Notes from the Field

Toward a Conceptual Framework for ICT for Development: Lessons Learned from the Latin American "Cube Framework"

Martin Hilbert
martinhilbert@gmail.com
Provost Fellow
Annenberg School for Communication & Journalism
University of Southern California
3502 Watt Way
Los Angeles, CA 90089
USA
and
Economic Affairs Officer
United Nations ECLAC
Av. Dag Hammarskjöld 3477
Santiago
Chile

Abstract

The ICT for development community has long searched for comprehensive and adequate conceptual frameworks. In 2003, the United Nations Regional Commission for Latin America and the Caribbean (UN-ECLAC) proposed a three-dimensional conceptual framework that models the transition toward information societies as the interplay among technology, policy, and social change. It has its theoretical roots in Schumpeterian innovation theory. This so-called "cube framework" has been adopted on several occasions throughout the region at the local, national, and international levels. It has been employed in all stages of the policy cycle to identify areas and priorities for research and hands-on policy making (planning), to coordinate actors and stakeholders (execution), and to monitor progress toward information societies (evaluation). This article presents the framework and its particularities, reviews some of the diverse applications it has found during recent years, provides concrete suggestions on how it could be used in the future, and discusses its strengths and limitations. The cube is not a dynamic model that can make predictions, but it turns out to be useful as a conceptual framework; it can be used to structure the often-confused discussion about what is involved in the ongoing social transformation.

I. Introduction

Governments, enterprises, and civil actors around the world have started to set up proactive policy and strategy agendas aimed at exploiting the benefits of information and communication technologies (ICTs) for economic, social, and political development. In the meantime (and despite all this tangible activity on the ground), scholars are still struggling to come up with a coherent conceptual framework that embraces all relevant aspects of this multidisciplinary endeavor (Heeks, 2006).

This article reviews a conceptual framework that has been developed and applied in Latin America and the Caribbean. Called the "cube framework," it is a frame of reference that enables us to sort out the intricate relationship between ICT and development. It focuses on the interdependency among technology, policy interventions, and the socioeconomic sectors that are subject to change (are being "digitized"). After presenting the framework and its variants, we review several cases of how the framework has been used and can potentially be used at the local, national, and international levels throughout the policy cycle, namely to identify priorities, coordinate actors and stakeholders, and evaluate progress. This

includes a review of how the cube has been used, both for scholarly research and teaching, and for the design and monitoring of policy action plans (such as the regional ICT for development [ICT4D] strategies of Latin America and the Caribbean, eLAC2007 and eLAC2010[1]), as well as a reflection on its potential use in shedding light on the coordination of the stakeholders and resources involved in national ICT strategies. The final section draws conclusions about the strengths and limitations of the framework.

II. The "Cube Framework"[2]

A. Theoretical Background

The conceptual framework presented here has its theoretical foundation in the Schumpeterian notion of socioeconomic evolution and innovation theory (Freeman, 2008; Freeman & Louçã, 2002; Perez, 2004; Schumpeter, 1939), which holds that human progress

> goes on in units separated from each other by neighborhoods of equilibrium. Each of those units, in turn, consists of two distinct phases, during the first of which the system, under the impulse of entrepreneurial activity, draws away from an equilibrium position, and during the second of which it draws toward another equilibrium position. (Schumpeter, 1939, p. 142)

In this case, the new equilibrium position is digital in nature, and the driving enabling technology of the transition is ICT. The ensuing evolution between equilibria (referred to as "far from equilibrium" in dynamic systems theory) results in a ruthless process of "creative destruction" that modernizes the modus operandi of society as a whole, including its economic, social, cultural, and political organization.

The idea that the engine behind this incessant force of creative destruction is technological change is not new (Perez, 1983, 2004). While the key carrier technology of the first Industrial Revolution (1770–1850) was water-powered mechanization (based on classical mechanics), the consecutive waves of comprehensive modernization were driven by evolving technologies. The second era (1850–1895) was enabled by steam-powered technology (thermodynamics), the next one (1895–1940) was characterized by the electrification of social and productive organizations (electromagnetism), and the following wave (1940–1970) by motorization and the automated mobilization of society (mechanical and chemical engineering). The most recent wave is characterized by the digitization of the information and communication processes in social systems (based on information theory and computer science) (Freeman & Louçã, 2002). These waves are often referred to as "long waves" or "Kondratiev waves" (sometimes spelled Kondratieff), after the Russian economist Nikolai Kondratiev (1892–1938), who empirically identified the first three of the above-mentioned periods (Kondratieff, 1935). However, the idea to classify periods of human progress by the driving technology behind social modernization is actually borrowed from historians and archeologists, whose distinction between the Stone Age (2,000,000 ~ 2200 BCE), Bronze Age (3300 ~ 1200 BCE), and Iron Age (1200 ~ 580 BCE) goes back to the first half of the 1800s (Gräslund, 1987). Recognizing this longstanding dynamic also makes clear that the ICT revolution will certainly not be the last of its kind. The ever-shortening length of the respective periods actually suggests that the next long wave must not be too far away (or is actually currently overdue).[3]

What all these waves have in common is that each one consists of a sustained period of social modernization, most notably brought about by sustained periods of increasing economic productivity.[4] According to Perez's seminal 1983 article:

> [T]his quantum jump in productivity can be seen as a technological revolution, which is made possible by the appearance in the general cost struc-

1. For the actual documents and the history and background of the consecutive Latin American and Caribbean Action Plans eLAC2007, eLAC2010, and eLAC2015, see http://www.cepal.org/eLAC and https://en.wikipedia.org/wiki/ELAC_Action_Plans

2. Part of this section has been previously published by the author in the online encyclopedia entry https://en.wikipedia.org/wiki/ICT4D (January 2012).

3. It can be speculated that the next long wave is to be driven by the molecular age, which consists of a combination of nano- and biotechnology (manipulating lifeless and living molecules), but it might as well be a new form of energy or another technological sector that achieves a major breakthrough.

