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

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***Abstract*—The ICT for Development community is long searching 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 interplay between technology, policy, and social change. It has its theoretical roots in Schumpeterian innovation theory. This so-called "cube-framework" has been adopted in several occasions throughout the region at the local, national and international levels in all stages of the policy cycle: to identify areas and priorities for research and hands-on policy-making (panning), 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 it is not a dynamic model that can make predictions, but it turns out to be useful as a conceptual framework to structure the often confuse discussion about what is involved in the ongoing social transformation.**

***Index Terms*—conceptual framework, digital, ICT for development, policy, strategy, theory, Latin America and Caribbean.**

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I. INTRODUCTION

Governments, enterprises, and civil actors around the world have long 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. It is a frame of references that enables to sort out the intricate relationship between ICT and development and focuses on the interdependency between technology, policy interventions, and the socio-economic sectors that are subject to change (are being "digitized"). After presenting the framework (and its variants), we will 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 the progress made. This will include a review of how the cube has been used for scholarly research and teaching, for the design and monitoring of policy action plans (such as the regional ICT-for-development strategies of Latin America and the Caribbean, eLAC2007 and eLAC2010[1]), and 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 presented conceptual framework has it theoretical foundation in the Schumpeterian notion of socio-economic evolution and innovation theory (Schumpeter, 1939; Freeman and Louca, 2002; Perez, 2004; Freeman, 2008), 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 ("far from equilibrium") 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 motor 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 based on water-powered mechanization (based on classical mechanics), the consecutive wave of comprehensive modernization (1950-1895) was enabled by steam-powered technology (thermodynamics), the next one (1895-1940) was characterized by the electrification of social and productive organization (electromagnetism), and the following wave by motorization and the automated mobilization of society (1940-1970) (mechanical and chemical engineering). The most recent one is characterized by the digitization of the information and communication processes in social systems (based on information theory and computer science) (Freeman and Louca, 2002). These waves are often referred to as "long waves" or "Kondratiev or Kondratieff waves", after the Russian economist Nicolai Kondatiev (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 ~ 2,200 B.C.), bronze age (3,300 ~ 1,200 B.C.), and iron age (1,200 ~ 580 B.C.) 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 of these waves have in common is that each of them consists of a sustained period of social modernization, most notably by sustained periods of increasing economic productivity.[4] According to Perez's seminal 1983 article (1983), "this quantum jump in productivity can be seen as a technological revolution, which is made possible by the appearance in the general cost structure 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."

Digital Information and Communication Technologies (ICT) fulfill those requirements: (1) the performance:cost relationship of computers, storage and communication devices has seen respective compound annual growth rates of

[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 ; http://en.wikipedia.org/wiki/eLAC

[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 driven by the "molecular age", which consists of a combination of nano- and bio-technology (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 focusing on the modernization of cultural or political processes is partially due to the lack of adequate performance indicators outside the economic realm (i.e. comparable to US$, productive output, etc).

76%, 72% and 56% during the period from 1980-2005 (Hilbert, López and Vasquez, 2010; also more extensively Kurzweil, 2001); (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 and López; 2011); (3) their all-pervasive nature as a general purpose technology affects all aspects of human conduct (Hilbert and Peres, 2010), and leads to (4) productivity increases and economic growth[4] (Cimoli, Hofman, and Mulder, 2010) and modernization of cultural production (Creeber and Martin, 2008), political uprisings (Allagui and Kuebler, 2011), the modernization of political will formation (Hilbert, 2009) and even 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), "digital age" (Negroponte, 1996), "Network Society" (Castells, 2009), and the "age of Information and Communication Technology" (Freeman and Louca, 2002), and "Information Society" (Masuda, 1980; Beninger, 1986; 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 (ECOSOC) under the theme: "the role of information technology in the context of a global knowledge-based economy" and led to the creation of the UN ICT Task Force and the realization of two consecutive World Summits on the "Information Society".[5]

