sector.

The applications presented here are based on literature research and comments of expert panel members.

Please read carefully the definitions and give us your opinion about the list.

If you think the list is complete and does not need changes, select the □ppropriate button at the end.

If you consider there are applications that need to be added, please indicate the name of the application and the definition.

In case an application needs to be modified, please indicate the name or number and the modification.

Finally, in case of deletion, please indicate the name of the application or number and the reason.

Keep in mind the objective is :

Level 2: Reduction of the Digital Divide in the Health Sector

By bringing hospitals, clinics, health centers, and health professionals in rural and urban areas to a level where they can utilize ICTs capabilities; and providing the community with the tools that are required for access to good medical service

Level 3: Applications in Health Sector

A11: Making health services widely available: telemedicine, remote consultation, diagnosis and treatment that take place without having the patient in the same physical location as the physician; the information is gathered and then sent through digital means to the respective physicians.

A12: Preventing diseases and improving epidemic response: capturing information about cases of contagious diseases, monitoring them and disseminating information by broadcast media or other ICTs means; creating DRGs (diagnosis related groups).

A13: Providing on-line medical libraries: making medical libraries accessible to health professionals especially in remote areas to keep up-to-date on medical knowledge and related literature; and providing the general population with means to learn more about certain illnesses or health issues.

A14: Facilitating medical research in distant research facilities: using ICTs technologies to get data for clinical trials locally to be evaluated in distant research facilities.

A15: Improving the efficiency of the public health system in every geographic area: using e-applications which provide low-cost healthcare information and facilitate consultation, referrals, scheduling, unique medical records and e-procurement; improving the efficiency in the auctions and bids of the public health system and resource management according to the geographic areas' needs.

A16: Creating awareness of health issues in the population through the use of ICTs: disseminating information about infant to old age health problems to the population through the use of ICTs.

Do you think the list needs any changes or not ?

Please select the appropriate button

- No changes are needed.
- Changes are needed. (Please indicate application name or number, and the changes needed. If you make any additions to the list, please provide title and definition. Finally, in case of deletion, please indicate the application name or number and reason.)

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ICTs Applications in the Education Sector

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Instructions:

The following is a list of technology oriented applications in the education sector.

The applications presented here are based on literature research and comments of expert panel members.

Please read carefully the definitions and give us your opinion about the list.

If you think the list is complete and does not need changes, select the □ppropriate button at the end.

If you consider there are applications that need to be added, please indicate the name of the application and the definition.

In case an application needs to be modified, please indicate the name or number, and the modification.

Finally, in case of deletion, please indicate the name of the application or number and the reason.

Keep in mind the objective is :

Level 2: Reduction of the Digital Divide in Education Sector

By bringing all the educational institutions and professionals in the country to a level where they can benefit from the use of ICTs; and providing the community with the tools that are required for access to good education no matter where the individuals are or what educational degree they pursue.

Level 3: Applications in Education Sector

A21: Enhancing learning process through the use of ICTs: Providing access to knowledge and facilitating collaborative and interactive learning, thus enhancing the traditional education system. It includes on-line communities for students, teachers and/or professors; instructor support through multimedia learning materials, bulletin boards and e-mails; collaborative projects among instructors and students; student tracking systems to evaluate the student's progress; chat rooms, email, bulletin boards and home pages to encourage shared research efforts among academics and students; special programs for teaching teachers how to utilize computer technologies as a teaching tool, promoting education with IT use in K-12.

A22: Improving the education system administration by using ICT application, with the objective of making education available to the entire population, providing a transparent and efficient management of resources at schools and in the Ministry of Education.

A23: Expanding distance learning: delivering education by ICTs where professors and students do not have to be in the same physical location; but can access the same virtual space where they interact or find the necessary information to acquire knowledge and the necessary tools to test the on-line acquired knowledge.

A24: Providing technical and vocational training to the entire population: developing specific skills for technology use including hardware/ software systems, as well as skills needed in various fields including health related professions, agriculture, mechanical repair, etc. through the use of ICT applications, internet and web-based classes.

A25: Making programs that foster innovation, creativity and research available throughout the country: using e-applications which provide low-cost healthcare information and facilitate consultation, referrals, scheduling, unique medical records and e-procurement; improving the efficiency in the auctions and bids of the public health system and resource management according to the geographic areas' needs.

Do you think the list needs any changes or not ?

Please select the appropriate button

- (•) No changes are needed.
- ( ) Changes are needed. (Please indicate application name or number, and the changes needed. If you make any additions to the list, please provide title and definition. Finally, in case of deletion, please indicate the application name or number and reason.)

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ICTs Applications in the Economic Sector

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Instructions:

The following is a list of technology oriented applications in the economic sector.

The applications presented here are based on literature research and comments of expert panel members.

Please read carefully the definitions and give us your opinion about the list.

If you think the list is complete and does not need changes, select the □ppropriate button at the end.

If you consider there are applications that need to be added, please indicate the name of the application and the definition.

In case an application needs to be modified, please indicate the name or number and the modification.

Finally, in case of deletion, please indicate the name of the application or number and the reason.

Keep in mind the objective is :

Level 2: Reduction of the Digital Divide in the Economic Sector

By improving business efficiency and productivity throughout the country to become competitive in a global economy through the use of ICTs; and providing businesses, professionals, farmers, and the general population with ideas and solutions to create and/or capture markets, and economic opportunities

Level 3: Applications on the Economic Sector

A31: Improving market intelligence available to every business in the country: providing timely access to market information, such as the status of a crop, fluctuations in the tourism industry, changes in the software industry, pricing structures and supply/demand relationships. This is also a tool for information dissemination.

A32: Enhancing rural economic opportunities: enabling people to work anywhere, so local communities are integrated into the global economy, for example, the use of telecenters, which are community resource centers equipped with the latest technology such as computers, faxes, and Internet connections.

A33: Improving business efficiency and productivity of SMEs through information and communication technologies: using ICTs to reduce operational cost by decreasing material, procurement and transaction costs; and enabling small & medium-sized businesses throughout the country to use more and better information to improve the value of their output.

A34: Sharing ICT resources among enterprises: enabling small and medium-sized enterprises to share resources for reducing the cost of access to technology. For example, two small- to medium-sized enterprises can share the use of a computer to work on business accounting.

A35: Creating new business models based on information networks: using ICTs to create and deliver products and services on a global scale, and to give developing countries access to new markets for competitive advantage. These new business models include applications such as e-trading, marketplaces, business-to-business, and portals.

Do you think the list needs any changes or not ?

Please select the □ppropriate button

- (•) No changes are needed
- ( ) Changes are needed. (Please indicate application name or number, and the changes needed. If you make any additions to the list, please provide title and definition. Finally, in case of deletion, please indicate the application name or number and reason.)

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ICTs Application in the Government Sector

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Instructions:

The following is a list of technology oriented applications in the government sector.

The applications presented here are based on literature research and comments of expert panel members.

Please read carefully the definitions and give us your opinion about the list.

If you think the list is complete and does not need changes, select the □ppropriate button at the end.

If you consider there are applications that need to be added, please indicate the name of the application and the definition.

If the application needs to be modified, please indicate the name or number and the modification.

Finally, in case of deletion, please indicate the name of the application or number and the reason.

Keep in mind the objective is :

Level 2: Reduction of the Digital Divide in the Government Sector

By fostering empowerment and participation of the people through the use of ICTs; and making government processes more efficient and transparent by sharing information among people, business and government.

Level 3: Applications in the Government Sector

A41: Facilitating participation of the public in democratic processes: encouraging the public's participation in the democratic process through the use of ICTs during elections or special voting procedures on a specific topic.

A42: Providing universal access to information and on-line services to empower people: developing hardware and software infrastructure that interconnects computers and provides free Internet access, free e-mail accounts and information to citizens nationwide; making information accessible through citizen service centers; providing the citizens with technological access to government agencies; promoting the use of applications that permit the citizens to have an equitable/fair access to the services of the government so they can make educated choices and political decisions.

A43: Improving public administration throughout the country: developing applications to improve the quality of service and the level of responsiveness of government institutions everywhere in the country; increasing the efficiency and transparency of government processes for the entire population; bringing up to date hardware/software and technological platforms of the governmental agencies in all provinces; improving the capability for equitable public spending and tax collection.

Do you think the list needs any changes or not ?

Please select the appropriate button

No changes are needed

Changes are needed. (Please indicate application name or number and the changes needed. If you make any additions to the list, please provide title and definition. Finally, in case of deletion, please indicate the application name or number and reason.)
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ICTs Applications in the Environmental Sector

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Instructions:

The following is a list of technology oriented applications in the environmental sector.

The applications presented here are based on literature research and comments of expert panel members.

Please read carefully the definitions and give us your opinion about the list.

If you think the list is complete and does not need changes, select the □ppropriate button at the end.

If you consider there are applications that need to be added, please indicate the name of the application and the definition.

In case an application needs to be modified, please indicate the name or number and the modification.

Finally, in case of deletion, please indicate the name of the application or number and the reason.

Keep in mind the objective is :

Level 2: Reduction of the Digital Divide in the Environmental Sector

By managing information about biodiversity and sustainable development through the use of ICTs with a focus not only on the research community but also on the public in general.

Level 3: Applications in the Environmental Sector

A51: Monitoring and disseminating information on ecological conditions for sustainable development: using ICT applications to improve efficient use of resources to fight contamination and to set prevention and mitigation measures. ICT applications can collect data and forecast pest problems and pesticide use. Weather information and soil monitoring are also parts of ecological monitoring.

A52: Promoting awareness of environmental issues in the public throughout the country: using ICTs to disseminate information about environmental and bio-diversity related issues, impacts on environmental quality, farming sustainability, marine management and energy sources. It includes a national computer database to contribute to bio-diversity and environmental knowledge and awareness.

A53: Monitoring and responding to environmental disasters: using ICTs to send information, especially images of environmental disasters, on a timely basis, so the rescue teams can have the information they need when they need it. Examples are monitoring of fire emergencies or oil spills.

Do you think the list needs any changes or not ?

Please select the appropriate button

- No changes are needed
- Changes are needed. (Please indicate application name or number and the changes needed. If you make any additions to the list, please provide title and definition.

Finally, in case of deletion, please indicate the application name or number and reason.)
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Information & Communication Technologies

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Instructions:

The technologies presented here are the enablers of the technology-oriented applications that will help to reduce the Digital Divide in the different sectors.

The list has been developed as a result of an extensive literature search and the incorporation of all the comments received from the expert panel.

Later on, we will evaluate the relative impact of each technology on the reduction of the Digital Divide in a developing country.

Please read carefully the definitions and answer the question at the end of this section.

Level 4: ICTs

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: Laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the blind, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices; as well as the required infrastructure to make any of these devices work.

Do you think the list needs any changes or not ?

Please select the □ppropriate button

◉ No changes are needed

○ Changes are needed. (Please indicate technology group name or number and the changes needed. If you make any additions to the list, please provide title and definition. Finally, in case of deletion, please indicate the technology group name or number and reason.)

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A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Main Menu

Welcome Expert's Name,

You can partially submit your responses at any time by clicking the "RETURN TO MENU" button at the bottom of each survey page. Then, you can come back to finish it or edit your previous responses before the expiration of accessibility period.

If you have any questions, please contact ww@xx.yy.zz.

Please select an option:

You can edit your answer now by clicking this button:	
Sign out	

Contact us : *ww@xx.yy.zz*

A Decision Model for Technology Assesment to Reduce the Internal Digital Divide by Using ICTs (Case: Costa Rica)

Survey Log Out

Thanks Audrey Alvear for your responses.

If you would like to receive the results of the study, please send an email message to ww@xx.yy.zz , and we will send your copy when the study is completed.

You can contact me at:
Audrey Alvear
Engineering and Technology Management Department
Portland State University

APPENDIX C: THE JUDGMENT QUANTIFICATION INSTRUMENT

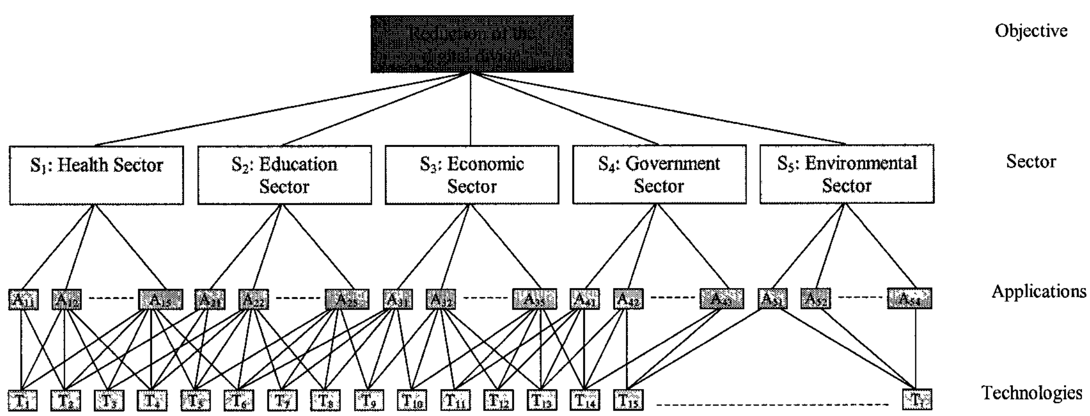
The Spanish version is available upon request from the author.

Reduction of the Digital Divide in a Developing Country

Digital Divide

> There is a gap between the people who can access, interact with and benefit from the use of ICTs (ICTs) and those who cannot. This gap is called the **"Digital Divide".**

There are different initiatives to reduce this Digital Divide in developing nations. You are part of a team responsible for identifying the relative impacts of the Reduction of the Digital Divide in various sectors of a country on reducing the Digital Divide, assessing various applications of ICTs, and selecting specific technologies for this purpose. A four-level hierarchical model has been developed for this purpose as shown below:



The elements at each level have been identifies as follow:

Level – 1: Reduction of the Digital Divide
Level – 2: Reduction of the Digital Divide in each of the five sectors
Level – 3: Applications (5 in health sector, 5 in education sector,
5 in economic sector, 3 in political sector, and
4 in environmental sector)
Level – 4: 7 ICTs

Instrument – 1

Relative impacts of the **reduction of the Digital Divide of the sectors** on the overall **reduction of the internal Digital Divide**.

Level – 1: Objective

Digital Divide: is the gap between the people who can access, interact with and benefit from the use of Information and Communication Technologies (ICTs) and those who cannot.

Level – 2: Reduction of the Digital Divide in the Key Sectors

S1: Reduction of the Digital Divide in the health sector: bringing hospitals, clinics,health centers, and health professionals in rural and urban areas to a level where they can utilize ICTs capabilities, as well as providing the community with the tools that are required for access to good medicalservice.

S2: Reduction of the Digital Divide in the education sector: bringing all the educational institutions and professionals to a level where they can benefit from the use of ICTs, as well as providing the community with the tools that are required for access to good education no matter where the individuals are or what educational degree they pursue.

S3: Reduction of the Digital Divide in the economic sector: improving business efficiency and productivity to become competitive in a global economy through the use of ICTs as well as providing businesses, professionals, farmers, and the general population with ideas and solutions to create and/or capture markets and economic opportunities

S4: Reduction of the Digital Divide in the governmental sector: fostering empowerment and participation of the people through the use of ICTs, as well as making government processes more efficient and transparent by sharing information among people, business and government.

S5: Reduction of the Digital Divide in the environmental sector: managing information about biodiversity and sustainable development through the use of ICTs with a focus not only on the research community but also on the publicin general.

Instructions

To determine the relative impact of the Reduction of the Digital Divide in the different sectors on the reduction of the Digital Divide, you are asked to compare the sectors in pairs and then express your judgment about the ratio of the impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that the **Reduction of the Digital Divide in the health sector** has 4 times as much impact as the **Reduction of the Digital Divide in the education sector** on the reduction of the Digital Divide, please give 80 points to the **Reduction of the Digital Divide in the health sector** and 20 points to the **Reduction of the Digital Divide in the education sector** in the first pair as follows:

Reduction of the Digital Divide in the health sector	80	20	Reduction of the Digital Divide in the education sector

If in your judgment the Reduction of the Digital Divide in the two sectors in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Measurements

Reduction of the Digital Divide in the health sector			Reduction of the Digital Divide in the education sector

Reduction of the Digital Divide in the environmental sector			Reduction of the Digital Divide in the education sector

Reduction of the Digital Divide in the government sector			Reduction of the Digital Divide in the economic sector

Reduction of the Digital Divide in the economic sector			Reduction of the Digital Divide in the environmental sector

Reduction of the Digital Divide in the government sector			Reduction of the Digital Divide in the environmental sector
Reduction of the Digital Divide in the education sector			Reduction of the Digital Divide in the economic sector
Reduction of the Digital Divide in the government sector			Reduction of the Digital Divide in the health sector
Reduction of the Digital Divide in the health sector			Reduction of the Digital Divide in the economic sector
Reduction of the Digital Divide in the government sector			Reduction of the Digital Divide in the education sector
Reduction of the Digital Divide in the environmental sector			Reduction of the Digital Divide in the health sector

Instrument – 2

Relative impact of **ICT applications** on the reduction of the Digital Divide in the **health sector**.

Level – 2: Reduction of the Digital Divide in key sectors

S1: Reduction of the Digital Divide in the health sector by bringing hospitals, clinics, health centers, and health professionals in rural and urban areas to a level where they can utilize ICTs capabilities; and providing the community with the tools that are required for access to good medical service.

Level – 3: Applications in Health Sector

A.1.1. Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population: telemedicine, remote consultation, diagnosis and treatment that take place without having the patient in the same physical location as the physician; the information is gathered and then sent through digital means to the respective physicians.

A.1.2. Preventing diseases and improving epidemic response: capturing information about cases of contagious diseases, monitoring them and disseminating information by broadcast media or other ICTs means; creating DRGs (Diagnosis Related Groups.)

A.1.3. Providing on-line medical libraries: making medical libraries accessible to health professionals especially in remote areas to keep up-to-date on medical knowledge and related literature; and providing the general population with the means to learn more about certain illnesses or health issues.

A.1.4. Facilitating diagnosis in distant medical labs: using ICTs technologies to get data for clinical trials locally to be evaluated in distant labs; standardizing the processes used in the labs for consistency and effectiveness of illness identification.

A.1.5. Improving the efficiency of the health system in every geographic area: using e-applications which provide low-cost healthcare information and facilitate consultation, referrals, scheduling, unique medical records e-procurement; developing a data base of medical records with Internet access for use by public and private healthcare providers; improving the efficiency in procurement and resource management in the health system according to the geographic areas' needs.

A.1.6. Creating awareness of health issues in the population through the use of ICTs: disseminating information about infant to old age health problems to the population through the use of ICTs.

Instructions

To determine the relative impact of the applications in the reduction of the Digital Divide in the health sector, you are asked to compare the applications in pairs and then express your judgment about their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population** is 4 time as important as **preventing diseases and improving epidemic response** for the reduction of the Digital Divide on the health sector, please give 80 points to **expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population** and 20 points to **preventing diseases and improving epidemic response** in the first pair as follows:

Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population	**80**	**20**	Preventing diseases and improving epidemic response

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the reduction of the Digital Divide on one sector has virtually no contribution in comparison with the Reduction of the Digital Divide on the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of the " ICTs appliacations" on the reduction of the Digital Divide in the "Health Sector"

Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population			Preventing diseases and improving epidemic response

Preventing diseases and improving epidemic response			Improving the efficiency of the health system in every geographic area

Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population			Improving the efficiency of the health system in every geographic area

Providing on-line medical libraries			Preventing diseases and improving epidemic response

Making health services available in remote areas			Providing on-line medical libraries

Facilitating diagnosis in distant medical labs			Providing on-line medical libraries

Preventing diseases and improving epidemic response			Facilitating diagnosis in distant medical labs

Facilitating diagnosis in distant medical labs			Creating awareness of health issues in the population through the use of ICTs

Improving the efficiency of the health system in every geographic area			Providing on-line medical libraries

Facilitating diagnosis in distant medical labs			Improving the efficiency of the health system in every geographic area

Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population			Facilitating diagnosis in distant medical labs

Making health services available in remote areas			Creating awareness of health issues in the population through the use of ICTs

Providing on-line medical libraries			Creating awareness of health issues in the population through the use of ICTs

Creating awareness of health issues in the population through the use of ICTs			Facilitating diagnosis in distant medical labs

Improving the efficiency of the health system in every geographic area			Creating awareness of health issues in the population through the use of ICTs

Expanding the availability of health services and identification of the appropriate level of medical response for the needs of the population			Creating awareness of health issues in the population through the use of ICTs

Instrument – 3

Relative impact of **ICT applications** on the reduction of the Digital Divide in the **Education Sector**.

