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**Software for Development:
The Case of Chile**

prepared for:

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Institute of Political Economy
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August 15, 2000

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The undersigned recommend to the Faculty of Graduate Studies
and Research acceptance of the thesis

SOFTWARE FOR DEVELOPMENT: THE CASE OF CHILE

submitted by Sabrina Barker, B.A. Hons.,
in partial fulfilment of the requirements for
the degree of Master of Arts

Thesis Supervisor

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September 18, 2000

Abstract

Software for Development: The Case of Chile

This research investigates software production in a developing country context. The central argument is that issues of software innovation, including capacity-building and technology assessment, should be viewed through a social innovation lens. It begins by providing an examination and analysis of the political economy of software. It also proposes a broad typology of software production options and relative market potential for developing countries to enter the global software market.

The inclusion of political and social dimensions requires that the subject be examined in a hybrid theoretical framework that captures social, international, and political dimensions, in addition to economic ones. An empirical test case of Chile is undertaken to show that by viewing the standard factors required for capacity-building through a democratization lens, implications for broader development become evident.

The methodological objective is to test the Internet as a vehicle for conducting social science research. Thus, the primary data are collected using a technique described as Rapid Electronic Appraisal.

Acknowledgement

This paper is a step in my lifelong pursuit of
mindful growth and fun,
as also my late father, A. John Barker, so firmly believed.

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INTRODUCTION

Chapter 1: Introduction

New information technology greatly facilitates the acquisition and absorption of knowledge, offering developing countries unprecedented opportunities to enhance educational systems, improve policy formation and execution, and widen the range of opportunities for business and the poor.¹

This perspective has gained increasing currency over the last decade, as information technology (IT) is credited with launching a new era of “convergence” via a “global information infrastructure”, and creating “knowledge societies.”² These trends have catalyzed much literature on the socioeconomic opportunities available to developing countries (DCs), for participating in IT development and production. Such arguments focus on issues of technological capacity-building, and formulae for achieving economic growth:

The key to national prosperity is perceived to be greater production capacity of a population. With the experience of the industrialized nations, the notion of science and technology as the propelling force of the modern mode of mass production has therefore been accepted. According to this view, the “underdeveloped” countries are in need of modern science and technology to start on the path of progress that is already set by the modern countries of the world.³

Information technology, or informatics, according to the World Bank definition, includes the supply side: hardware, software, applications, telecommunications equipment, and electronics-based industries, as well as the demand or user’s side: informatics applications in all economic sectors, information services industries, electronic publishing, broadcasting, MIS, etc.⁴ In the realm of IT, capacity-building

¹ World Bank, 1998, p. 9.

² See Annex 1 for full description of “global information infrastructure.”

³ Shodjai, <<http://edie.cprost.sfu.ca/~shodai/am.fm.htm>>

⁴ Hanna, p. 2.

strategies can be undertaken in three main areas: core technology, hardware, and software; and a growing body of literature debates the merits of each sector.

Increasingly, software production has been promoted as *the* target area for developing country involvement in IT.⁵ Debate has ensued over identifying and elaborating the most effective and feasible modes of technology transfer, desired roles and interventions of governing agencies, consequences for employment and education, and other politico-economic factors.

In general, the literature on software in developing countries is concerned with applying prescriptions for adopting software technology, and for participating as users and re-sellers in the global software market. Barriers to market entry have been identified, though the central concern has emphasized methods and criteria for countries to acquire, adapt and use technology. Most approaches consider issues related to the transfer and choice of technology from abroad, and require an understanding of how imported technology is assimilated and changed to suit local circumstances, and how technological improvements of various kinds are brought about.⁶

As well, most of the approaches concern large-scale projects, espoused by IFIs and aid organizations, targeted to large developing economies, such as Brazil and India. Their relevance to smaller markets and weaker economies is questionable.

For example, IDRC considers that:

Few countries are capable of radical innovation, as R&D becomes more expensive and complicated. For these countries, a more appropriate indicator is the capacity, in terms of know-how and wealth, to make the appropriate choice between

⁵ Schware (1992), Kopetz, Friedmann, Rajeswari.

⁶ Lall, 1982, p. 124-6. Kenburn Conference.

competing technologies and to develop or adapt technology to fit their own needs.⁷

As Mansell and When observe, the domestic capacity for producing and using software and information content has largely been ignored.⁸ Why is this so?

Also, little of the literature has seriously considered non-economic issues such as social equity, participation or social innovation. Yet, any process of technical change unevenly benefits people at different locations in a structure of social inequality.

Consequently, the interaction of technological innovation and market forces have led to a contradiction: the IT “revolution” seems to have widened the technological gap to overwhelming proportions both within and between countries.

Underlying such issues of power distribution, are ones of political and economic relationships, both globally and domestically. The link between poverty and IT remains unclear. How can countries that suffer from maldevelopment find the means to pursue any IT strategy at all?

This paper explores what the political economy of software really means in the context of DCs, and attempts to provide insight into software development and use. It begins by contending that while existing models may promote economic growth, and may provide economic benefits to sections of DC populations, such “success” cases have not proven to be stable or sustainable. It also argues that while some of the current thinking on IT addresses important sociopolitical aspects of development, the literature on software technology specifically, does not. This inquiry is grounded in asking: How can developing countries harness software for sustainable socioeconomic development

⁷ Kenburn Conference. IDRC. <<http://www.idrc.ca/books/835/03pref.html>> Van Audenhove, p. 396.

and create their own capacities, in the context of the transforming “global information economy”?” The thesis has two parts.

First, this paper contends that the political economy of software is not well understood. The very nature and characteristics of software differ from those of other IT areas, and require examination and analysis. Also, it argues that existing models for entering the software industry are simplistic and, thus proposes a broader typology of software production options to capture the intricacies and implications of software production and relative market potential for developing countries.

Second, the inclusion of political and social dimensions requires that the subject of software for development be examined in a theoretical framework that captures social, international and political dimensions, in addition to purely economic ones. An empirical test will show that viewing the standard factors required for capacity-building through a democratization lens, implications for broader development become evident.

The inclusion of political and social dimensions requires that the subject of software for development be treated with more than a purely economic theoretical framework. The discussion will begin, therefore, with outlining a more holistic theoretical backdrop, which is used to guide the analysis. The literature on software capacity-building as an economic solution will be reviewed in this context. Also, literature addressing social innovation issues in IT will be drawn upon and applied to software.

This review will reveal the need to construct a more theoretically robust framework for analysis than the anecdotal models that typify the IT literature. Thus, the

⁸ Mansell and When, p. 400.

empirical test will be constructed to investigate the key political and social, as well as the economic, factors related to software capacity-building for development. This is not to disprove the hypotheses raised in the literature, but to test them and extend them. The empirical analysis will be based on a case study of a medium-sized developing country in Latin America. Chile was selected as it boasts some software capability, but has not successfully established as sustainable software industry. The reasons for this merit considerable explanation. It may be shown that attention to long term development and to local capacity-building are the key factors.

The method of empirical research design and data collection motivates the second purpose of this paper. The objective is to test information technology as a principle vehicle for conducting social science research. Thus, the Internet (a communication and software vehicle) will be used to gather all primary, and most secondary information sources. The process builds on Rapid Rural Appraisal methodology, and applies it to the Internet, creating a new method, coined "Rapid Electronic Appraisal." The Website for this research is located at <http://www.igs.net/~sabrina/tesis>.

This paper will conclude with a richer understanding of the dimensions of software production and of the political economy of software in Chile. Some implications for software and sustainable development will be outlined, as well as recommendations for further research. Lastly, the effectiveness of Internet technology as a vehicle for conducting social science research will be evaluated.

Locus of Project in Theoretical Traditions

Currently, no single theoretical tradition adequately captures the relationships within IT and development. In order to properly consider the complexity and depth of political and socioeconomic development issues, an analysis of software innovation must be located in a multi-disciplinary theoretical approach. Thus, to create an inclusive conceptual framework, aspects of four current theoretical traditions are interrogated and adapted.

1. International Political Economy Paradigm

An international political economy theoretical basis is useful for situating key transformations in the “global economy” which influence, and are influenced by, IT. This framework also provides insights into the international division of labour of IT, and into its relationships of power and hegemony. It also frames the complex interaction between technology, political and economic factors and government policies, which together shape the direction of development. However, nation states cannot be the only level of analysis. The globalization of information technology must also be linked to local socio-economic conditions and factors.

2. New Techno-Economic Paradigm

The new techno-economic paradigm maintains that, despite transformations in the international political economy, there would be wider— rather than narrower— scope for major positive change in development prospects for Third World nations. The key to creating an effective development strategy today is an understanding that planning must

address the problems and opportunities of the future and not those of yesterday. The approach to development must be locally-based and thus, Schumpeterian⁹ in essence, as only indigenous local enterprise can sustain development, while providing solutions to diverse local needs and contexts. As explains Williams, the

Schumpeterian view is the most pertinent to the study of IT because of this emphasis upon the carriers of a new technological paradigm and the transformation of existing products and processes. In the first instance, digital electronic technology has led to the creation of new industrial sectors. Second, the technology is having a profound effect upon the nature of economic activity across all sectors, particularly in terms of the creation of a myriad of economic opportunities centered upon information as an economic resource.¹⁰

Individual, national, or regional initiatives, involving non-imitative behaviour could develop and gear the new potential towards more appropriate solutions for Third World conditions. For each developing country, this implies a fundamental rethinking of its own relative position of advantage within the international division of labour, before new possibilities can be identified. Thus, this paradigm sets out the core framework and assumptions for analyzing information technology, and for technological assessment, in a development context.

Further, the new techno-economic paradigm argues that while both demand-pull and technology-push approaches to understanding technological change have a domain of validity, processes of technological change powerfully influence economic and social developments, even though technology does not uniquely determine them. Thus, this

⁹ Schumpeter, J.S. *A Theoretical, Historical and Statistical Analysis of the Capitalist Process*. New York: McGraw-Hill, 1939.

¹⁰ Williams, p. 45.

perspective also provides a framework for analyzing both technological, as well as social innovation.

3. Unconventional¹ Approaches to Technology Issues in Development

“Unconventional approaches” reject the modernization and neo-classical theorists, who traditionally promote pursuing foreign direct investment and foreign technology transfer in order to gain access to new technologies. Traditional approaches to technology transfer in developing countries assume that there is no problem in assimilating the transferred technology; that there are no adaptations required, since options are available for all factor prices; that all firms remain equally efficient; and that firm-specific learning or technical effort are unnecessary. Most unconventional perspectives, however, maintain that much of the technology transferred during foreign investment is “truncated”, and that reliance on foreign capital and technology yields dependency.

Instead, these approaches assign a central role to indigenous technological effort in mastering new technologies, adapting them to local conditions, improving on them, and diffusing them with the economy; and in exploiting them overseas by manufactured export growth and diversification, and by exporting the technologies themselves. These views complement and expand on the new techno-economic paradigm.

The unconventional perspective will provide tools to assessing implications of technology transfers, such as licensing conditions and patents. It will also frame the analysis of software capacity-building. This tradition, however, focuses on

industrialization and does not consider information technology, let alone software, explicitly.

This paper is informed by a fusion of, and an application of, these three theoretical perspectives. Such a framework can provide a rich conceptual framework for analyzing the many complex aspects of software and social development. It is grounded in international political economy, but recognizes the importance of technological assessment, and local capacity building. The analysis will draw largely from the new techno-economic paradigm as well as from “unconventional” approaches to technology issues in development, while considering issues of technological dependence, in an international context. The theoretical framework will guide the gathering, analysis, and informing of empirical evidence and issues.

The strengths of this research method lie in its ability to theorize and interrogate the critical factors. The methodology conceals, however, related assumptions and issues such as local desire to pursue IT, “Luddite” opposition, environmental concerns, or national governments’ role in promoting such economic endeavors.

The methodology¹² will be used to investigate the key factors in software and development: the international division of labour of software; developing and harnessing software technology; socioeconomic development; and power structures and social relations. Empirical analysis together with theoretical propositions will permit analysis of the inner connections between the various factors. The construction and

¹¹ So named by Sanjana Lall. Lall, 1992. p. 166.

¹² Methodology is understood here as the interface between research method, substantive theory and epistemological underpinnings, to paraphrase Lee Harvey in *Critical Social Methods*.

deconstruction of these variables will reveal the nature of information technology and development, their interrelationships, structures and processes. The theoretical conjectures, together with the interpretation of available evidence, will be tested and illustrated using a selected case.

Using Chile to test the theoretical propositions, this research draws on “new techno-economic paradigm” to characterize software innovation and social innovation elements. The “Unconventional” approaches inquire about mechanisms and implications of technology transfer, and IPE is applied to issues of market share, pricing strategies, and internationalization efforts in Chile.

Case Selection

The case will concern Chile, for several interrelated reasons. First, Chile typifies Latin American countries in as much as it suffers from similar broad political and socio-economic problems, such as an weak government administration, social stratification, income stratification, a limited manufacturing sector, high foreign debt, structural un- and underemployment, low foreign exchange earnings, and inflation.

Conversely, Chile also exemplifies the more positive attributes of its Latin neighbors, such as a well-developed health care system, high education standards, and adequate infrastructure. Chile also provides a different, more external, orientation in that a stock exchange has recently opened in Santiago, and it is considering joining NAFTA, Mercosur, and APEC. This implies that Chile is moving farther into the international political economy, and is thereby increasingly exposed to information technology and its implications.

Finally, Chile has also begun to develop a small software capacity, which has grown from approximately 60 firms in 1995 to about 200 at present. Chile has not engaged in either microchip or hardware production.

The case study will include an examination of the evolution of the computing sector in Chile, an analysis of the software industry, firms and products. Thus, the research method is largely empirical, and will be oriented from the early 1980s, when the IT industry first started to boom, and when the literature on IT and development first emerged, up to the present. This analysis will be informed and contextualized by a broader analysis of the political economy of Chile.