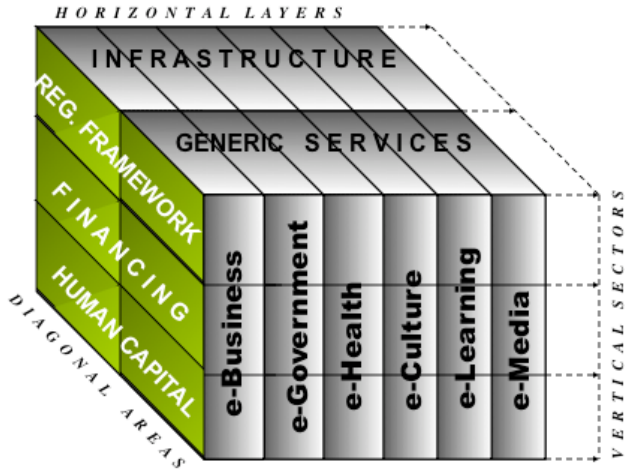

Figure 1. The original three-dimensional conceptual framework of ICT for Development: the "ICT-for development-cube".

B. An interplay of three dimensions: technology, policy and social change

The United Nation's Economic Commission for Latin America and the Caribbean (UN-ECLAC, or "CEPAL" as it is known in Latin America for its Spanish acronyms[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 (2003-2005)5, UN-ECLAC suggested to its 33 member countries to view the transition toward Information Societies as an interplay between the underlying digital general purpose technologies (telecom, hardware and software), the socio-economic sectors that are subject to change (such as business, health, education, government, etc.) and normative policy areas that cross-cut both of these areas (including regulation and incentives) (Hilbert and Katz, 2002; 2003a; 2003b); (see Figure 1).

In line with the Schumpeterian school of thought, the first enabling factor for the associated socio-economic transformations is the existence of an enabling technological infrastructure. In the case 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 (Grigonis, 2000). It consists of seven layers. The "ICT-for-development-cube-framework" ("el cubo", as it has been 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 and mobile phones, fiber-optic networks, digital TV, and all other tangible access equipment), and rather intangible generic services (software and other generic digital services, such as Webhosting, browsers, multimedia applications, search engines, and online social networks). The

[5] The World Summit on the Information Society (WSIS) was held in two phases. The first phase took place in Geneva hosted by the Government of Switzerland from 10 to 12 December 2003, and the second phase took place in Tunis hosted by the Government of Tunisia, from 16 to 18 November 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).

"Infrastructure Layer" and "Generic Service Layer" form the grounds upon which the process of digitization takes place and are referred to as "Horizontal Layers".

These technological foundations are the basis for the digitization of information flows and communication mechanisms in different sectors of society (such as the business and commerce sector, the health sector, public administration, education, etc.). All of these different sectors of society make use of 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, which provides 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 "e-lectronic" networks in a given sector is usually identified in literature by adding an "e-" as prefix. This custom is of course only a temporary habit of this generation, as the generation of today's kindergarten kids will not refer to a government webpage as "e-government", but simply as "government", since they never knew another form of public administration. There are many different "e-Sectors". The expanding process of digitization is not exclusively restricted to the sectors depicted in the figure, and the list of Vertical Sectors could be extended to other important fields of interest, as indicated by the arrows in the diagram (such as e-democracy, e-security, e-entertainment, e-banking, e-payment, e-research, e-tourism, e-dating, etc.).

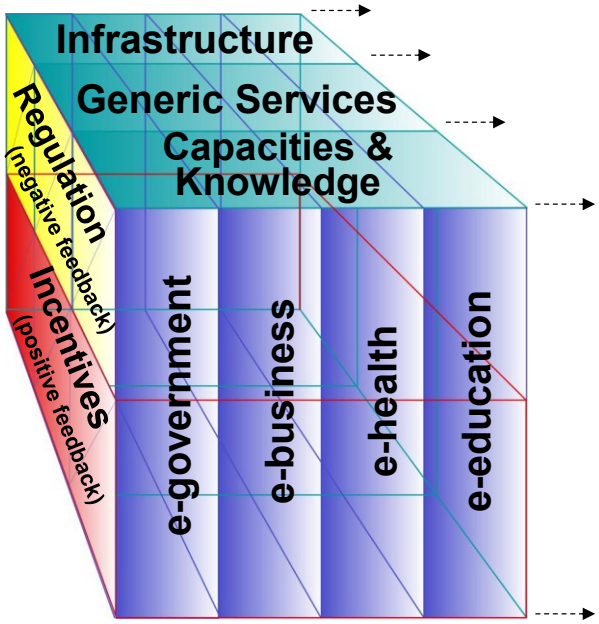

Figure 2. The modified version of the "ICT-for development-cube".