Level – 2: Reduction of the Digital Divide in key sectors

S2: Reduction of the Digital Divide in the educational sector by bringing all the educational institutions and professionals in the country to a level where they can benefit from the use of ICTs; and providing the community with the tools that are required for access to good education no matter where the individuals are or what educational degree they pursue.

Level – 3: Applications in Education Sector

A.2.1. Enhancing the learning process through the use of ICTs: Providing access to knowledge and facilitating collaborative and interactive learning, thus enhancing the traditional education system. It includes on-line communities for students, teachers and/or professors; instructor support through multimedia learning materials, bulletin boards and e-mails; collaborative projects among instructors and students; student tracking systems to evaluate the student's progress; chat rooms, email, bulletin boards, conceptual maps, and home pages; special programs for teaching teachers on how to utilize computer technologies as a teaching tool, promoting education with IT use in K-12; creating new instruments for evaluation and appraisal.

A.2.2. Improving the education system administration by using ICT applications, with the objective of making it available to the entire population, providing a transparent and efficient management of resources at schools and in the Ministry of Education.

A.2.3. Expanding distance learning: delivering education by ICTs where professors and students do not have to be in the same physical location, but can access the same virtual space where they interact or find the necessary information to acquire knowledge and the necessary tools to test the on-line acquired knowledge.

A.2.4. Providing technical and vocational training to the entire population: developing specific skills for technology use including hardware/ software systems, as well as skills needed in various fields including health related professions, agriculture, mechanical repair, etc. through the use of ICT applications, Internet and web-based classes.

A.2.5. Making programs that foster innovation, creativity and research available throughout the country: Creating programs where academics and students can freely interact with the computer in an open environment according to their interests; encouraging shared research efforts among researchers.

Instructions

To determine the relative impact of the applications in the reduction of the Digital Divide in the educational sector, you are asked to compare the applications in pairs and then express your judgment about their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **enhancing the learning process through the use of ICTs** is 4 time as important as **improving the education system administration** for the Reduction of the Digital Divide in the educational sector, please give 80 points to **enhancing the learning process through the use of ICTs** and 20 points **improving the education system administration** in the first pair as follows:

Enhancing the learning process through the use of ICTs	80	20	Improving the education system administration

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICT applications" on the Reduction of the Digital Divide in the "Education Sector"

Enhancing the learning process through the use of ICTs			Improving the education system administration

Making programs that foster innovation, creativity and research available throughout the country			Providing technical and vocational training to the entire population

Enhancing the learning process through the use of ICTs			Expanding distance learning

Providing technical and vocational training to the entire population			Enhancing the learning process through the use of ICTs

Making programs that foster innovation, creativity and research available throughout the country			Expanding distance learning

Improving the education system administration			Making programs that foster innovation, creativity and research available throughout the country

Expanding distance learning			Improving the education system administration

Improving the education system administration			Providing technical and vocational training to the entire population

Making programs that foster innovation, creativity and research available throughout the country			Enhancing the learning process through the use of ICTs

Providing technical and vocational training to the entire population			Expanding distance learning

Instrument – 4

Relative impacts of the **ICT applications** on the reduction of the Digital Divide in the **Economic sector**.

Level – 2: Reduction of the Digital Divide in the key sectors

S3: Reduction of the Digital Divide in the economic sector by improving business efficiency and productivity throughout the country to become competitive in a global economy through the use of ICTs; and providing businesses, professionals, farmers, and the general population with ideas and solutions to create and/or capture markets and economic opportunities.

Level – 3: Applications in the economic sector

A.3.1. Improving market intelligence available to every business in the country: providing timely access to market information, such as the status of a crop, fluctuations in the tourism industry, changes in the software industry, pricing structures and supply/demand relationships; facilitating data mining to identify predictive patterns in the market behavior; this is also a tool for information dissemination.

A.3.2. Enhancing the rural economic opportunities: enabling people to work anywhere, so local communities are integrated into the global economy, for example, the use of telecenters, which are community resource centers equipped with the latest technology such as computers, faxes, and Internet connections.

A.3.3. Improving business efficiency and productivity of SMEs through information and communication technologies: using ICTs to reduce operational cost by decreasing material, procurement and transaction costs; and enabling SMEs throughout the country to use more and better information to improve the value of their output.

A.3.4. Sharing ICT resources among enterprises: enabling SMEs to share resources for reducing the cost of access to technology; developing data centers and centralized computer systems for computing on demand; for example, two SMES can share the use of a computer to work on business accounting.

A.3.5. Creating new business models based on information networks: using ICTs to create and deliver products and services on a global scale, and to give developing countries access to new markets for competitive advantage; improving direct marketing and data acquisition for import/export of specific products; identifying the vendors, buyers and suppliers. These new business models include applications such as e-trading, marketplaces, business-to-business, and portals.

A.3.6. Creating a database to match the available human resources and job offerings: matching the skills of the available man power with the needs that exist in the economic sector.

Instructions

To determine the relative impact of the applications on the Reduction of the Digital Divide in the economic sector, you are asked to compare the applications in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **improving market intelligence available to every business in the country** is twice as important as **enhancing rural economic opportunities** for the Reduction of the Digital Divide in the economic sector, please give 67 points to **improving market intelligence available to every business in the country** and 33 points to **enhancing rural economic opportunities** in the first pair as follows:

Improving market intelligence available to every business in the country	**67**	**33**	Enhancing rural economic opportunities

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of the "ICT applications" on the Reduction of the Digital Divide in the "Economic Sector"

Improving market intelligence available to every business in the country			Enhancing rural economic opportunities
Sharing ICT resources among enterprises			Improving market intelligence available to every business in the country
Improving market intelligence available to every business in the country			Creating new business models based on information networks

Enhancing rural economic opportunities			Improving business efficiency and productivity of SMEs through information and communication technologies
Enhancing rural economic opportunities			Sharing ICT resources among enterprises
Improving market intelligence available to every business in the country			Improving business efficiency and productivity of SMEs through information and communication technologies
Enhancing rural economic opportunities			Creating new business models based on information networks
Improving market intelligence available to every business in the country			Creating a database to match the available human resources and job offerings
Enhancing rural economic opportunities			Creating a database to match the available human resources and job offerings
Sharing ICT resources among enterprises			Improving business efficiency and productivity of SMEs through information and communication technologies
Creating new business models based on information networks			Improving business efficiency and productivity of SMEs through information and communication technologies
Sharing ICT resources among enterprises			Creating new business models based on information networks
Creating a database to match the available human resources and job offerings Creating a database to match the available human resources and job offerings			Improving business efficiency and productivity of SMEs through information and communication technologies
Creating new business models based on information networks			Creating a database to match the available human resources and job offerings
Sharing ICT resources among enterprises			Creating a database to match the available human resources and job offerings

Instrument – 5

Relative impact of **ICT applications** on the Reduction of the Digital Divide in the **Government Sector**

Level – 2: Reduction of the Digital Divide in key sectors

S4: Reduction of the Digital Divide in the government sector by fostering empowerment and participation of the people through the use of ICTs; and making government processes more efficient and transparent by sharing information among people, business and government.

Level – 3: Applications in the Government Sector

A.4.1. Facilitating participation of the public in democratic processes: encouraging the public's participation in the democratic process via elections, forums, discussions, establishment of criteria about specific topics, enforcement of accountability of public officials, and voting in elections through the use of ICTs.

A.4.2. Providing universal access to information and on-line services to empower people: developing hardware and software infrastructure that interconnects computers and provides free Internet access, free e-mail accounts and information to citizens nationwide; making information accessible through citizen service centers; providing the citizens with technological access to government agencies; promoting the use of applications that permit the citizens to have an equitable/fair access to the services of the government so they can make educated choices and political decisions at local, regional, and national levels.

A.4.3. Improving public administration throughout the country: developing applications to improve the quality of service and the level of responsiveness of government institutions everywhere in the country; increasing the efficiency and transparency of government processes for the entire population; bringing up to date hardware/software and technological platforms of the governmental agencies in all provinces; improving the capabilities of personnel by providing education in the IT field and access to the information networks; improving the capability for equitable public spending and tax collection.

Instructions

To determine the relative impact of the applications on the reduction of the Digital Divideen in the government sector, you are asked to compare the applications in pairs and then express your judgment about the ratio of their relative impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that the facilitating participation of the public in the democratic process is twice as important as providing universal access to information and on-line services to empower people for the Reduction of the Digital Divide in the government sector, please give 67 points to **facilitating participation of the public in democratic process** and 33 points to **providing universal access to information and on-line services to empower people** in the first pair as follows:

Facilitating participation of the public in democratic process	**67**	**33**	Providing universal access to information and on-line services to empower people

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of the "ICT applications" on the reduction of the Digtial Divide in the "Government Sector"

Facilitating participation of the public in democratic process			Providing universal access to information and on-line services to empower people

Improving the public administration throughout the country			Facilitating participation of the public in democratic process

Providing universal access to information and on-line services to empower people			Improving the public administration throughout the country

Relative impact of **ICT applications** on the Reduction of the Digital Divide in the **Environmental Sector**

Level - 2: Reduction of the Digital Divide in key sectors

S5: Reduction of the Digital Divide in the environmental sector by managing information about biodiversity and sustainable development through the use of ICTs with a focus not only on the research community but also on the public in general.

Level – 3: Applications in the Environmental Sector

A.5.1. Monitoring and disseminating information on ecological conditions: using ICT applications to improve efficient use of resources to fight contamination and to set prevention and mitigation measures. ICT applications can collect data and forecast pest problems and pesticide use. Weather information and soil monitoring are also parts of ecological monitoring.

A.5.2. Promoting awareness of environmental issues in the public throughout the country: using ICTs to disseminate information about environmental and bio-diversity related issues, impacts on environmental quality, farming sustainability, marine management and energy sources. It includes a national computer database to contribute to biodiversity and environmental knowledge and awareness.

A.5.3. Monitoring environmental conditions to facilitate decision making: using ICTs to send information, including images of environmental disasters, on a timely basis, so the decision makers can have the information they need when they need it; to incorporate satellite information in environmental decision making (examples include fire emergencies, oil spills, as well as developing strategies for protecting the environment).

A.5.4. Promoting biodiversity and sustainable development: using ICTs to disseminate information about biodiversity and the impact in society; encouraging the society to put higher value on natural resources and to conserve them.

A.5.5. Dissemination of information about best practices: making information available about successful approaches to environmental management; describing best practices to establish benchmarks for comparison.

Instructions

To determine the relative impact of the applications on the Reduction of the Digital Divide in the environmental sector, you are asked to compare the applications in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that monitoring ecological conditions is twice as important as biodiversity and sustainable resources management for the Reduction of the Digital Divide in the environmental sector, please give 67 points to **monitoring ecological conditions** and 33 points to **biodiversity and sustainable resources management** in the first pair as follows:

Monitoring ecological conditions	**67**	**33**	Biodiversity and sustainable resources management

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of the "ICT applications" on the Reduction of the Digital Divide in the "Environmental Sector"

Monitoring and disseminating information on ecological conditions			Promoting awareness of environmental issues in the public throughout the country

Monitoring environmental conditions to facilitate decision making			Monitoring and disseminating information on ecological conditions

Monitoring and disseminating information on ecological conditions			Promoting biodiversity and sustainable development

Dissemination of information about best practices			Monitoring and disseminating information on ecological conditions

Monitoring environmental conditions to facilitate decision making			Promoting awareness of environmental issues in the public throughout the country
Promoting awareness of environmental issues in the public throughout the country			Promoting biodiversity and sustainable development
Dissemination of information about best practices			Promoting awareness of environmental issues in the public throughout the country
Monitoring environmental conditions to facilitate decision making			Promoting biodiversity and sustainable development
Dissemination of information about best practices			Monitoring environmental conditions to facilitate decision making
Promoting biodiversity and sustainable development			Dissemination of information about best practices

Instrument – 7

Relative impacts of **ICTs** on **making health services available in remote areas**

Level – 3: Applications in the Health Sector

A.1.1. Making health services available in remote areas: remote consultation, diagnosis and treatment that take place without having the patient in the same physical location as the physician; the information is gathered and then sent through digital means to the respective physicians

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **making health services available in remote areas**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **making health services available in remote areas**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "making health services available in remote areas"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools

Country specific software			Internet content and infrastructure

Collaborative tools			Country specific software

Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 8

Relative impacts of **ICTs** on **disease prevention and epidemic response.**

Level – 3: Applications in the Health Sector

A.1.2. Disease prevention and epidemic response: capturing information about cases of contagious illness, monitoring them and disseminating information by broadcast media or other ICTs means.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **Disease prevention and epidemic response**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastruct** for **disease prevention and epidemic response**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastruct

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "disease prevention and epidemic response"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software

Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 9

Relative impacts of **ICTs** on **providing on-line medical libraries to health professionals especially in remote areas**

Level – 3: Applications in the Health Sector

A.1.3. Providing on-line medical libraries to health professionals especially in remote areas to keep up-to-date on medical knowledge.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **providing on-line medical libraries to health professionals especially in remote areas**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **providing on-line medical libraries to health professionals especially in remote areas**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "providing on-line medical libraries to health professionals especially in remote areas"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools

Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 10

Relative impacts of **ICTs** on **facilitating medical research in distant research facilities**

Level – 3: Applications in the Health Sector

A.1.4. Facilitating medical research in distant research facilities: using ICTs technologies to get data for clinical trials locally to be evaluated in distant research facilities

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Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools,

data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **facilitating medical research in distant research facilities**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **facilitating medical research in distant research facilities**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "Facilitating medical research in distant research facilities"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software

General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 11

Relative impacts of **ICTs** on **improving the administrative efficiency in the public health system**

Level – 3: Applications in the Health Sector

A.1.5. Improving the administrative efficiency in the public health system: includes e-applications which provide low-cost healthcare information as well as facilities for consultation, referrals, scheduling and e-procurement.

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Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and

the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **improving the administrative efficiency in the public health system**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **improving the administrative efficiency in the public health system**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "improving the administrative efficiency in the public health sytem"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software

Mobile devices and infrastructure			Mass communication systems

General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Relative impacts of **ICTs** on **creating awareness of health issues in the population through the use of ICTs**

Level – 3: Applications in the Health Sector

A.1.6. Creating awareness of health issues in the population through the use of ICTs: disseminating information about infact to old age health problems to the population through the use of ICTs.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **creating awareness of health issues in the population through the use of ICTs**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **creating awareness of health issues in the population through the use of ICTs**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "creating awareness of health issues in the population through the use of ICTs"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems

Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 13

Relative impacts of **ICTs** on **enhancing the learning process through the use of ICTs**

Level – 3: Applications in the Education Sector

A.2.1. Enhancing the learning process through the use of ICTs: ICTenables access to knowledge and facilitates by collaborative and interactive learning, thus enhancing the traditional education system. It includes on-line communities for students, teachers and/or professors; instructor support through multimedia learning materials, bulletin boards and e-mails; collaborative projects among instructors and

students; student tracking systems to evaluate the student's progress; and chat rooms, email, bulletin boards and home pages to encourage shared research efforts among academics and students; special programs for teaching teachers how to utilize computer technologies as teaching tools, promoting education with IT use in K-12.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **enhancing the learning process through the use of ICTs**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **enhancing the learning process through the use of ICTs**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "enhancing the learning process through the use of ICTs"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure

Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 14

Relative impacts of **ICTs** on **improving education system administration**

Level – 3: Applications in the Education Sector

A.2.2. Improving education system administration by using ICT applications, which provide a transparent and efficient management of resources at schools as well as in the Ministries of Education.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work.

(Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **improving education system administration,** you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **improving education system administration,** please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "Improving Education System Administration"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software

Mobile devices and infrastructure			Internet content and infrastructure

Instrument –15

Relative impacts of **ICTs** on **extending distance learning to remote areas**

Level – 3: Applications in the Education Sector

A.2.3. Extending Distance learning to remote areas: Education can be delivered by ICTs where professors and students do not have to be in the same physical location, but can access the same virtual space where they interact or find the necessary information to acquire knowledge and the necessary tools to test the on-line acquired knowledge.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **extending distance learning to remote areas**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **extending distance learning to remote areas**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "Extending Distance Learning to remote areas"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument –16

Relative impacts of **ICTs** on **providing technical and vocational training**

Level – 3: Applications in the Education Sector

A.2.4. Providing technical and vocational training: developing specific skills through the use of ICT applications, Internet and web-based classes.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **providing technical and vocational training**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **providing technical and vocational training**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "providing technical and vocational training"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools

Country specific software			Internet content and infrastructure

Collaborative tools			Country specific software

Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 17

Relative impacts of **ICTs** on **making programs that foster innovation, creativity and research available throughout the country.**

Level – 3: Applications in the Education Sector

A.2.5. Making programs that foster innovation, creativity and research available throughout the country: creating programs where academics and students can freely interact with the computer in an open environment according to their interests; encouraging shared research efforts among researchers.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **making programs that foster innovation, creativity and research available throughout the country**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **making programs that foster innovation, creativity and research available throughout the country**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "making programs that foster innovation, creativity and research available throughout the country"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software

Mobile devices and infrastructure			Mass communication systems

General purpose software			Mobile devices and infrastructure

Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 18

Relative impacts of **ICTs** on **creating market information system**

Level – 3: Applications in the Economic Sector

A.3.1. Creating market information system: timely access to market information, such as, the status of a crop, its price in the city and the demand for it. This is also a tool for information dissemination.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **creating market information system**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **creating market information**

system, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "creating market information systems"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software

General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 19

Relative impacts of **ICTs** on **enhancing rural economic opportunities**

Level – 3: Applications in the Economic Sector

A.3.2. Enhancing rural economic opportunities: ICTs to enable people to work anywhere, so local communities are integrated into global economy. For example, the use of telecenters, which are community resource centers equipped with the latest technology such as computers, faxes, and Internet connections.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **enhancing rural economic opportunities**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **enhancing rural economic opportunities** , please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "enhancing rural economic opportunities"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Relative impacts of **ICTs** on **improving business efficiency and productivity**

Level – 3: Applications in the Economic Sector

A.3.3. Improving business efficiency and productivity: use of ICTs to reduce operational cost by decreasing material, procurement and transaction costs; and enabling business to use more and better information to improve the value of their output.

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Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **improving business efficiency and productivity**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **improving business efficiency and productivity**, please give 75 points to **Mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "improving business efficiency and productivity"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 21

Relative impacts of **ICTs** on **sharing ICT resources**

Level – 3: Applications in the Economic Sector

A.3.4. Sharing ICT resources: enabling small and medium sized enterprises to share resources for reducing the cost of access to technology. For example two small to medium-sized enterprises can share the use of a computer to work on business accounting.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools,

data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **sharing ICT resources**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **sharing ICT resources**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.i

Impacts of "ICTs" on "sharing ICT resources"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software

Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 22

Relative impacts of **ICTs** on **creating new business models**

Level – 3: Applications in the Economic Sector

A.3.5. Creating new business models: use of ICTs to create and deliver products and services on a global scale, and to give developing countries access to new markets for competitive advantage. These new business models include applications such as e-trading, marketplaces, business-to-business, and portals.

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Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and

the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **creating new business models,** you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **creating new business models,** please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "creating new business models"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure

Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Relative impacts of ICTs on **creating a database to match the available human resources and job offerings**

Level – 3: Applications in the Economic Sector

A.3.6. Creating a database to match the available human resources and job offerings: matching the skills of the available man power with the needs that exist in the economic sector.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **creating a database to match the available human resources and job offerings**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **creating a database to match the available human resources and job offerings**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "creating a database to match the available human resources and job offerings"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools

Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 24

Relative impacts of **ICTs** on **facilitating the participation in democratic processes**

Level – 3: Applications in the Government Sector

A.4.1. Facilitating the participation in democratic processes: ICTs mechanisms encourage participation in the democratic process, for example, elections or voting in a specific topic.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools,

data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **Facilitating the participation in democratic processes**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **Mobile devices and infrastructure** are 3 times as important as **Land-based devices and infrastructure** for **Facilitating the participation in democratic processes**, please give 75 points to **Mobile devices and infrastructure** and 25 points to **Land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "Facilitating the participation in democratic processes"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software

General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 25

Relative impacts of **ICTs** on **providing universal access for citizens**

Level – 3: Applications in the Government Sector

A.4.2. Providing universal access for citizens: hardware and software infrastructure that interconnects computers nationwide and/or that provides free Internet access, free e-mail accounts and information to citizens nationwide; making information accessible through citizen service centers.