4. The reason why most theories on social evolution focus on economics, instead of the modernization of cultural or political processes, is partially due to the lack of adequate performance indicators outside the economic realm (i.e., comparability to US$, productive output, etc.).

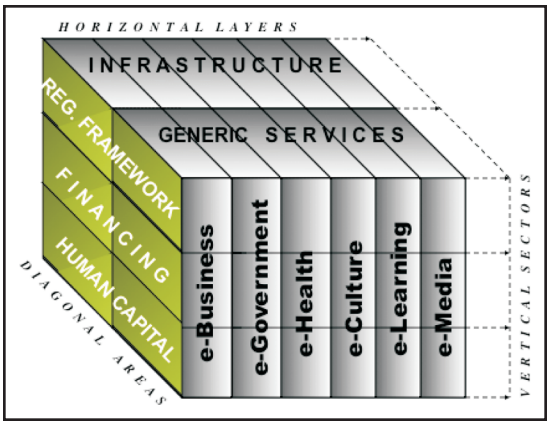

Figure 1. The original three-dimensional conceptual framework of ICT4D: The ICT4D cube.

> ture of a particular input that we could call the "key factor," fulfilling the following conditions: (1) clearly perceived low and descending- relative cost; (2) unlimited supply for all practical purposes; (3) potential all-pervasiveness; (4) a capacity to reduce the costs of capital, labour and products as well as to change them qualitatively. (1983, p. 361)

Digital information and communication technologies (ICTs) fulfill those requirements: (1) The performance: cost relationship of computers, storage, and communication devices has seen respective compound annual growth rates of 76%, 72%, and 56% during the period 1980–2005 (Hilbert, López, & Vasquez, 2010; see also Kurzweil, 2001, for more extensive treatment of the topic); (2) their practically unlimited supply has led to a technological diffusion process that is unprecedented in human history (for ICT penetration rates during the past 15 years, see ITU, 2011; for the growth of the world's capacity to store, communicate, and compute information, see Hilbert & López, 2011); and (3) their all-pervasive nature as a collective general-purpose technology affects all aspects of human conduct (Peres & Hilbert, 2010), which (4) leads to productivity increases and economic growth (Cimoli, Hofman, & Mulder, 2010) as well as modernization of cultural production (Creeber & Martin, 2008), political uprisings (Allagui & Kuebler, 2011), the modernization of political will formation (Hilbert, 2009), and even modernization of the way people date and fall in love (Epstein, 2007), among many others.

The ensuing process of social transformation has been given many names, among them the fifth Kondratiev (Perez, 1983), the post-industrial society (Bell, 1976), the information economy (Porat, 1977), the information technology revolution (Forester, 1985), the digital age (Negroponte, 1996), the network society (Castells, 2009), the age of information and communication technology (Freeman & Louçã, 2002), and the information society (Beniger, 1986; Masuda, 1980; Webster, 2002). This last term stuck with the international community, which took up the topic in the 2000 session of the United Nations Economic and Social Council under the theme, "the role of information technology in the context of a global knowledge-based economy," leading to the creation of the UN ICT Task Force and the realization of two consecutive world summits on the "information society."[5]

B. An Interplay of Three Dimensions: Technology, Policy, and Social Change

The United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC, or CEPAL, as it is known in Latin America by its Spanish initials[6]) has proposed a three-dimensional reference framework to conceptualize the scope and nature of this transformation. In the midst of the preparations for the World Summit on the Information Society (WSIS) (2003–2005), UN-ECLAC suggested that its 33 member countries should view the transition toward information societies as an interplay among the underlying digital general-purpose technologies (telecom, hardware, and software), the socioeconomic sectors that are subject to change (such as business, health, education, government, etc.), and normative policy areas that crosscut both of these areas (including regulation and incentives; Hilbert & Katz, 2002, 2003a, 2003b; see Figure 1).

In line with the Schumpeterian school of thought, the first enabling factor for the associated socioeconomic transformations is the existence of an enabling technological infrastructure. In the case

5. The WSIS was held in two phases. The first phase took place in Geneva, hosted by the Swiss government December 10–12, 2003, and the second phase took place in Tunis, hosted by the Tunisian government November 16–18, 2005 (http://www.itu.int/wsis).

6. UN-ECLAC was established in 1948 and is headquartered in Santiago, Chile. It is one of the five regional commissions of the United Nations (http://www.cepal.org).

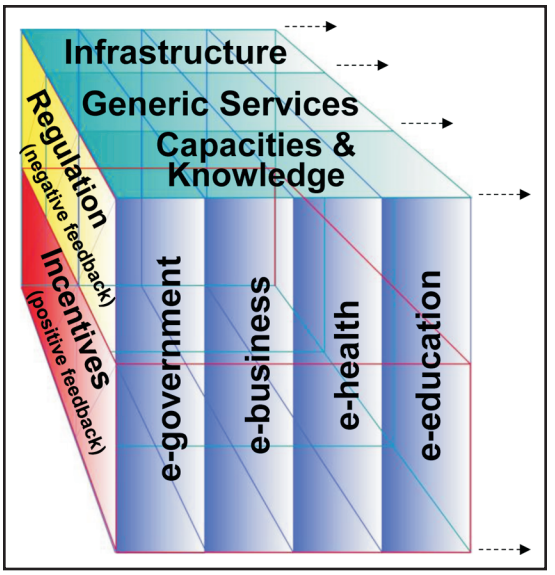

Figure 2. The modified version of the ICT4D Cube.

of digital ICT, engineers usually refer to the open system interconnection reference model (OSI reference model or OSI model) to abstractly describe the layered communications and computer network protocol design. It consists of seven layers. The "ICT4D cube framework" (*el cubo,* as it has become known in Latin America), reduces this technological dimension to only two broad layers: physical infrastructure (i.e., hardware and telecommunications networks: computers, fixed telephone lines, mobile phones, fiber-optic networks, digital TV, and all other tangible access equipment) and intangible generic services (software and other generic digital services, such as Web hosting, browsers, multimedia applications, search engines, and online social networks). The infrastructure layer and generic services layer form the grounds on which the process of digitization takes place, and these two are referred to as the horizontal layers.