The foregoing layers and sectors are the basic requirements and building blocks of an Information society, but they are not sufficient 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 socio-economic change, in a world in which human kind constantly proves technological determinism wrong and is taking 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 the minimization of negative effects, the removal of eventual bottlenecks, and the promotion of normatively desired advances. ICT for Development policies are found here. These crosscutting or "Diagonal Areas" permeate both Horizontal Layers and Vertical Sectors. In the original version of the cube, the identified areas of policy activity were regulatory frameworks that foster and provide scope for these new forms of behavior, financing mechanisms that support the diffusion of these technologies and their implementation, and human capital that acts 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 & legislation" and "incentives & financing". This is justifiable since all kinds of public policies or private strategies can broadly be grouped under two types: positive feedback for the socio-economic 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 socio-economic system, such as regulation and laws that limit of prohibit certain options). In order not to undermine the importance of human capital, a new Horizontal Layer was added, called: "Capabilities and Skills". It focuses on the effective usage of the technology and is therefore a natural extension of the Horizontal Layers which provide the necessary, but not sufficient supply conditions for digital development (see Figure 2).

[7] The most cited example against technological determinism is human kind's dealing with the atomic bomb: if human history would be blindly guided by the deterministic notion that "every technology will do what is can do, independent of social guidance", human kind would not have made it through the cold war.

Each of these sectors represents different dynamics, social sectors and industries and above all, actors. As with other socio-economic organization models (i.e. micro-economics), the dynamics that form the interrelationship between the different fields, are characterized by uncertainty, incomplete contracts, irrational behavior, spillover effects and other deficiencies and failures. Institutions and organizations from all the different Horizontal Layers, Diagonal Areas and Vertical Sectors are involved in the complex task of guiding a society in its transition towards an Information society. Since the characteristics of every particular field vary in different regions and countries, there is no "one size fits all" recipe for the transition towards an "Information society". The "optimum 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 discussed at the World Summit on the Information Society, 2003-2005.[5] Some regions have also set up regional strategies, such as Europe (eEurope2002, eEurope2005 and i2010)[8] and Latin America and the Caribbean (eLAC2007, eLAC2010, and eLAC2015)[1]. National Strategies have been the subject of much attention (Hilbert, Bustos, and Ferraz, 2005; ECLAC, DIRSI, UNDP, 2008; Guerra and Jordan, 2010), and local communities and municipalities have long set up their digital agendas as well.[9] Individual companies, hospitals, universities and schools might as well recur 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 the overcoming of 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. Shapiro and Varian, 1998; Castells, 2009).

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 to demonstrate its practicality throughout the entire cycle of policy-making, including the identification of areas of interest (planning), the coordination of actors and stakeholders (execution) and the monitoring of progress (evaluation).

Table 1 gives an overview of the selected examples, their scope and nature. Most of the examples review past usages and applications of the framework, with the exception of the section that refers to the potential usage of the cube in the coordination of actors on the national level (see Table 1). In order to avoid repetition, we skip examples of how the cube was or could be used to coordinate actors and monitor progress on the local level and how to monitor progress at the national level (see empty spaces in Table 1). It would be straightforward to apply the framework also to these levels.

[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/

A. Researching local digital developments

The "cube" has originally been developed as a tool to structure research and related research seminars (see the structure of the books Hilbert and Katz, 2003a; 2003b). It provides the opportunity to focus on specific aspects of the ICT-for-development dynamic, while at the same time not to lose 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 has been helpful to structure 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 with 31 questions that were elaborated by UN-ECLAC, in collaboration with Chile's SUBTEL (Subsecretaría de Telecomunicaciones de Chile), and 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 which focused on the different Horizontal and Diagonal Layers 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 Service 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 of in these layers (measured in terms of the penetration of computers, email, internet, software programs, and websites) (Hilbert, 2005; p. 27). A closer look at the Generic Service Layer revealed that the most sophisticated application in Peru was the "Participatory Budget" processes (17% of the municipalities already used ICT for this), which is a model of citizen participation in which local governments allow citizens to influence the decision which percentage of the total municipal budget gets