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Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and

the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **providing universal access for citizens**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **providing universal access for citizens**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "providing universal access for citizens"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software

Mobile devices and infrastructure			Mass communication systems

General purpose software			Mobile devices and infrastructure

Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 26

Relative impacts of **ICTs** on **improving the public administration by creating ICT applications**

Level – 3: Applications in Government Sector

A.4.3. Improving the public administration by creating ICT applications: developing applications to improve the quality and level of responsiveness of government services and to promote ubiquitous access to the infrastructure. Through e-government it is possible to increase the efficiency and transparency of government processes.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **improving the public administration by creating ICT applications**, you are asked to compare the techologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **improving the public administration by creating ICT applications**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "improving the public administration by creating ICT applications"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software

Mobile devices and infrastructure			Mass communication systems

General purpose software			Mobile devices and infrastructure

Mobile devices and infrastructure			Country specific software

Land-based devices and infrastructure			Mass communication systems

Internet content and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 27

Relative impacts of **ICTs** on **monitoring ecological conditions for sustainable development**

Level – 3: Applications in the Environmental Sector

A.5.1. Monitoring ecological conditions for sustainable development: use of ICT applications to improve efficient use of resources to fight contamination and to set prevention and mitigation measures. ICTs applications can collect data and forecast pest problems and pesticide use. Weather information and soil monitoring are also parts of ecological monitoring.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **monitoring ecological conditions for sustainable development**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **monitoring ecological conditions for sustainable development**, please give 75 points to **mobile devices and**

infrastructure and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "monitoring ecological conditions for sustainable development"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software

General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 28

Relative impacts of **ICTs** on **biodiversity and sustainable resource management**

Level – 3: Applications in the Environmental Sector

A.5.2. Biodiversity and sustainable resource management: use of ICTs for management of resources that address bio-diversity issues, impacts on environmental quality, farming sustainability, marine management and energy sources. It also includes a national computer database to contribute to bio-diversity knowledge and awareness.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **biodiversity and sustainable resource management**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **biodiversity and sustainable resource management**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "biodiversity and sustainable resource management"

Mobile devices and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Relative impacts of **ICTs** on **monitoring and responding to environmental disasters**

Level – 3: Applications in the Environmental Sector

A.5.3. Monitoring and responding to environmental disasters: use of ICTs to send information, especially images of environmental disasters, on a timely basis, so the rescue teams can have the information they need when they need it. An example is monitoring of fire emergencies or oil spills.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **monitoring and responding to environmental disasters**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **monitoring and responding to environmental disasters**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "monitoring and responding to environmental disasters"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure

Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 30

Relative impacts of **ICTs** on **promoting biodiversity and sustainable development**

Level – 3: Applications in the Environmental Sector

A.5.4. Promoting biodiversity and sustainable development: using ICTs to disseminate information about biodiversity and the impact on society; encouraging the society to put a higher value on natural resources and to conserve them.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools,

data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **promoting biodiversity and sustainable development**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **promoting biodiversity and sustainable development**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "promoting biodiversity and sustainable development"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software
Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software

General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

Instrument – 31

Relative impacts of **ICTs** on **disseminating environmental information**

Level – 3: Applications in the Environmental Sector

A.5.5. Disseminating environmental information: use of ICTs to disseminate information throughout the country's population.

Level – 4: Technologies

T1: General purpose software: software for general applications including back office and front office programs, databases, CRM, OLAP, ERP, data analysis tools, data modeling tools, simulation tools, multimedia tools, geographic information systems and other similar software.

T2: Mobile devices and infrastructure: laptop computers, PDA's, imaging devices such as video cameras or digital cameras, cell phones and the required infrastructure to make them work such as low earth orbit satellite systems, wireless for LAN and so on.

T3: Internet content and infrastructure: basic uses of the Internet, such as web searching, web services, security systems on the Internet, e-mail, Internet content and other related Internet tools as well as the required infrastructure to make them work. (Collaborative Internet tools such as web forums, chats, etc. are not included in this group of technologies.)

T4: Collaborative tools: web forums, chats, video conferencing, teleconferencing and other related collaborative tools and the required infrastructure to make them work.

T5: Land-based devices and infrastructure: low-cost computers, personal computers, servers, as well as the improvement of land-based telephone systems and the required infrastructure to make them work such as fiber optic systems, DSL, cable and so on.

T6: Country specific software: applications software customized for the specific requirements of the country, including multilingual tools, reading tools for the vision impaired, interpreting / translating tools for content, voice recognition tools, and other similar software.

T7: Mass communication systems: Television, radio and other related hardware and broadcast devices as well as the required infrastructure to make any of these devices work.

Instructions

To determine the relative impact of the technologies on **disseminating environmental information**, you are asked to compare the technologies in pairs and then express your judgment about the ratio of their impacts with respect to each other by distributing 100 points between the two.

For example, if you believe that **mobile devices and infrastructure** are 3 times as important as **land-based devices and infrastructure** for **disseminating environmental information**, please give 75 points to **mobile devices and infrastructure** and 25 points to **land-based devices and infrastructure** in the first pair as follows:

Mobile devices and infrastructure	75	25	Land-based devices and infrastructure

If, in your judgment, the applications in a pair have equal contribution to the reduction of the Digital Divide, please give 50 points to each.

Please do not use zero ("0") in your comparisons to avoid computational difficulties. In case you believe that the Reduction of the Digital Divide in one sector has virtually no contribution in comparison with the Reduction of the Digital Divide in the other sector in the pair, you can express your judgment by using a 99 to 1 ratio instead of 100 and 0.

Impacts of "ICTs" on "disseminating environmental information"

Mobile devices and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			General purpose software
Mobile devices and infrastructure			Mass communication systems
General purpose software			Mobile devices and infrastructure
Mobile devices and infrastructure			Country specific software

Land-based devices and infrastructure			Mass communication systems
Internet content and infrastructure			Land-based devices and infrastructure
Land-based devices and infrastructure			Collaborative tools
Country specific software			Land-based devices and infrastructure
Mass communication systems			General purpose software
Mobile devices and infrastructure			Collaborative tools
Mass communication systems			Internet content and infrastructure
Collaborative tools			Mass communication systems
Mass communication systems			Country specific software
General purpose software			Internet content and infrastructure
Collaborative tools			General purpose software
General purpose software			Country specific software
Internet content and infrastructure			Collaborative tools
Country specific software			Internet content and infrastructure
Collaborative tools			Country specific software
Mobile devices and infrastructure			Internet content and infrastructure

APPENDIX D: DISTRIBUTION OF THE PAIRWISE COMPARISON INSTRUMENTS

Experts / Inst. #	Sectors 2003 / 2010	ICTs Applications				
		H.	Edu.	Ec.	Gov.	Env.
	1	2	3	4	5	6
Exp 1	X					
Exp 2	X		x			
Exp 3	X		x			x
Exp 4	X	x				
Exp 5	X			x	x	
Exp 6	X				x	
Exp 7	X			x	x	
Exp 8	X	x	x			
Exp 9	X		x			
Exp 10	X			x	x	x
Exp 11	X			x	x	
Exp 12	X					x
Exp 13	X		x			
Exp 14	X	x				
Exp 15	X	x	x	x		x

Experts / Inst. #	Information & Communication Technologies																								
	Health						Education					Economic						Government			Environment				
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Exp 1																									
Exp 2																									
Exp 3																x						x	x	x	x
Exp 4		x	x	x	x	x																			
Exp 5															x			x	x						
Exp 6	x				x																				
Exp 7												x	x		x		x	x							
Exp 8				x		x																			
Exp 9							x	x	X	x	x														
Exp 10														x			x			x				x	
Exp 11										x		x	x	x		x				x					
Exp 12																					x	x	x		
Exp 13								x	X																
Exp 14	x	x	x																						
Exp 15							x				x								x		x			x	x

APPENDIX E: RESULT INSTRUMENTS

The Spanish version is available upon request from the author.

Analysis of results **November 18/03**

Introduction

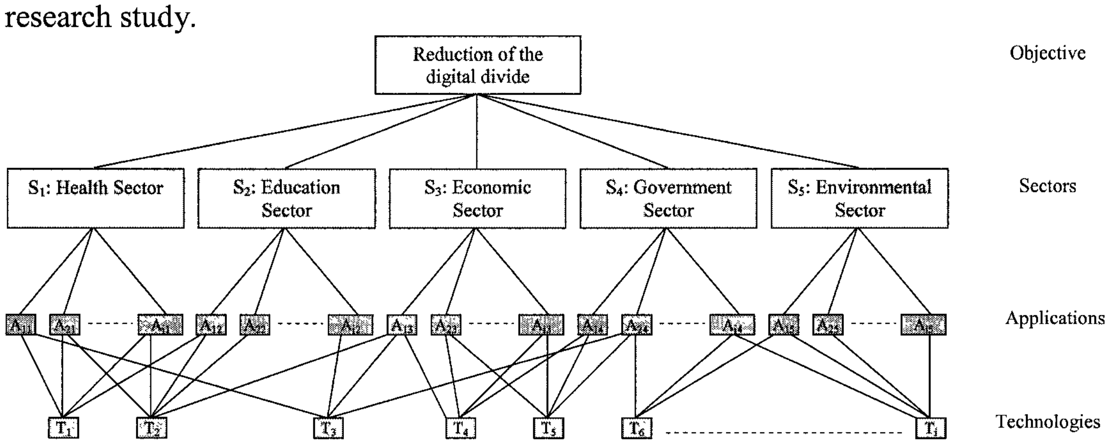
This document presents partial results obtained from the data collected in Costa Rica in June 2003 for my research on the impact of ICTs on the reduction of the Digital Divide.

The preliminary results have been obtained at all levels of the model's hierarchy shown in the figure below.

The results presented in this document include the impacts of the sectors on the reduction of the Digital Divide; and the impacts of the technological applications in each sector. I need your assessment of the validation off these preliminary results

After this step is completed I will send you the rest of the results including the impacts of the technological applications; and the identification of the technologies to reduce the Digital Divide.

The following figure represents the model hierarchy that we use in this research study.

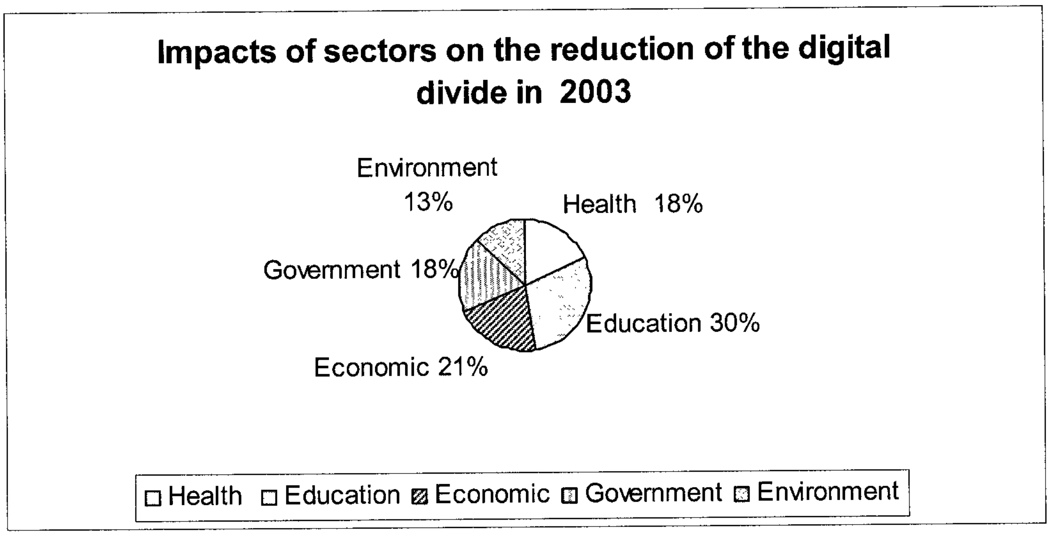


Each set of results has two parts. The first part includes the presentation and interpretation of results, and the second part involves the validation of these results. The interpretation is based on the analysis of results along with the comments received from the experts during the data collection process.

Please read the document carefully and provide your feedback.

Result #1 - Impact of key sectors on the reduction of the Digital Divide in 2003

The following figure represents the impacts of the key sectors on the reduction of the Digital Divide in Costa Rica for 2003 according to the judgment of the experts.



In 2003 the sector with the highest impact on the reduction of the Digital Divide is the education sector. If we group the sectors by high, medium and low impact on the reduction of the Digital Divide, the group will be as follows:

- High impact: education and economic sectors (50% combined)
- Medium impact: government and health sectors
- Low impact: environmental sector

Discussion:

In general, the education sector has a long-term vision of 5 to 10 years, and does not need big economical investments in comparison with other sectors to see results in the reduction of the Digital Divide.

It is expected that the investment in education will also have an impact on the economic sector. Costa Rica has good professionals and they can be easily retrained for activities related to information and communication technologies.

Validation Questions:

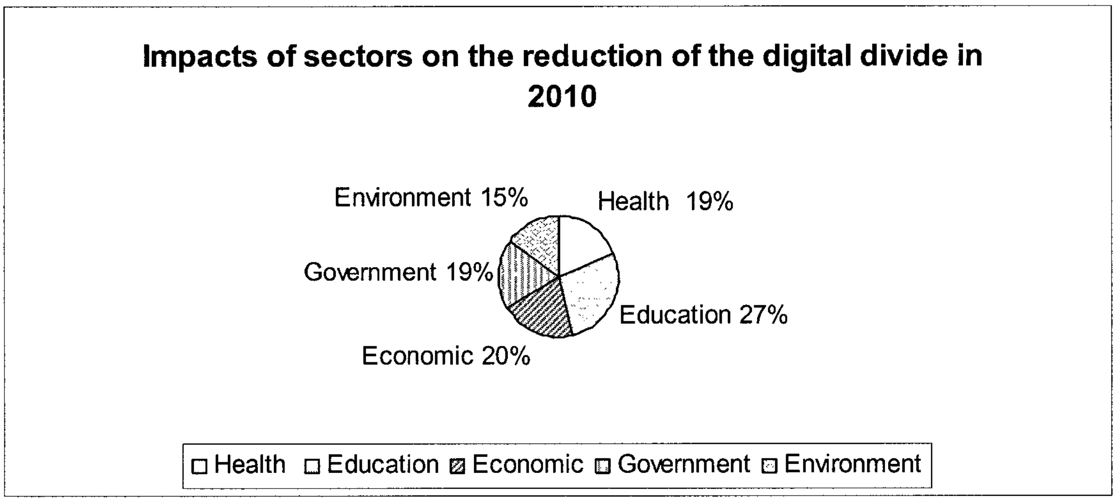
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #2 - Impact of key sectors on the reduction of the Digital Divide in 2010

The following figure represents the impacts of the key sectors on the reduction of the Digital Divide in Costa Rica for 2010 according to the judgment of the experts.



For the year 2010, the sector with the highest impact on the reduction of the Digital Divide is again the education sector. By grouping the sectors by their impact on the reduction of Digital Divide we will obtain:

- High impact: Education and economic sector (47% combined)
- Medium impact: Government and health sectors
- Low impact: Environmental sector

Discussion:

The pattern is basically the same; some experts consider that seven years is not a long enough period to reflect any change if policies were in place in 2003 to reduce the Digital Divide; and the situation will be the same in 2010, and the impacts on the sectors will be the same.

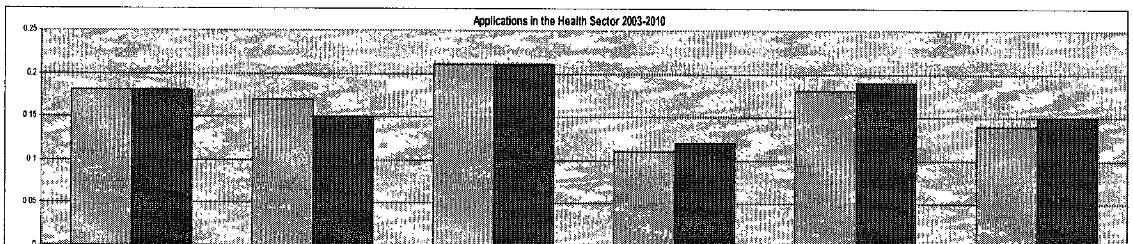
Validation Questions:
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #3 - Impact of applications on the reduction of the Digital Divide in the health sector

The following figure represents the impacts of the ICT applications on the reduction of the Digital Divide in the health sector for the years 2003 and 2010.



	A.1.1. Making health services widely available & identifying the appropriate level of medical response according to the population needs	A.1.2. Preventing diseases and improving epidemic response	A.1.3. Providing on-line medical libraries	A.1.4. Facilitating medical research in distant research facilities	A.1.5. Improving the efficiency of the public health system in every geographic area	A.1.6. Creating awareness of health issues in the population through the use of ICT
2003	0.18	0.17	0.21	0.11	0.18	0.14
2010	0.18	0.15	0.21	0.12	0.19	0.15

Grouping the applications by the level of impact we will have:

High impact:	A13:	Providing on-line medical libraries
Medium impact:	A11:	Making health services widely available & identifying the appropriate level or medical response according to the population needs

	A15:	Improving the efficiency of the public health system in every geographic area
	A12:	Preventing diseases and improving epidemic response
Low impact:	A16:	Creating awareness of health issues in the population through the use of ICTs
	A14:	Facilitating medical research in distant research facilities

Discussion:

For both 2003 and 2010, providing on-line medical libraries, making medical libraries accessible to health professionals, especially in remote areas to keep up-to-date on medical knowledge, and providing the general population with the means to learn more about certain illnesses or health issues is the application with the highest impact. The second group relates to improving the current health system. Finally, the third group relates to general awareness and medical research.

Validation Questions:

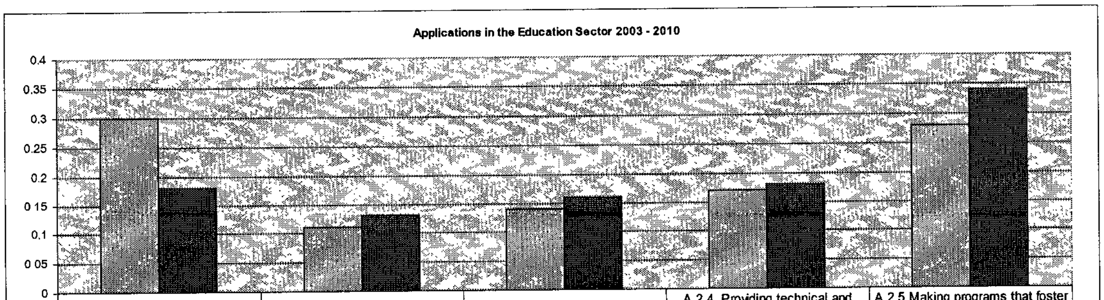
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #4 - Impact of applications on the reduction of the Digital Divide in the education sector

The following figure represents the impacts of the ICT applications on the reduction of the Digital Divide in the education sector for the years 2003 and 2010.



	A.2.1. Enhancing the learning process through the use of ICT	A.2.2. Improving the education system administration	A.2.3. Expanding distance learning	A.2.4. Providing technical and vocational training to the entire population	A.2.5 Making programs that foster innovation, creativity and research throughout the country.
2003	0.3	0.11	0.14	0.17	0.28
2010	0.18	0.13	0.16	0.18	0.34

Grouping the applications by the level of impact on the reduction of the Digital Divide in the education sector in 2003, we have:

High impact:	A21:	Enhancing learning process through the use of ICTs
	A25:	Making programs that foster innovation, creativity and research throughout the country
Medium impact:	A24:	Providing technical and vocational training to the entire \population
Low impact:	A23:	Expanding distance learning
	A22:	Improving the education system administration

On the other hand, in the year 2010, by grouping the applications by the level of impact, we will have:

High impact:	A25:	Making programs that foster innovation, creativity and research throughout the country
Medium impact:	A24:	Providing technical and vocational training to the entire population
	A21:	Enhancing learning process through the use of ICTs
	A23:	Expanding distance learning
Low impact:	A22:	Improving the education system administration

Discussion:

In 2003 there is an emphasis on enhancing education through the use of ICTs, enhancing the traditional education system, facilitating collaborative and interactive learning as well as fostering innovation and research. In 2010, the innovation and creativity factor become more and more important in a country where the population is already familiar with ICTs in the education sector. This application helps to generate new / in-house technologies to help to reduce the Digital Divide according to the country's own needs. It also reduces technology dependency on other countries for their human capital and technologies.