Chapter 2: Advancing IT for Developing Countries: Review of the Literature

Throughout the 1980s, many development economists debated whether or not IT was appropriate for economic growth and prosperity in developing countries.¹³

Gradually, the proponents' opinions prevailed, and many theorists now agree that the issue is not *if* developing countries can enter the IT race, but rather *how* they are to manage the transition.¹⁴

Such transition involves building domestic technological capacities. Substantive research into technology capacity-building has brought about two complementary approaches to directing domestic technological effort: innovating IT into existing industry, and developing an IT capability.

Most of the literature regarding IT effort in developing countries focuses on the former: acquiring and adapting foreign technology; or incorporating IT into existing industries to promote productivity and international competitiveness in the global move toward "flexible specialization".¹⁵ This strategy depends, however, on continuous investment capital and consequently, has been slow to diffuse through industrial operations in the North, let alone through those in the South. As well, an inability to efficiently operate, maintain and expand the new technologies reduces their potential benefits.

¹³ A broad conception of human development is used in the United Nations Development Program (UNDP) which includes human autonomy and breadth of choice, equity, sustainability, and empowerment as well as productivity.

¹⁴ Bhatnager, p. 35. Credé and Mansell, R. 1998. p. 17.

¹⁵ Mytelka, 1993.

Thus, while new technologies may be accessible to Third World producers, their relative lack of technological capacities, notably skills and capital, constitutes a large barrier to entry into IT. Only the larger newly industrialized countries' firms may be able to innovate rapidly. Most importantly, however, both developing countries and NICs must *still* import most IT, and its technical support needed for "flexible specialization" innovation, from advanced countries.

The second approach involves the development of indigenous technological capacity. At the country level, capabilities include, in three general categories: physical investment, human capital and technological effort.¹⁶ Creating a domestic technological capability seeks in the long term to break foreign technological dependence. With respect to IT, this strategy can be undertaken in three general areas, the core technology (semiconductors and chips), hardware (computing equipment and peripherals), and software (programs and languages).¹⁷ Each of these areas varies in investment requirements, skill requirements, labour intensities, difficulty, and length of time needed for development and production.

There is a growing body of literature which speaks to this second approach with respect to all three sectors. Furthermore, much of the writing has prescribed software production as *the* target area for developing country involvement in IT, particularly for Latin America.

¹⁶ Schware, 1995, p. 417.

¹⁷ The definition will not include other non-market software, such as embedded software and in-house software), Kopetz, p. 300.

Software Production as a Development Solution

Robert Schware, among others, credit software as a booming sector, and one that is growing faster than most industries.¹⁸ The world software market was estimated at \$500 billion in 1995, and increasing at a staggering 10% yearly.¹⁹ According to Schware the growing world demand for software coupled with the shortage of resources to provide it, has led some countries to single out software for promotion under industrial policy, and to consider it a 'strategic sector'.²⁰

Also, for Friedmann,

the main value to less developed countries of the informatics revolution is not the eventual role of computer manufacturing but that of computer utilization, which in turn is valuable because it is a tool for the best use of information.²¹

In the realm of scientific and technological activities, contends A.R. Rajeswari, "software is one of the 'thrust' areas, as it has the potential for earning vital foreign exchange which hastens the process of economic development."²² For, Howard Williams, the major economic impact of IT products is not the products themselves, but rather in their *application*. He maintains that, "increasingly, it is the realization of new economic opportunities associated with the capture, storage, processing and communication of information that is central to economic growth."²³

Based on these assertions, the implications of these trends and innovations for developing economies are ominous: those without a relatively active and up-to-date domestic market for software will find it increasingly difficult to develop a software

¹⁸ Schware, p. 143.

¹⁹ Kopetz, p. 296.

²⁰ Schware, p. 159.

²¹ Friedmann, p. 39.

²² Rajeswari, p. 284-295.

²³ Williams, p. 56.

sector, which involves absorbing new technologies for software production, monitoring and analyzing trends in the industry, and using software to solve domestic productivity problems. The cost of developing such capabilities increases rapidly over time, making “catch-up” more difficult in terms of experience, labour, skills, multiple levels of intellectual property protection, and the growing importance of organization and management in software production.²⁴

These views are further complicated by the international dimensions. The United States continues to dominate the global software industry, while the Third World barely accounts for a few percentage points of market share. There is evidence, however, that the size of software markets in some countries is increasing rapidly, and that governments in some countries, such as Brazil, Argentina and Mexico, are taking proactive measures to support the development of their software industries.

In discussing how developing countries could participate in the global software industry, most of the literature has proposed niches which they could penetrate, and how they could capture comparative advantages. Sequencing, in moving from domestic production to exports, is a key strategy for developing nations.²⁵ Also addressed are the practical problems involved in developing local software production and acquiring the requisite know-how, technology and market intelligence and access.²⁶

The requirements and inputs for software production has encouraged proponents to propose methods and criteria for emerging Latin American economies to enter the sector. For example, fixed capital requirements are low, the scientific principles and the

²⁴ Schwabe, p. 144.

²⁵ Ibid., p. 159.

methodologies for developing software are, in principle, non-proprietary, and access to technology does not pose an entry barrier. A software business is relatively easy to start, remains largely labour intensive and offers important employment opportunities and higher value-added jobs. In many Latin American countries, people are well educated in computer science and other disciplines, making it possible to undertake work in software design and programming. Effectively harnessing these resources has allowed some countries, such as Brazil, Mexico and Chile, to enter the software market, and to move along a slow growth path.

Notwithstanding these benefits, a few authors, notably Carlos Correa and Ricardo Baeza, warn of limitations to creating a domestic software industry: local markets are too small to be used as platforms for software packages; marketing costs are high and beyond the reach of typical software firms, which are small or medium sized; compliance with high quality documentation standards is often disregarded; competition with imported software packages is intense (piracy further complicates this); and financing is generally difficult to secure (mainly due to a lack of assets for bank guarantees).²⁷

Despite these problems, it is argued that software can be applied to pressing social and economic problems, such as health, employment generation, income generation, nutrition, education and the over-arching problem of environmental protection. For instance, software can play a productive role by enabling the improvement of the quality of social services, administration of health care, education and skills upgrading.

²⁶ Wad, p. 1.

²⁷ Correa, p. 171-175.

Accordingly, state machinery is to play a very large role, first as a market, and second, software can improve the efficiencies of bureaucracies.

Yet, with all the attention paid to software and its benefits, this mainstream neo-liberal literature does not provide a cohesive theoretical framework for considering software innovation for sustainable socioeconomic development. The “unconventional approaches” to technology and development, can be drawn on and applied to software.

Dimensions of Software Innovation

Applying “unconventional” capacity-building literature to the software sector involves two core elements: technological capacity-building, and issues of technological dependence. At the country level, capabilities include, as mentioned: physical investment, human capital and technological effort. Issues of technological dependence focus on market exposure (domestic or foreign) and technological assessment.

Software Capacity-Building

Fields and Ruitenbeek distinguish two types of infrastructure. One, physical infrastructure, is that used for delivering goods and people. The other, information infrastructure, involves that used for delivering services.²⁸ The latter is of particular concern for developing a software sector. Information infrastructure encompasses a vast array of goods and services, consisting of physical capital— ranging from satellites and communications grids, to computers, telephones and radios— as well as the specific information provided by these services.

²⁸ Fields, p. 1.

From a prosperity and sustainability perspective, information infrastructure is often credited with improving economic well-being and providing social amenity; and the historical environmental impacts of this infrastructure have often been presumed beneficial.²⁹ However, key sustainability concerns revolve around social issues, as will be discussed later.

Although some of the necessary infrastructure, such as electricity and telecommunications systems, is in place, Latin American countries suffer acute shortages of capital resources. Thus, physical investment demands the cooperation and support of government agencies and financial institutions, in terms of actually providing capital, as well as of promoting a good investment climate.

At the firm level, software is one of the few areas of IT that requires relatively little physical investment. Capital costs of setting up a software firm involve primarily the acquisition of computer equipment. Not only are PCs and peripherals readily available from the U.S., East Asia, and Brazil, but also they are constantly decreasing in cost. Moreover, software can be developed on a given PC for about five years before upgrading the hardware is necessary.³⁰ As well, programming languages, the basic tools for developing software, have been in use for many years with little modification or obsolescence.³¹ This means that recurring costs are quite low. With adequate telecommunications and electricity infrastructure in place and growing, the physical

²⁹ Fields, p. 31.

³⁰ Quintas, p. 46.

³¹ The main programming languages are FORTRAN (1957), ALGOL (1958), COBOL (1959), BASIC (1964), and PASCAL (1969). None of these has been upgraded to date. There are, of course, newer programming tools, such as Visual Basic and Java, with life spans yet to be determined.

investment needed to develop software is feasible in Latin America. However, for Correa, lack of financing for labour costs and marketing constitute a barrier to entry.³²

The second component of capacity-building, human capital or “brainware”, is the key to developing a software capability. Formal education becomes the *essential* investment in learning capacity and societal communication, increasing the overall knowledge base of society as well as the individual’s “human capital”. The role of the state is fundamental in ensuring that an adequate educational system is in place. In recent years, Latin Americans have achieved high educational levels, and have the educational institutions in place for IT skill development. Education facilities, especially universities, can also act as a vehicle for IT transfer, by acquiring the tools necessary for building their own capabilities, and then by training others. The primary mode of software technology transfer is through this sort of training. Educational institutions are also fertile grounds for research and development activities.

The development of human capital must also encompass technology sourcing capabilities, which involve monitoring and keeping up with software techniques and know-how on a global basis. A software firm should be able to adapt and digest technology obtained from external sources for local purposes, and be able to develop technologies locally, as appropriate. As well, software workers must be able to deliver the technologies to the end user effectively.³³

³² Correa, 1996, p. 176.

³³ Wad, p. 21.

In addition to programming skills, knowledge and application of quality standards and formal design methodologies, marketing and management skills make up the human requirements of software firms.

With respect to the third area, technological effort, software technology depends on computer hardware technology (which in turn depends on semiconductors and chip technology) for development and application. Software development and manufacturing do not demand costly capital investment, nor are difficult, relative to other areas of IT. Software development and manufacturing neither demand costly capital investment, nor are relatively difficult; but they are very labour- and time- intensive. Indeed, each generation of software tends to be more complex and labour-intensive than the last. However, software technology is much more autonomous than the other components, since any computer can be used to design and develop software (assuming a large enough processor, memory etc.)

Thus, the strategy for entering into IT via software implies initial dependence on foreign computer hardware, although countries can, in the long term, become self-sufficient in terms of technological assessment. It should be noted that this approach does not prevent entering other IT areas that the North dominates. Rather, it suggests that infant firms will not be able to gain comparative advantage and compete internationally in the shadows of such giants. Instead, by initiating technological effort in relatively easier areas, such as software, capacities can grow before moving onto more difficult IT territories. After a capacity in software is obtained, and a software industry grows, development can then turn to other aspects of IT, such as hardware and “flexible specialization” for industry.

At the same time, software firms may develop products for both domestic markets and for export. This can lessen dependency in two ways. First, for the domestic market, competitiveness with foreign products can be gained if software products are appropriate and cheaper.³⁴ This condition drives the second way: if software products become viable internationally, through export (of both the product and the technology itself), then technological dependence may evolve into interdependence.

This suggests that there is no particular strategic need for a DC to be industrially independent. For most developing countries, the best road to acquiring the benefits of new technologies is often not that of establishing their own local R&D and industrial capabilities, but that of concentrating on those few areas with a natural advantage or a priority interest. Harvey Brooks calls this process ‘technology assessment’: the means of building up technological capacity for wise technology choice in the context of a more autonomous and self-reliant development strategy.³⁵

In the case of Chile, for example, there is a need and justification for developing a national IT capability in sectors such as copper mining and refining, forestry, and cellulose processing. In these areas, Chile could develop a software industry based on its own needs (and eventually direct them to export markets). For other areas, skilled professionals could search for, evaluate, negotiate, and adapt the best equipment and technology available globally for the specific needs of the country. However, the underlying question here is, how can a country like Chile sustain a software sector and

³⁴ Software is relatively expensive to purchase in North America because it is very labour intensive and also because of high advertizing overheads (about 30% of revenue for most large firms). Advertizing is less of a cultural mainstay in Latin America, and therefore, will likely be less costly.

³⁵ Brooks, p. 492-1.

enhance domestic socioeconomic development? As the new techno-economic paradigm would espouse, this issue requires a better understanding of the nature of software, and production possibilities for DCs, which is analyzed in the next section. But first, the literature on social innovation must be addressed.

The problem with these capability-building arguments thus far is that they imply an unrealistic “*ceteris paribus*” condition. Economic factors interplay with political and social ones. Seeing technology as an independent variable (invention leading to innovation and diffusion), suggests technological determinism which does not reflect reality: economic factors interplay with political and social ones.

The political economy theoretical basis contends that technological development does not operate in isolation from social forces, or transform society the moment it becomes available. Technology is also a “social product”, largely determined by those who hold and administer power at a given time. Technology now becomes a dependent variable, and innovation more significant than the invention. A central concern of this paper is the interface between society and technology, and the choices decision-makers can take in social and technological innovations. Any process of technical change unevenly benefits people at different locations in a structure of social inequality. Therefore, this study argues that for software to be an appropriate technology³⁶, attention to major inequalities should be explicitly incorporated as a goal in the design of an IT strategy. Key issues for “democratization” of IT include a range of social and cultural innovations.

Dimensions of Social Innovation

The application of technology can seek to embrace complex and interrelated technical and social problems together, and in this way, become an indispensable component of a more sophisticated and holistic approach to development.