TABLE 1

EXAMPLES OF PAST AND POTENTIAL FUTURE USE 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 multi-stakeholder strategies (like in Bolivia and Peru) Coordinating resource availability (like in Chile)	Past use: Coordinating actors (eLAC2010 Regional Action Plan)
Monitoring progress	-	-	Past use: Monitoring and evaluation (eLAC2007 Regional Action Plan)

dedicated to which task (such as street works, environmental services, habitation and living spaces, sports and culture, or social assistance, etc.) (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 (p. 46). Moving on the Diagonal Layers of policy intervention, in Peru 20 % of the municipalities had explicitly stated not to possess any kind of explicit budget dedicated to create a positive feedback loop that would incentivize e-government development (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 (p. 47).

These selected excerpts of the study 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 to lose sight of the manifold interdependencies in the ICT-for-development 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 ICT-for-development agenda (for reviews see Hilbert, Bustos, and Ferraz, 2005; ECLAC, DIRSI, UNDP, 2008; Guerra and Jordan, 2010). The nature, structure and functioning of those agendas is quite 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 initiative can be found at different levels of governmental hierarchy (in some countries at the Vice-Presidency, in others a specific Ministry is in charge and in 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 and often also private sector authorities.

1) Past use: identifying priorities

The Dominican Republic used the cube as a tool for orientation to assure to gather a comprehensive multi-stakeholder group of national opinion leaders on diverse aspects of ICT-for-development. 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 from Dominican Republic (CNSIC, 2005). The plan refers to the cube as a "structural model of the Information Society" and its authors underline that the policy dimension of the cube makes it very clear that any effective ICT-for-development 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" (CNSIC, 2005: 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 around 2006. These meetings were structured according to the dimensions of the cube and mainly consisted in the identification of relevant actors and projects from the public and private sectors.

The multiple dimensions of the cube were helpful in revealing the interdependencies between the different actors and to visualize how their projects and strategies relate 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, transport, health, trade and public administration, and so forth. The changes affect all of these turfs at once, while each of them is affected in interdependent ways. For example, since these meetings in the Dominican Republic were provoked by the national telecommunications regulator INDOTEL, it was natural that the discussion often focused around infrastructure and access (i.e. the first Horizontal Layer of the cube). However, it quickly became clear that connectivity is only 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 and public administration, to cultural production). Still, the cube framework reminded everybody that they are all interdepend and that both of them can and should be affected by the cross-cutting nature of policy interventions from the Diagonal Layers. While this is nothing new, it turns out that the mere visualization of these interdependencies during the policy-making process seems to contribute to a lowering of anxieties and figurative performance desires among the actors, and acts as a constant reminder that everybody around the table contributes an important and complementary aspect to a common goal.

[10] The same is true at the international level among the different 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.).

2) Potential use 1: coordinating multi-stakeholder strategies

Inspired by this experience we can now explore how the cube could be used if we would take this logic one step further. Many ICT-for-development strategies in Latin America consist of multi-stakeholder efforts. For example, Peru's "Multi-sector Commission for Information Society development (CODESI)" counts 87 organizations and 207 specialists (CODESI, 2005). In Bolivia, the National Strategy for Information and Communication Technology (ETIC) is based on a 14 months consultation (starting in 2003) and counted with the contribution 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 the participants), among them NGOs working in poverty reduction programs and in development sectors such as agriculture, gender and education, followed by representatives of the private sector (22%) as well as the academic sector (17%) (Rodas and Lopez, 2007).