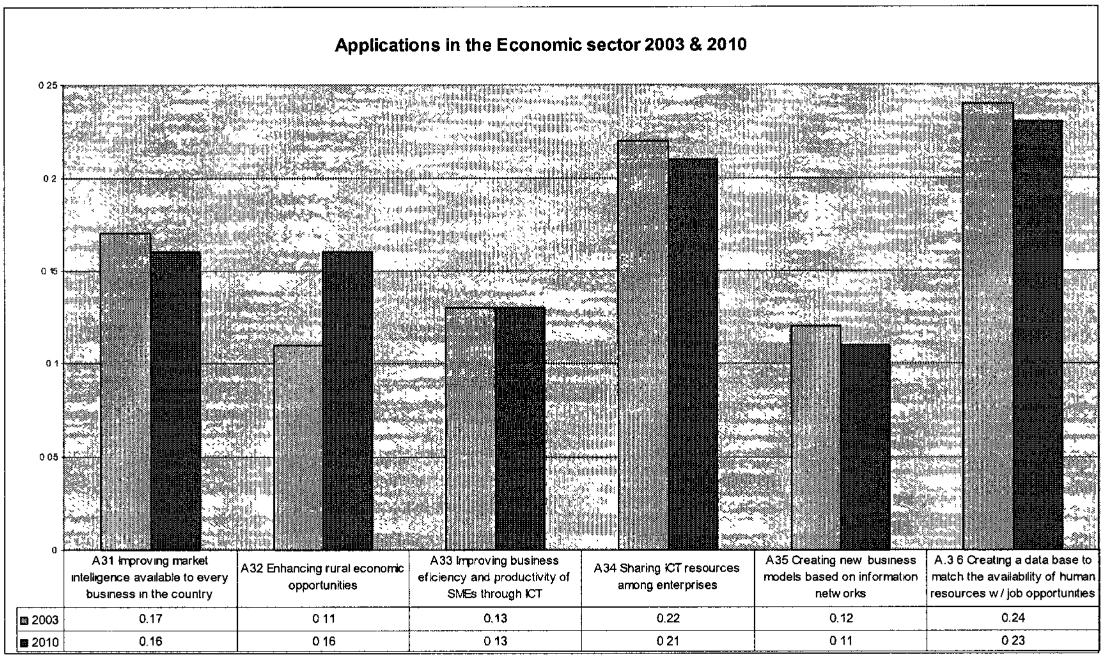
Validation Questions:
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #5 - Impact of applications on the reduction of the Digital Divide in the economic sector

The following figure represents the impacts of the ICT applications on the reduction of the Digital Divide in the economic sector for the years 2003 and 2010.



Grouping the application in the economic sector by the level of impact on the reduction of the Digital Divide in the economic sector in 2003, the groups are as follows:

High impact:	A36:	Creating a database to match the availability of human resources with job opportunities
	A34:	Sharing ICT resources among enterprises
Medium impact:	A31:	Improving market intelligence available to every business in the country
Low impact:	A33:	Improving business efficiency and productivity of SMEs through information and communication technologies
	A35:	Creating new business models based on information networks
	A32:	Enhancing rural economic opportunities

However, in 2010 the application of enhancing rural economic opportunities becomes part of the group with medium impact on the reduction of the Digital Divide of the economic sector as shown below:

High impact: A36: Creating a database to match the availability of human resources with job opportunities
A34: Sharing ICT resources among enterprises

Medium impact: A31: Improving market intelligence available to every business in the country
A32: Enhancing rural economic opportunities

Low impact: A33: Improving business efficiency and productivity of SMEs through information and communication technologies
A35: Creating new business models based on information networks

Discussion:

Costa Rica should use its existing human & ICT resources effectively in 2003. In 2010 the focus should be on improving the economic opportunities and the available market intelligence.

Validation Questions:

1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

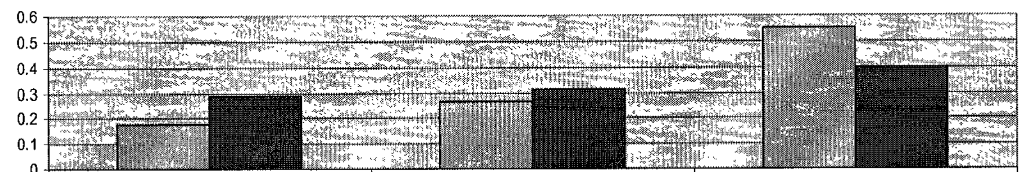
2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #6 - Impact of applications on the reduction of the Digital Divide in the government sector

The following figure represents the impacts of the ICT applications on the reduction of the Digital Divide in the government sector for the years 2003 and 2010.

Applications in Government Sector 2003-2010



	A.4.1 : Facilitating participation of the public in democratic process	A.4.2: Providing universal access to information and on-line services to empower people	A.4.3: Improving public administration throughout the country
2003	0.18	0.27	0.55
2010	0.29	0.31	0.4

Grouping these applications according to their impact on the reduction of the Digital Divide in the government sector in 2003, we have three groups:

High impact:	A43:	Improving public administration throughout the country
Medium impact:	A42:	Providing universal access to information and on-line services to empower people
Low impact:	A41:	Facilitating participation of the public in democratic processes

On the other hand, for the year 2010 we will have two groups:

High impact:	A43:	Improving public administration throughout the country
Medium impact:	A42:	Providing universal access to information and on-line services to empower people
	A41:	Facilitating participation of the public in democratic processes

Discussion:

Improving public administration is the key area that needs major improvements to reduce the Digital Divide in the government sector. It is expected that the public administration will improve by 2010, and the other applications related to empowering the people and providing universal access will gain more weight. Basically we have the same pattern in 2003 and 2010 but the relative impact of the applications in the medium and low impact groups will be higher in 2010.

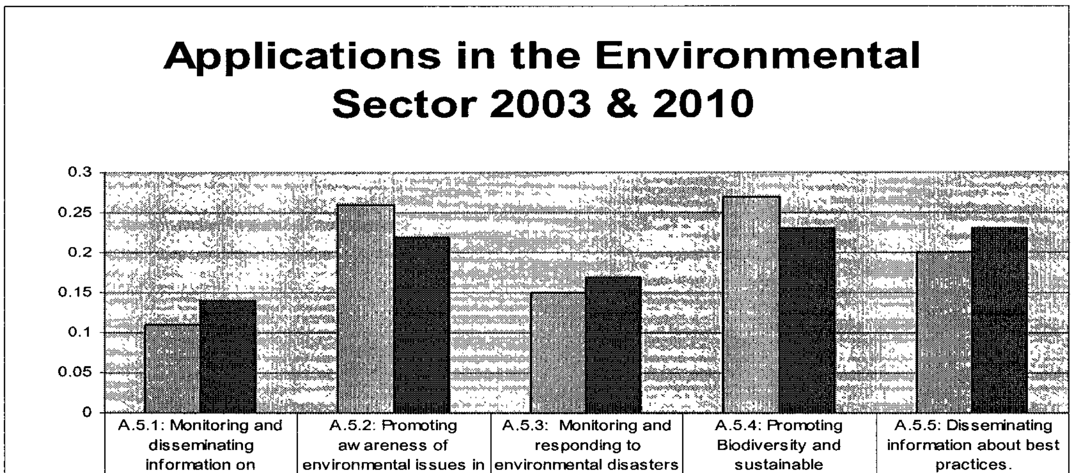
Validation Questions:
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #7 - Impact of application on the reduction of the Digital Divide in the environmental sector

The following figure represents the impacts of the ICT applications on the reduction of the Digital Divide in the environmental sector for the years 2003 and 2010.



	A.5.1: Monitoring and disseminating information on	A.5.2: Promoting awareness of environmental issues in	A.5.3: Monitoring and responding to environmental disasters	A.5.4: Promoting Biodiversity and sustainable	A.5.5: Disseminating information about best practices.
2003	0.11	0.26	0.15	0.27	0.2
2010	0.14	0.22	0.17	0.23	0.23

Grouping the applications in the environmental sector by their impacts on the reduction of the Digital Divide on that sector in 2003, we have:

High impact:	A54:	Promoting biodiversity and sustainable development
	A52:	Promoting awareness of environmental issues in the public throughout the country
Medium impact:	A55:	Disseminating information about the best practices
Low impact:	A53:	Monitoring and responding to environmental disasters

A51: Monitoring and disseminating information on ecological conditions

For the year 2010, the groups are as follows:

High impact:	A54:	Promoting biodiversity and sustainable development
	A55:	Disseminating information about the best practices
	A52:	Promoting awareness of environmental issues in the public throughout the country
Medium impact:	A53:	Monitoring and responding to environmental disasters
Low impact:	A51:	Monitoring and disseminating information on ecological conditions

Discussion:
It is important for Costa Rica to promote awareness of environmental issues, biodiversity and sustainable development. In time, disseminating information about best practices becomes more and more important.

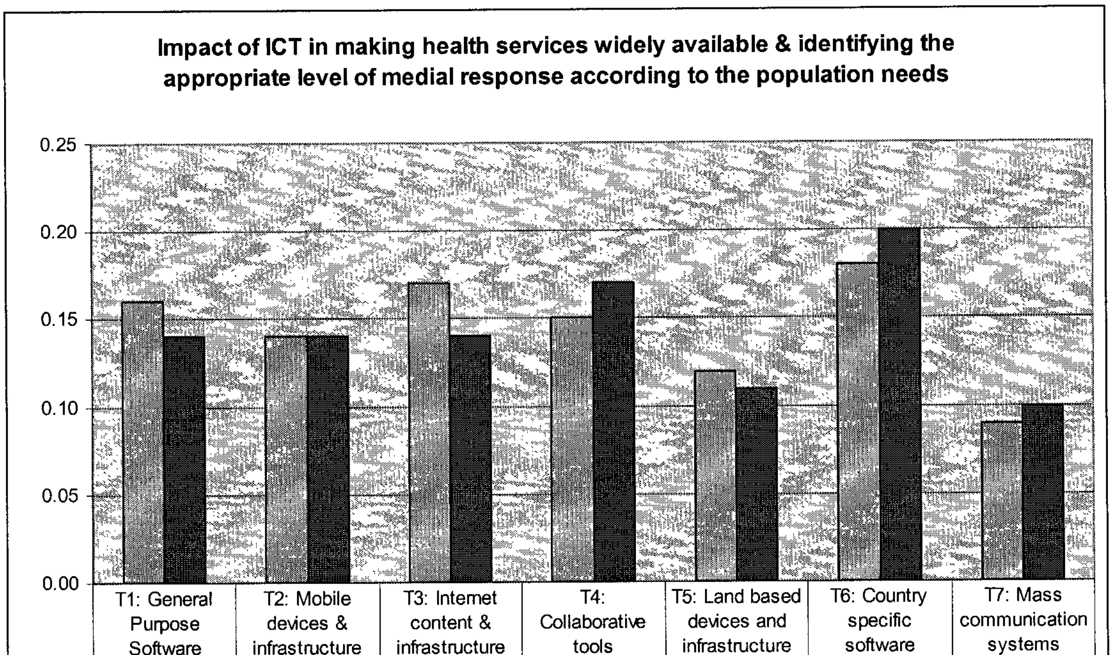
Validation Questions:
1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #1h - Impact of ICTs on the application: "Making health services widely available & identifying the appropriate level of medical response according to the population needs"

The following figure represents the impacts of the ICTs on "making health services widely available & identifying the appropriate level of medical response according to the population needs" for the years 2003 and 2010.



	T1: General Purpose Software	T2: Mobile devices & infrastructure	T3: Internet content & infrastructure	T4: Collaborative tools	T5: Land based devices and infrastructure	T6: Country specific software	T7: Mass communication systems
2003	0.16	0.14	0.17	0.15	0.12	0.18	0.09
2010	0.14	0.14	0.14	0.17	0.11	0.20	0.10

Grouping the ICTs by the level of impact on this application we will have:

High impact: T6: Country specific software
T3: Internet content & infrastructure

Medium impact: T1: General purpose software
T4: Collaborative tools
T2: Mobile devices & infrastructure

Low impact: T5: Land-based devices and infrastructure
T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T6: Country specific software
	T4: Collaborative tools
Medium impact:	T2: Mobile devices & infrastructure
	T3: Internet content & infrastructure
	T1: General purpose software
Low impact:	T5: Land-based devices and infrastructure
	T7: Mass communication systems

<u>Discussion:</u>

Right now, the Internet content and infrastructure as well as the country specific software are important. The health area needs specific software and some Internet infrastructure. However, for 2010, the collaborative tools will be more important than the Internet infrastructure. Collaborative tools will be followed by mobile devices and general purpose software. The land-based devices and infrastructure as well as mass communication systems in both cases will have low impact on "making health services widely available & identifying the appropriate level of medical response according to the population needs".

Validation Questions: Instrument # 1h

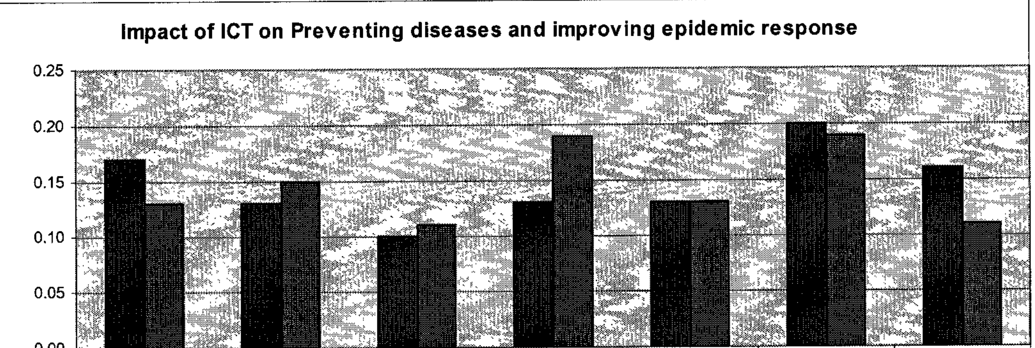
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #2h - Impact of ICTs on the application: "Preventing diseases and improving epidemic response"

The following figure represents the impacts of the ICTs on preventing diseases and improving epidemic response for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.17	0.13	0.10	0.13	0.13	0.20	0.16
2010	0.13	0.15	0.11	0.19	0.13	0.19	0.11

Grouping the ICTs by the level of impact on this application we will have:

High impact: T6: Country specific software
T1: General purpose software
T7: Mass communication systems

Medium impact: T5: Land-based devices and infrastructure
T4: Collaborative tools
T2: Mobile devices & infrastructure

Low impact : T3: Internet content & infrastructure

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact: T6: Country specific software
T4: Collaborative tools

Medium impact: T2: Mobile devices & infrastructure
T1: General purpose software
T5: Land-based devices and infrastructure

Low impact: T7: Mass communication systems
T3: Internet content & infrastructure

Discussion:

For 2003, country specific software, general software and mass communication systems will have high impact on preventing diseases and improving epidemic response. Collaborative tools and communication devices will have a medium impact. For the year 2010, Collaborative tools and country specific software will have high impact on this applications; with more collaborative tools the role of mass communication systems will decrease and have a low impact on "preventing diseases and improving epidemic response".

Validation Questions: Instrument # 2h

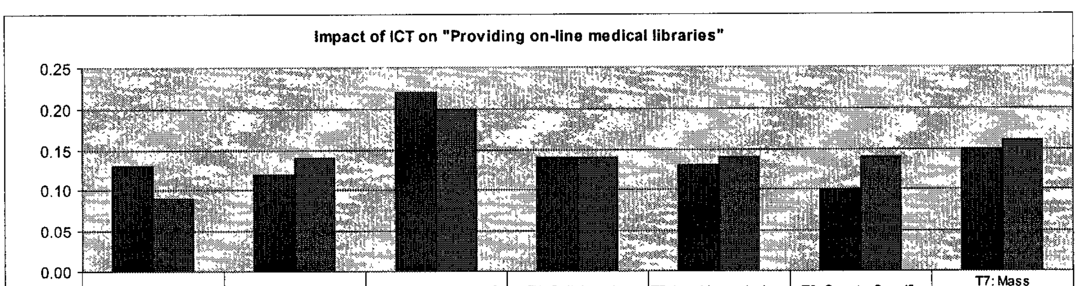
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

<u>Result #3h - Impact of ICTs on the application: "Providing on-line medical libraries"</u>

The following figure represents the impacts of the ICTs on providing on –line medical libraries for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.13	0.12	0.22	0.14	0.13	0.10	0.15
2010	0.09	0.14	0.2	0.14	0.14	0.14	0.16

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
Medium impact:	T7: Mass communication systems
	T4: Collaborative tools
	T1: General purpose software
	T5: Land-based devices and infrastructure
Low impact:	T2: Mobile devices & infrastructure
	T6: Country specific software

On the other hand in the year 2010 grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
Medium impact:	T7: Mass communication systems
	T4: Collaborative tools
	T5: Land-based devices and infrastructure
	T2: Mobile devices & infrastructure
	T6: Country specific software
Low impact:	T1: General purpose software

Discussion:

Internet content and infrastructure will have the highest impact on this application. The rest of the technologies will have a medium to low impact. For the year 2010 the situation is the same, except for the reversal of the ranks of "general software" and "country specific software".

Validation Questions: Instrument # 3h

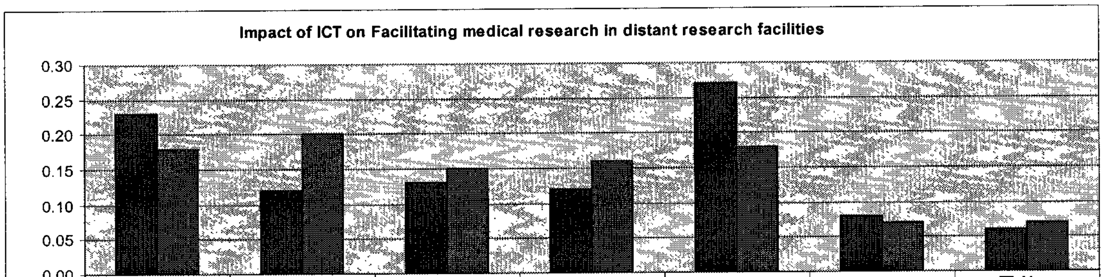
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #4h - Impact of ICTs on the application: "Facilitating medical research in distant research facilities"

The following figure represents the impacts of ICTs on facilitating medical research in distant research facilities for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.23	0.12	0.13	0.12	0.27	0.08	0.06
2010	0.18	0.2	0.15	0.16	0.18	0.07	0.07

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T5: Land-based devices and infrastructure
	T1: General purpose software
Medium impact:	T3: Internet content & infrastructure
	T2: Mobile devices & infrastructure
	T4: Collaborative tools
Low impact:	T6: Country specific software
	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T2: Mobile devices & infrastructure
	T1: General purpose software
	T5: Land-based devices and infrastructure
Medium impact:	T4: Collaborative tools
	T3: Internet content & infrastructure
Low impact:	T6: Country specific software
	T7: Mass communication systems

Discussion:

Right now, the information and communication technologies with higher impact on this applications are the land-based devices and the general software. However, with time, the mobile devices will become more and more important.

Validation Questions: Instrument # 4h

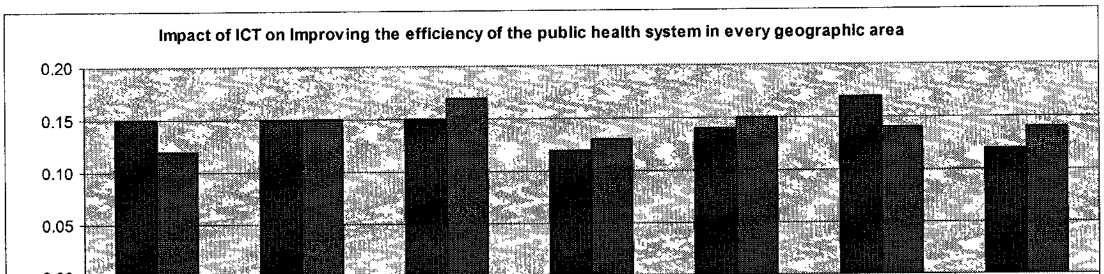
1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

<u>Result #5h - Impact of ICTs on the application: "Improving the efficiency of the public health system in every geographic area"</u>

The following figure represents the impacts of the ICTs on improving the efficiency of the public health system in every geographic area for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.15	0.15	0.15	0.12	0.14	0.17	0.12
2010	0.12	0.15	0.17	0.13	0.15	0.14	0.14

Grouping the ICTs by the level of impact on this application we will have:

High impact: T6: Country specific software
Medium impact: T3: Internet content & infrastructure
T2: Mobile devices & infrastructure
T1: General purpose software

	T5: Land-based devices and infrastructure
Low impact:	T4: Collaborative tools
	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T3: Internet content & infrastructure
Medium impact:	T2: Mobile devices & infrastructure
	T5: Land-based devices and infrastructure
	T6: Country specific software
	T7: Mass communication systems
Low impact:	T4: Collaborative tools
	T1: General purpose software

Discussion:

Right now, the country specific software has the highest impact, closely followed by Internet content and infrastructure as well as mobile and land-base devices and general purpose software. The impact profile will change in 2010. "Internet content & infrastructure" and "Mobile devices & infrastructure will increase their relative impact and "country specific software" and "general purpose software" will have much less impact on improving the efficiency of the public health system in every geographic area. However, mass communication systems will go up from the low impact level to medium impact level.