These technological foundations are the basis for the digitization of information flows and communication mechanisms in different sectors of society, such as business and commerce, health, public administration, education, etc. All of these sectors use a more or less similar combination of hardware and software tools to reorganize and modernize their modus operandi through digitization. Those vertical sectors are the application areas of the technology, areas which provide the "content" of the networks in an information society and lead to social change. The focus of vertical sectors is on "digital processes," as opposed to the focus on "digital products" in the horizontal layers. The fact that part of the information flows and communication processes take place through "electronic" networks in a given sector is usually identified in literature by adding an "e-" prefix. This custom is, of course, only a temporary habit of this generation. The generation of today's kindergarten kids will not refer to a government website as "e-government," but simply as "government," since they will have never known another form of public administration. There are many "e-sectors." The expanding process of digitization is not exclusively restricted to the sectors depicted in the figure, and as indicated by the arrows in the diagram, the list of vertical sectors could be extended to other important fields of interest (such as e-democracy, e-security, e-entertainment, e-banking, e-payment, e-research, e-tourism, e-dating, etc.).

The foregoing layers and sectors are the basic requirements and building blocks of an information society, but their mere existence is insufficient to convert them into a tool for development. While technological determinism would argue that the mere existence of a new technology predetermines the direction of socioeconomic change, in a world in which humankind constantly proves technological determinism wrong and takes development into its own hands,[7] public policies and private strategies convert the notion of directionless "progress" into normatively guided "development." In practice, the digitization process is supported by institutional developments aimed at minimizing negative effects, removing eventual bottlenecks, and promoting normatively desired advances. ICT4D policies are found here. These crosscutting or "diagonal areas" permeate both horizontal layers and vertical sectors. In the cube's original version, the identified areas of policy activity were regulatory frameworks that fostered and provided scope for these new forms of behavior, financing mechanisms that supported the

7. The most commonly cited example to counter claims of technological determinism is humankind's dealing with the atomic bomb. If human history would be blindly guided by the deterministic notion that "every technology will do what it can do, independent of social guidance," humankind would not have made it through the Cold War.

diffusion of these technologies and their implementation, and reserves of human capital that acted as the driving force behind the technology.

After discussions within the region at countless conferences and events, UN-ECLAC introduced a slight modification to the framework a few years later (Hilbert, 2006a, 2006b). The policy areas were simplified to "regulation and legislation" and "incentives and financing." This is justifiable, since all kinds of public policies or private strategies can broadly be grouped under two types: positive feedback for the socioeconomic system (where goal-oriented human intervention leads to an increase in the magnitude of the effect, such as incentives in the form of subsidies or favorable legislation) and negative feedback (which leads to an attenuation or even elimination of a certain dynamic in the socioeconomic system, such as regulation and laws that limit or prohibit certain options). So as to not undermine the importance of human capital, a new horizontal layer was added, called "capabilities and skills." It focuses on the effective use of the technology and is therefore a natural extension of the horizontal layers that provide the other necessary, but insufficient, supply conditions for digital development (see Figure 2).

Each sector represents different dynamics, social sectors, industries, and above all, actors. As with other socioeconomic organization models (i.e., microeconomics), the dynamics that form the interrelationships among the different fields are characterized by uncertainty, incomplete contracts, irrational behavior, spillover effects, and other deficiencies and failures. Institutions and organizations from all the horizontal layers, diagonal areas, and vertical sectors are involved in the complex task of guiding a society in its transition toward becoming an information society. Since the characteristics of every particular field vary by region and country, there is no one-size-fits-all recipe for the transition toward an information society. The optimal transition path depends on country- and region-specific particularities (Hilbert, 2011a).

It is noteworthy that the logic of the cube can be applied to the local, national, and even international levels. The result can be understood as a system of Russian *matryoshka* dolls, with "cubes inside cubes." The largest cube would embrace the global information society, such as the imagined entity discussed at the WSIS, 2003–2005. Some regions have also set up regional strategies, such as Europe (eEurope2002, eEurope2005, and i2010),[8] as well as Latin America and the Caribbean (eLAC2007, eLAC2010, and eLAC2015). National strategies have been the subject of much attention (ECLAC, DIRSI, & UNDP, 2008; Guerra & Jordan, 2010; Hilbert, Bustos, & Ferraz, 2005), and local communities and municipalities have long set up their digital agendas, as well.[9] Individual companies, hospitals, universities, and schools might as well adhere to a strategy similar to the three dimensions outlined with the cube. It can be expected that those different levels of abstractions are interdependent and are governed by some common, underlying logic stemming from the universal characteristics of digitization, such as overcoming time and space barriers; the choice and complementarity between real-time and asynchronous communication; the possibility for one-to-one, one-to-many, many-to-one, and many-to-many communication; network externalities; and lock-in effects, among others (e.g., Castells, 2009; Shapiro & Varian, 1998).

III. Playing Around with "The Cube"

During recent years, the presented conceptual framework has found several applications, and it is straightforward to think about potential future applications of the cube. The chosen examples in this section have been selected to show how the framework can be applied to the local, national, and international levels, and also to demonstrate its practicality throughout the entire cycle of policy making, including identifying areas of interest (planning), coordinating actors and stakeholders (execution), and monitoring progress (evaluation).

Table 1 gives an overview of the selected examples, highlighting their scope and nature. Most of the examples review past uses and applications of the framework, with the exception of the section

8. For the history and background of the three consecutive European Action Plans, see http://ec.europa.eu/information_society/eEurope/2002/index_en.htm

9. For a longstanding initiative that involves hundreds of municipalities from Latin America, see http://www.iberomunicipios.org

Table 1. Examples of Past and Potential Uses of the Cube Framework.