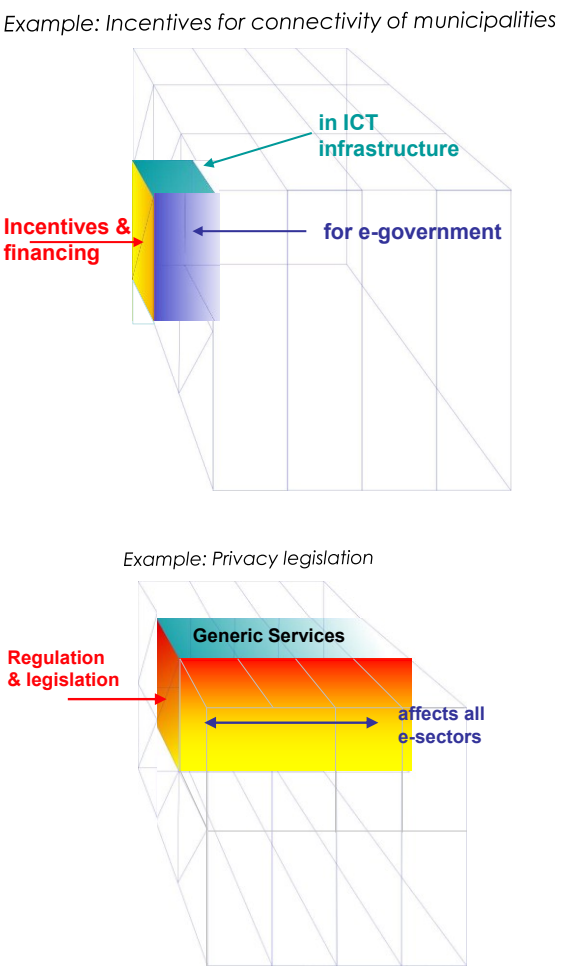

Figure 3. Identifying actors and their relationships with help of the cube.

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 talked about local e-government before. A policy that consists in providing an incentive structure to facilitate connectivity of a country's municipalities crosscuts the Horizontal Layer of infrastructure (and therefore require the involvement telecommunication authorities from the private, public and nonprofit actors), mayors and municipal representatives (the Vertical Sector of e-government), and actors that have 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 of them have to be involved to move this aspect forward.

This logic does not need to be restricted to one specific coordinate of the three-dimensional setting, but can also be expanded along an entire vector. For example, legislation on privacy protection involves legislators and regulatory authorities on the Diagonal Layer policy side, and software and service industry representatives from Generic Service in the Horizontal Layer. As can be seen in Figure 3, such legislation is crosscutting for all Vertical e-Sectors, and will therefore need to serve as diverse sectors as banking and health, which are essential when setting up the related policy agendas.

The need for a decentralized and multi-sector 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 ICT-for-development is that the budget for ICT activities is dispersed among the different institutions and organizations, each of which is working on initiatives to move its sector forward into the digital age. This typically spans spending priorities like expanding telecommunications infrastructure and providing public access centers, integrating ICT in the school curriculum, digitizing health systems and introducing databases in hospitals, training entrepreneurs, supporting new legislation or property rights options for software choices, supporting tele-working modalities or digital tools for cultural heritage, and managing disasters and assuring national security, among many others. This leads us to another potential use of the cube.

3) Potential use 2: coordinating resource availability

Much in line with the use of the cube to identify actors, the presented conceptual framework could be used as a tool for the identification and designation of resources in a national ICT-for-development strategy, which is fundamental during the implementation phase of any multi-stakeholder policy. It is puzzling that until now, most countries do not even track who spends how much on ICT-for-development 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 and onetime 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 (CTO) estimates that the federal government spends up to US$ 70 billion (Chopra, 2010) on ICT-for-development projects. In contrary to what many believe, it shows that the bulk of the pie is 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.

TABLE 2
HORIZONTAL CROSS-TABULATION OF PUBLIC ICT SPENDING IN CHILE, 2003 (IN % OF TOTAL)

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

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 %**

In a unique effort, as part of its Digital Agenda[11] the Chilean government included an ICT-spending rubric into the national budget of 2003, 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 ICT-spending in 2003 summed up to US$205 million and therefore widely multiplied the US$ 5 million that were assigned to the much-cited Chilean telecommunications development fund in the same period (Wellenius & Bank, 2002). Tables 2 and 3 uses 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. It shows that, contrary to what might have 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 the administration of ICT projects, which usually receive most of the visibility, only represent a fraction of the total fiscal spending on promoting Chile's transformation toward an Information society. Another fact which is shown with surprising clarity is that the large majority of public policies are not focused on the provision of incentives, but on regulation. Incentives provide positive feedback to guide digital development into the desired direction and are usually very resource intense. 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 rather oriented toward regulation than the provision of proactive incentives[12]).