Validation Questions: Instrument # 5h

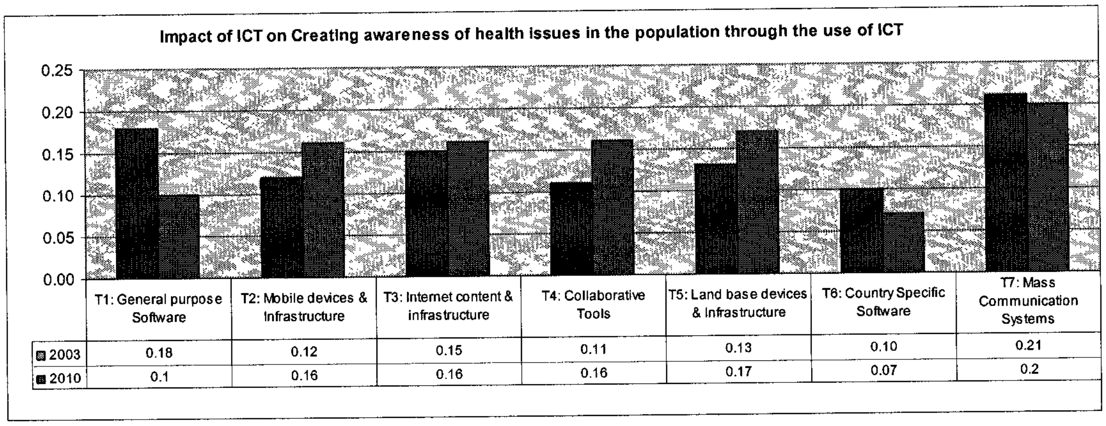
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #6h - Impact of ICTs on the application: "Creating awareness of health issues in the population through the use of ICTs"

The following figure represents the impacts of the ICTs on creating awareness of health issues in the population through the use of ICTs for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.18	0.12	0.15	0.11	0.13	0.10	0.21
2010	0.1	0.16	0.16	0.16	0.17	0.07	0.2

Grouping the ICTs by the level of impact on this application we will have:

High impact: T7: Mass communication systems
Medium impact: T1: General purpose software
T3: Internet content & infrastructure
Low impact: T5: Land-based devices & infrastructure
T2: Mobile devices & infrastructure
T4: Collaborative tools
T6: Country specific software

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact: T7: Mass communication systems
Medium impact: T5: Land-based devices and infrastructure
T2: Mobile devices & infrastructure
T3: Internet content & infrastructure
T4: Collaborative tools
Low impact: T1: General purpose software
T6: Country specific software

Discussion:

Mass communication systems such as radio and television have a high impact on creating awareness of health issues in the population through the use of ICTs in 2003, followed by the Internet content and infrastructure as well as general software. For the year 2010, mass communication systems will still have the highest impact but the role of Internet and collaborative tools as well as land-based and wireless devices have higher impacts. "General purpose software" will drop from medium impact level to low impact level, and the land-based and mobile communication devices will increase their relative impacts.

Validation Questions: Instrument # 6h

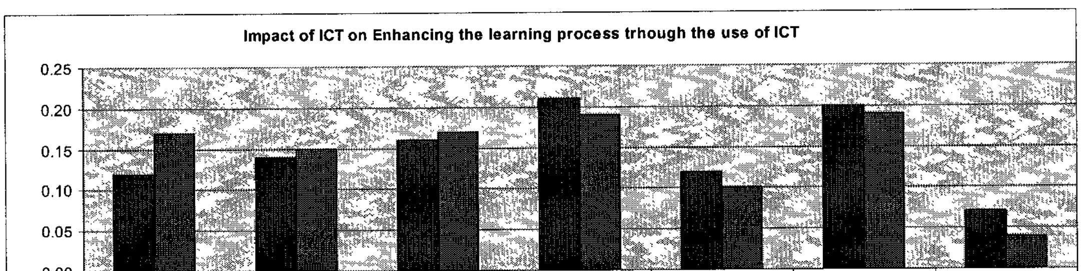
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #1e - Impact of ICTs on the application: "Enhancing the learning process through the use of ICTs"

The following figure represents the impacts of the ICTs on enhancing the learning process through the use of ICTs for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.12	0.14	0.16	0.21	0.12	0.20	0.07
2010	0.17	0.15	0.17	0.19	0.1	0.19	0.04

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T4: Collaborative tools
	T6: Country specific software
Medium impact:	T3: Internet content & infrastructure
	T2: Mobile devices & infrastructure
	T1: General purpose software
	T5: Land-based devices and infrastructure
Low impact:	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T6: Country specific software
Medium impact:	T3: Internet content & infrastructure
	T1: General purpose software
	T2: Mobile devices & infrastructure
Low impact:	T5: Land-based devices and infrastructure
	T7: Mass communication systems

Discussion:

Collaborative tools and country specific software are the information and communication technologies with higher impact on enhancing the learning process through the use of ICTs followed by Internet content and infrastructure in 2003. For the year 2010, we have the same pattern, although the land-based devices will decrease their relative impact and the mobile devices will increase slightly.

Validation Questions: Instrument # 1e

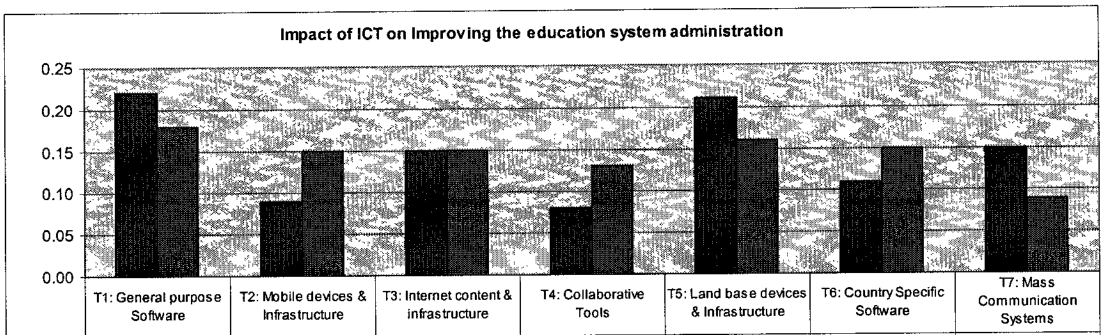
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #2e - Impact of ICTs on the application: "Improving the education system administration"

The following figure represents the impacts of the ICTs on improving the education system administration for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.22	0.09	0.15	0.08	0.21	0.11	0.15
2010	0.18	0.15	0.15	0.13	0.16	0.15	0.09

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T1: General purpose software
	T5: Land-based devices and infrastructure
Medium impact:	T3: Internet content & infrastructure
	T7: Mass communication systems
	T6: Country specific software
Low impact:	T2: Mobile devices & infrastructure
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T1: General purpose software
	T5: Land-based devices and infrastructure
Medium impact:	T3: Internet content & infrastructure
	T6: Country specific software
	T2: Mobile devices & infrastructure
Low impact:	T4: Collaborative tools
	T7: Mass communication systems

Discussion:

For improving the education systems, the technologies with higher impact are "general purpose software" and "land-based devices and infrastructure" followed by the Internet and the country specific software and mass communication systems. For the year 2010, the ICTs with higher impact will be the same, but the relative impact of mass communication systems will decrease, and the relative impact of mobile devices, collaborative tools and country specific software will increase.

Validation Questions: Intrument #2e

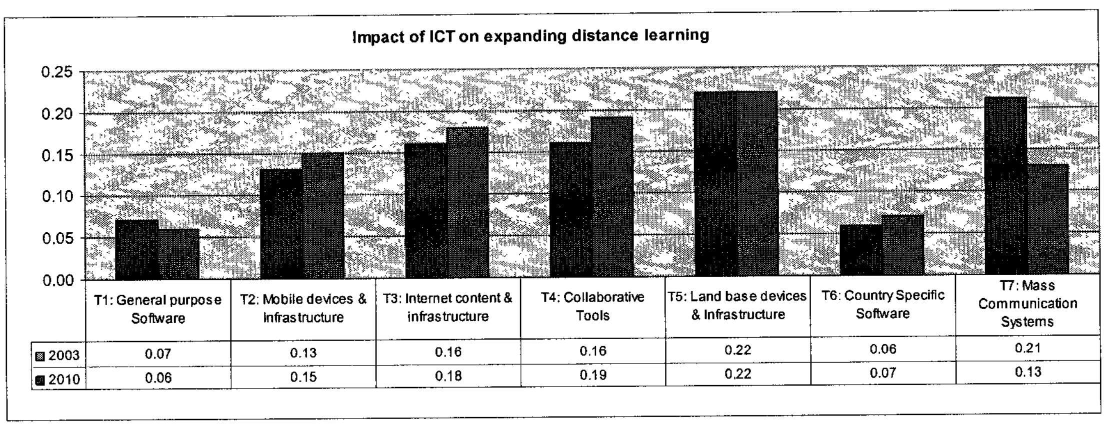
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #3e - Impact of ICTs on the application: "Expanding distance learning"

The following figure represents the impacts of the ICTs on expanding distance learning for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.07	0.13	0.16	0.16	0.22	0.06	0.21
2010	0.06	0.15	0.18	0.19	0.22	0.07	0.13

Grouping the ICTs by the level of impact on this application we will have:

High impact: T5: Land-based devices and infrastructure
T7: Mass communication systems

Medium impact:	T4: Collaborative tools
	T3: Internet content & infrastructure
	T2: Mobile devices & infrastructure
Low impact:	T1: General purpose software
	T6: Country specific software

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T5: Land-based devices and infrastructure
	T4: Collaborative tools
	T3: Internet content & infrastructure
Medium impact:	T2: Mobile devices & infrastructure
	T7: Mass communication systems
Low impact:	T6: Country specific software
	T1: General purpose software

Discussion:

Right now, the role of land-based devices and mass communication systems have a high impact on expanding distance learning. However, with time the role of mass communication systems is expected to decrease in this application. Equipment is important in expanding distance learning. In 2003 land-based devices and infrastructure have a high impact; for 2010 they are still going to have high impact but mobile devices will increase their impact too. In the same way collaborative tools and Internet will move from medium impact level to high impact level. In both years, the software will have a low impact on expanding distance learning.

Validation Questions: Instrument # 3e

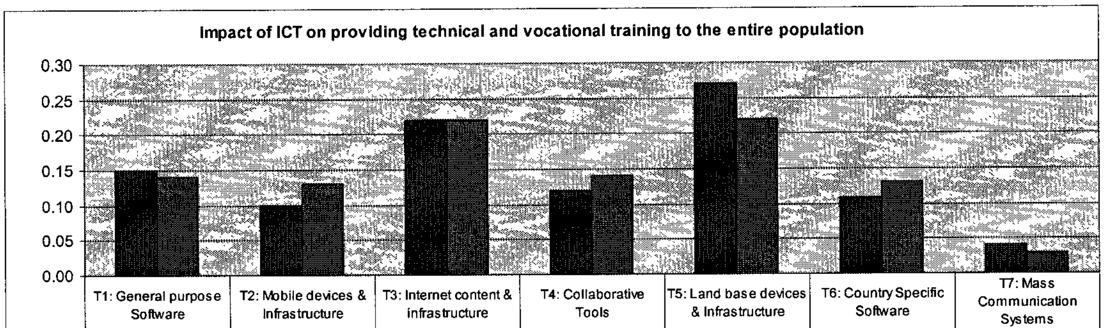
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #4e - Impact of ICTs on the application: "Providing technical and vocational training to the entire population"

The following figure represents the impacts of the ICTs on providing technical and vocational training to the entire population for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.15	0.10	0.22	0.12	0.27	0.11	0.04
2010	0.14	0.13	0.22	0.14	0.22	0.13	0.03

Grouping the ICTs by the level of impact on this application we will have:

High impact: T5: Land-based devices and infrastructure
T3: Internet content & infrastructure
Medium impact: T1: General purpose software
T4: Collaborative tools
T6: Country specific software
T2: Mobile devices & infrastructure
Low impact: T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact: T5: Land-based devices and infrastructure
T3: Internet content & infrastructure
Medium impact: T1: General purpose software
T4: Collaborative tools
T6: Country specific software
T2: Mobile devices & infrastructure
Low impact: T7: Mass communication systems

Discussion:

The ICTs with highest impact on providing technical and vocational training are the land-based devices and infrastructure and the Internet content and infrastructure followed by the general purpose software, collaborative tools, country specific software and mobile devices in 2003. It is interesting to notice that for the year 2010 the collaborative tools, country specific software and mobile devices will become more and more important. The ICTs with the least impact in both years are mass communication systems.

Validation Questions: Instrument # 4e

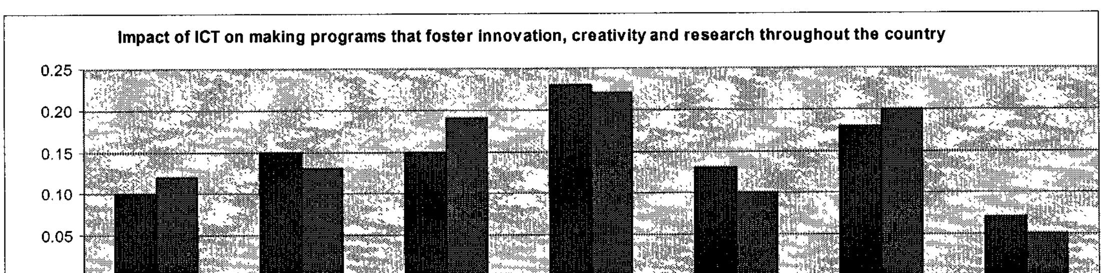
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #5e - Impact of ICTs on the application: "Making programs that foster innovation, creativity and research throughout the country"

The following figure represents the impacts of the ICTs on making programs that foster innovation, creativity and research throughout the country for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.10	0.15	0.15	0.23	0.13	0.18	0.07
2010	0.12	0.13	0.19	0.22	0.1	0.2	0.05

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T4: Collaborative tools
	T6: Country specific software
Medium impact:	T3: Internet content & infrastructure
	T2: Mobile devices & infrastructure
	T5: Land-based devices & infrastructure
Low impact:	T1: General purpose software
	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T6: Country specific software
	T3: Internet content & infrastructure
Medium impact:	T2: Mobile devices & infrastructure
	T1: General purpose software
	T5: Land-based devices & infrastructure
Low impact:	T7: Mass communication systems

Discussion:

The ICTs with the highest impact on making programs that foster innovation, creativity and research throughout the country are collaborative tools and country specific software in both 2003 and 2010. Internet content and infrastructure will increase its relative impact from medium level in 2003 to high level in 2010. The devices in general have a medium impact. The role of general purpose software will slightly increase in 2010.

Validation Questions: Instrument # 5e

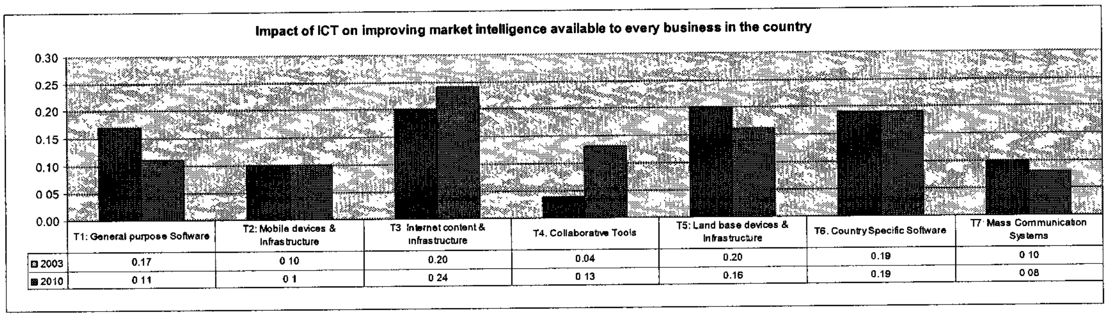
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #1ec - Impact of ICTs on the application: "Improving market intelligence available to every business in the country"

The following figure represents the impacts of the ICTs on improving market intelligence available to every business in the country for the years 2003 and 2010.



Grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
	T5: Land-based devices and infrastructure
	T6: Country specific software
Medium impact:	T1: General purpose software
Low impact:	T2: Mobile devices & infrastructure
	T7: Mass communication systems
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T3: Internet content & infrastructure
Medium impact:	T6: Country specific software
	T5: Land-based devices and infrastructure
	T4: Collaborative tools
Low impact:	T1: General purpose software
	T2: Mobile devices & infrastructure
	T7: Mass communication systems

Discussion:

For the year 2003, the Internet content & infrastructure and the land-based devices followed by country specific software are the ICTs with high impact on improving the market intelligence available to every business in the country. However, for the year 2010 the relative impact of collaborative tools will increase while general purpose software will decrease with time.

Validation Questions: Instrument # 1ec

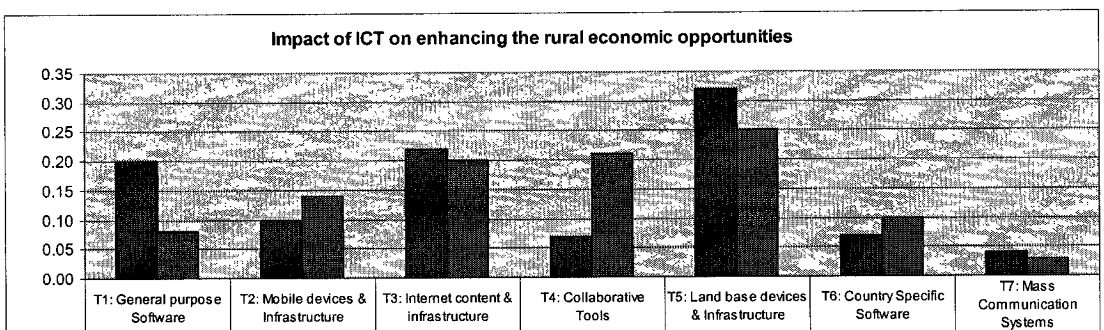
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

<u>Result #2ec - Impact of ICTs on the application: "Enhancing the rural economic opportunities"</u>

The following figure represents the impacts of the ICTs on enhancing the rural economic opportunities for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.20	0.10	0.22	0.07	0.32	0.07	0.04
2010	0.08	0.14	0.2	0.21	0.25	0.1	0.03

Grouping the ICTs by the level of impact on this application we will have:

High impact: T5: Land-based devices and infrastructure
Medium impact: T3: Internet content & infrastructure
T1: General purpose software
Low impact: T2: Mobile devices & infrastructure
T4: Collaborative tools
T6: Country specific software
T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T5: Land-based devices and infrastructure
	T4: Collaborative tools
	T3: Internet content & infrastructure
Medium impact:	T2: Mobile devices & infrastructure
Low impact:	T6: Country specific software
	T1: General purpose software
	T7: Mass communication systems

<u>Discussion:</u>

For the year 2003, the land-based devices and infrastructure is the ICT with the highest impact on enhancing rural economic opportunities followed by the Internet content & infrastructure and general purpose software. For 2010, the relative impact of the land-based devices will have a substantial reduction, even though it still will be the ICT with the highest impact on this application. The general purpose software will also have a big reduction on its relative impact. On the other hand, collaborative tools will have a substantial increase in their relative impact on enhancing rural economic opportunities. Mobile devices and country specific software will also have slight increases in their relative impacts on this application.

Validation Questions: Instrument # 2ec

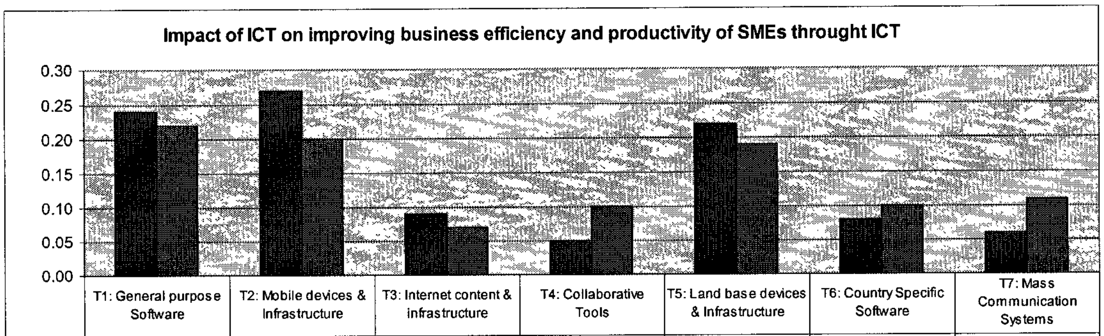
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #3ec - Impact of ICTs on the application: "Improving business efficiency and productivity of SMEs through ICTs"

The following figure represents the impacts of the ICTs on improving business efficiency and productivity of SMEs through ICTs for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.24	0.27	0.09	0.05	0.22	0.08	0.06
2010	0.22	0.2	0.07	0.1	0.19	0.1	0.11

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T2: Mobile devices & infrastructure
Medium impact:	T1: General purpose software
	T5: Land-based devices and infrastructure
Low impact:	T3: Internet content & infrastructure
	T6: Country specific software
	T7: Mass communication systems
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T1: General purpose software
	T2: Mobile devices & infrastructure
	T5: Land-based devices and infrastructure
Medium impact:	T7: Mass communication systems
	T6: Country specific software
	T4: Collaborative tools
Low impact:	T3: Internet content & infrastructure

Discussion:

For the year 2003, the ICTs with highest impact on improving business efficiency and productivity of SMEs are the mobile devices and infrastructure; followed by general purpose software and land-based devices. For the year 2010 these ICTs will still have high relative impact but less than in 2003. Collaborative tools and mass communication systems will have a substantial increase in their relative impacts in 2010. On the other hand, country specific software and internet content & infrastructure will have a slight reduction in their impacts on improving business efficiency and productivity.