For a development proposal to be progressive, it must enable widespread participation and beneficiaries. The intention of the *Brundtland Report*, for example, was that development would lead to “changes in access and resources and in the distribution of costs and benefits.”³⁷

Yet, as mentioned earlier, any process of technical change unevenly benefits people at different locations in a structure of social inequality. The reduction of major inequalities should, therefore, be explicitly incorporated as a goal in designing a national software strategy. To date, however, software sectors in North America have largely ignored issues of social development. At the same time, factors for democratizing IT more generally, have been addressed.

Key dimensions of social innovations necessary for democratizing software include: institution building, universal access to resources, employment, distribution of wealth and power, and a new role for governments. On the international level, analysis involves the international division of labour and its implications. Each of these issues raised in the literature on social innovation for IT will be described with a focus on software development.

³⁶ Appropriateness of technology can be measured by: effectiveness, usefulness, usability, supportability, adaptability, cost-effectiveness, relevance of content, relevance of form (interface/inference mechanisms), available training. King, pp. 228-229.

³⁷ Brundtland Report, p.43.

Institution Building

The basic tenet of the Schumpeterian theory of economic growth is that growth is dependent upon the ability and initiative of entrepreneurs to realize opportunities for new investment, growth and employment drawing upon the discoveries of scientists and innovators. The emphasis is on autonomous investment embodying new technical innovation. Consequently, the framework for economic growth can be perceived as a process of resource allocation between industries. Economic growth is not merely accompanied by fast-growing new technologies, it is dependent upon such industries and the transformation of methods of production in traditional industries.³⁸

It is not enough to simply invent and develop new software towards generating a domestic “IT revolution.” As Jequier points out,

what is required is an entrepreneurial class and perhaps more important, a system of values—cultural, social or religious, and organizational forms—which can legitimize and encourage social and economic change.³⁹

This suggests that new cultural and social systems and institutions need to be established. Instead of a tool for dependency and domination, software needs to become a means for more equal participation, and for the preservation of cultural identity and national sovereignty. Social institutions are also necessary for promoting widespread distribution of wealth and power, and access to resources.

³⁸ Williams, p. 45.

³⁹ Jequier, p. 22.

Universal Access

Not everyone has access to information equipment, networks, services, or training, and therefore, software technology has the potential to polarize a population into information 'haves' and 'have nots'. For developing countries, as Fields contends, a universally accessible and affordable telecommunications system must be established and maintained.⁴⁰ Furthermore, universal access to training and education is imperative. Computers, televisions, and telecommunications can be used in such a way as to extend coverage to rural and urban poor areas and to all levels of education.⁴¹

These requirements are obviously costly to implement, and may be prohibitive to many cash-strapped Latin American countries. However, not all barriers to access are economic in nature. There are also obstacles, for example, to girls' and women's participation in scientific and technical education and careers, and there are relatively few women in science and technology decision-making bodies and advisory boards. Therefore, widening access to the 'masses' also requires removing systemic discrimination, which links directly to employment issues and distribution of gains. For software production and use to reach as many people as possible, national access must remain of central concern.

Employment

While much of Latin America has educated labour forces, widespread structural unemployment persists. Establishing a software capacity could contribute to alleviating

⁴⁰ Fields, p. 39. He notes, however, that limiting access, to protect individual privacy or corporate interests, can also be a prerequisite for social, economic and political stability.

⁴¹ Friedmann, p. 40.

this chronic problem for some (well-educated) segments of society. Software development could help create job and income opportunities, although it is unlikely that the sector would create massive job openings, or become an important source of income, until computerization spreads widely, while greater demand for software products is created, and the translation and adaptation of imported application software occurs.⁴²

Christopher Freeman suggests that there are good reasons to believe that rising software production would generate an even faster increase in software employment.⁴³

He warns, however, that

only a minority of the new jobs would actually be in the IT industries and services themselves, or indeed in IT occupations in other industries and services... However, the main effects would not be in manufacturing, but in the area of information services, data banks, publishing, education, training, and health services.⁴⁴

In addition, IT is expected to restructure work forces, and to impact both work modes and job quality. Some predict that the changes will lead to “bi-modalism” of the work force job structure.⁴⁵ Rapid technological change may essentially eliminate much of the middle class, elevating its members to high-tech jobs, while concurrently increasing the subjugation and marginalization of lower class workers.

Others warn that the use of microelectronics will de-skill and marginalize workers and thereby disrupt the local employment structure.⁴⁶ The skill structure of IT industries departs substantially from those which prevail in most other manufacturing industries. Labour requirements are becoming polarized between a small, but relatively rapidly

⁴² Schwabe (1992) p. 144.

⁴³ Freeman, p. 33.

⁴⁴ Freeman, p. 78.

growing, segment of highly qualified labour (scientists, technicians, managers) and a large, but declining, un- or semi-skilled workforce engaged in assembly. Such a movement towards a bifurcated workforce has resulted in skilled manual labour becoming under-represented in the IT production sector.⁴⁷ There remains wide concern that some people will be left behind because of current organizational structures. This dichotomy of labour is accentuated by the global division of IT labour.

In terms of labour and management relations, employment practices are contributing to the absence of any strong trade union presence within the software industry.⁴⁸ Thus, while software development and production may yield important employment opportunities for some segments of Latin American economies, industry and governments will have to collaborate to create systems and practices to minimize possible socioeconomic stratification, and to promote equitable distribution of benefits.

Role of Government

In addition to its traditional roles of regulation and innovation, governments must embrace new development priorities: private sector development, governance, and environmental issues. Policy making and implementation, and related policy instruments reflect power structures in society, and consequently affect the choice of priorities in resource allocation, capital disbursements and other areas. National innovation systems can support software industrial initiatives. Also, states must put in place and maintain the

⁴⁵ Fields, p. 41.

⁴⁶ CSE Microelectronics Group 1980; Joran, 1981; Albury and Schwartz, 1982; and Kaplinsky, R., 1984.

⁴⁷ Williams, p. 54.

⁴⁸ Williams, p. 54.

legal infrastructure to protect intellectual property associated with software, including copyright protection and anti-‘pirating’ measures.

At the same time, software can enhance bureaucratic operations, and reduce inefficiencies. For example, automation can modernize public institutions, and transform trade and tax administration. Nagy Hanna notes that network computer systems reduce central bureaucracies and allow services to move closer to clients. For example, data communication networks can link decentralized customs facilities to reduce customs processing time.⁴⁹

Distribution of Wealth and Power

Argues Jequier, technology is neither egalitarian nor socially neutral, and tends to accentuate the social and economic differences between those who benefit and the vast majority of the population living at subsistence levels in the rural areas.⁵⁰ Underlying the question of the distribution of wealth and power related to IT in a given society, is: who benefits from its creation and use? As a market-based solution, the software sector only covers the interests of those who can participate in it.⁵¹

The distribution of computers and related equipment is uneven within Latin America. The heaviest concentration of equipment, some 90%, is to be found in the three most industrialized nations, Argentina, Mexico, and Brazil.⁵² Moreover, it is concentrated in urban centres, with little rural penetration.

⁴⁹ Hanna, p. 34.

⁵⁰ Jequier, p. 31.

⁵¹ Casanova, p. 22.

⁵² Hanson, p. 99.

How are poor people to change an all-powerful technology? IT has been held responsible for disrupting the mechanisms by which wealth is distributed in a liberal democratic society, and that has led to the centralization of political power and the disenfranchising of sections of society. Yet, development of technology is largely a consequence of choices made by men and women who hold power. John Street states that “if scientific and technological cadres have accumulated vast powers in modern society, it is only because their visions and values have echoed, amplified, and realized our own.”⁵³

A national software strategy must allow for new cultural and political pluralism, and allow for the breakdown of social barriers. The conditions under which technology is developed raise real problems for democracy—problems about accountability in the use of public monies, about control over the development of the technology, and about sovereign power in an international economy.⁵⁴

Extensive use of IT leads to a general restructuring of society. B. Jordan foresees the emergence of three classes of people: the technical, scientific and political elite of designers and planners; the machine minders, charged with ministering to the needs of the technology; and the unemployed, the old and the sick.⁵⁵ Other dimensions of this stratification involve marginalization of rural people, and the gender-specific nature of technical change.⁵⁶

⁵³ Street, p. 2.

⁵⁴ Street, p. 5.

⁵⁵ Jordan, p. 70.

⁵⁶ Refers to the tendency for women to be marginalized from technology and science sectors. Gender Working Group of the United Nations. <http://www.idrc.ca/sip/gender/scitech/>

IT also affects the form and availability of information in society. It can add to the store of information available to ordinary citizens, and thereby improve the quality of democracy. Sheldon Annis concentrates less on the economic benefits of the information age, and more on the benefits to social relations in Latin America. His main premise is that the advent of information technology is producing a more participatory system of government in the region. Annis maintains that the advent of electronic information has “profound implications for the process of democratization.”⁵⁷ In this scenario, the poor are the greatest beneficiaries of new information and communications technologies, providing them with a means of political activism not previously possible. Conversely, IT can increase the store of information available to central governments, and thereby enhance its ability to control its subjects.⁵⁸ Cuba, which forbids its citizens access to the Internet, is one country in evidence.

These arguments suggest that the problems for democracy generated by IT are not just those of unemployment. IT has a further effect upon the kinds of interests in society and the way they are organized. Insofar as IT leads to a restructuring of the job market and an increase in unemployment, it highlights and exacerbates those problems of legitimacy which liberal democratic societies constantly face. Democracy is not just about the distribution of interests in society, it is also about the information available to those interests.⁵⁹

These issues indicate that there is a greater role for government than strictly economic policies and investment in software-related infrastructure and production.

⁵⁷ Annis, p. 94-95.

⁵⁸ Street p. 10.

International Division of Labour in IT Industries

Developing countries continue to depend on industrialized ones for new technologies, and for products based on those technologies. In the case of software, however, the configuration of technological dominance and dependence does not reflect the traditional pattern of the North as core, and developing countries lumped together as periphery. Instead, the core role is played almost exclusively by the U.S., followed at a distance by Japan and parts of Europe.

According to Schware, if Latin American software industries are to move rapidly up the product development ladder and become internationally competitive, they need to start building sub-contracting relationships with international systems integrators and hardware vendors. These relationships would expose their software houses to best practice on the key aspects of software development: cost control, quality assurance, demonstrated compliance with standards, project management skills, and data security.⁶⁰

Also, developing countries are to invest in the developed countries for the purpose of obtaining technology, just as the developed countries firms invest in the developing world to obtain market access. But, although equity participation is one of the most prevalent means of accessing technology in both the semi-conductor and software industries, obtaining such equity access in the developing economies, for a number of reasons, is extremely difficult.⁶¹

Overall, a gradual reduction in dependence on foreign technology, combined with local technological capacity and progressive social innovations, could better position

⁵⁹ Street p. 9.

⁶⁰ Schware, p. 417.

Latin American countries, both nationally and internationally. Are countries designing strategies to integrate their software initiatives into longer term development plans? A pre-requisite to such an endeavour is to fully understand the characteristics of software creation and production.

The Nature and Economics of Software

Information technology presents new challenges to modern economic thinking. The pure economics of information are fundamentally different from the economics of commodities.⁶² To begin with, the nature of information deviates from that of standard products and services. What does it mean to own information? If land or capital is exchanged, then ownership is also exchanged. However, if intelligence or an idea is exchanged, ownership is duplicated. According to the dominant, neo-liberal approach to IT, information has been commodified, achieving an economic value as a mode of production.⁶³

Commodities can be replicated only through the expense of manufacture; information can be replicated at almost zero cost without limit. Commodities wear out, information does not, although it can become obsolete or untrue. Commodities exist in a physical location, with unique legal jurisdictions; information is simultaneously nowhere and everywhere. Some commodities are subject to diminishing returns, other commodities subject to increasing returns, such as volume production; information has

⁶¹ Wills, p. 117.

⁶² Evand and Warster. p. 15.

⁶³ World Bank, Information Technology Union espouse the tradition.

perfectly increasing returns.⁶⁴ This is contrary to industrial age-thinking, in which value comes from scarcity. With information, value comes from abundance. Further, information has “externalities,” as the sharing of information increases its value.

As information is commodified, communication is viewed less as a civil right, and more as a tradable product or service. Communication networks also have “externalities” meaning that the value of a network increases disproportionately as the network is extended.⁶⁵

Traditional economic theories of the firm assume “perfect information” with which to examine relationships between factors of supply, demand, and price. The economics of information overturns that fundamental assumption.⁶⁶ The economy of commodities is one of efficient markets, in which firms and products compete as price takers in competitive markets. The economy of information *requires* imperfect markets; unless originators have some way to limit the access of others, (via licenses, IPRs) they will never earn a return on investment. The economics of information becomes less tied to the economy of commodities.

In the emerging “information economy,” knowledge, networks and connectivity become central to the productive process. To remain competitive in a global market, firms depend more on knowledge than on natural endowments or production advantages. In terms of ICT production, tangible inputs such as machines and equipment are being

⁶⁴ Evans and Warster, p. 15.

⁶⁵ Credé and Mansell, R., p. 23.

⁶⁶ Quintas, p. 80.

replaced by intangible investments, such as technology, marketing, and R&D, as the decisive factors in competitiveness market penetration.⁶⁷

In modern economies, IT has become central to the workings of most firms and could be responsible for the beginning of a new long Kondratiev wave. Any long-term resurgence into a new (fifth) cycle would have very different social implications than anything that transpired in previous periods, particularly in areas of occupational employment and income distribution.⁶⁸

All of these economic characteristics of information are reflected in software. As well, the challenges to understanding the economics of IT are epitomized in the economics of software. As Carlos Correa noted in 1996,

the technical and market-related aspects of software business activities have received considerable attention. The economics of software generation and production, however, have been studied to a very limited extent.⁶⁹

To undertake such a study, the nature of software and the characteristics of its production process must be identified and examined.