	Local	National	International
Identifying areas / priorities	Past use: Researching local digital developments (in Chile & Peru)	Past use: Identifying priorities (e-Dominicana strategy)	Past use: Identifying priorities (eLAC2010 Regional Action Plan)
Coordinating actors	—	*Potential uses:* Coordinating multistakeholder strategies (as in Bolivia and Peru); Coordinating resource availability (as in Chile)	Past use: Coordinating actors (eLAC2010 Regional Action Plan)
Monitoring progress	—	—	Past use: Monitoring and evaluating (eLAC2007 Regional Action Plan)

that refers to the potential use of the cube in coordinating actors on the national level. To avoid repetition, we skip the examples of how the cube was or could be used to coordinate actors and monitor progress on the local level, and of how to monitor progress at the national level (see empty spaces in Table 1). It would be straightforward to apply the framework to those levels.

A. Researching Local Digital Developments

The cube was originally developed as a tool to structure research and related research seminars (see the structure of the books, Hilbert & Katz, 2003a, 2003b). It provides the opportunity to focus on specific aspects of the ICT4D dynamic while not losing sight of the big picture and the interdependencies of the diverse set of related issues.

1) Past Use: Municipalities in Chile and Peru

For example, the cube was helpful in structuring a research project on the digitization of municipalities in Chile and Peru during 2002 and 2003 (Hilbert, 2005). The study was based on a questionnaire comprised of 31 questions that were elaborated by UN-ECLAC, in collaboration with Chile's SUBTEL (Subsecretaría de Telecomunicaciones de Chile), as well as Peru's CONCYTEC (Consejo Nacional de Ciencia y Tecnología) and INEI (Instituto Nacional de Estadística e Informática). Almost one-third of the Chilean municipalities (106) and one-third of the Peruvian provincial municipalities (77) participated in this extensive study. The cube provided a structure to systematically identify obstacles and their interrelations through a questionnaire focused on the horizontal layers and diagonal areas of the cube that intersect with the vertical sector of local e-government.

The results of the part of the questionnaire that focused on the infrastructure and generic services layers in local governments (compare with Figure 2) showed statistically significant positive correlations between the existence of a municipal modernization project and the state of advancement in these layers (measured in terms of the penetration of computers, e-mail, Internet, software programs, and websites; Hilbert, 2005, p. 27). A closer look at the generic services layer revealed that the most sophisticated application in Peru was the participatory budget processes (17% of the municipalities already used ICT for this), a model of citizen participation in which local governments allow citizens to influence the decision as to what percentage of the total municipal budget is dedicated to which task (such as street works, environmental services, habitation and living spaces, sports and culture, social assistance, etc.; ibid., p. 32). This is interesting, since e-government applications at the national level rarely focus on citizen participation (UN-DESA, 2008). It was also shown that, in both countries, municipalities often opt for the digitization of services that are not necessarily the most beneficial for them, but are relatively easy to implement, showing a trade-off between the desirable and the feasible (Hilbert, 2005, p. 35). Within the layer of capacities and knowledge, it is reported that in Chile 28% of the municipalities had a specialized local e-government team. The large majority of municipal

e-government teams are internal staff members, and only 7% exclusively outsourced their e-government project (ibid., p. 46). Moving on the diagonal areas of policy intervention, in Peru, 20% of the municipalities had explicitly stated that they did not possess any kind of explicit budget dedicated to creating a positive feedback loop that would incentivize e-government development (ibid., p. 44). With regard to regulation that could disperse or eliminate data security concerns, it is interesting to observe that some 60% of the Peruvian municipalities considered "data security and confidentiality" to be crucial, while only 4% of the Peruvian municipalities had elaborated and published some kind of policy and declaration about privacy and the security of digital data treatment (ibid., p. 47).

These selected study excerpts show how the conceptual framework can be used as a comprehensive organizing tool for the systematic identification of eventual shortcomings, bottlenecks, and critical aspects of the different dimensions of the cube, while at the same time not losing sight of the manifold interdependencies in the ICT4D dynamic, which is an intricate interplay between technology (ICT), society (in this case, local public administration), and policy (strategies for digital municipalities).

B. Identifying National Priorities and Actors

Almost all countries in Latin America and the Caribbean have by now established some kind of national ICT4D agenda (for reviews, see ECLAC, DIRSI, & UNDP, 2008; Guerra & Jordan, 2010; Hilbert, Bustos, & Ferraz, 2005). The nature, structure, and functioning of those agendas are heterogeneous. Different countries have different priorities (with access and e-government being the two most prominent topics), and the authorities in charge of leading the policy initiatives can be found at different levels of governmental hierarchy (in some countries, such initiatives are run at the vice presidential level; in others, a specific ministry is in charge; and in still others, the independent telecom regulator takes the leading role).[10] One aspect all of them have in common is that they are, to some degree, decentralized and involve several governmental authorities and often private sector authorities.

1. Past Use: Identifying Priorities

The Dominican Republic used the cube as an orientation tool to ensure that it gathered a comprehensive, multi-stakeholder group of national opinion leaders on diverse aspects of ICT4D. In 2005, the government of the Dominican Republic (led by the national telecom regulator INDOTEL) gathered this group to collectively work on the e-Dominicana strategy (CNSIC, 2005). The plan refers to the cube as a "structural model of the Information Society," and its authors emphasize that the policy dimension of the cube makes it clear that any effective ICT4D strategy "requires also an active participation by the productive sectors in processes of financing the different projects and in coordinating the actions, in order to avoid duplicate or counterpoising efforts" (ibid., p. 23). The result of this effort was the National Commission for the Information and Knowledge Society, which gathered for a series of consultation meetings over a 15-month period in 2005–2006. These meetings were structured according to the dimensions of the cube, and they mainly consisted of identifying relevant actors and projects from the public and private sectors.

The cube's multiple dimensions were helpful in revealing the interdependencies among the different actors, and in visualizing how their projects and strategies related to each other. A common multidimensional conceptualization of the crosscutting nature of the transformations is important because the changes provoked by general purpose technologies like ICT do not neatly fit the traditional organizational structure and responsibility divisions among traditional institutions, such as the ministries of telecommunication, education, transportation, health, trade, public administration, and so forth. The changes affect all these turfs at once in interdependent ways. For example, since these meetings in the Dominican Republic were instigated by the national telecommunications regulator INDOTEL, it was natural that the discussion often focused on infrastructure and access (i.e., the first horizontal layer of the cube). However, it quickly became clear that connectivity would only be the first step, and the discussion was taken over for long stretches by authorities with expertise from the most diverse sectors of society (vertical sectors of the cube, ranging from education

10. The same is true at the international level among the specialized agencies of the United Nations and other international actors and organizations, such as ITU, UNESCO, UNCTAD, ILO, UN-DESA, the UN Regional Commissions, etc.