Validation Questions: Instrument # 3ec

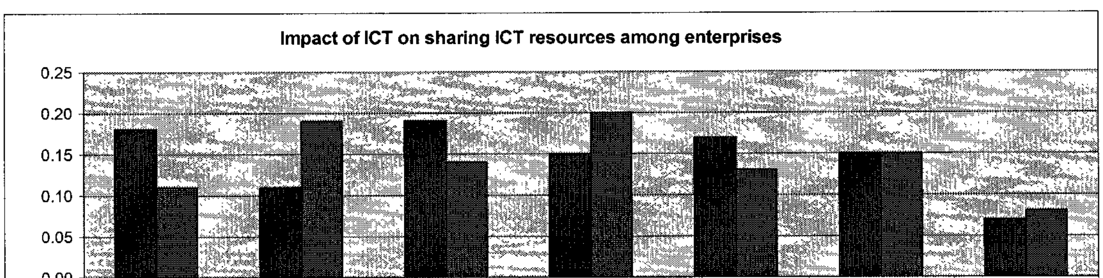
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #4ec - Impact of ICTs on the application: "Sharing ICT resources among enterprises"

The following figure represents the impacts of the ICTs on sharing ICT resources among enterprises for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.18	0.11	0.19	0.15	0.17	0.15	0.07
2010	0.11	0.19	0.14	0.2	0.13	0.15	0.08

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
	T1: General purpose software
Medium impact:	T5: Land-based devices and infrastructure
	T4: Collaborative tools
	T6: Country specific software
Low impact:	T2: Mobile devices & infrastructure
	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T2: Mobile devices & infrastructure
Medium impact:	T6: Country specific software
	T3: Internet content & infrastructure
	T5: Land-based devices and infrastructure
	T1: General purpose software
Low impact:	T7: Mass communication systems

Discussion:

The Internet content and infrastructure as well as general purpose software are the ICTs with the highest impact on sharing ICT resources among enterprises in 2003. In 2010, collaborative tools and mobile devices will increase their relative impact while the Internet content & infrastructure as well as general software will decrease theirs. The relative impacts of land-based devices will also be reduced in 2010.

Validation Questions: Instrument # 4ec

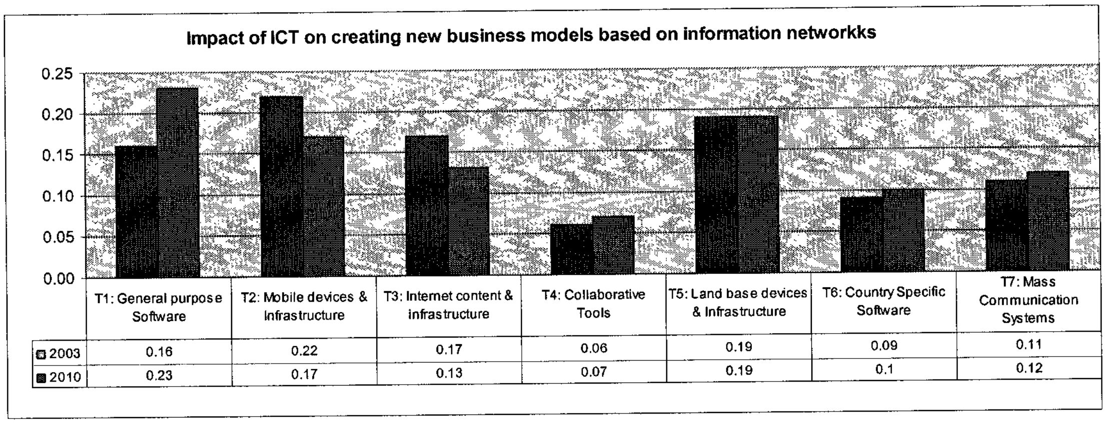
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #5ec - Impact of ICTs on the application: "Creating new business models based on information networks"

The following figure represents the impacts of the ICTs on creating new business models based on information networks for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.16	0.22	0.17	0.06	0.19	0.09	0.11
2010	0.23	0.17	0.13	0.07	0.19	0.1	0.12

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T2: Mobile devices & infrastructure
	T5: Land-based devices and infrastructure
Medium impact:	T3: Internet content & infrastructure
	T1: General purpose software
Low impact:	T7: Mass communication systems
	T6: Country specific software
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T1: General purpose software
Medium impact:	T5: Land-based devices and infrastructure
	T2: Mobile devices & infrastructure
Low impact:	T3: Internet content & infrastructure
	T7: Mass communication systems
	T6: Country specific software
	T4: Collaborative tools

Discussion:

Mobile devices and infrastructure is the ICT with the highest impact on creating new business models based on information networks in 2003. It is followed by land-based devices, Internet content & infrastructure and general purpose software. General purpose software becomes the ICT with highest relative impact in 2010 followed by the devices and infrastructure in general (land-based and/or mobile devices). The relative impacts of Internet content and infrastructure will be reduced with time.

Validation Questions: Instrument # 5ec

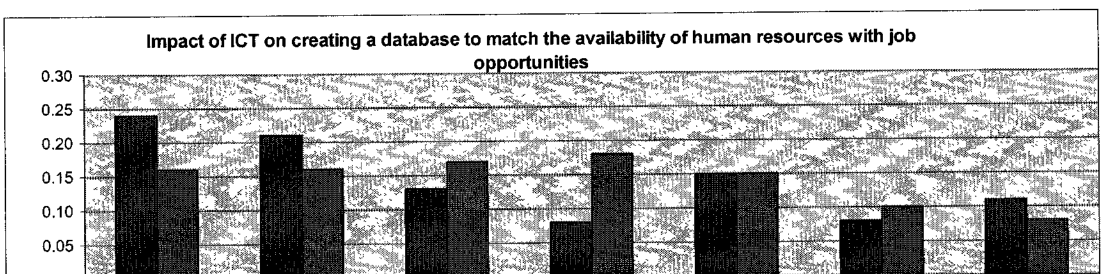
1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #6ec - Impact of ICTs on the application: "Creating a database to match the availability of human resources with job opportunities"

The following figure represents the impacts of the ICTs on creating a database to match the availability of human resources with job opportunities for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.24	0.21	0.13	0.08	0.15	0.08	0.11
2010	0.16	0.16	0.17	0.18	0.15	0.1	0.08

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T1: General purpose software
	T2: Mobile devices & infrastructure
Medium impact:	T5: Land-based devices and infrastructure
	T3: Internet content & infrastructure
	T7: Mass communication systems
Low impact:	T6: Country specific software
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T3: Internet content & infrastructure
	T1: General purpose software
	T2: Mobile devices & infrastructure
Medium impact:	T5: Land-based devices and infrastructure
Low impact:	T7: Mass communication systems
	T6: Country specific software

Discussion:

For the year 2003, the ICTs with higher impact on creating a database to match the availability of human resources with job opportunities are general software and mobile devices, followed by land-based devices and infrastructure as well as Internet content & infrastructure. The ICTs with highest impact will be collaborative tools and the Internet content & infrastructure in 2010. The rest of the technologies follow the same pattern as in the year 2003.

Validation Questions: Instrument # 6ec

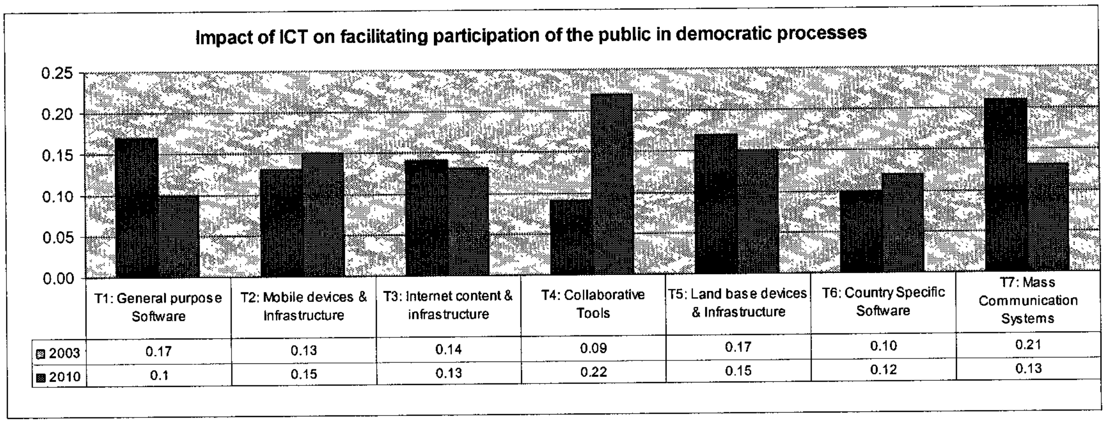
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #1g - Impact of ICTs on the application: "Facilitating participation of the public in democratic processes"

The following figure represents the impacts of the ICTs on facilitating participation of the public in democratic processes for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.17	0.13	0.14	0.09	0.17	0.10	0.21
2010	0.1	0.15	0.13	0.22	0.15	0.12	0.13

Grouping the ICTs by the level of impact on this application we will have:

High impact: T7: Mass communication systems
Medium impact: T5: Land-based devices and infrastructure
T1: General purpose software
T3: Internet content & infrastructure
T2: Mobile devices & infrastructure
Low impact: T6: Country specific software
T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact: T4: Collaborative tools
Medium impact: T5: Land-based devices and infrastructure
T2: Mobile devices & infrastructure
T3: Internet content & infrastructure
T7: Mass communication systems
Low impact: T6: Country specific software
T1: General purpose software

Discussion:

Mass communication systems have the highest relative impact on facilitating participation of the public in democratic processes in 2003. However, collaborative tools will have higher impact than the mass communication systems in 2010. The devices and Internet content & infrastructure will have medium impacts in both years.

Validation Questions: Instrument # 1g

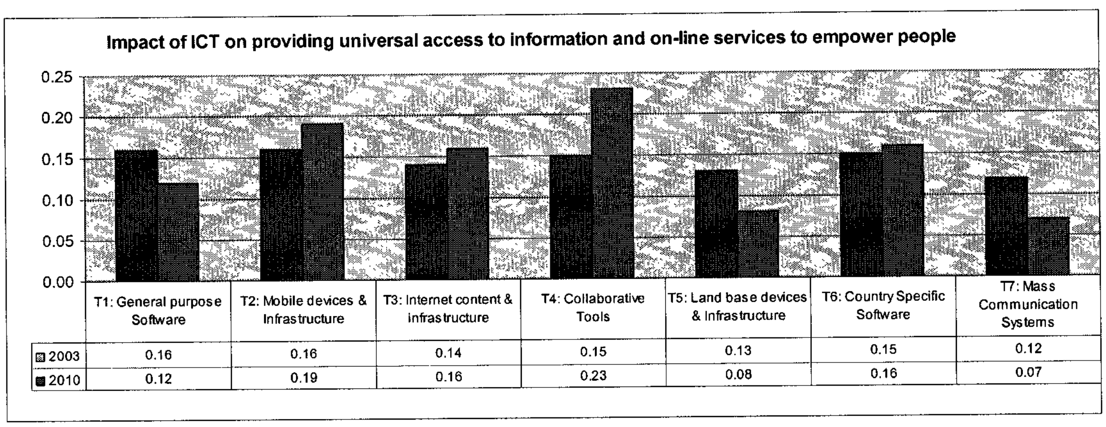
1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #2g - Impact of ICTs on the application: "Providing universal access to information and on-line services to empower people"

The following figure represents the impacts of the ICTs on providing universal access to information and on-line services to empower people for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.16	0.16	0.14	0.15	0.13	0.15	0.12
2010	0.12	0.19	0.16	0.23	0.08	0.16	0.07

Grouping the ICTs by the level of impact on this application we will have:

High impact: T1: General purpose software
T2: Mobile devices & infrastructure

Medium impact:	T4: Collaborative tools
	T6: Country specific software
	T3: Internet content & infrastructure
Low impact:	T5: Land-based devices and infrastructure
	T7: Mass communication systems

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T2: Mobile devices & infrastructure
	T4: Collaborative tools
Medium impact:	T6: Country specific software
	T3: Internet content & infrastructure
	T1: General purpose software
Low impact:	T7: Mass communication systems
	T5: Land-based devices and infrastructure

Discussion:

The ICTs with highest impact on providing universal access to information and on-line services to empower people are the general software and mobile devices in 2003. However, the collaborative tools and the mobile devices will have a substantial increase in their relative impact. The Internet content and infrastructure as well as the country specific software have slight increases in their impacts on this application over time, while the land-based devices will decrease their relative impact.

Validation Questions: Instrument # 2g

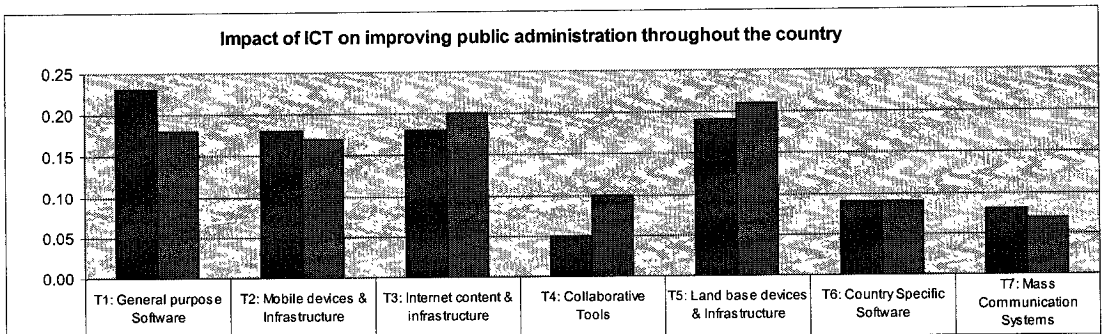
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #3g - Impact of ICTs on the application: "Improving public administration throughout the country"

The following figure represents the impacts of the ICTs on improving public administration throughout the country for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.23	0.18	0.18	0.05	0.19	0.09	0.08
2010	0.18	0.17	0.2	0.1	0.21	0.09	0.07

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T1: General purpose software
Medium impact:	T5: Land-based devices and infrastructure
	T2: Mobile devices & infrastructure
	T3: Internet content & infrastructure
Low impact:	T6: Country specific software
	T7: Mass communication systems
	T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T5: Land-based devices and infrastructure
	T3: Internet content & infrastructure
Medium impact:	T1: General purpose software
	T2: Mobile devices & infrastructure
Low impact:	T4: Collaborative tools
	T6: Country specific software
	T7: Mass communication systems

Discussion:

The ICT with highest impact on improving public administration throughout the country is the general purpose software, followed by land-based devices, mobile devices and infrastructure as well as internet content and infrastructure. For the year 2010, the general purpose software will reduce its impact and the land-based devices & infrastructure as well as Internet content & infrastructure will be the ICTs with the highest impact for that year. It is important to notice that for 2010 the collaborative tools have a substantial increase in their impact on "improving public administration throughout the country".

Validation Questions: Instrument # 3g

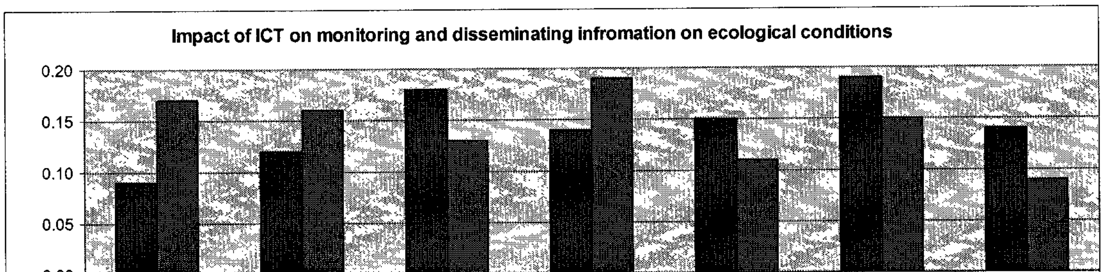
1. The results are acceptable and I validate them. **Yes:** ___ **No:** ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #1env - Impact of ICTs on the application: "Monitoring and disseminating information on ecological conditions"

The following figure represents the impacts of the ICTs on monitoring and disseminating information on ecological conditions for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.09	0.12	0.18	0.14	0.15	0.19	0.14
2010	0.17	0.16	0.13	0.19	0.11	0.15	0.09

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T6: Country specific software
	T3: Internet content & infrastructure
Medium impact:	T5: Land-based devices and infrastructure
	T7: Mass communication systems
	T4: Collaborative tools
Low impact:	T2: Mobile devices & infrastructure
	T1: General purpose software

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T1: General purpose software
Medium impact:	T2: Mobile devices & infrastructure
	T6: Country specific software
	T3: Internet content & infrastructure
Low impact:	T5: Land-based devices and infrastructure
	T7: Mass communication systems

Discussion:

For the year 2003, the ICTs with the highest impact are country specific software and Internet content & infrastructure, followed by land-based devices, mass communication systems and collaborative tools. However, for the year 2010 collaborative tools and general purpose software are the technologies with highest impact, followed that mobile devices & infrastructure. The relative impact of mass communication systems will be reduced substantially in the year 2010.

Validation Questions: Instrument # 1env

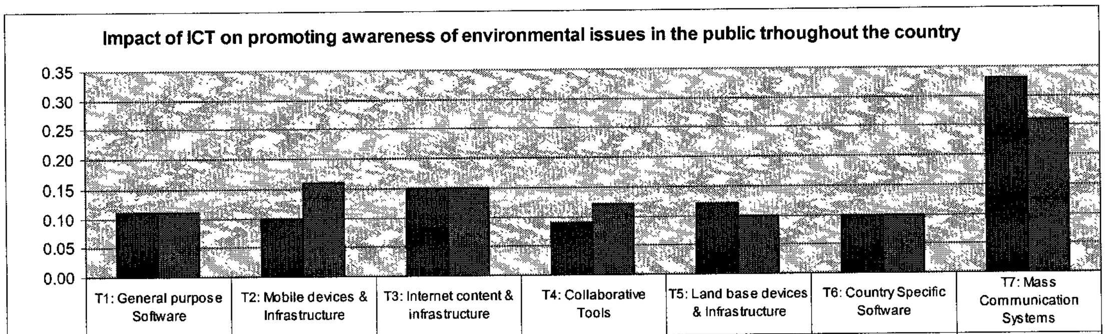
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #2env - Impact of ICTs on the application: "Promoting awareness of environmental issues in the public throughout the country"

The following figure represents the impacts of the ICTs on promoting awareness of environmental issues in the public throughout the country for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.11	0.10	0.15	0.09	0.12	0.10	0.33
2010	0.11	0.16	0.15	0.12	0.1	0.1	0.26

Grouping the ICTs by the level of impact on this application we will have:

High impact: T7: Mass communication systems
Medium impact: T3: Internet content & infrastructure
T5: Land-based devices and infrastructure
Low impact: T1: General purpose software
T2: Mobile devices & infrastructure
T6: Country specific software
T4: Collaborative tools

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact: T7: Mass communication systems
Medium impact: T2: Mobile devices & infrastructure
T3: Internet content & infrastructure
T4: Collaborative tools
Low impact: T1: General purpose software
T5: Land-based devices and infrastructure
T6: Country specific software

Discussion:

For the year 2003, the ICT with the highest impact on promoting awareness of environmental issues in the public throughout the country is the mass communication systems. Its relative impact is substantially reduced in the year 2010 but it still remains as the ICT with highest impact on this application. For the year 2003 the technologies with medium impact are the Internet content & infrastructure and land-based devices. For the year 2010 the technologies with medium impact will be the mobile devices, Internet content & infrastructure and collaborative tools.