Software refers to a set of instructions that control and operate computer and telecommunication systems. Software is written in logically based languages that define lists of symbols and instructions known as 'code'. In many ways, the process of writing software can be likened to other forms of authorship, such as writing music or literature. And as a written code, software programmes are regarded as intellectual property equivalent to literary work, in most countries' legal frameworks.

⁶⁷ UNESCO, 1992, p. 26.

⁶⁸ Schwabe, 1992, p. 147.

⁶⁹ Correa, p. 171.

However, unlike literary works, software is written in order to be applied to various productive processes. When run on a computer system, different software can produce a seemingly endless array of functions: temperature control in a room, automatic teller operations, or spreadsheet processing. With each different application, software turns the same computing hardware into a functional, virtual machine. Modify the software, and the functions of the machine are changed, and therefore, the nature of the machine itself is transformed. Hence, without software, a computer cannot function or exist as a machine— it has a virtual nature.⁷⁰

The production process for software also has distinctive characteristics. The whole process of creating new software is more aptly described as a process of writing-development rather than of manufacturing. Software development is essentially a multilayering design process, which includes designing, writing, and testing software code. In contrast, conventional hardware products have a design phase followed by a manufactured production, so that the product may be reproduced in quantity. The only segment of software production with an element of manufacturing is packaged “shrink-wrapped” programme applications.

As software production is an iterative process, continuous, repetitive design and redesign is the norm. However, software products vary greatly in how successive design iterations are achieved, and how these are made available to customers. For many types of software, the development process does not stop when the software item is delivered to the customer. Instead, redesign may continue, in different forms, throughout the product life. This continuous process of design is not only the design-in-use effected by users, it

⁷⁰ Quintas, p. 76-79.

is a continuing involvement of software professionals in post-delivery maintenance of existing systems.

Unlike manufactured products, the cost of reproduction of a software programme is minimal, compared to the cost of its design and construction. Software, like other written information, can be shared and copied without loss and at very low cost.

One of the most distinctive aspects of software as a commercial product is that it is often given away free of charge, as freeware, or at nominal cost, as shareware. From operating systems, such as Linux, to graphics tools, such as Lview, there are over 250,000 freeware or shareware applications available via the Internet.⁷¹ All Winsock software, for most platforms, can be downloaded from Tucows Ltd.⁷² Some companies, notably Netscape, consider charging license fees to be counter-productive, and have gained considerable market share by giving their products away at no cost. The Internet has developed quickly partly because the major protocol owners charge rights fees to producers (servers) but not to end users (clients).

Software also has unconventional patterns of diffusion.⁷³ The replication and distribution of software is effortless compared with its design and creation. Software can be copied and distributed, using removable media or the Internet, quickly and inexpensively. Furthermore, there are millions of illegal copies of software packages dispersed around the globe.⁷⁴ In addition to diffusion via diskette, transmission of

⁷¹ <<http://www.shareware.com>>

⁷² Winsock software is a library of routines creating communication capability via the Internet.
<<http://www.tucows.com>>

⁷³ Quintas, p. 80.

⁷⁴ In 1996, Lotus estimated that in India, 130,000 of the 140,000 copies of their 1-2-3 package were pirated copies.

software via the Internet, is generally undetectable. Thus, the extent to which software products and systems have spread throughout the world cannot be accurately assessed.

In addition to wide access to software products, software development technology is also widely accessible. As Carlos Correa observed, technology for software development is widely available at universities and research institutions.⁷⁵ Many resources for developers are accessible in newsgroups and Web sites. Technologies for software development are not proprietary, although the use of certain tools, platforms or interfaces may require the negotiation of a license and the payment of royalties. The relative accessibility of software technology discredits the idea of “technological shelf”, as readily available to all firms, of all sizes, wherever they may be located, and leads to technological uncertainty.⁷⁶

Further, the decision to use either open source⁷⁷ or proprietary systems has important commercial implications. For example, it indicates that there is no unique way of developing a certain product. Software producers must make strategic choices, taking into account the type of products and markets envisaged.

Further, the capability to develop software is one of the most highly decentralized and distributed technological competences of the late 20th century. This distributed capability to design and develop software suggests that assumptions about relationship between suppliers and consumers must be regarded critically.

As software development is very skill intensive, the availability of qualified analysts and programmers is essential. It also remains a labour-intensive activity that

⁷⁵ Correa, p. 172.

⁷⁶ Ibid., p. 140.

largely has resisted automation. There are indications, however, that capital costs are increasing with the growing automation of software development tasks.⁷⁸ Since some aspects of developer activity are now being automated, labour markets, skills requirements and productivity, and employment opportunities are changing.

Despite the high degree of formalization of knowledge involved in software development, considerable room is left for creativity and ingenuity, and for “tacit” knowledge⁷⁹ based upon experience. Software development is often described as still being an “amateurish, craft-based discipline”. Historically, some software has been developed by unaccredited developers or amateurs. This duality has caused much debate about the software development process: whether it should be the preserve of trained and accredited professional software engineers, or whether technological developments should enable non-professionals and even end-users to design and build their own systems. At the level of social relations, software professionals’ use of specialist language and appeals to a ‘technical’ realm were, and indeed still are, used to circumscribe areas of knowledge and technical expertise that delimits and controls user-developer discourse.⁸⁰

The tacit aspect of software knowledge has other important implications. Since it is not formalized, it is difficult to transfer. To exchange programming ideas and problem-solving, developers often must meet face-to-face, to solicit input and feedback. Herein lies a contradiction in the social mechanisms of software development. On one hand, it

⁷⁷ Programming code provided by its creators free of licensing requirements or any other monetary charge.

⁷⁸ Ibid..

⁷⁹ Tacit knowledge, is that which is not formalized and is therefore difficult to transfer.

⁸⁰ Quintas p. 96.

occurs in cyberspace, and on the other hand, it requires personal contact. As a result, software firms have tended to cluster together in “software parks.” Not only are there collective efficiencies in the supply of infrastructure, personnel and finances, but proximity also facilitates informal knowledge exchange. Some governments, such as Malaysia and India, have established “technology and science” parks, in an effort to support software innovation.⁸¹

A second tension also relates to the skill and labour intensity of software. On one hand, firms must engage in a process of constant innovation, as the industry is continually evolving. On the other hand, according to Freeman, large capital inputs to generate R&D yields a “bureaucratized R&D” process.⁸²

With this unusual and heterogeneous nature of software activity, it is no surprise that the software design process varies greatly according to the type of software, its mode of development, the agencies and actors involved in the development process, and the environment in which it is to be used.

Thus, software development processes cannot be divorced from the social contexts in which they take place. It is widely accepted that technology is socially constructed; that is, innovation takes place within economic, social, and institutional frameworks; and technology embodies certain values and assumptions which have implications for users, predetermining use-patterns.⁸³ In practice, technology is shaped by the social setting in which it is both developed and used. So, too, users subvert

⁸¹ Samaranayate, p. 135.

⁸² Freeman, p. 87.

⁸³ Quintas, p. 100.

technology, using it in ways not envisaged by the designers, effectively designing-in-use.

For Paul Quintas,

the structure of software development capability is unique, principally because of the lack of concentration of that capability within a supply-side, hypothetical software industry. The locus of software design and development has changed continually over the last fifty years. During these transitions there have been shifts in the balance of power between suppliers, developers and users.⁸⁴

The structural basis of power was partially broken down in many organizations by the availability of microcomputers in the late 1970s, and again with PCs in the early 1980s. When microcomputers entered many homes and workplaces, home-computing enthusiasts often wrote some of their application software. Since the 1980s, software professionals have largely regained control of organizational information systems development with the spread of networks, and centrally-stored PC software.

Furthermore, as Quintas observes, developer effort has shifted towards higher-level business analysis:

The concept of business process re-engineering, whereby organizational processes are restructured in order to align working practices with the best practice characteristics of ITs, aims to place IT developers at the centre of organizational development. Rather than designing the IT system to fit the needs of the organization, or adaptation, this approach proposes that the business processes of the organization be changed to best fit or exploit the characteristics of IT systems.⁸⁵

The spread of networks has also caused software to become highly internationalized by nature. Its infrastructure, driven by telecommunications and cable networks is growing at a rapid pace, as evinced by the boom of the Internet. Increasingly, software entrepreneurs

⁸⁴ Ibid., p. 98.

⁸⁵ Quintas, p. 96

must become “outwards oriented” in their solutions. The characteristics of software creation and production are further elucidated when viewed from an historical perspective.

History of Software Programming

The first programming languages were developed in the 1950s. Hardware companies in the West were developing and supplying software to meet their own standards. As applications multiplied, scientific users in R&D started to undertake their own software programming. Large departments formed software teams to work with hardware suppliers. The 1970s brought the emergence of independent software companies giving advice and support to users and designing systems. Between the mid-1970s and the early 1990s, software product and service firms grew very rapidly, especially in the U.S. Packaged, user-friendly software facilitated extraordinarily rapid diffusion of personal computer hardware, especially to small and medium sized enterprises, while customized software and modified packages business also grow very rapidly. A movement to Open Systems in the late 1980s facilitated interconnections and networking. Shortages of software personnel were acute in the 1970s and 1980s, but is abating in 1990s.

Since the mid-1990s, the requirements for software labour have declined, because of shifts to standard packages, automation of coding and testing, reduced mainframe support and improved skills of users. Better knowledge and techniques are increasing programmer productivity and enabling routine reuse of software modules in the manner of integrated circuits. Emerging trends include: object-oriented programming; an

emerging market for software components and software agents; and accelerating growth of embedded software and Internet-related applications. At the same time, these trends have been offset by new software demand from parallel processing, multi-media and virtual reality and expert systems, and changing configurations because of continuing organizational and technical change. These shifts have renewed surge of demand for more skilled software design and maintenance workers.

The Internet also provides a fruitful mechanism for open-source development projects, in which most of the content is submitted electronically by users. Linux, for example, uses thousands of online volunteers to develop its operating system. The company has learned that contributions by volunteers can lead to better software than the “coordinated efforts of a company’s paid employees.”⁸⁶ Similarly, Netscape uses thousands of volunteer users to develop and maintain Open Directory, an extensive catalogue of Web sites. Both projects are based on rigorous peer review of content submissions, as well as sophisticated quality control.

With these new trends, a new theoretical framework must be developed to characterize IT developments since Carlota Pérez’ techno-economic paradigm.⁸⁷ The application of software to this system highlights information and knowledge intensity; flexibility in manufacturing; diffusion of new concepts of organizational efficiency; and systemization rather than automation, in productive processes.⁸⁸ It also engages a

⁸⁶ *The Economist*, December 4, 1999. p. 66.

⁸⁷ Pérez, 1983, p. 441.

⁸⁸ Freeman and Soete characteristics of the techno-economic paradigm in terms of economic advantages:

1. speed and accuracy of processing and transmitting information
2. storage capacity for large quantities of information
3. flexibility in organising manufacturing, design, marketing and administration
4. networking within and between firms and other individuals and organizations

“science push” theoretical focus, as a systematic means for ensuring a continuous search for knowledge. Further, software evinces most or all of the characteristics of innovation as espoused by Schumpeter and later by Clarke.

Rejecting the neo-classical view of profits as market imperfections, Joseph Schumpeter argued that the expectation of profits had another role: to lure the entrepreneur to innovate. Innovations for Schumpeter were new combinations of productive resources, designed to improve efficiency, and had five major forms:

1. introduction of a new good or of a new quality of a good,
2. introduction of a new production process (not necessarily based on scientific discovery),
3. opening up a new market,
4. development of a new source of input supply, and
5. changes in industrial organization.⁸⁹

For Norman Clark there are three key characteristics of today’s innovation process. First is the notion of technological convergence, in which has brought increased specialization and differentiation of economic production both horizontally (the production of new goods and services) and vertically (the capitalization of the productive process). Technological convergence produces important consequences for new techniques and their diffusion. Second, is a process of vertical disintegration, by which specialist firms “spin off” from mother firms. Third is a process of sequential innovation, in which continuous learning and technological improvement.⁹⁰

The pace of both technological developments and growth have been as rapid in the software sector as in the so-called “IT revolution.” Proponents of the “new

5. display of information. p. 47.

⁸⁹ Schumpeter p. 117.

information economy” see no slowing down by technological limits, as advances in IT are startling and continuing apace. And, many constraints perceived in the past as impassable, have been breached. Often quoted, “Moore’s Law” illustrates the evolutionary power of microprocessors, for example. Coined by Gordon Moore, co-founder of Intel, the principle states that microcomputer chip density doubles every 18 months, and has held for 30 years. Any doubts about physical barriers, particularly the minimum size of silicon transistors, have been lifted by new research. For example, IBM expects technological advances and innovation to continue, without serious barriers, for another 30 years.

Yet as promising as the “global “software sector seems, the vast majority of its growth occurs in developed countries. Indeed, only 2-3% of software production involves developing countries.⁹¹ Yet much of literature on IT potential in developing countries is fixed, as stated earlier, on software production and application as the favoured area for developing country involvement in IT, particularly for Latin America.

Arguments such as these are disturbing, not because they may not be correct, but because of their lack of evidence, and their lack of analysis of software capacity issues and production in developing economy contexts. Economic growth, foreign exchange earnings, and other benefits are heralded as achievable, provided DCs embark on a route involving software. For two examples:

⁹⁰ Clark. p. 31-34

⁹¹ Economist, December 99. <<http://www.economist.com>>

Empirical results have shown that spillover effects from information and communication technologies also have an important impact on the productivity level of the whole economy. Inefficient markets will limit these spillover effects.⁹²

Domestic software industries should be of more value to a DC in leveraging greater efficiencies and other competitive advantages for larger infrastructure-building industries, e.g. tourism, than in direct software export sales. Successful systems for demanding, internationally successful domestic customers are what is most likely to lead to the best kind of exports.⁹³

Meanwhile, the OECD argues that not only is the software sector difficult to measure, its impact has not been quantifiable until very recently.⁹⁴ However, no argument for entering the global software market—particularly to enable socioeconomic development—can be made, without a thorough understanding of software development and production possibilities and strategies.