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

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

Table 3 looks at the same numbers from the perspective of the intersection between the cube's Vertical Sectors. It shows that the largest public ICT-spender in Chile is the Ministry of Finance itself, spending 15.2% of the total, closely followed by the Ministry of Education and the Ministry of Defense. While most national ICT-for-development 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 ICT-for-development than the much-cited Chilean telecommunications fund, managed by the telecom regulator SUBTEL. Even the Chilean Ministry of Health, with is notoriously absent in the elaboration and execution of the national strategy[11], is spending 4.5 times more than the telecom authorities are managing. This analysis which involves all different aspects of the cube shows that in national ICT-for-development 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 can also be used as an active tool to direct the coordination of resources. It can lay the basis for cross-fertilization, synergies and the avoidance of double-efforts, which is especially important in a resource intense challenge in resource-scarce developing countries. A typical example of double 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 school 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 times students are not at school, valuable synergies can be created. This, however, requires an identification and coordination of the diverse aspects of a multi-dimensional 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 ICT-for-development agenda.

C. Designing and monitoring international policy agendas

Last but not least, we will review the experience of the first two eLAC Action Plans[1], an experience that used the cube throughout all three phases of policy making: the planning and identification of priorities, the coordination of actors, and the monitoring and evaluation. eLAC is a regionally concerted official ICT-for-development strategy of the 33 governments of Latin America and the Caribbean, 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 (MDGs) and those of the World Summit on the Information Society (WSIS)[5], which focus on the time-frame 2000-2015. Recognizing the dynamic and short-lived innovation cycles of ICT, the region decided to face these long-term ambitions with a series of consecutive short-term Action Plans that are based on concrete qualitative and quantitative goals to be achieved:

* eLAC2007 with 27 goals with 70 activities was successfully implemented during the years 2005-2007;

* eLAC2010 with 83 goals was successfully executed during the period 2008-2010.

* eLAC2015 with 26 goals to be achieved during the 2010-2015 period.

In the following we will 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, and then continue with 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 left-hand column shows very clearly how the different chapters of the plan naturally follow the structure of the cube. It shows that the stakeholders of the initiative have given those dimensions their public sector signature: private sectors and civil society stressed the need for a stand-alone chapter on "capacity-building and knowledge creation", which subsumes the two Horizontal Layers of

Generic Services and Capacities & Knowledge (see Figure 2). Governments have also stressed the need to use the plan to concentrate the effort on publicly relevant e-sectors, such as those included in the chapter on "governmental transparency and efficiency".

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

TABLE 4
FINAL MONITORING OF PROGRESS OF ELAC2007

Area	Goal	Amount of progress
A. Digital access and inclusion *(Horizontal Layer)*	1 Regional infrastructure	*Progress*
	2 Community centres	*Strong progress*
	3 Online schools and libraries	*Progress*
	4 Online health centres	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 Layer)*	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 Layer)*	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 World Summit and execution of eLAC2007	*Strong progress*

The 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 of ICT access in health centers (goal 4) and the establishment of an adequate legislative framework (goal 25). Since neither goal 4, not goal 25 showed any progress during the period from 2005-2007 (see Table 4), it is not surprising that goal 17 did not make any progress. In contrary, 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 inter-related challenges is merely one way of looking at it.

The authors of the final evaluation of the agenda (OSILAC, 2007) 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 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; p. 7-8].

2) Past use: identifying priorities of eLAC2010

The structure of the consecutive Action Plan eLAC2010 shows evidence that policy-makers took this conclusion very seriously. Stakeholders re-shifted the focus from the Horizontal and Vertical Layers toward the Vertical Sectors as a policy entry-point and structured the new plan the following broad chapters:

1. education and training *(Vertical Sector);*
2. infrastructure and access *(Horizontal Layer)*;
3. health *(Vertical Sector)*;
4. public administration and e-government *(Vertical Sector)*;
5. the productive sector *(Vertical Sector)*; and
6. policy instruments and strategic tools *(Diagonal Layer)*.