Validation Questions: Instrument # 2env

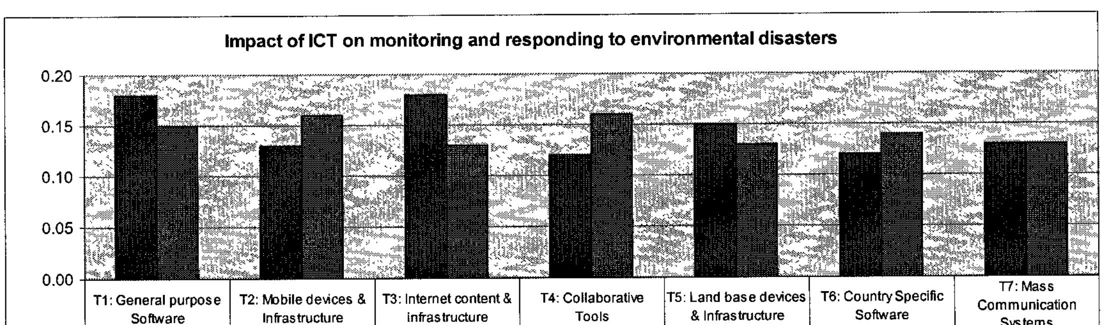
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #3env - Impact of ICTs on the application: "Monitoring and responding to environmental disasters"

The following figure represents the impacts of the ICTs on monitoring and responding to environmental disasters for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.18	0.13	0.18	0.12	0.15	0.12	0.13
2010	0.15	0.16	0.13	0.16	0.13	0.14	0.13

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
	T1: General purpose software
Medium impact:	T5: Land-based devices and infrastructure
Low impact:	T2: Mobile devices & infrastructure
	T7: Mass communication systems
	T4: Collaborative tools
	T6: Country specific software

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T4: Collaborative tools
	T2: Mobile devices & infrastructure
Medium impact:	T1: General purpose software
	T6: Country specific software
Low impact:	T3: Internet content & infrastructure
	T7: Mass communication systems
	T5: Land-based devices and infrastructure

Discussion:

For the year 2003, the technologies with the highest impact on monitoring and responding to environmental disasters are the Internet content & infrastructure and general software followed by land-based devices and infrastructure. For the year 2010 the collaborative tools and mobile devices will have the highest relative impact, followed by general purpose software and country specific software. There is a substantial decrease in the relative impact of internet content & infrastructure on this application for the years 2003 to 2010.

Validation Questions: Instrument # 3env

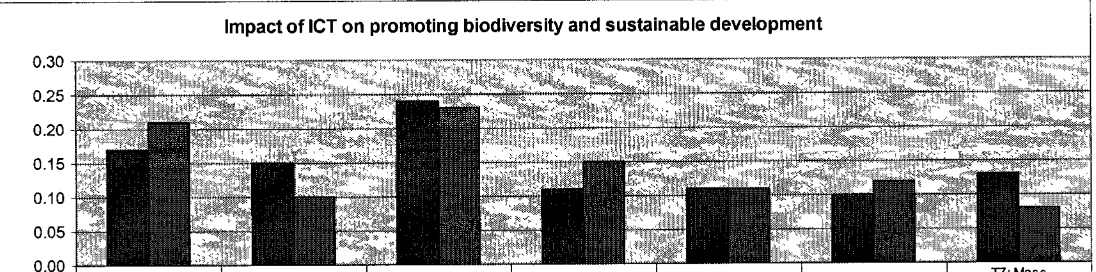
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #4env - Impact of ICTs on the application: "Promoting biodiversity and sustainable development"

The following figure represents the impacts of the ICTs on the promoting biodiversity and sustainable development for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.17	0.15	0.24	0.11	0.11	0.10	0.13
2010	0.21	0.1	0.23	0.15	0.11	0.12	0.08

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T3: Internet content & infrastructure
Medium impact:	T1: General purpose software
	T2: Mobile devices & infrastructure
	T7: Mass communication systems
Low impact:	T5: Land-based devices and infrastructure
	T4: Collaborative tools
	T6: Country specific software

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T3: Internet content & infrastructure
	T1: General purpose software
Medium impact:	T4: Collaborative tools
	T6: Country specific software
Low impact:	T5: Land-based devices and infrastructure
	T2: Mobile devices & infrastructure
	T7: Mass communication systems

Discussion:

For the year 2003 the Internet content & Infrastructure is the ICT with the highest impact on promoting biodiversity and sustainable development followed by general purpose software, mobile devices & infrastructure and general purpose software. For the year 2010 the Internet will still be a high-impact technology, but general purpose software will also have a high impact. However, it is important to notice that the technologies with relative low impact in 2003 have medium impact in 2010.

Validation Questions: Instrument # 4env

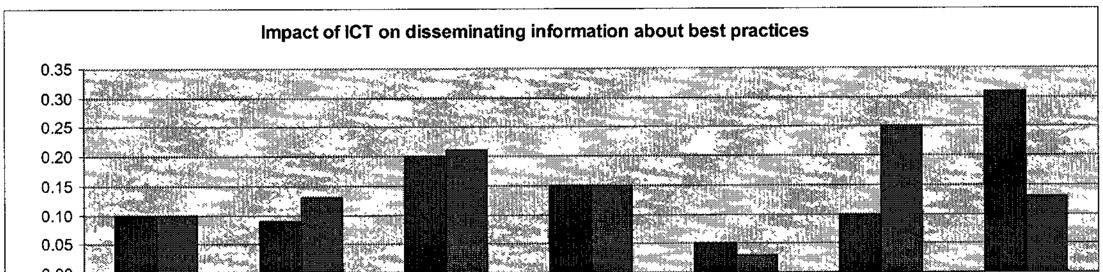
1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

Result #5env - Impact of ICTs on the application: "Disseminating information about best practices"

The following figure represents the impacts of the ICTs on disseminating information about best practices for the years 2003 and 2010.



	T1: General purpose Software	T2: Mobile devices & Infrastructure	T3: Internet content & infrastructure	T4: Collaborative Tools	T5: Land base devices & Infrastructure	T6: Country Specific Software	T7: Mass Communication Systems
2003	0.10	0.09	0.20	0.15	0.05	0.10	0.31
2010	0.1	0.13	0.21	0.15	0.03	0.25	0.13

Grouping the ICTs by the level of impact on this application we will have:

High impact:	T7: Mass communication systems
Medium impact:	T3: Internet content & infrastructure
	T4: Collaborative tools
Low impact:	T1: General purpose software
	T6: Country specific software
	T2: Mobile devices & infrastructure
	T5: Land-based devices and infrastructure

On the other hand, in the year 2010, grouping the ICTs by the level of impact on this application, we will have:

High impact:	T6: Country specific software
	T3: Internet content & infrastructure
Medium impact:	T4: Collaborative tools
	T7: Mass communication systems
	T2: Mobile devices & infrastructure
Low impact:	T1: General purpose software
	T5: Land-based devices and infrastructure

Discussion:

For the year 2003 the mass communication systems is the ICT with the highest impact on disseminating information about best practices followed by country specific software and Internet content & infrastructure. For the year 2010, the country specific software and Internet content & infrastructure are the ICTs with highest impact followed by collaborative tools, mobile devices & infrastructure and mass communication systems. The relative impacts of mass communication systems are substantially decreased and the relative impact of country specific software is substantially increased from the year 2003 to the year 2010.

Validation Questions: Instrument # 5env

1. The results are acceptable and I validate them. **Yes**: ___ **No**: ___
(If "yes" please skip question No. 2 and go to 3)

2. If you do not validate the results please explain your reasoning.

3. Any additional comments (optional)

APPENDIX F: DISTRIBUTION OF THE RESULT INSTRUMENTS

Expert / Instrument	Sectors		ICT applications					Information & Communication Technologies																								
	2003 /2010		H	Ed	Ec	Gov	Env	Health						Education					Economic						Gov			Environment				
	1		2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	1	2	3	4	5	6	1	2	3	1	2	3	4	5
Expert 1	x	x																							x	x						
Expert 2	x	x		x																												
Expert 3	x	x		x			x																x						x	x	x	x
Expert 4	x	x	x						x	x	x	x	x																			
Expert 6	x	x				x		x				x																				
Expert 7	x	x			x	x													x	x		x		x	x							
Expert 8	x	x	x								x		x																			
Expert 9	x	x		x										x	x	x	x	x														
Expert 10	x	x			x	x	x														x			x			x					
Expert 11	x	x			x	x											x		x	x	x		X				x					
Expert 12	x	x					x																					x	x	x		
Expert 13	X	x		x											x	x						x										
Expert 14	X	X	x					x	x	x																						
Expert 15	X	X	x	x			x							x				x							x	x		x			x	x

APPENDIX I: SENSITIVITY ANALYSIS (CASE BY CASE)

I1: SECTORS 2003

HEALTH SECTOR 2003

Table 1 Changes in the rankings of ICTs in the health sector's impact in 2003

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Minimum	0.07	0.3289	0.23817	0.204146	0.1474	0.1595	0.1417	0.1657	0.1214	0.1639	0.1246	0.1154	3	4	1	6	2	5	7
...																			
Mean	0.18	0.29	0.21	0.18	0.13	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...																			
Change	0.25	0.26524	0.19207	0.164634	0.1189	0.1601	0.1393	0.1638	0.1228	0.1601	0.1277	0.1187	2	4	1	6	3	5	7
...																			
Maximum	0.33	0.23695	0.17159	0.147073	0.1062	0.1604	0.1383	0.163	0.1234	0.1583	0.1291	0.1202	2	4	1	6	3	5	7

Table 2 Summarized changes in the health sector in 2003

	Health Sector	Ict's Values							ICTs Rankings						
		T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.159535	0.141697	0.16569	0.1214	0.1639	0.1246	0.1154	3	4	1	6	2	5	7
...															
Mean	0..18	0.159886	0.140254	0.164556	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Change	0.25	0.160109	0.139336	0.163834	0.1228	0.1601	0.1277	0.1187	2	4	1	6	3	5	7
...															
Max	0.33	0.160364	0.138287	0.163009	0.1234	0.1583	0.1291	0.1202	2	4	1	6	3	5	7

EDUCATION SECTOR 2003

Table 3 Changes in the rankings of ICTs in the education sector's impact in 2003

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.223099	0.12	0.260282	0.223099	0.161127	0.168598	0.142925	0.164138	0.108676	0.158986	0.121005	0.123244	1	4	2	7	3	6	5
...																			
Change	0.212958	0.16	0.248451	0.212958	0.153803	0.166548	0.142296	0.164237	0.111872	0.159587	0.122305	0.121882	1	4	2	7	3	5	6
...																			
Change	0.200282	0.21	0.233662	0.200282	0.144648	0.163986	0.141511	0.164359	0.115868	0.160338	0.123929	0.120181	2	4	1	7	3	5	6
...																			
Change	0.190141	0.25	0.221831	0.190141	0.137324	0.161936	0.140882	0.164458	0.119064	0.160938	0.125229	0.11882	2	4	1	6	3	5	7
...																			
Mean	0.18	0.29	0.21	0.18	0.13	0.159886	0.140254	0.164556	0.122261	0.161539	0.126529	0.117459	3	4	1	6	2	5	7
...																			
Change	0.154648	0.39	0.180423	0.154648	0.11169	0.154761	0.138683	0.164802	0.130252	0.163041	0.129778	0.114056	3	4	1	5	2	6	7
...																			
Change	0.131831	0.48	0.153803	0.131831	0.095211	0.150149	0.137269	0.165023	0.137445	0.164392	0.132703	0.110994	3	5	1	4	2	6	7
Max	0.129296	0.49	0.150845	0.129296	0.09338	0.149636	0.137112	0.165047	0.138244	0.164542	0.133028	0.110654	3	5	1	4	2	6	7

Table 4 Summarized changes in the education sector in 2003

	Education Sector	ICTs's values							ICTs Rankings						
		T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.12	0.1686	0.1429	0.1641	0.1087	0.1590	0.1210	0.1232	1	4	2	7	3	6	5
...															
Change	0.16	0.1665	0.1423	0.1642	0.1119	0.1596	0.1223	0.1219	1	4	2	7	3	5	6
...															

Change	0.21	0.1640	0.1415	0.1644	0.1159	0.1603	0.1239	0.1202	2	4	1	7	3	5	6
...															
Change	0.25	0.1619	0.1409	0.1645	0.1191	0.1609	0.1252	0.1188	2	4	1	6	3	5	7
...															
Change	0.27	0.1609	0.1406	0.1645	0.1207	0.1612	0.1259	0.1181	3	4	1	6	2	5	7
...															
Mean	0.29	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Change	0.39	0.1548	0.1387	0.1648	0.1303	0.1630	0.1298	0.1141	3	4	1	5	2	6	7
...															
Change	0.48	0.1501	0.1373	0.1650	0.1374	0.1644	0.1327	0.1110	3	5	1	4	2	6	7
Max	0.49	0.1496	0.1371	0.1650	0.1382	0.1645	0.1330	0.1107	3	5	1	4	2	6	7

ECONOMIC SECTOR 2003

Table 5 Changes in the rankings of ICTs in the economic sector's impact in 2003

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min/change	0.205063	0.33038	0.1	0.205063	0.148101	0.1545	0.1369	0.1647	0.1281	0.157	0.1284	0.12209	3	4	1	6	2	5	7
...																			
Mean	0.18	0.29	0.21	0.18	0.13	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.117459	3	4	1	6	2	5	7
...																			
Change	0.161772	0.260633	0.29	0.161772	0.116835	0.1638	0.1427	0.1644	0.118	0.1648	0.1252	0.114091	3	4	2	6	1	5	7
...																			
Change	0.157215	0.253291	0.31	0.157215	0.113544	0.1648	0.1433	0.1644	0.117	0.1656	0.1249	0.113249	2	4	3	6	1	5	7
...																			
Max	0.145823	0.234937	0.36	0.145823	0.105316	0.1672	0.1448	0.1643	0.1143	0.1677	0.124	0.111144	2	4	3	6	1	5	7

Table 6 Sumarized changes in the economic sector in 2003

	Economic Sector	ICTs's values							ICTs Rankings						
		T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Minimum	0.10	0.1545	0.1369	0.1647	0.1281	0.157	0.1284	0.12209	3	4	1	6	2	5	7
...															
Mean	0.21	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.117459	3	4	1	6	2	5	7
...															
Change	0.29	0.1638	0.1427	0.1644	0.118	0.1648	0.1252	0.114091	3	4	2	6	1	5	7
...															
Change	0.31	0.1648	0.1433	0.1644	0.117	0.1656	0.1249	0.113249	2	4	3	6	1	5	7
...															
Maximum	0.36	0.1672	0.1448	0.1643	0.1143	0.1677	0.124	0.111144	2	4	3	6	1	5	7

GOVERNEMENT SECTOR 2003

Table 7 Changes in the rankings of ICTs in the government sector's impact in 2003

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1954	0.3148	0.2279	0.1100	0.1411	0.1564	0.1381	0.1648	0.1255	0.1608	0.1281	0.1177	3	4	1	6	2	5	7
...																			
Mean	0.1800	0.2900	0.2100	0.1800	0.1300	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...																			
Change	0.1690	0.2723	0.1972	0.2300	0.1221	0.1624	0.1418	0.1644	0.1199	0.1621	0.1254	0.1173	2	4	1	6	3	5	7
..																			
Max	0.1646	0.2652	0.1921	0.2500	0.1189	0.1633	0.1424	0.1643	0.1190	0.1623	0.1249	0.1172	2	4	1	6	3	5	7

Table 8 Summarized changes in the government sector in 2003

	Government Sector	ICTs's values							ICTs Rankings						
		T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1100	0.1564	0.1381	0.1648	0.1255	0.1608	0.1281	0.1177	3	4	1	6	2	5	7
...															
Mean	0.1800	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Change	0.2300	0.1624	0.1418	0.1644	0.1199	0.1621	0.1254	0.1173	2	4	1	6	3	5	7
...															
Max	0.2500	0.1633	0.1424	0.1643	0.1190	0.1623	0.1249	0.1172	2	4	1	6	3	5	7

ENVIRONMENTAL SECTOR 2003

Table 9 Changes in the ranking of ICTs in the environment sector's impact in 2003

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1924	0.3100	0.2245	0.1924	0.07	0.1619	0.1418	0.1628	0.1227	0.1651	0.1275	0.1105	3	4	2	6	1	5	7
...																			
Change	0.1862	0.3000	0.2172	0.1862	0.1	0.1609	0.141	0.1637	0.1225	0.16332	0.127	0.114	3	4	1	6	2	5	7
...																			
Mean	0.1800	0.2900	0.2100	0.1800	0.13	0.1599	0.1403	0.1646	0.1223	0.161539	0.1265	0.1175	3	4	1	6	2	5	7
..																			
Change	0.1655	0.2667	0.1931	0.1655	0.2	0.1576	0.1384	0.1667	0.1218	0.157384	0.1254	0.1255	2	4	1	7	3	6	5
...																			
Max	0.1510	0.2433	0.1762	0.1510	0.27	0.1553	0.1365	0.1687	0.1213	0.153229	0.1242	0.1336	2	4	1	7	3	6	5

Table 10 Summarized changes in the environment sector in 2003

	Environment	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.1619	0.1418	0.1628	0.1227	0.1651	0.1275	0.1105	3	4	2	6	1	5	7
Change	0.1	0.1609	0.141	0.1637	0.1225	0.16332	0.127	0.114	3	4	1	6	2	5	7
Mean	0.13	0.1599	0.1403	0.1646	0.1223	0.161539	0.1265	0.1175	3	4	1	6	2	5	7
Change	0.2	0.1576	0.1384	0.1667	0.1218	0.157384	0.1254	0.1255	2	4	1	7	3	6	5
Max	0.27	0.1553	0.1365	0.1687	0.1213	0.153229	0.1242	0.1336	2	4	1	7	3	6	5

SUMMARIZED TABLE FOR EACH SECTOR CHANGES IN 2003

Table 11 Summarized changes in each sector for 2003

Sector	Affected Technologies	Previous Ranking	Final Ranking
Health	T1,T5	3,2	2,3
Education	T6,T7	6,5	5,6
	T1,T3	1,2	2,1
	T4,T7	7,6	6,7
	T1,T5	2,3	3,2
	T4,T6	6,5	5,6
	T2,T4	4,5	5,4
Economic	T3,T5	1,2	2,1
	T1,T3	3,2	2,3,
Government	T1,T5	3,2	2,3
Environment	T3,T5	2,1	1,2
	T1,T5	3,2	2,3

I2: SECTORS 2010

HEALTH SECTOR 2010

Table 12 Changes in the rankings of ICTs in the health sector's impact in 2010

	Health	Edu	Eco.	Gov.	Env.	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.31	0.23	0.22	0.17	0.14	0.15	0.17	0.17	0.14	0.14	0.09	6	3	1	2	4	5	7
...																			
Mean	0.19	0.27	0.20	0.19	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Max	0.33	0.22	0.17	0.16	0.12	0.13	0.15	0.17	0.16	0.14	0.14	0.10	6	3	1	2	4	5	7

EDUCATION SECTOR 2010

Table 13 Changes in the rankings of ICTs in the education sector's impact in 2010

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.23	0.12	0.24	0.23	0.18	0.14	0.15	0.17	0.16	0.14	0.14	0.10	5	3	1	2	4	6	7
...																			
change	0.22	0.14	0.24	0.22	0.18	0.14	0.15	0.17	0.16	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Mean	0.19	0.27	0.20	0.19	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Max	0.13	0.49	0.14	0.13	0.10	0.13	0.15	0.17	0.17	0.15	0.14	0.09	6	3	1	2	4	5	7

ECONOMIC SECTOR 2010

Table 14 Changes in the rankings of ICTs in the economic sector's impact in 2010

	Health	Edu	Eco	Govt	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.21	0.30	0.10	0.21	0.17	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	5	4	7
Change	0.21	0.30	0.11	0.21	0.17	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Mean	0.19	0.27	0.20	0.19	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
change	0.15	0.22	0.35	0.15	0.12	0.14	0.15	0.17	0.16	0.15	0.14	0.09	5	3	1	2	4	6	7
Max	0.15	0.22	0.36	0.15	0.12	0.14	0.15	0.17	0.16	0.15	0.14	0.09	5	3	1	2	4	6	7

GOVERNMENT SECTOR 2010

Table 15 Changes in the rankings of ICTs in the government sector's impact in 2010

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.21	0.30	0.22	0.11	0.16	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Mean	0.19	0.27	0.20	0.19	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
Max	0.18	0.25	0.19	0.25	0.14	0.14	0.15	0.17	0.17	0.15	0.14	0.10	6	3	1	2	4	5	7

ENVIRONMENTAL SECTOR 2010

Table 16 Changes in the rankings of ICTs in the environmental sector's impact in 2010

	Health	Edu	Eco	Gov	Env	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.22	0.31	0.23	0.22	0.03	0.13	0.15	0.17	0.17	0.15	0.14	0.09	6	3	1	2	4	5	7
...																			
Mean	0.19	0.27	0.20	0.19	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...																			
change	0.17	0.25	0.18	0.17	0.22	0.14	0.15	0.17	0.16	0.14	0.14	0.10	6	3	1	2	5	4	7
...																			
Max	0.16	0.23	0.17	0.16	0.27	0.14	0.15	0.17	0.16	0.14	0.14	0.10	6	3	1	2	5	4	7