Entering the Software Industry

In tandem with volumes of literature on “knowledge economies” and IT, Schware, Friedmann, Rajeswari, and Williams represent a body of thought determined to usher in software as the most favorable area for DC involvement in IT. Most of this literature was published in the late 1980s and early 1990s. Since 1996, only two articles have addressed software capacity building and constraints in DCs. This lack of substantive or critical thinking on software issues is alarming, although the two articles, one by Carlos Correa and the other by Richard Heeks, merit examination.

In 1996, Correa developed the most rigorous study to date on Latin America’s developing a software capacity. Considering software is so highly internationalized, and

⁹² World Bank. 1998, p. 10.

⁹³ Hanna, p. 37.

⁹⁴ OECD, p. 5.

assuming domestic markets to be of limited potential, Correa described three main strategies for entry into international software market: export of work, export of product development services, and export of products.⁹⁵

1. Export of Work/Off-shore Services

For Correa, this strategy is based on the provision of short-term “off-shore” services by means of work at the premises of the employing country, often the U.S. This activity, also known as “body shopping”, is characterized by low entry barriers in terms of capital, marketing skills and costs. It is also a low-risk, low value-added activity, with a limited impact on technological capacity building.⁹⁶ The attraction for DC firms is the possibility to compete on the comparative advantage of low labour costs. Personnel gain experience and knowledge of foreign markets, and software project management, although the learning process in terms of design is not substantial. Firms in India and the Philippines have had some success with this type of operation. In the early 1990s, a substantial part of software exports (85-90%) comprised body-shopping operations.⁹⁷

However, there are some serious drawbacks, notably the loss of workers through “brain drain”. Also required are liberal immigration policy by receiving country. Increasingly, stringent visa requirements for the U.S. may substantially limit this type of activity, cautioned Correa. To date, this has not been the result. Staff who work on export projects are far more likely to receive Green Cards and move on rather than go

⁹⁵ Correa, p. 178.

⁹⁶ Ibid. p. 180.

back to domestic market work. India loses up to 15% of its software workers every year, largely to the U.S. Furthermore, most work is relatively low-skill coding and testing, leaving the high-skill tasks of analysis and design in Western hands. And as such, the position is typically an export enclave in which skills and technology fail to trickle down to the domestic market.⁹⁸ Thus, an “off-shoring” strategy should be discredited as a favourable alternative for developing countries.⁹⁹

2. Customized Development and Services for Export

A second option, as Correa describes, involves contractual relationships, in a variety of activities: custom-made software development, sub-contracting arrangements for programming, and joint ventures with foreign companies.¹⁰⁰

These modalities incur higher financial risk and capital than do body-shopping operations, but they also generate higher value-added, profitability, and a more substantial learning process. They also require better local infrastructure, and support for industry. The governments in Taiwan and Singapore have promoted this strategy, which has also been applied by most software firms in Latin America, including some Chilean firms.

3. Software Products (Packages) for Export

⁹⁷ Schware, 1992, 151.

⁹⁸ Heeks, p. 17.

⁹⁹ Credé and Mansell, R., 1998. p. 19. Talero, <<http://www.worldbank.org>>

¹⁰⁰ Correa, p. 179.

Developing software packages involves substantially more capital investments, and required managerial and marketing skills levels are higher, than with services. The risks are greater, although the potential for more value-added and profitability are also greater. Package production offers larger impact on learning and building up of technological capabilities, and may be less vulnerable to recession and easier to sell than services.

This sector is also significantly different from software services, as it involved a manufacturing phase, and corresponding capital resources. Also, package suppliers must gain a deep understanding of user needs, must develop or obtain access to a distribution network, provide documentation, and ensure post-sales service. The production of packaged software generally poses higher quality and reliability requirements, and entails substantially larger (and riskier) financial investments in R&D. Competition is intense, particularly in the universal desk-top applications market, and dominated by established American firms, and advantages based on low labour costs lose their relative importance.

Thus, while the potential gains from package production seem promising, the barriers to entry remain formidable. Although Correa does not discuss software efforts targeted at domestic markets, domestic software service and product markets remain not only possible but also likely. Further, it is unlikely that a software enterprise could penetrate a foreign market without having first gained some experience and capacity locally. However, as DC markets are often small and un-demanding, Correa rightly points to external markets for larger growth potential. Sequencing, in moving from domestic production to exports, is a key strategy for developing nations.¹⁰¹

¹⁰¹ Ibid., p. 159.

Then in 1999, Richard Heeks presented a “strategic positions” matrix describing potential software markets for DCs, with two distinctions from Correa’s work.¹⁰² First, Heeks considers the off-shore services and development services as one option. Second, he includes domestic markets, in addition to export markets, as options for developing software enterprises. The matrix uses letters to designate five “strategic positions,” and has been modified here to include Correa’s three export options.

Table 1: Export Options

	Software	Business
Market Served	Services	Packages
Export	A 1	B 3
Domestic	C	D

4. (C) Software Services for Domestic Market

Providing consulting services, and custom work to local customers, is by far the easiest market segment for software start-ups to enter. The opportunities and barriers are generally similar to those involved in services for export areas. However, the capability to understand and meet local user needs is far more easily acquired, and essential for tailored, customized services.

¹⁰² Heeks, p. 16.

5. (D) Products for Domestic Market

The option of providing software packaged for local customers encompasses similar characteristics as in Option 3 above. This can be a good starting point for progress into exports. A sizable and demanding domestic market can be the springboard from which to launch into exports by providing a base of relevant skills, experience, user feedback on products and track record. Second, a sizable domestic market will draw large numbers of IT multinationals into collaborative partnerships with local partners in order to serve that market. As these relationships deepen, an export component often emerges.

Unfortunately, the domestic software market in many DCs cannot yet be described as either sizable or demanding. In Western countries software represents more than 55% of the IT market; in countries like China and Indonesia, the figure is less than 20% and there is a technology lag of some years behind the leading edge. For them, position-D is more a survival strategy than a development strategy.

Position-E

Heeks suggests that position-E is the “other main success story of DC software,” alongside position-A.¹⁰³ Position-E is defined as specialization for niche markets that include: sectoral niches like banking; application niches such as Web browser add-ons; and linguistic niches for regional languages such as Spanish or Chinese. Previous literature on software potentials for developing country firms, including Williams, Rajeswari and notably Schware, discusses niche market penetration, and capturing

comparative advantages. They do not, however, suggest an all-encompassing position, such as position-E, which includes a sub-set of all four quadrants.

There are two fundamental pitfalls with Heeks’ proposed strategy. First, Heeks does not offer more than a few well-known examples from DCs as support for his argument. More importantly, what he offers is not a strategy that DCs can systematically undertake. Position-E is a “do everything for everyone” position, as it involves simultaneously providing a variety of products and services to multiple markets. Heeks declines to offer a process or course of action for which DCs could engender a software capacity. Where is the entry point? What is the logical path for growth?

Second, a four-fold typology is too simplistic to accurately portray the possibilities for software technological effort and development. With over 70,000 applications for the Windows platforms alone, (meaning only the PC desktop market), the possible areas in which to develop capacity have vastly grown. This paper proposes a broader typology of software production options to capture the intricacies and implications of software production and relative market potential. The typology will show that there are many strategies for entry into the (global) software market. This scope has important implications for technological assessment and capacity-building, neither of which can be prescribed without rigorous, situational analysis.

Table 2: Software Production Possibility Matrix

	Software Services and Products Possibilities
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¹⁰³ Heeks, p. 18.

Market	Off-shore Service	Customized/ Service	Universal Applications	Industry-tailored Applications	In-house/ Customized	Embedded Tools
Domestic	n/a					
Regional (proximity in geo, lang, cult, etc.)						
Global						

The service options include those described by Correa and others, in terms of “off-shoring” and customized software services. Then, however, it distinguishes between packaged product types. Universal products are those which include general software applications targeted at horizontal markets. Industry-tailored products are software applications targeted at vertical markets. The differences between these markets bear important implications for skill requirements and customer knowledge.

The last two types include in-house development, and embedded software tools. Both sectors represent software capacity-building that is outside the software industry, in as much as the producers do not retail the software products or services.¹⁰⁴ Instead, software is developed and applied to enhance the firm’s central products or services. Thus, they are “greyed-out” in the above schema.

Next, this typology distinguishes two areas of international markets, regional and global. The regional market can be described as proximate in terms of geographical distance, common language, or shared cultural norms. The global market includes areas

¹⁰⁴ organizations that create and use their own software but do not generate revenue from sales of software products or services. Examples of in-house developers include banks, insurance companies, utilities, and government agencies.

outside the regional jurisdiction. Sequencing, therefore, in market penetration, involves an added phase of targeting regional markets, prior to entering global ones.

In terms of embedded software, computer-aided design (CAD) applications have spurred innovation within electronics capital goods sector, and have shown to have applications in variety of others, with dramatic impacts on employment patterns, prices and industrial structure. These areas of software capacity-building are beyond the scope of this paper.

Software service and product possibilities exhibit variations in their characteristics, and implications in terms of opportunities and barriers to entry. These implications in turn input considerations for undertaking technological assessment and corresponding capacity-building requirements.

The nature and economics of software reveal the main commonalities between software product types. However, each of the characteristics, market scope, market force, labour intensity, skill intensity, firm intensity, and user-developer interaction, differs in terms of relative difficulty and relative costs, which helps determine the relative size of barriers to market entry. For example, a horizontal market is less costly and easier to penetrate than is a vertical one. Task-driven innovation is a less demanding market force than user-driven innovation. Skill intensity determines resource intensity. Firm intensity determines level and scope of competition. And, the higher the user-developer interaction, the more volatile the innovation process.

Understanding these characteristics can contribute to assessing capacity-building requirements and barriers to market entry, and their links will be outlined in Chapter 4.

Table 3: Characteristics of Software Production Possibilities

	Software Services and Products Possibilities					
Characteristics	Off-shore Service	Customized / Service	Universal Products	Industry-tailored Products	In-house Customized	Embedded Tools
Market Scope	Horizontal	Horizontal	Horizontal	Vertical	Vertical	n/a
Market Force (source of innovation)	Task driven	User Driven	User/ Task Driven	Industry Alliance Driven	User/ Task Driven	
Skill Intensity	Low	High	High	High	High	
Firm Intensity	Low	High	Medium	Low/integrated	n/a	
User /Developer Interaction	Low	High	Medium	Medium	High	

The key for DC enterprises seeking to develop software capacity, is to be able to systematically undertake technology assessment, that is to assess these options and markets, and evaluate them within the context of the various barriers to entry, and contexts of their own societies. They can then determine appropriate levels of technological effort, as required for capacity-building. This view of software production possibilities as more diverse, bears implications on software innovation in developing economies. As espoused by the “new techno-economic paradigm,” a country like Chile must carefully evaluate its own relative position in the global software market.

Chapter 3: Empirical Research Method and Design

Primary social science research often takes the form of interviews, conducted within a fairly formalized framework designed to collect quantitative or qualitative data. The researcher selects interview candidates considered reputable in the field of inquiry, and seeks their permission to conduct an interview in person. Generally, researchers require a representative and statistically significant sample of a given population, to whom a pre-defined set of questions is administered. The interviews may vary, as answers may steer the conversation in different directions, while the researcher strives to ensure that each question is covered. It is unlikely that the researcher may return to the interviewee to fill in any omissions found later.

The interview is often tape-recorded, while the researcher takes notes, then later transcribes the tapes. The recording and transcribing process is repeated for each interview, making it very time consuming for both the researcher and each interviewee. Next, the information is synthesized and analyzed, and the research progresses.

The formal interview method is an effective data collection method, assuming several conditions such as: reliable interviewees are available and cooperative; the pre-defined questionnaire can address all the issues to be addressed in the research; and the information communicated in the interview session can be captured and recorded.

In conducting a case study of Chile, the researcher should travel to Chile to carry out required interviews. The entire process requires substantial advanced planning, coordinating logistics, and allocating time and money. Most importantly, the researcher must be sure to gather all pertinent information, as a subsequent return trip is unlikely.

This paper suggests that the Internet offers an alternate and effective vehicle for conducting field research.

The Internet as a Tool for Social Science Research

There are currently at least seven areas of the Internet which can serve as tools for researchers to gather information. These services and their functions can be briefly explained.

1. The World Wide Web is one of the most pervasive aspects of the Internet, with over 56,218,000 hosts¹⁰⁵. There are more than 17 comprehensive search engines, with which researchers can do key-word searches to find Web sites on subjects, persons, organizations and other information. If the site contains an e-mail address, the researcher can contact the originators. The Web also now supports forms, so that visitors can provide information directly to the originator. Availability, reliability, and credibility of information posted on the Web is determined exclusively by the originators.
2. Usenet newsgroups are discussion groups, categorized by subject matter, which allow a user to post queries to which other readers can respond to the group and/or to the originator. Newsgroups can be used as forums to discuss issues being researched. Users can post queries, to which other readers can reply, or can passively read discussions between other readers. Although there are more than 15,000 newsgroups with worldwide distribution, they are created upon demand, and do not cover subjects comprehensively. For example, currently, there are no groups discussing the software industry in Chile.