Each of these six chapters of the plan consists of four sections: Framework (with general and holistic goals); Access (referring to the intersection of this topic with the Horizontal Infrastructure and Generic Service 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 of the six chapters of eLAC2010 can be seen as a different cross-cutting slice of the cube, which penetrates 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 Layers (chapter 6 of the plan refers to holistic policies that apply to all other Layers and Sectors). Of course, eLAC2010 is a political document and the result of a messy political process, not the result of 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 general framework of the cube provided the underlying structure to conceptually organize an unprecedented open-ended collaboration among all sectors which resulted in the eLAC2010 Action Plan (Hilbert, Miles and Othmer, 2009). The consultation started out with the old eLAC2007 Action Plan as a first blue-print and consisted of a five round Delphi exercise that aimed at identifying the priorities of the near-term future challenges. The eLAC Policy Priorities Delphi counted with 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 also replaced and other evolved. Only 20% of the goals in eLAC2010 are very similar to goals in eLAC2007, half of the goals have been adjusted to a changing environment, and around 30% of the goals of eLAC2010 are completely new on the agenda, with no equivalent in the old Action Plan (Hilbert, Miles and Othmer, 2009). As a result of this experience we can see that the three-dimensional framework can be looked at from different perspectives and that some ways of looking at it might be more beneficial than others, while at the same time, the content of the cube can change dynamically over time, without loss of 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:

• Policy options and goals that are quantifiable and measurable (*results-oriented*); and/or

• Policy options and goals that rely on existing international mechanisms (*action-oriented*).

The first kind of result-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) or execute at least 80% of the universal ICT access funds (goal 23). 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 kind of action-oriented goals did not allow for a concrete quantification and include 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). It would be difficult to quantify the progress in these areas, so each of the goals of this second kind was accompanied with a list of international agencies from the public and private sector who committed to work on and support national actors in the implementation of 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 the one hand, the list of the organizations in Annex 2 of eLAC2010 can be simply seen as a "who-is-who" of international organizations in ICT-for-development work in Latin America and the Caribbean. It shows which actors specialize on which topic. On the other hand, in the light of the cube framework which 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 ICT-for-development cube and how the work of different actors is related. The three-dimensional interrelatedness of topics allows for a rough idea of the topography of the entangled network of international ICT-for-development actors in the region, and therefore served as a tool for coordinated action during the implementation of eLAC2010.[1]

IV. Conclusions and Limitations

The ICT-for-development "cube" is a conceptual framework that depicts the transition toward information societies as a mutually dependent interplay between technology, social change, and policies. Its focus on technology as a driver of development 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 use of it. Teaching experience has shown that especially students who are newly introduced to the ICT-for-development discussion gladly welcome the structure of the cube to assist them in the task of systematically thinking through a chosen ICT-for-development 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 one single dynamic. The resulting visualization of interdependencies facilitates to transcend the frequently employed artificial dichotomy between technological means and social ends.

One of the main drawbacks of the cube is that it is a mere 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 special 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, but 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 making predictions, testing hypotheses, or directing normatively.

The search for a dynamical model in ICT-for-development analysis will inevitably run into the same problem as all Schumpeterian approaches to socio-economic change: the fact that 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 and Winter, 1985), and leads us down a path of studying complex social systems which are only partially following nicely predictive patterns (e.g. Anderson and Arrow, 1988; Blume and Durlauf, 2005). From the present position (in which we are far from equilibrium) the future equilibrium position (in our case the 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 just currently unfolding (or, saying it in a less Newtonian and more anthropocentric tone: are currently "being created and defined"). This does not mean that we should stop trying to model it, but it shows that the elaboration of a coherent model that captures the dynamic of how ICT affect development comes down to working on the broader challenge of elaborating a modern socio-economic theory that recognizes at its core that the evolution of complex social systems are far from equilibrium, and that the next equilibrium is uncertain and constantly changing. This makes dynamic analysis and the creation of any predictive model extremely difficult. We do not have an adequate theory (yet), neither for the economy and society as a whole, nor for the digital component of it. In the meantime, rough conceptual frameworks such as the cube can act as a first aid kid to assist researchers and policy- and decision-makers in their enormous tasks of guiding societies during the quickly changing environment of the current

transition.

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