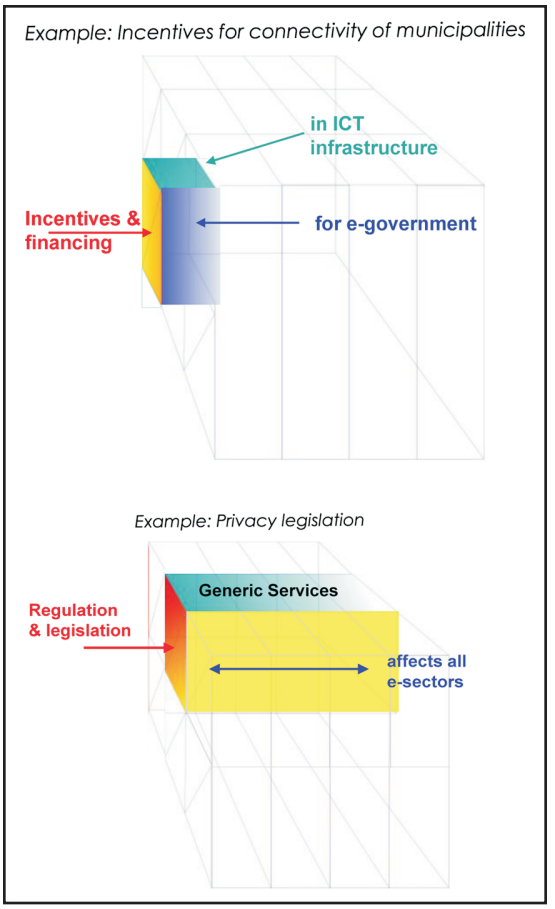

Figure 3. Identifying actors and their relationships with help of the cube.

and public administration to cultural production). Still, the cube framework reminded everyone that they were all interdependent, and also that both the horizontal layers and vertical sectors could and should be affected by the crosscutting nature of policy interventions from the diagonal areas. While this is nothing new, it turns out that the mere visualization of these interdependencies during the policy-making process seemed to contribute to a lowering of anxieties and figurative performance desires among the actors and acted as a constant reminder that everyone around the table was contributing important and complementary aspects toward a common goal.

2. First Potential Use: Coordinating Multi-stakeholder Strategies

Inspired by this experience, we can now explore how the cube could be used if we took this logic one step further. Many Latin-American ICT4D strategies consist of multi-stakeholder efforts. For example, Peru's Multisector Commission for Information Society Development (CODESI) counts 87 organizations and 207 specialists in its membership (CODESI, 2005). In Bolivia, the National Strategy for Information and Communication Technology (ETIC) is based on a 14-month consultation (starting in 2003) that took into account the contributions of 3,176 people from 770 organizations (Careaga, 2006). Participation and interest in these strategies go far beyond the public policy-making circles. The sector with the strongest interest in Bolivia's strategy was civil society (40% of participants), among them NGOs working in poverty reduction programs and development sectors such as agriculture, gender, and education, followed by representatives of the private sector (22%), as well as the academic sector (17%) (Rodas & Lopez, 2007).

We can now play around with the cube to identify who of these actors would need to cooperate on different challenges (see Figure 3). For example, we discussed local e-government before. A policy of providing an incentive structure to facilitate the connectivity of a country's municipalities crosscuts the horizontal layer of infrastructure (and therefore requires the involvement of telecommunication authorities from private, public, and nonprofit actors), mayors and municipal representatives (the vertical sector of e-government), and actors who possess the practical tools and resource authority to create such an incentive structure (e.g., Ministry of the Interior, Ministry of Finance, local communities, private banks, or donor agencies, among others) (see Figure 3). This leads to a three-dimensional intersection among technology authorities, social agents of change, and policy makers. All parties must be involved to move this aspect forward.

This logic does not need to be restricted to one specific coordinate of the three-dimensional setting; it can be expanded along an entire vector. For example, legislation on privacy protection involves legislators and regulatory authorities on the diagonal area policy side, as well as software and service industry representatives from the generic services horizontal layer. As can be seen in Figure 3, such legislation crosscuts all vertical e-sectors. Therefore, it needs to serve such diverse sectors as banking and health, which are essential when setting up the related policy agendas.

Table 2. Horizontal Cross-Tabulation of Public ICT Spending in Chile, 2003 (in % of total).

Symbol	Regulation	Incentives	Total
Infrastructure *(horizontal)*	12%	4%	16%
Generic Services *(horizontal)*	35%	18%	52%
Capacities and Skills *(horizontal)*	16%	5%	20%
Project Administration *(diagonal)*	11%	0%	12%
Total	73%	27%	100%

The need for a decentralized and multisector approach to ICT policy making goes inevitably back to the fact that ICT is a general-purpose technology. One of the most tangible consequences of this particularity for policy making in the field of ICT4D is that the budget for ICT activities is dispersed among many institutions and organizations, with each one working on initiatives to move its sector forward into the digital age. This typically spans spending priorities such as expanding telecommunications infrastructure and providing public access centers, integrating ICT into the school curriculum, digitizing health systems, introducing databases in hospitals, training entrepreneurs, supporting new legislation or property rights options for software choices, supporting teleworking modalities or digital tools for cultural heritage, managing disasters, and assuring national security, among many others. This leads us to another potential use of the cube.

3. Second Potential Use: Coordinating Resource Availability

Much in line with using the cube to identify actors, the presented conceptual framework could be used as a tool to identify and designate resources in a national ICT4D strategy, which is fundamental during the implementation phase of any multistakeholder policy. It is puzzling that, until now, most countries have not tracked who spends how much on ICT4D projects and policy implementations (see also Hilbert, 2011a).