¹⁰⁵ The number of separate hosts, or assigned IP addresses. There can be many Web sites under each host. <<http://www.nw.com>>

3. Listservs can be likened to electronic mailing lists, where subscribers automatically receive e-mail messages by the list editor. For example, the Red Rock News Eater Service is a mailing list of 4,300 subscribers, compiled by Dr. Phil Agre of UCLA, usually on the social and political aspects of networking and computing.¹⁰⁶ There is no interaction between subscribers, and the originator acts as a “gatekeeper” of the communications and content.
4. Telnet is a portal to access databases, such as library catalogues. With such searches, or “data mining,” users can determine the availability of resources they seek, and usually can request that those resources be reserved or requested.
5. File Transfer Protocol (FTP) is limited to transferring files (documents) from one computer to another. The files cannot be opened during transmission. FTP is the most unstable area of the Internet, and is gradually being replaced by the Web, for downloading documents.
6. Electronic mail is a messaging system, whereby two-way text-based communication can take place between individuals or groups. E-mail can be used to conduct electronic interviews.
7. Chat rooms are sophisticated areas of the Internet, whereby users can send and receive messages in real-time, store files, hold group discussions and display images and text. Chat is a very new tool, which could host “research communities,” and conduct interviews, although it cannot provide anonymity to its users.

Conducting research via the Internet requires, at minimum, access to a personal computer with Internet service, and the skills to operate the software applications. All

¹⁰⁶ <http://dlis.gseis.ucla.edu/people/pagre/rre.html>

required Internet software is available minimal or no cost, and this is known as shareware or freeware¹⁰⁷. Such accessibility represents one of the main philosophies of the Internet: non-elitist, transparent, open communication with other individuals or groups with common interests.

For many years, the Internet was also free of regulation. Yet, despite this seeming lawlessness, Internet users are obliged to behave and interact according to a set of norms known as “netiquette.”¹⁰⁸ Netiquette covers both common courtesy online and the unofficial “rules of the road” of cyberspace. The purpose of netiquette is to respect the functions of the Internet, discourage its abuse, and maximize its resources. Any researcher must abide by cybercultural norms when collecting data, on any service of the Internet.

To date, most of the focus on conducting research on the Internet has been on searching and gathering information on the Web. Indeed, the Web is a valuable tool for researching secondary sources. Although marketing firms often use online forms to conduct customer surveys, there has been little use of the Web as a primary data collection tool in the academic realm.¹⁰⁹ Yet, with Web or e-mail surveys, researchers can reach countless potential interviewees, crossing barriers of distance and time. The obvious constraint of online research is the availability of Web sources, and the

¹⁰⁷ Shareware authors provide either a “lite” version of their applications, or charge a nominal fee for their efforts. Freeware is entirely free of monetary charge. Full versions of Internet software can be purchased by users who desire customer support and documentation.

¹⁰⁸ <<http://www.albion.com/netiquette/>>

¹⁰⁹ The only site I found was that by a student doing gender research for psychology in a German university. The site is now down, presumably she has finished, but it is possible that her data collection was unsuccessful.

connectivity of desired interviewees. And, none of these services can replace personal interaction between the researcher and the interview candidates.

This study employs the services of the Web, Telnet, and FTP to research secondary sources, and the Web and e-mail to conduct primary source interviews. The interviewing tools are inspired by “Rapid Appraisal” and participatory approaches to information collection.

Rapid Appraisal (RA), also known as relaxed appraisal, rapid rural appraisal and participatory rural appraisal, are part of a continuum of qualitative appraisal methodologies used by development practitioners to quickly and reliably develop understanding of a social issue, by collecting and analyzing data.¹¹⁰

RA is fast and flexible but rigorous. It is grounded in recognition that all dimensions of a local system (be it an irrigation system or a political system) cannot be identified in advance, and that attempts to do so reflect primarily the outsider's culture. Instead, a team of individuals with contrasting expertise can develop an understanding of a system by synthesizing information from several sources: prior research and reports, direct observation, and semi-structured interviews. The goal is to grasp an insider's perspective on the system and to understand it as a whole, rather than to come up with a statistical description of its constituent units.¹¹¹ As a form of qualitative research, RA is based on three principles: systems perspective, triangulation, and iterative process.¹¹²

Research Techniques of Rapid Appraisal

Systems Perspective

1. Semi-structured interviews;

¹¹⁰ World Bank. <<http://www.worldbank.org/wbi/sourcebook/sba104.htm>>

¹¹¹ Sweetser, <<http://www.usaid.gov>>

¹¹² Beebe, p. 11.

2. Use of "individual respondents" to represent variability and "key informants" who can describe the broader system beyond their own direct participation; and
3. Drawing diagrams and pictures.

Triangulation

1. Multidisciplinary teams;
2. Information collected in advance; and
3. Direct observation.

Iterative Data Collection and Analysis

1. Structuring research time to allow for appraisal team interaction.

Systems Perspective

The first task of RA is to make rough approximations of the system and those elements that might be most important in the specific context. These informed guesses must be recognized as hypotheses. They are the starting point for repeated and critical reevaluation as the researcher clarifies understanding of the system as viewed by insiders. A range of techniques may be employed to obtain information about a system.

Triangulation

The second principle is use of triangulation. This term comes from navigation, and means seeking a position or location by means of bearings from two known points. When applied to Rapid Appraisal, it involves systematically combining the observations of team members with different backgrounds and using a variety of research methods. The assumption is that for most situations, there is no one "best" way to obtain information, and even if there were, it could not be foreseen.

Rapid Appraisal must triangulate among people by listening to the viewpoints of different groups. It is also necessary to triangulate among methods, to combine

information from interviews and direct observation with information collected in advance. This improves the quality of information and provides cross-checking.

Iterative process

Using Rapid Appraisal, researchers begin with information collected in advance, and then progressively expand their knowledge and deepen their understanding by gathering new information through semi-structured interviews and direct observations, and sharing their interpretations of this new information as it is collected. The research effort is structured to encourage participants to rapidly change questions, interviews, and direction as their understanding evolves.

Limitations of RA

Rapid Appraisal's advantages in terms of cost, speed, and type of information, come with some equally large limitations. First is the question of reliability, which can be undermined in three ways:

1. RA does not employ probability sampling and therefore may be criticized for producing results that are unrepresentative.
2. Individual judgments can affect the conduct of the inquiry substantially. Flexibility can help investigators to achieve depth, but it comes at the price of potential bias or distortion. The risk is that investigators hear only what they want to hear.
3. Qualitative information can be very hard to record, code, and analyze.¹¹³

The second weakness is that it does not provide data from which generalizations can be made about populations. Rapid appraisal helps to enrich the picture, but it doesn't provide information about the extent or pervasiveness of a phenomenon. The third

¹¹³ Gibbs. p. 1

weakness is that its findings often lack credibility. Decision makers often prefer precision to a rich description.

Despite these shortcomings, RA techniques are applicable to this research project for several reasons. While the core dimensions of software and socioeconomic development are well understood, there is little documented on the interrelationships between the two areas. Thus, qualitative data can be collected, more qualitative information would contribute greatly to deepening the understanding. Thus, the central question for conducting the case study is “What do Chileans think about software for socioeconomic development in Chile?” This question can be explored using rapid appraisal techniques, carried out with Internet technology.

Rapid Electronic Appraisal

The process of undertaking RA and baseline survey techniques, over the Internet could be described as Rapid Electronic Appraisal. This methodology has no precedent to draw from, and therefore presents a test case, designed to determine the effectiveness of conducting RA approaches electronically, as a social science research strategy.

Research Techniques of Rapid Electronic Appraisal

Systems Perspective

1. Structured online surveys;
2. Unstructured e-mail interviews with willing respondents; and
3. Use of "individual respondents" who can describe the broader system beyond their own direct participation.

Triangulation

1. Researcher; Chilean Respondents; Canadian group;
2. Information collected in advance; and
3. Virtual observation.

Iterative Data Collection and Analysis

1. Structuring research time to allow for appraisal team interaction.

Systems Perspective

Certain issues are apparent, but little solid quantitative or qualitative information exists about the Chilean software industry. Thus, the questionnaire is designed to collect qualitative information, perceptions, and self-evaluation and self-analysis of the respondents. The survey is administered using the Web and e-mail.

The study begins with more control than RA typically would, by initiating dialogue using a structured online interview, followed by un-structured discussion. Each survey question represents a hypothesis of known factors related to software and development, leaving room for other variables to emerge and be identified.

Triangulation

Since this research contributes to an individual's thesis, gains from triangulation of research perspectives are limited. However, observations were gathered from Canadian software professionals with both academic and entrepreneurial backgrounds.

There was more possibility to triangulate among data collection methods, as sources include literature, baseline data, virtual (Web) observations of organizations, and qualitative information collected from survey respondents.

Iterative Process

The information gathering process flowed between several steps including: analysis from secondary sources, survey responses, feedback to Chilean respondents, follow-up interviews with certain respondents, presenting information to Canadian group, synthesizing their input, and informing Chileans of latest findings, and engaging in electronic dialogues based on virtual observations.

The approach to conducting REA attempts to create a “research community” online by building an information sharing Web site that extends the parameters of static Web sites, which are limited to passive information collecting. The participants can engage in a process that is dynamic and evolutionary, rather than in a one-sided communication process. It also improves on the schema of traditional extractive research which engages in one-on-one communication. REA is more participatory and interactive. It offers a broader exchange of information to capture local knowledge. The approach can uncover the opinions of others, and offers ways of making connections, while providing anonymity to the respondents. It represents one vehicle for generating communication flows between South and North. As it crosses geographical boundaries and distance time constraints, it can reach a potentially broader population of respondents, and connect them together no longer just as interviewees, but rather they are transformed into an integral part of the development of the knowledge base. In this information exchange, Internet technology is the enabler of developing this process. The assumptions and limitations of this process are raised later in this chapter.

Figure 1: Flows in Research Models

Traditional Approach

Researcher represented at centre of group.

Interviewees around edge.

REA Approach

Researcher at centre.

Chileans around edge. Canadians as bottom right group.

Survey Questions

The questionnaire includes 15 questions, some containing two parts, and is divided into three sections. The survey progresses from general to specific questions, several with opening phrases to contextualize the issue, and hopefully reducing possible misinterpretation. The survey attempts to test the socio-economic factors raised in the literature on IT and software. The first 13 questions are open-ended so that the answers can be viewed in the context of social innovation dimensions, while the last two address

equity issues directly. A second reason for asking open questions is to offer opportunities for respondents to raise issues outside the scope of the questions.

This paper argues that aspects of social innovation must be fully integrated into a discussion on harnessing software capabilities for socioeconomic development ends. Drawing on capacity-building literature described earlier, the survey questions address physical investment in terms of information infrastructure and financial capital; and human investment in terms of education and sourcing. It also regards technological dependence as including domestic or foreign market orientation; and pricing.

As these areas apply to software innovation, their relationship to technological assessment and barriers to market entry become apparent. These factors are examined within the key dimensions of social innovation: institution building, universal access, employment, global division of labour, distribution of wealth and power, and the role of government. This inquiry will lead to public policy recommendations. An explanation of the rationale and motivation behind each question is provided following the list of 15 questions.

I—Chilean Software Industry

1. *There are at least 200 software firms in Chile, and the number appears to be growing.* What are the Chilean software industry's strengths? What are its weaknesses? Which ones are successful?
2. *Equity and debt capital are crucial for new businesses.* How do software firms in Chile finance their development and growth?
3. *Software companies in Latin America often suffer from inadequate infrastructure, small domestic market size, and shortages of quality standards.* What barriers do software firms in Chile face? How can these obstacles be overcome?
4. *It appears that subsidiaries of foreign firms have greater access to qualified and experienced managers, programmers, and marketing personnel, and to many*

software engineering tools (such as CASE). Do firms in Chile have equal access to the resources and "know-how" that they need?

5. What role do educational institutions play in software development? To what extent does Chile's education and training system meet the needs of the local software industry?
6. How is the government involved in software? How have labour organizations interacted with the software sector?
7. What are the strengths and weaknesses of management practices in the software sector?
8. *Chile is "looking outwards" more and more, with its new stock exchange and thoughts on joining NAFTA.* What effects could such internationalization efforts have on the software sector?
9. How can software firms achieve significant market share at home? How can firms achieve a position in the international market?

II—Software products

10. What kinds of Chilean software products have been successful to date? What kinds have failed?
11. Are Chilean software products more culturally and linguistically appropriate than foreign products?
12. Are Chilean software products targeted for domestic customers or for other markets?
13. How are Chilean software products priced to compete in different markets?

III—Social Equity

14. Who benefits from software production in Chile?
15. Do software institutions have any kind of social mandates? Is there a role for the software industry in philanthropy?

Additional Comments

Do you have any additional comments or feedback?

Design of Each Survey Question

General Perspective:

1. How do Chileans define success? Can Chile maintain its strengths and overcome its weaknesses in order to enhance its longer-term sustainability?

Software capacity-building, and technological dependence:

Physical Investment: Questions 2. and 3. raise issues of information infrastructure, financial capital, software development resources, marketing resources, and relative weight of labour costs. Is the IT infrastructure available and accessible? Is the physical capital sufficient? Are sources of finance sufficient, stable and sustainable? What sort of market will entrepreneurs be able to penetrate? Are they looking towards meeting the (high) costs of labour required for R&D and marketing?

Human capital: Questions 4. and 5. address quality standards, methodologies, qualifications and education, management skills, marketing skills and identification of local needs. Can local firms attract the software talent that they need to develop? Or are they overpowered by multinational subsidiaries? Are Chilean colleges, institutes and universities teaching software design and programming exclusively? Or do they play a larger role as vehicles for technology transfer and R&D? Are software firms themselves stepping in to ensure that their employees gain technology sourcing capabilities.

12. 13. Issues of technological dependence focus on market exposure (domestic or foreign). Is market exposure reflecting in pricing policies?