SUMMARIZED TABLE FOR EACH SECTOR CHANGES IN 2010

Table 17 Summarized changes for each sector in 2010

Sector	Affected Technologies	Previous Ranking	Final Ranking
Health	None		
Education	T1,T6	5,6	6,5
Economic	T5,T6 T1,T6	5,4 6,5	4,5 5,6
Government	None		
Environment	T5,T6	4,5	5,4

I3: APPLICATIONS 2003

Table 18 Changes when varying application 1.4

	A14	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.04	0.1589	0.1404	0.1649	0.1224	0.1598	0.1274	0.1185	3	4	1	6	2	5	7
...															
Mean	0.11	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Max/change	0.21	0.1613	0.1401	0.1640	0.1221	0.1641	0.1253	0.1160	3	4	2	6	1	5	7

Table 19 Changes when varying application 2.1

	A21	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.23	0.1600	0.1399	0.1647	0.1214	0.1631	0.1251	0.1181	3	4	1	6	2	5	7
...															
Mean	0.3	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Max/change	0.39	0.1598	0.1407	0.1643	0.1234	0.1596	0.1284	0.1166	2	4	1	6	3	5	7

Table 20 Changes when varying application 2.3

	A23	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.1611	0.1402	0.1647	0.1227	0.1604	0.1286	0.1147	2	4	1	6	3	5	7
...	0.13	0.1601	0.1403	0.1646	0.1223	0.1614	0.1268	0.1171	3	4	1	6	2	5	7
Mean	0.14	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...	0.24	0.1581	0.1403	0.1643	0.1216	0.1632	0.1235	0.1214	3	4	1	6	2	5	7
Change	0.25	0.1579	0.1403	0.1643	0.1216	0.1633	0.1232	0.1218	3	4	1	7	2	5	6
Max	0.26	0.1577	0.1403	0.1643	0.1215	0.1635	0.1229	0.1222	3	4	1	7	2	5	6

Table 21 Changes when varying application 2.4

	A24	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.06	0.159	0.141	0.162	0.125	0.158	0.128	0.120	2	4	1	6	3	5	7
...															
Change	0.11	0.159	0.141	0.163	0.123	0.159	0.127	0.119	3	4	1	6	2	5	7
...															
Mean	0.17	0.160	0.140	0.165	0.122	0.162	0.127	0.117	3	4	1	6	2	5	7
...															
Max	0.25	0.161	0.139	0.166	0.121	0.164	0.125	0.116	3	4	1	6	2	5	7

Table 22 Changes when varying application 3.6

	A36	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1	0.1583	0.1385	0.1658	0.1223	0.1632	0.1278	0.1165	3	4	1	6	2	5	7
...															
Mean	0.24	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															
Change	0.31	0.1607	0.1411	0.1639	0.1223	0.1607	0.1259	0.1180	2	4	1	6	3	5	7
...															
Max	0.4	0.1617	0.1423	0.1631	0.1222	0.1596	0.1251	0.1186	2	4	1	6	3	5	7

Table 23 Changes when varying application 4.3

	A43	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.33	0.1573	0.1390	0.1630	0.1253	0.1598	0.1281	0.1205	3	4	1	6	2	5	7
...															
Mean	0.55	0.1599	0.1403	0.1646	0.1223	0.1615	0.1265	0.1175	3	4	1	6	2	5	7
...															

Change	0.97	0.1649	0.1427	0.1676	0.1165	0.1649	0.1235	0.1117	2	4	1	6	3	5	7
Max	0.98	0.1650	0.1427	0.1677	0.1164	0.1649	0.1234	0.1116	2	4	1	6	3	5	7

Table 24 Summarized table of changes in ranking when varying applications in 2003

Application	Affected Technologies	Previous Ranking	Final Ranking
A14	T3,T5	1,2	2,1
A21	T1,T5	3,2	2,3
A23	T4,T7	6,7	7,6
A24	T1,T5	2,3	3,2
A36	T1,T5	3,2	2,3
A43	T1,T5	3,2	2,3

I4: APPLICATIONS 2010

Table 25 Changes when varying application 4.1 in 2010

	A41	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.1374	0.1527	0.1721	0.1634	0.1447	0.1394	0.0932	6	3	1	2	4	5	7
...															
Mean	0.29	0.1352	0.1515	0.1699	0.1661	0.1446	0.1393	0.0958	6	3	1	2	4	5	7
...															
Change	0.47	0.1333	0.1505	0.1681	0.1682	0.1445	0.1393	0.0978	6	3	2	1	4	5	7
...															
Max	0.54	0.1326	0.1501	0.1674	0.1691	0.1444	0.1393	0.0986	6	3	2	1	4	5	7

Table 26 Changes when varying application 4.3 in 2010

	A43	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.16	0.1320	0.1515	0.1674	0.1718	0.1402	0.1416	0.0971	6	3	2	1	5	4	7
...															
Change	0.28	0.1336	0.1515	0.1686	0.1689	0.1424	0.1405	0.0964	6	3	2	1	4	5	7
...															
Mean	0.4	0.1352	0.1515	0.1699	0.1661	0.1446	0.1393	0.0958	6	3	1	2	4	5	7
...															
Change	0.59	0.1377	0.1514	0.1718	0.1616	0.1480	0.1375	0.0947	5	3	1	2	4	6	7
...															
Max	0.67	0.1388	0.1514	0.1727	0.1596	0.1495	0.1367	0.0943	5	3	1	2	4	6	7

Table 27 Changes when varying application 5.5 in 2010

	A55	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.13	0.1361	0.1516	0.1692	0.1661	0.1458	0.1374	0.0960	6	3	1	2	4	5	7
	...														
Mean	0.23	0.1352	0.1515	0.1699	0.1661	0.1446	0.1393	0.0958	6	3	1	2	4	5	7
	...														
Change	0.4	0.1337	0.1512	0.1711	0.1661	0.1425	0.1426	0.0954	6	3	1	2	5	4	7
	...														
Max	0.43	0.1334	0.1512	0.1713	0.1661	0.1422	0.1432	0.0954	6	3	1	2	5	4	7

The following table summarizes the technologies affected and the ranking changes in these three ICT applications.

Table 28 Summarized table of changes when varying applications in 2010

Application	Affected Technologies	Previous Ranking	Final Ranking
A41	T3,T4	1,2	2,1
A43	T5,T6 T3,T4 T1,T6	5,4 2,1 6,5	4,5 1,2 5,6
A55	T5,T6	4,5	5,4

I5: TECHNOLOGIES 2003

Table 29 Application A12 modifying T1 in 2003

	A12-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.11	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
	...														
Mean	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
	...														
Change	0.21	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
Max	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 30 Application A13 modifying T1 in 2003

	A13-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.04	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.13	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 31 Application A14 modifying T5 in 2003

	A14-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
..															
Change	0.21	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

..														
Mean	0.27	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
..															
Max	0.36	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

Table 32 Application A21 modifying T5 in 2003

	A21-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.11	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
Mean	0.12	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max/change	0.19	0.16	0.14	0.16	0.12	0.17	0.13	0.12	3	4	2	6	1	5	7

Table 33 Application A21 modifying T6 in 2003

	A21-T6	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.11	0.16	0.14	0.17	0.12	0.16	0.12	0.12	3	4	1	5	2	6	7
...															
Change	0.17	0.16	0.14	0.17	0.12	0.16	0.12	0.12	3	4	1	6	2	5	7
...															
Mean	0.20	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max	0.28	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

Table 34 Application A22 modifying T1 in 2003

	A22-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.12	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															

Mean	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.27	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Max	0.31	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 35 Application A22 modifying T7 in 2003

	A22-T7	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.15	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max/change	0.29	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	7	2	5	6

Table 36 Application A23 modifying T1 in 2003

	A23-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.03	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.07	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max/change	0.11	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 37 Application A23 modifying T5 in 2003

	A23-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.16	0.16	0.14	0.17	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															

Change	0.19	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max	0.28	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

Table 38 Application A24 modifying T1 in 2003

	A24-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.10	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.15	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Max	0.20	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 39 Application A25 modifying T1 in 2003

	A25-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.07	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.1	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.12	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
Max	0.13	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 40 Application A25 modifying T5 in 2003

	A25-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7

Min	0.04	0.16	0.14	0.17	0.12	0.15	0.13	0.12	2	4	1	6	3	5	7
...															
Change	0.12	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
Mean	0.13	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	2	6	1	5	7
...															
Max	0.22	0.16	0.14	0.16	0.12	0.17	0.13	0.12	3	4	2	6	1	5	7

Table 41 Application A25 modifying T6 in 2003

	A25-T6	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.11	0.16	0.14	0.17	0.12	0.16	0.12	0.12	3	4	1	5	2	6	7
...															
Change	0.14	0.16	0.14	0.17	0.12	0.16	0.12	0.12	3	4	1	6	2	5	7
...															
Mean	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max	0.25	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

Table 42 Application A32 modifying T1 in 2003

	A32-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.11	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.2	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.26	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															

Max	0.29	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 43 Application A34 modifying T1 in 2003

	A34-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.12	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
change	0.21	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Max	0.23	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 44 Application A34 modifying T5 in 2003

	A34-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.09	0.16	0.14	0.17	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Change	0.15	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.23	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	2	6	1	5	7
...															
Max	0.26	0.16	0.14	0.16	0.12	0.17	0.13	0.12	3	4	2	6	1	5	7

Table 45 Application A41 modifying T1 in 2003

	A41-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7

Min	0.09	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
..															
Mean	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Max	0.25	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 46 Application A42 modifying T1 in 2003

	A42-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.09	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.16	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.19	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Max	0.23	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 47 Application A42 modifying T4 in 2003

	A42-T4	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.06	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	7	2	5	6
Change	0.07	0.16	0.14	0.17	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.15	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.23	0.16	0.14	0.16	0.13	0.16	0.13	0.12	3	4	1	5	2	6	7
Max	0.24	0.16	0.14	0.16	0.13	0.16	0.13	0.12	3	4	1	5	2	6	7

Table 48 Application A42 modifying T5 in 2003

	A42-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.09	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Change	0.11	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.13	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

Table 49 Application A43 modifying T5 in 2003

	A43-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.16	0.16	0.14	0.17	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Change	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
Mean	0.19	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
....															
Change	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	2	6	1	5	7
Max	0.23	0.16	0.14	0.16	0.12	0.17	0.13	0.12	3	4	2	6	1	5	7

Table 50 Application A53 modifying T1 in 2003

	A53-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.1	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7

...															
Change	0.26	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
Max	0.27	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 51 Application A54 modifying T1 in 2003

	A54-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.13	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.17	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Change	0.22	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
..															
Max	0.24	0.16	0.14	0.16	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7

Table 52 Application A54 modifying T5 in 2003

	A54-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.06	0.16	0.14	0.17	0.12	0.16	0.13	0.12	2	4	1	6	3	5	7
...															
Change	0.08	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Mean	0.11	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	1	6	2	5	7
...															
Max/change	0.18	0.16	0.14	0.16	0.12	0.16	0.13	0.12	3	4	2	6	1	5	7

Table 53 Summarized table of changes when varying ICTs per ICT application in 2003

Application	Modified Technoloy	Affected Technologies	Previous Ranking	Final Ranking
A12	T1	T1,T5	3,2	2,3
A13	T1	T1,T5	3,2	2,3
A14	T5	T1,T5	2,3	3,2
A21	T5	T1,T5 T3,T5	2,3 1,2	3,2 2,1
A21	T6	T4,T6	5,6	6,5
A22	T1	T1,T5	3,2	2,3
A22	T7	T4,T7	6,7	7,6
A23	T1	T1,T5	3,2	2,3
A23	T5	T1,T5	2,3	3,2
A24	T1	T1,T5	3,2	2,3
A25	T1	T1,T5	3,2	2,3
A25	T5	T1,T5 T3,T5	2,3 1,2	3,2 2,1
A25	T6	T4,T6	5,6	6,5
A32	T1	T1,T5	3,2	2,3
A34	T1	T1,T5	3,2	2,3
A34	T5	T1,T5 T3,T5	2,3 1,2	3,2 2,1
A41	T1	T1,T5	3,2	2,3
A42	T1	T1,T5	3,2	2,3
A42	T4	T4,T7 T4,T6	7,6 6,5	6,7 5,6
A42	T5	T1,T5	2,3	3,2
A43	T5	T1,T5 T3,T5	2,3 1,2	3,2 2,1
A53	T1	T1,T5	3,2	2,3
A54	T1	T1,T5	3,2	2,3
A54	T5	T1,T5 T3,T5	2,3 1,2	3,2 2,1

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Table 54 Application A22 modifying T1 in 2010

	A22-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.06	0.13	0.15	0.17	0.17	0.15	0.14	0.10	6.00	3	1	2	4	5	7
...															
Mean	0.18	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6.00	3	1	2	4	5	7
...															
Max/change	0.28	0.14	0.15	0.17	0.17	0.14	0.14	0.10	5.00	3	1	2	4	6	7

Table 55 Application A25 modifying T1 in 2010

	A25-T1	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.05	0.13	0.15	0.17	0.17	0.15	0.14	0.10	6	3	1	2	4	5	7
...															
Mean	0.12	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...	0.15	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
Change	0.16	0.14	0.15	0.17	0.17	0.14	0.14	0.10	5	3	1	2	4	6	7
...	0.18	0.14	0.15	0.17	0.16	0.14	0.14	0.10	5	3	1	2	4	6	7
Max	0.19	0.14	0.15	0.17	0.16	0.14	0.14	0.10	5	3	1	2	4	6	7

Table 56 Application A25 modifying T5 in 2010

	A25-T5	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
min	0.03	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	5	4	7
...															
change	0.06	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															

mean	0.1	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
change	0.17	0.13	0.15	0.17	0.16	0.15	0.14	0.10	6	4	1	2	3	5	7
max	0.18	0.13	0.15	0.17	0.16	0.15	0.14	0.10	6	4	1	2	3	5	7

Table 57 Application A25 modifying T6 in 2010

	A25-T6	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.13	0.14	0.15	0.17	0.17	0.15	0.13	0.10	5	3	1	2	4	6	7
...															
change	0.17	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
Mean	0.20	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
change	0.26	0.13	0.15	0.17	0.16	0.14	0.14	0.10	6	3	1	2	5	4	7
Max	0.27	0.13	0.15	0.17	0.16	0.14	0.15	0.10	6	3	1	2	5	4	7

Table 58 Application A36 modifying T4 in 2010

	A36-T4	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.09	0.14	0.15	0.17	0.16	0.15	0.14	0.10	6	3	1	2	4	5	7
...															
Mean	0.22	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
Change	0.25	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	2	1	4	5	7
...															
Max	0.36	0.13	0.15	0.17	0.17	0.14	0.14	0.09	6	3	2	1	4	5	7

Table 59 Application A41 modifying T4 in 2010

	A41-T4	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.09	0.14	0.15	0.17	0.16	0.15	0.14	0.10	6	3	1	2	4	5	7
...															
Mean	0.22	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
change	0.28	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	2	1	4	5	7
...															
Max	0.36	0.13	0.15	0.17	0.17	0.14	0.14	0.09	6	3	2	1	4	5	7

Table 60 Application A43 modifying T4 in 2010

	A43-T4	T1	T2	T3	T4	T5	T6	T7	T1	T2	T3	T4	T5	T6	T7
Min	0.05	0.14	0.15	0.17	0.16	0.15	0.14	0.10	6	3	1	2	4	5	7
...															
Mean	0.1	0.14	0.15	0.17	0.17	0.14	0.14	0.10	6	3	1	2	4	5	7
...															
Max/change	0.15	0.13	0.15	0.17	0.17	0.14	0.14	0.10	6	3	2	1	4	5	7

Table 61 Summarized table when varying ICTs for each ICT application in 2010

Application	Modified Technoloy	Affected Technologies	Previous Ranking	Final Ranking
A22	T1	T1,T6	6,5	5,6
A25	T1	T1,T6	6,5	5,6
A25	T5	T5,T6 T2,T5	5,4 3,4	4,5 4,3
A25	T6	T1,T6 T5,T6	5,6 4,5	6,5 5,4
A36	T4	T3,T4	1,2	2,1
A41	T4	T3,T4	1,2	2,1
A43	T4	T3,T4	1,2	2,1

APPENDIX J: Human Subjects Agreement

You are invited to participate in a research study conducted by Audrey Alvear from Portland State University, Engineering and Technology Management / Systems Science Departments. The researcher hopes to develop a decision model for technology policies to reduce the digital divide by using Information and Communication Technologies (ICTs) using Costa Rica as a particular case of study. This study is being conducted in partial fulfillment of the requirements for a doctoral degree under the supervision of Dr. Dundar F. Kocaoglu at Portland State University. You were selected as a possible participant in this study because of your knowledge and/or high level of decision-making in health, education, economic, environment, government and technology issues for strategic development and policy making in Costa Rica.

If you decide to participate, you will be asked to answer a couple of instruments based on your personal judgment. The instruments will ask you to compare pairs of sectors, technology applications, and information and communication technologies. You will express your judgment about their impacts with respect to each other by distributing 100 points between the two. There are no physical, social, psychological, legal, economic or other risks to subjects involved in this research. You may not receive any direct benefit from taking part in this study, but you will gain insights in different areas in relation to the reduction of the digital divide and Information and Communication Technologies in Costa Rica. The study may help to increase knowledge, which may help others in the future.

The scope of research outcomes does not include the linkage between the human subjects and their responses by any means. However, if any, the information that is obtained in connection with this study and that can be linked to you or identify you will be kept confidential by allowing only the researcher to have access to the data.

Your participation is voluntary. You do not have to take part in this study, and it will not affect your relationship with Audrey Alvear or any organization with which the researcher is associated. You may also withdraw from this study at any time without affecting your relationship with the researcher or any associated organization.

If you have concerns or problems about your participation in this study or your rights as a research subject, please contact the Human Subjects Research Review committee, Office of Research and Sponsored Projects, 111 Cramer Hall, Portland State University, (503) 725-4288 . If you have questions about the study itself, contact Audrey Alvear at ETM (503) 725-4660.

Your signature or emailed response indicates that you have read and understand the above information and agree to take part in this study. Please understand that you may withdraw your consent at any time without penalty, and that by signing you are not waiving any legal claims, rights or remedies. The researcher will provide you with a copy of this form for your own records.

To consent via e-mail, please insert your signature below and email this document to the author. To respond in writing please sign the document and mail to Audrey Alvear, Portland State University, Engineering & Technology Management Department, PO BOX 751, Portland, OR 97207. To consent via the web, please click on the button reading, “I agree to participate”.

APPENDIX K: Confidentiality Agreement

Dear

Thank you for your time and help in my research. I have obtained the results based on the data provided by the members of the expert panel. Attached you will find the first portion of those results. I will send you the rest of them after this step is completed.

I am asking your help in validating the results now, and I will appreciate receiving any additional comments you might have.

Please do not forget that the contents of this document and the subsequent ones that I will send to you are parts of a doctoral dissertation. They are considered confidential and not to be disseminated, published or discussed without permission from the researcher.

Before opening the envelope, please sign at the bottom of this sheet, agreeing to abide by the confidentiality of the contents of this envelope and the subsequent ones that I will send you. If you disagree, please return the sealed envelope without opening it.

Thanks again you for your time and collaboration.

Audrey Alvear Báez

Name: Date:

APPENDIX L: References for applications

ICT applications in the health sector [1]:

- Expanding the availavility of health services and identification of the appropriate level of medical response for the needs of the population [62, 90]
- Preventing diseases and improving epidemic response [62]
- Providing on-line medical libraries [92]
- Facilitating diagnosis in distant medical labs
- Improving efficiency of the health system in every geographic area
- Creating awareness of health issues in the population through the use of ICTs [62]

ICT applications in the education sector [1]:

- Enhancing the learning process through the use of ICTs [129, 130] [1, 129]
- Improving the education system administration
- Expanding distance learning [130]
- Providing technical and vocational training to the entire population
- Making programs that foster innovation, creativity and research available throughout the country

ICT applications in the economic sector [1]:

- Improving market intelligence available to every business in the country

Enhancing rural economic opportunities [1, 135].

- Improving business efficiency and productivity of small- to medium-sized enterprises through ICTs [6, 78]
- Sharing ICT resources among enterprises
- Creating new business models based on information networks
- Creating a database to match the available human resources and job offerings

ICT applications in the government sector [1]:

- Facilitating participation of the public in democratic processes
- Providing universal access to information and on-line services to empower people [54, 78, 136]
- Improving public administration throughout the country [78]

ICT applications in the environemnetal sector [1]:

- Monitoring and disseminating information on ecological conditions
- Promoting public awareness of environmental issues throughout the country
- Monitoring environmental conditions to facilitate decision making
- Promoting biodiversity and sustainable development
- Dissemination of information about best practices