In the case of the United States, we know that the Federal Communications Commission (FCC) manages roughly US$8 billion annually to fight the digital divide in the country, and that the American Reinvestment and Recovery Act temporarily appropriated an additional ad hoc, one-time US$7.2 billion to expand digital broadband access and adoption in communities across the country (NTIA, 2010). At the same time, the first federal chief technology officer of the United States has estimated that the federal government spends up to US$70 billion (Chopra, 2010) on ICT4D projects. Contrary to what many believe, it shows that the bulk of those funds are managed by authorities that do not focus on the horizontal layers of infrastructure, but by authorities that try to make ICT work for the development of the country throughout society (vertical sectors). However, there is no publicly available information about the details of this total.

In a unique effort, as part of its Digital Agenda,[11] the Chilean government included an ICT-spending rubric into the 2003 national budget, which allowed the assessment of its nationwide public ICT spending (DIRPES, 2005). The inventory covered 210 institutions from 22 budgetary rubrics, focusing on agencies of the centralized national government (excluding entities that respond directly to Congress and higher education). Total 2003 ICT spending amounted to US$205 million, therefore widely multiplying the US$5 million that had been assigned to the much-cited Chilean telecommunications development fund in the same period (Wellenius & Bank, 2002). Tables 2 and 3 use the dimensions of the cube (see Figure 2) to display and structure the rubrics of the different budget lines. The input for this presentation is taken from DIRPES (2005).

Table 2 depicts the intersection along the dimensions of the horizontal layers and the diagonal areas of the cube in percentages of total spending. Table 2 shows that, contrary to what might have

11. Chile was one of the pioneers in national agenda-setting for digital development in developing countries. The first generation of the plan, 2004–2006, was called Digital Agenda Chile, while the 2007–2012 plan is called Digital Strategy; http://www.estrategiadigital.gob.cl/node/91

Table 3. Vertical Cross-Tabulation of Public ICT Spending in Chile, 2003 (in % of total).

Finance Ministry	Education Ministry	Defense Ministry	Judicial Power and Ministry	Health Ministry	Ministry of Labor, Social Security	Others	TOTAL
15.2%	14.9%	14%	12.4%	10.7%	8.6%	24.3%	100%

been expected, the government at large does not spend most of its resources on promoting ICT hardware or telecommunications infrastructure, but rather, on purchasing and maintaining ICT software and digital services (more than half of the total spending). It also shows that ICT project administration, which usually receives most of the visibility, represents only a fraction of the total spending on promoting Chile's transformation toward an information society. Another fact that is shown with surprising clarity is that the large majority of public policies are not focused on providing incentives, but on regulation. Incentives provide positive feedback to guide digital development into the desired direction and are usually quite resource intensive. Table 2 shows that, in the case of Chile, regulation, which guides development through negative feedback and therefore provides stability to a self-organizing system, takes up most of the attention (73% of all active spending is oriented toward regulation, rather than providing proactive incentives[12]).

Table 3 looks at the same numbers from the perspective of the intersection of the cube's vertical sectors. It shows that the largest public ICT spender in Chile is the Ministry of Finance, spending 15.2% of the total, closely followed by the ministries of Education and Defense. While most national ICT4D strategies are politically dominated by telecommunications and technology authorities, it turns out that the agencies that are the largest catalysts of digital development in the country often are not even present at the table when setting up the digital agenda. These numbers show that the Chilean Ministry of Education has spent 6.3 times more on ICT4D than the much-cited Chilean telecommunications fund managed by the telecom regulator SUBTEL. Even the Chilean Ministry of Health, which is notoriously absent in the elaboration and execution of the national strategy, is spending 4.5 times more than the telecom authorities are managing. This analysis, which involves all aspects of the cube, shows that, in national ICT4D strategies, the money is not necessarily where the mouth is.

In this sense, the multidimensional perspectives of the cube allow for the identification of spending realities and priorities, but they can also be used as a tool to direct resource coordination. The cube can lay the basis for cross-fertilization, synergies, and the avoidance of duplicated efforts, a problem which is especially important when addressing a resource-intense challenge in resource-scarce developing countries. A typical example of duplicated efforts is the coordination of diverse public access strategies (such as public access centers and libraries) with e-education strategies (i.e., computers in schools; Hilbert, 2011a). Public ICT access centers target the larger public, while computer labs in schools focus exclusively on students. While it is natural that the latter use their computer labs during morning hours (financed by the Ministry of Education), the general public usually visits public access centers during the afternoon and evening (financed by a universal access fund). By allowing the public at large to use school computer labs during those times that students are not at school, valuable synergies can be created. This, however, requires an identification and coordination of the diverse aspects of a multidimensional challenge.

From a theoretical perspective, it is interesting to view the cube in the light of actual resource intensity. One could use resource intensity to adjust the display of the volumes of the cube's dimensions. As a result, the cube would deform (with larger and smaller parts of the whole cube). This deformation would visualize the financial priorities and the main concerns of the ICT4D agenda.

12. This does not include tacit incentives, such as tax incentives or import-duty exceptions, which are never "collected" and therefore not registered.

C. Designing and Monitoring International Policy Agendas

Last but not least, we review the experience of the first two eLAC action plans, which used the cube throughout all three phases of policy making: planning and identifying priorities, coordinating actors, and monitoring and evaluating. The eLAC plans represent a regionally coordinated official ICT4D strategy of the 33 Latin American and Caribbean governments, one which is elaborated and implemented in close collaboration with the private sector and civil society. The strategy contributes to the long-term vision outlined in the Millennium Development Goals and those of the WSIS, which focus on the time frame of 2000–2015. Recognizing the dynamic and short-lived innovation cycles of ICT, the region decided to address these long-term ambitions with a series of consecutive short-term action plans based on concrete qualitative and quantitative goals to be achieved:

- eLAC2007, made up of 70 activities, was successfully implemented during the years 2005–2007;
- eLAC2010, with 83 goals, was successfully executed during the period 2008–2010; and
- eLAC2015, with 26 goals, is to be achieved during the 2010–2015 period.