Politico-economic Environment:

Question 3. Seeks to identify overall barriers to entry. Particularly important are views on relative market size, and the role of government (Question 6.) in shaping a progressive software sector.

Competitiveness (Domestic and Foreign) International Division of Labour: 8. 9. 11. 12. and 13. What is the configuration of technological dominance and dependence? Are these positions competitive and sustainable for growth and enhancement? Also, with 12.,

the decision to use either open source¹¹⁴ or proprietary systems has important commercial implications. For example, it indicates that there is no unique way of developing a certain product. Software producers must make strategic choices, taking into account the type of products and markets envisaged.

Further, the capability to develop software is one of the most highly decentralized and distributed technological competencies of the late 20th century. This distributed capability to design and develop software suggests that assumptions about relationship between suppliers and consumers must be regarded critically.

Social Innovations:

Role of government: 6. How is Chile's government contributing to a national software strategy? Issues raised in other questions also apply to this topic.

Institution building (networks, coalition-building and alliances): Are schools, software associations and local authorities concerned with the distribution of wealth and power, and of access to resources in Chile? Are they progressive enough to dismantle discriminatory barriers?

Universal access: Question 6. Is considered with respect to IT infrastructure, education and training. What is the government doing in this regard? Software can be copied quickly and inexpensively. What are the patterns of diffusion in this regard? This is also brought out in 4. At the same time, the tacit aspect of software knowledge has other important implications. Since it is not formalized, it is difficult to transfer. To exchange

¹¹⁴ Programming code provided by its creators free of licensing requirements or any other monetary charge.

programming ideas and problem-solving, developers often must meet face-to-face, to solicit input and feedback. Herein lies a contradiction in the social mechanisms of software development. On one hand, it occurs in cyberspace, and on the other hand, it requires personal contact. As a result, software firms have tended to cluster together in “software parks.” Not only are there collective efficiencies in the supply of infrastructure, personnel and finances, but proximity also facilitates informal knowledge exchange.

Employment: Can rising software production generate significant software employment? Or will labour become bi-polarized? How does the nature of software effect employment characteristics? 6. and 7. Will industry and governments collaborate to create systems and practices to minimize possible socioeconomic stratification and to promote equitable distribution of benefits? Are government policies effectively promoting employment?

Distribution of wealth and power: Again, 6. and 7, in terms of progressive roles played by industry and government. 14. Who are the beneficiaries of software creation and use? Who can participate in the software sector? 15. Are software professionals thinking progressively? 5. Note the duality between software as an “amateurish, craft-based discipline, where “enthusiasts” learn by doing (tacit knowledge and experience/ unaccredited developers and amateurs) versus formalized system of accredited professional software engineers? Are end-users involved in the process? Structural basis for power related to universal access issues. Also related to 6., the conditions under which technology is developed raise real problems for democracy— problems about accountability in the use of public monies, about control over the development of the

technology, and about sovereign power in an international economy. Is IT viewed as a civil right or as a tradable commodity?

Will rural people be marginalized? 6. Form and availability of information by governments to people. Affects democratic processes, transparency and accountability. Benefits to social relations? Will IT lead to producing a more participatory system of government?

These questions were assessed in terms of both the answers provided by the survey respondents, as well as by empirical observations and other evidence found on the Web.

Data Collection Process

In 1995, there were only 57 Chilean software-related Web sites found on Web search engines. It was doubtful that much response could be generated from such a small number of sources. By 1997, 103 sites were posted, although 36 sites of the original list were no longer live. By late 1998, the number of sites had increased significantly; about 200 organizations, related to the Chilean software industry, were reachable via the Internet. However, only 58 of the 103 sites identified in 1997 were still live.

Nevertheless, at this point, with many more potential Chilean Web sources, undertaking REA seemed feasible. Over the following few months, however, new Chilean sites were launched, and others were removed. Thus, the list of sources evolved, reflecting the volatility of new software enterprises.

The next step was to compile a contact list of organizations in Chile as sources of potential interviewees. Key-word searches were conducted in all the major search engines and directories. The types of organizations sought included: universities and training institutions; software and computing firms; government agencies related to technology and economic development; IT media; Members of IEEE-Chile¹¹⁵; non-profit organizations; and IT-related unions and associations. The most comprehensive source of relevant sites was the Chilean version of Yahoo!, called La Brujula.¹¹⁶ Interestingly, La Brujula is not referenced in conventional (American) search engines or directories. All contacts were found directly or indirectly from search engines, all resulting sites were Chilean, and most located in Chile.

The contact list required two months to compile. In an effort to increase its reliability, the list was tailored in several respects:

- Neither Internet Service Providers or Web solution providers were included as they are not software developers;
- Any site that was down consistently, “non-existent” or “file not found”; for more than two months, was taken off the list;
- Sites of some major multinationals, such as Olivetti, Apple, Oracle, Microsoft, were linked to their parent site, with no direct Chilean contact, and therefore these were taken off the list;
- In some cases, no e-mail contact information was provided, or the contacts page was consistently down. These were removed from the list;
- To companies with Web sites that did not have e-mail contact information, messages were sent to postmaster@name.cl and webmaster@name.cl.¹¹⁷ There was no reply to any, and were removed;
- In other cases, in which more than one contact e-mail was provided on a firm’s Web site, two addresses were randomly selected. For example, NEC Chile provides e-mail contact for all employees in the company. However, it is inadvisable to send to all, as

¹¹⁵ The Institute of Electrical and Electronics Engineers, Chilean Chapter

¹¹⁶ <<http://www.brujula.cl>>

¹¹⁷ It is standard procedure to register both names on any Web domain.

that constitutes spamming, one of the worst infractions on netiquette.¹¹⁸ Therefore, some companies received two separate e-mails; and

- In all cases, attempts were made to reach the most senior, relevant, officials in the organization.

The resulting list of potential sources in each organizational category was then marked up into Web pages, which included lists of potential contacts and their organizations, with their Web and e-mail addresses. From these Web pages the contacts were e-mailed individually, in order to maintain their anonymity. Netscape Mail, the e-mail software used in this study, keeps records of number of e-mails sent, addresses, messages and dates.

After deleting all “down” Web sites and non-functional e-mail addresses, all “live” contacts were compiled into a Web page entitled “All Contacts”. Of the 277 potential sources for contacts, only 242, or 87%, provided any useful contact information. The potential 242 contacts include members of firms, educational institutions, government agencies, associations, members of IEEE, and non-profit organizations. The “All Contacts” Web page contains notes about the Web sites and contact attempts, and is presented in Annex 2.

Table 4: Compiled Contact E-mail List

Area	# Chilean Organizations with Web Presence (All Sources)	# Chilean Organizations Reachable via Internet (All Contacts)
Academic	36	17
Firms	199	179
Government Agencies	7	7
IT Media	1	1
Members of IEEE-Chile	14	14
NGOs	14	5
Unions and Associations	6	19

¹¹⁸ Spamming is emailing or newsgroup posting of unsolicited advertizing messages to a wide audience. Everett-Church, Ray. "Why Spam is a Problem" *OnTheInternet* 5(3) (May/June 1999): 16-21.

Totals	277	242
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Nearly all organizations were located in major urban areas in Chile, and therefore have access to telecommunication and electrical infrastructures.

Next, each contact in the list, as a potential interview candidate, was sent an introductory e-mail message, soliciting their input to the research. The message introduced the researcher and the research issue, and provided context to the inquiry. It proceeded to invite them to visit Web site, to answer the online survey. Also, it offered a compilation of the survey results in return for their cooperation. Finally, it asked to forward the message to any other potentially interested in the study. It should be noted that all communications with Chileans was carried out in Spanish.

After two weeks, a second e-mail was sent to all, excepting those who had responded, reminding them of the inquiry. This message included the survey questions in the body of the e-mail. Another two weeks later, a third message, advising of the imminent closure of the study, was sent. During this process, additional Chilean Web leads were found and were compiled in a similar manner as the initial list. The second list received two request messages. The request e-mails are included in Annex 3.

The communication process, designed to generate as much response as possible, without being intrusive, involved an iterative process, lasting six months.

Communication Schedule

5th and 6th March 1999:

First request e-mail: Introduction to software study, and solicitation of interest

21, 22, and 23 March

Second E-mail: Reminder message sent

12th April, 1999

Third E-mail: "Last chance" e-mail sent

Meanwhile, new URLs¹¹⁹ were found and compiled, and integrated into the “All Contacts” list.

23, 29 March and 12 April 1999

First and second e-mails sent to second list.

Some were down on first try, but second try succeeded, and another e-mail was sent.

18th May 1999

All responses were received and tabulated.

8th June, 1999

Synthesized responses, initial observations and comments were sent to respondents.

28th June, 1999

Compilation sent to Canadian group to solicit their perspectives.

10th July, 1999

Total compilation, including input from Canadians, was sent to Chileans.

Table 5: Communication Statistics

Area	# Orgs Reachable via Internet	# Contacts made†	# Bounces (each x 2 attempts)+	# 1 st E-mails Sent ^α	# 2 nd Reminders Sent	Total E-mails Sent	# Respondents	% Orgs*
Academic	17	30	6	36	0	36	0	0
IEEE-Chile	14	14	0	14	0	14	2	14.3
Unions/ Assoc.	19	19	1	20	0	20	2	10.5
NGOs	5	12	2	14	0	14	0	0
Gov't	7	15	0	15	7	22	1	14.29
IT Media	1	0	1	1	0	1	0	0
Firms	179	193	22	215	114	329	19	10.61
Totals	242	283	32	315	121	436	23	9.5

† successful transmission of messages

+ only one bounce recorded. Attempts were then made to reach each organization via webmaster@ and postmaster@, but neither was successful.

α successful contacts and bounces.

* percentage of responses from organizations reachable via the Internet.

There were a total of 436 contact e-mails to the list of 242 potential contacts.

After all stages of communication, and two unsolicited replies, there were a total of 23

¹¹⁹ Universal Resource Locators (URLs), or Internet Protocol addresses, are unique identifiers for Web pages.

respondents, or 9.5% of the “All Contacts” list. This figure reflects a reasonably good response rate.¹²⁰ The two unsolicited responses were presumably generated by the request to forward the message to any interested parties. In addition, there were ten cases where dialogue ensued with organizations and individuals, whereby they showed their interest in the project, although they declined to submit completed surveys.

Table 6: Number of Requests and Response Medium

	# Respondents	% Respondents
1 request e-mail	16	69.57
2 request e-mails	5	21.74
Unsolicited replies	2	8.7
Total	23	100.01
Personal address	7	33.33
Generic address (info or sales)	14	66.67
Total	21*	100.00
Replies via e-mail	11	47.83
Replies via Web form	12	52.17
Total	23	100.00

* unsolicited contact not applicable.

This information implies that sending two e-mails to potential respondents, increased the likelihood of their response, as an additional 21% replied to the second request. The networking aspect yielded two respondents. It is unlikely that generic e-mail addresses on Web sites in North America would have resulted in reliable responses, a situation which appears to be effective in Chile. The respondents showed no preference for reply format, as there were equal numbers responding by e-mail and the Web form.

¹²⁰ Direct mail unsolicited marketing campaigns expect to generate a response rate of 2-3 percent of the total target market. <<http://www.fundraisersintl.com>>

The “knowledge exchange” Web site represents the cornerstone of the REA techniques. It was designed to generate electronic interviews, and to engage participants in meaningful discussion of software and development issues. It is located at <http://www.igs.net/~sabrina/tesis>.

Web Site Design

- brief overview of thesis concepts/goal of research project
- hypothesis and general assumptions - secondary page for more information
- need to maximize response potential - results of survey were offered in exchange for completing questionnaire

Interview questions (On-line survey)

- explanation as to why questions are being asked
- brief questions
- offer to follow-up

Information about Researcher

- biographical information
- link to Carleton University Web site.

Other sources

- links to information related to software in Chile
- interview quotes

Contact Information.

Answers were received from respondents in one of two formats. First, in the body of an e-mail, and second, via a Web form. Form data are sent from the Web page to a designated e-mail address in an attachment.

Example of Web form data:

Name=Carlos+Fuentealba&Title=Software+Consultant&BusinessType=Business&WebSite=[http %3A%2F%2Fwww.infotecnia.cl](http://www.infotecnia.cl)&EMAIL=cfuentealba@infotecnia.cl&1_1=Fortalezas%3A%0D%0ABajo+precio+de+la+mano+de+obra%0D%0ABuenos+sistemas+de+comunicaci%F3n%0D%0AAlto+est%E1ndar+de+calidad%0D%0A%0D%0ADebilidades%3A%0D%0APoco+capital+de+riesgo%0D%0AAlejado+de+los+centros+de+desarrollo+tecnol%F3gico&1_2=Con+capital+propio&

Using the “search and replace” function in a text editor, all format characters were removed and accented characters input. For example “+” represents a space, and “%E9” represents “é”; and “&” represents a field break.

All of the information gathered from respondents was recorded in a response database, using Microsoft Access. One record, with respondent information, and answers to questions was created for each interviewee. This process was undertaken so that responses could be queried and viewed by respondent or by question. All information was translated into an English version, and also summarized for clarity.

Also, the validity and reliability of the respondents was verified by re-visiting their organization’s Web sites and by following up references mentioned in their replies. (See Annex 3) The entire process of compiling contact lists, soliciting participants, and conducting electronic interviews generated substantial observations regarding the interviewees, their organizations and the software industry in Chile.