In the following section, we focus on how the cube framework assisted in the planning, execution, and monitoring of eLAC2007 and 2010. For reasons of chronological order, we start with the evaluation of eLAC2007, followed by the planning and execution of eLAC2010.

1. Past Use: Monitoring and Evaluation of eLAC2007

Table 4 presents the structure of the eLAC2007 action plan. The leftmost column clearly shows how the chapters of the plan naturally follow the cube's structure. It shows that the initiative's stakeholders have given those dimensions their public sector signature, while private sectors and civil society stressed the need for a standalone chapter on "capacity-building and knowledge creation," which subsumes the two horizontal layers of generic services and capacities and knowledge (see Figure 2). Governments have also stressed the need to use the plan to concentrate efforts on publicly relevant e-sectors, such as those included in the chapter on "governmental transparency and efficiency."

The United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC/CEPAL) was given a mandate by the governments of its constitutive countries to monitor the plan implementation. UN-ECLAC/CEPAL gathered 35 tables and 94 graphs to evaluate the advancement of each of the 27 goals (middle and right columns of Table 4; OSILAC, 2007). The result was mixed, as 15 goals showed progress or strong progress, while 12 showed moderate or no progress.

Recognition that the one-dimensional and linear listing of the goals of the plan (Table 4) actually refers to a three-dimensional interplay of connected parts of one whole (Figure 2) enables us to connect some of the dots. For example, advancement in e-health (goal 17) depends on progress in ICT access in health centers (goal 4), as well as the establishment of an adequate legislative framework (goal 25). Since neither goal 4 nor goal 25 showed any progress during the period 2005–2007 (see Table 4), it is not surprising that goal 17 did not make any progress. On the other hand, ICT access in schools advanced well (goal 4), and the region also saw progress in training (goal 9) and content industries (goal 13), which allowed for strong progress in e-education (goal 16). The three-dimensional visualization demonstrates that the eLAC2007 action plan might as well have been structured differently, and that this way of presenting the interrelated challenges is merely one way of looking at it.

The authors of the final evaluation of the agenda argue that the latter way of looking at the same dynamic is more beneficial than the former:

> The conceptual distinction between access, capacities, applications and policies is based on a technological view that has proven highly useful in research on, and analysis of, information societies. It aids in understanding the phenomenon, its dynamics and the relationships between the different components of the development of information societies. While there is no debate over the analytical advantages of this scheme, eLAC2007 monitoring suggests that the use of this conceptual framework in policymaking may lead to an unintegrated approach to digital development. There is a danger of interpreting access and capacities as ends in themselves, rather than

Table 4. Final Progress Monitoring of eLAC2007.

Areas	Goals	Amount of Progress
A. Digital Access and Inclusion *(Horizontal Layer)*	1. Regional infrastructure	*Progress*
	2. Community centers	*Strong progress*
	3. Online schools and libraries	*Progress*
	4. Online health centers	No progress
	5. Employment	Moderate progress
	6. Local government	*Strong progress*
B. Capacity-Building and Knowledge Creation *(Horizontal Layer)*	7. Alternative technologies	Moderate progress
	8. Software	Moderate progress
	9. Training	*Progress*
	10. Research and education networks	*Strong progress*
	11. Science and technology	No progress
	12. Businesses	*Progress*
	13. Creative and content industries	*Progress*
	14. Internet governance	*Progress*
C. Governmental Transparency and Efficiency *(Vertical Sector)*	15. e-Government	*Progress*
	16. e-Education	*Strong progress*
	17. e-Health	No progress
	18. Disasters	No progress
	19. e-Justice	Moderate progress
	20. Environmental protection	Moderate progress
	21. Public information and cultural patrimony	*Progress*
D. Policy Instruments *(Diagonal Areas)*	22. National strategies	*Progress*
	23. Financing	No progress
	24. Universal access policies	No progress
	25. Legislative framework	No progress
	26. Indicators and measurement	*Strong progress*
E. Empowering Environment	27. Monitoring of the WSIS and execution of eLAC2007	*Strong progress*

as means. In a non-academic, policy-oriented context, it may be useful to adopt a sectorial approach based on the beneficiaries and targets of digital development—e.g., considering the realities in areas such as education, health, government, business and communities, etc. Within each of these sectors, the development of access, capacities, applications and policy should be approached holistically. This is particularly true in view of the virtuous circle that links these areas. Access promotes use, which is needed to develop capacity, while capacity in turn generates demand for electronic applications and content, which in their turn increase demand for access. Thus, work must be conducted simultaneously in each of these areas, and policies addressing the specific needs of each economic and social sector must be integrated. ICT development must follow a society's general scheme of organization, not the reverse. (OSILAC, 2007, pp. 7–8)

2. Past Use: Identifying Priorities of eLAC2010

The structure of the next action plan, eLAC2010, shows evidence that policy makers took this conclusion seriously. Stakeholders shifted the focus from the horizontal layers and diagonal areas toward the vertical sectors as a policy entry point and structured the new plan following broad chapters: 1) education and training *(vertical sector),* 2) infrastructure and access *(horizontal layer),* 3) health *(vertical sector),* 4) administration and e-government *(vertical sector),*

5) productive sector *(vertical sector),* and 6) policy instruments and strategic tools *(diagonal area).*

Each chapter consists of four sections: framework (with general and holistic goals), access (referring to the intersection of this topic with the horizontal infrastructure and generic services layers, or to generic access policies in chapter 2 of the plan), capacities (referring to the intersection of this topic with the horizontal capacities and knowledge layer), and applications and content (specifying particularities or intersections with vertical sectors). In this sense, each one of the six chapters of eLAC2010 can be seen as a different cross section of the cube, penetrating the various dimensions. Naturally, since the action plan is a policy instrument, the perspective is mainly taken from the point of view of the diagonal areas (chapter 6 of the plan refers to holistic policies that apply to all other layers, areas, and sectors). Of course, eLAC2010 is a political document; it is the result of a messy political process, not an academic exercise drawn on a white board. Therefore, there is not a nice one-to-one match between the cube and the structure of the plan, but the basic structure is still evident.

Indeed, the cube's general framework provided the underlying structure to conceptually organize an unprecedented open-ended collaboration among all sectors, which resulted in the eLAC2010 action plan (Hilbert, Miles, & Othmer, 2009). The consultation started with the old eLAC2007 action plan as a beginning blueprint and consisted of a five-round Delphi exercise intended to identify the priorities of the near-term future challenges. The eLAC policy priorities Delphi counted almost 1,500 contributions and is believed to have been the most extensive online participatory policy-making foresight exercise in the history of intergovernmental processes in the developing world. In addition to the general shift toward a focus on vertical sectors, some of the goals were replaced and others evolved. Only 20% of the eLAC2010 goals are very similar to the eLAC2007 goals. Half of the goals have been adjusted to address a changing environment, and around 30% of the eLAC2010 goals are new on the agenda, with no equivalent in the old action plan (ibid.). As a result of this experience, we can see that the three-dimensional framework can be looked at from different perspectives, and that some of the ways of looking at it might be more beneficial than others, while at the same time, the cube's content can change dynamically over time without losing the applicability of the general structure of the framework itself.

3. Past Use: Coordinating Actors of eLAC2010

The 83 goals of eLAC2010 fall into two distinct classes: (1) quantifiable and measurable policy options and goals *(results-oriented),* or (2) policy options and goals that rely on existing international mechanisms *(action-oriented).*

The first kind of results-oriented goals contain concrete numerical goals, such as "Increase the number of ICT access centres serving the community, including libraries and other facilities, in order to halve the average ratio of potential users per centre, or achieve a ratio of 1,750 people per centre" (goal 18, p. 6), or "execute at least 80%" of the universal ICT access funds (goal 23, p. 7). It is straightforward for a monitoring agency to evaluate the progress in these areas (much in the spirit of OSILAC, 2007; see Table 4).

The second category of action-oriented goals did not allow for concrete quantification and includes specific goals like "Promote the interoperability of standards-based e-government systems in Latin America and the Caribbean and continue with the development of a regional interoperability platform and standards for e-government services" (goal 38, p. 9). It would be difficult to quantify progress in these areas, so each goal of this second kind was accompanied by a list of international agencies from the public and private sectors that had committed to work on and support national actors in implementing these action-oriented goals (listed in annex 2 of the eLAC2010 action plan). Seminars and workshops, as well as research reports and training sessions, were the result of this.

On one hand, the list of organizations in annex 2 of eLAC2010 can be seen as a who's who of international organizations in Latin American and Caribbean ICT4D work. It shows which actors specialize in which area. On the other hand, in the light of the cube framework that tacitly underlies this structure, it gives a pretty good idea about which regional organization resides in which corner or slice of the hypothetical Latin American and Caribbean ICT4D cube, and about how the work of different actors is related. The three-dimensional interrelatedness of topics allows for a rough conceptualization of the topography of the entangled network of interna-

tional ICT4D actors in the region, and therefore served as a tool for coordinated action during the eLAC2010 action plan's development.

IV. Conclusions and Limitations

The ICT4D cube is a conceptual framework that depicts the transition toward information societies as a mutually dependent interplay among technology, social change, and policies. Its focus on technology as a development driver is based on the Schumpeterian notion that recognizes innovation and technological change as the main catalyst of social evolution. The framework has been applied on the local, national, and international levels to structure research and identify priorities, to coordinate actors, and to evaluate and monitor progress. But not only researchers and policy makers have found a use for it. Teaching experience has shown that students who are newly introduced to the ICT4D discussion welcome the cube structure to assist them in systematically thinking through a chosen ICT4D topic, especially when designing their own class papers (e.g., see the syllabus of Hilbert, 2011b). The three-dimensional framework unfolds its explanatory power when used as a tool to flexibly explore complementary aspects of a single dynamic. The resulting visualization of interdependencies facilitates transcending the frequently employed artificial dichotomy between technological means and social ends.

One of the cube's main drawbacks is that it is a conceptual framework, not a dynamic model. A natural first step in the ambition to make the cube dynamic is to add a fourth dimension (time) to the three spatial dimensions, and to regularly evaluate the cube as it morphs in content and priorities through time (resulting in a sequence of evolving cubes). However, this again would be merely descriptive, and neither predictive nor prescriptive. The cube serves as a broad classification system of the issues, actors, and activities involved in the transitions toward information societies, but it does not allow one to make predictions, test hypotheses, or direct normatively.

The search for a dynamic model in ICT4D analysis will inevitably run into the same problem as all Schumpeterian approaches to socioeconomic change: The Schumpeterian notion explicitly draws on the fact that human progress is always far from equilibrium, constantly drawing "away from an equilibrium position" and constantly drawing "toward another equilibrium position" (Schumpeter, 1939, p. 142). This prevents us, per definition, from applying equilibrium analysis (Nelson & Winter, 1985) and leads us down a path of studying complex social systems that are only partially following nicely predictive patterns (e.g., Anderson & Arrow, 1988; Blume & Durlauf, 2005). From the present position (in which we are far from equilibrium), the future equilibrium position (in our case, the realization of a full-fledged information society) is still unidentifiable. It is subject to too many uncertainties for a succinct model. We cannot know all the variables and their relationships, since they are currently unfolding (or, to phrase it in a less Newtonian and more anthropocentric tone, they are currently "being created and defined"). This does not mean we should stop trying to model it. But it shows that the elaboration of a coherent model to capture the dynamics of how ICT affects development comes down to working on the broader challenge of elaborating a modern socioeconomic theory. This theory must recognize, at its core, that the evolutions of complex social systems occur in the "far from equilibrium" state, and that the next equilibrium is uncertain and constantly changing. This makes dynamic analysis and the creation of any predictive model difficult. We do not yet have an adequate theory for the economy and society as a whole, nor even for just the digital component of it. In the meantime, rough conceptual frameworks such as the cube can act as a first-aid kit to assist researchers, policy makers, and decision makers in their enormous tasks of guiding societies in the quickly changing environment of the current transition. ■

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