Virtual Observations on Chilean Web Presence

There is a much higher level of information related to software and Chile, on the Web as compared to a few years ago. There is an increase in the “noise” level as well. Most of the observed increase relates to Chilean businesses. There appears to be a high turn-over of sites, as new ones are put up, while others go down, almost daily. Many firms have sophisticated, elaborate, and expensive Web sites. However, many also have glitzy, over-done sites, with enormous, slow-loading images, but little information of substance. The nature of their business, main products or services are sometimes not

easily found. Very few software firms advertise their products overtly. This is peculiar, considering that a primary use of the Web is for self-promotion and marketing.

In many cases, contact information is not present, or is difficult to find. Many provide street addresses, fax and telephone numbers, yet no e-mail address. In others, one must fill out a form and submit it to an unseen e-mail address in order to communicate. Such forms ask for a contact's name, e-mail address and comment in three fields— the same information included in any standard e-mail message. Is this a bureaucratic approach to electronic mail?

The Web presence of government departments related to science and technology is surprisingly weak. Information is sparse and updated infrequently. For example, the Comité de Empresas Exportadoras de Software (CEES) Web site was last updated in June 1998, and there is no index (main) page.

All organizations and most firms have dot.cl domain names registered. Very few have dot.com. However, some firms employ Web site hosting services of xoom.com, which is free of charge, but highly intrusive.

Observations on Respondents

Nearly all respondents are high-level officials, senior executives and programmers. Collectively they constitute a more sophisticated group of respondents than what was expected from the contact list, as there were many “general mailbox” addresses. The group includes two women, which was also surprising, based on the low number of women in the software industry generally.

The lack of response from academic institutions, associations and government agencies also was unexpected. Interestingly for Chile, which has had a strong labour union movement historically, there is apparently no union organization for software professionals.

Of the firms, the type of business is predominantly consulting enterprises, re-sellers and developers, which reflects the nature of the software industry in Chile. No “year 2000” compliance firms or multinational subsidiaries responded.

Categorization of the respondents by organization type, however, proved difficult, as several belonged to two known types. For example, members of IEEE are also either academics or entrepreneurs, and some academics are also entrepreneurs. Thus respondents, were grouped according to the type of organization they themselves specified. (See Annex 4 and 5).

All of these observations, together with a synthesis of responses was shared with a group of Canadian software professionals, in order to provide an opportunity for triangulation. The group comprised 12 individuals, both academics, entrepreneurs and developers, of which ten provided perspectives on the discussion. (Their input is detailed in Chapter 4.)

Assumptions and Limitations of REA

The critical assumption underlying this compilation was that target organizations have access to the Internet. This was not an unrealistic expectation for organizations involved in the software sector. In terms of cost-accessibility, in Chile, the purchase of personal computer equipment and business software packages is generally two-thirds of

the cost in Canada. Internet Service Providers in Chile are equivalent in service to those in Brazil, Mexico and Argentina.¹²¹ However, domain name system (DNS) registration for dot.cl subdomains costs US\$25 for the first two years and US\$10 thereafter.¹²² This is about one-tenth the cost in Canada for the enlisting of dot.com sub-domains, although dot.ca is free of charge. The Chilean DNS registration service is run by the University of Chile in Santiago.

In terms of limitations, there were five contacts who had difficulty with the Web form, three of which sent in their answers by e-mail, and two of which ultimately did not complete the survey. Many contacts were using old Web browsers (<v3.0, most often of MS IE), which did not support forms.

It was difficult to determine the organizational origin of those respondents with entelchile.net e-mail addresses, since the organization name is not specified. There were 14 companies with entelchile.net subdomains.

Finally, the task of translation between Spanish and English constituted a substantial increase in workload and time commitment. Information collected from Web sites and Respondents is tabled in Annex 5.

¹²¹ Intellired, ChileRed, Entelchile.net. Some providers offer discounts at night and off-hours.

¹²² <<http://www.nic.cl>>

Chapter 4: Software Development and Country Development in Chile: Data Analysis

This inquiry begins with a general assessment of Chile's software sector, in the context of its historical evolution. Then the central factors of software capacity-building are examined integrated with social innovation issues. These factors are considered with input from the empirical tests (Chilean survey respondents and Canadian views from the REA) as well as from Web-based observations.

Historical Overview

Software development is an opportunity for countries with capacity in creativity, intelligence and knowledge. In all countries there is this capacity, but it still requires that the countries themselves believe in themselves and strengthen themselves.

— Respondent¹²³

Information technology was introduced to Chile almost forty years ago.¹²⁴ The first computer was used at the University of Chile in 1962. The 1960s also brought the first data processing company, the state-owned ECOM; the first data processing network, at the Banco del Estado; and the first Computer Science programme, at the University of Chile. Growth in the computing sector was slow to begin with, but has been increasing since the introduction of personal computers, particularly during the last decade.

In the early 1980s, large Chilean companies, equipped with microcomputers, began importing packaged software applications. Ricardo Baeza noticed that

¹²³ The survey respondents shall be referred to as “respondents”, as their anonymity was promised. The exception is Dr. Ricardo Baeza-Yates. The Canadian respondents will be referred to as “the Canadians.”

¹²⁴ Major dates in Chile's software history are listed in Annex 6.

they soon discovered that many required significant modifications or were completely useless, due to local accounting practices, widespread use of indexed currency, and local regulations concerning banking accounts. Support and updates were needed at reasonable costs. These problems and needs drove the birth of the Chilean software industry.¹²⁵

By 1992, the Chilean computing market was worth \$US120 million. American suppliers held, and continue to hold, half of the Chilean hardware market. Acer, Compaq, and IBM became the most popular personal computer brands, and no domestic manufacturers of hardware emerged.¹²⁶

American suppliers also dominated the software market. The supply continues to be concentrated, and in 1999, seventy percent of the software sold in Chile was imported. Microsoft, Novell, IBM operating software, and Wordperfect became the major software suppliers, and many American software producers established subsidiaries in Chile.

By 1995, the Chilean software market was worth about US\$55 million. However, there is some discrepancy between the various sources of statistics on software market size and growth, as shown in the table below.¹²⁷ Despite this inconsistency, there has been a trend of increased software demand in all computing areas, likely due to a rapid expansion in hardware use. More recently, custom-designed software is starting to replace packaged software in many business applications. Growth is expected in the home computing sector, as educational applications and home offices multiply. Other

¹²⁵ Baeza, <<http://www.acm.org/pubs/citations/journals/cacm/1995-38-9/p23-baeza-yates/>>

¹²⁶ DFAIT, p. 3.

¹²⁷ The OECD notes that data on software suffer from weaknesses in terms of robustness, coverage and accuracy. OECD, p. 5.

software areas with growth potential include multimedia and entertainment technologies, EDI, remote applications, desktop personal productivity applications and groupware.¹²⁸

Table 7: Chilean IT Market (\$US millions)

Year	IT Market	Growth %	Software Market	Growth %	Software Exports	Growth %	PC Units ('000s)	Growth %
1989					1.4		30	
1990					3.6	157	40	33
1991					6.4	88	60	50
1992	439		50 (120 [^])		13.9	117	83	38
1993	496	13	70	35	22.0	58	110	33
1994	555	12	77	10			120	9
1995*	630		55					
1999 [^]					100			

Data from the Comité de Empresas Exportadoras de Software, *DFAIT, [^]Heeks, [^]Correa.

During the 1990s, Chile was progressing as the main software exporter of the Latin American region.¹²⁹ Chilean software exports have consisted predominantly of packages and custom-made systems. Exported software products include MIS applications packages (e.g. transactional banking systems, integrated management systems, and statistical analysis), software utilities (anti-virus software, software distribution systems, text retrieval tools) and applications in which Chile has special experience (mining, forestry). The main export market became Latin America, which accounted for 57% of total exports in 1992, while 16% went to Asia.

Latin America is a logical regional market for Chilean software companies. Besides having a common language and traditions, Latin American countries have experienced substantial economic growth and improved infrastructures. Furthermore,

¹²⁸ DFAIT p. 2.

¹²⁹ Correa p. 175.

Chile has recently signed free trade agreements with several Andean countries. As well, some Chilean software firms have established subsidiaries in nearby capitals.

Consequently, Chilean share of Latin American sales grew from 1.2% in 1994 to 4% in 1998; while Chilean share of world sales grew from 0.05% to 0.13% during the same period.¹³⁰ It is noteworthy that despite these positive growth indicators, Chile's software market remains dominated by re-selling foreign products, while the market share figures are still very small in relative terms.

In the early 1990s, Chile became the example used by IT and development authors to illustrate "successful" software industries in developing countries. DFAIT reported to potential Canadian investors that Chile had capacity in developing vertical, customized applications for large systems, various platforms and diverse clients.¹³¹ In 1994, Ricardo Baeza-Yates named five "of some of the more successful software companies in Chile" as Aisoft, Ars Innovandi, Excelsys, Sistemas Integrales, and Sonda.¹³² All are still active except for Ars Innovandi. Also, Baeza mentioned two companies that provided off-shore programming, Binaria and DTS. The former was defunct by 2000.

The survey respondents named Softland, Action Workflow Metro, Oyster, Anti-virus, UnLimited, Aisoft, El Coordinador, and Xnear as examples of successful companies. Only one of the companies named by Baeza appears in this list: Aisoft. It remains to be seen how these firms fare in the future.

¹³⁰ Asociación Chilena de Tecnologías de la Información. <<http://www.acti.cl>>

¹³¹ DFAIT, <<http://www.infoexport.gc.ca>>

¹³² Baeza, p. 25. Ricardo Baeza was also one of the respondents. He did a PhD in software engineering at University of Waterloo, and is a professor at the University of Chile at Santiago.

Richard Heeks, like Baeza, explains the relative success of Chilean firms in terms of their products:

Typically they began by providing one client with Spanish interface software, custom-built to meet particular local needs. They then created a “semi-package”: a set of menu or window interfaces used as a marketing of development platform for further customization initially in the local market and then, as opportunities were perceived, in the Spanish-speaking markets of Latin America and even Europe.¹³³

The respondents identified successful Chilean software products to include administrative and support systems, finance applications, educational and entertainment products, and custom-made solutions. One respondent noted that “a few specialized products, like the COETAC of the army, has been exported to various countries.” Three respondents did not know of any successes. Strangely, the same product types were also included in their lists of failed software products. This could imply that software entrepreneurs and stakeholders lack awareness of their industry, or that their perceptions of defining “success” vary widely.

For Correa, other inputs and economic conditions explain the relative success of Chilean firms. First, he notes that access to hardware and software is relatively unrestricted, and the economy is open and export-oriented. The Chilean government has been opening the economy gradually over the last 25 years. The state began liberalizing services in 1987, and promoted competition in all sectors by 1994.¹³⁴

Second, there is adequate supply of qualified personnel at the technical and managerial levels. Third, the government has offered some support to software firms seeking export opportunities. Chilean firms have benefited from government support

¹³³ Heeks. <http://www.man.ac.uk/idpm/di_wp6.htm>

mainly in the form of financing for commercial missions abroad, the preparation of promotional materials and for the participation in international exhibitions. The federal program, ProChile, for example, has also promoted coordination among exporter companies. Funds for innovative projects are available under various mechanisms set up by the government.¹³⁵

The respondents' views of the strengths in Chilean software sector echo support for those identified by Correa and Heeks. The respondents' observations about weaknesses in the sector also focused on the lack of innovation in firms. The staffing deficiencies highlight organizational problems, and lack of sales and marketing abilities. Other weaknesses include lack of international networking, venture capital, international credibility, and small domestic market.

Many of these factors were identified in the literature as barriers to entry, as shown in the previous chapter. However, the vision for Chile with respect to IT seems progressive, as evinced by the largest association of IT firms in Chile, ACTI (Chilean Association of IT Firms). At an IT conference in 1999, the president of ACTI, Fernando Prieto, declared "this meeting raises the hope that the theme of technological development is intimately linked with the development of the country."¹³⁶

Why, then, does the Chilean government still espouse the "acquire and adapt" approach to IT? For example, the federal Committee on New Information Technologies recently released a comprehensive report outlining IT challenges and policy recommendations for Chile. After methodical treatment of infrastructure, access,

¹³⁴ Correa, p. 176

¹³⁵ Bishop, p. 40.

competitiveness, and state modernization issues, 61 policy recommendations were proposed. There was no mention of software, or any domestic capacity-building in any of the recommendations.¹³⁷

Further, this focus is reflected in the composition of Chile's software firms and products. Of the 199 firms identified in 1999, the vast majority are re-sellers of both software and hardware, many are multinational subsidiaries, or provide consultancy and/or data-processing services. Only 22 consider their primary function as software development. Many of the new firms have jumped on the Internet and entertainment bandwagon, with little, if any, substantive product or service strengths. (This trend in new firms is also occurring in Canada and the United States).

The software sector is also experiencing some instability, although it is still in its initial stages. In 1997, this research found 103 Web sites of software organizations in Chile. Two years later, only 58 of those were still live, while 140 new sites had been created. High firm turnover is characteristic of the software industry worldwide, and constitutes a major destabilizing factor in firm development.

Nevertheless, software firms have shown signs of success, at least on the surface. In future, can Chile develop a *sustainable* software production capacity, that can contribute to socioeconomic development of the whole country.

Software for Development

¹³⁶ ACTI <<http://www.acti.cl>>

¹³⁷ Comisión de Nuevas Tecnologías de Información. <<http://www.cnti.cl>>

I believe that in Chile we have the power and the people to do much more than we do in terms of software.

– Respondent

In his 1996 article, Correa developed a typology of the main internal and external barriers for developing countries to enter the software industry.¹³⁸ Since then, these barriers to entry have been revisited by other proponents of software development, including Baeza and Heeks. These factors formed the basis for the survey questions and analysis undertaken in this inquiry. The elements of software capacity-building and technological dependence are considered more broadly in their analysis, as they are viewed through a social innovation lens.

1.0 Physical Investment

1.1 Information Infrastructure and Universal Access

Lack of sufficient infrastructure is often identified as an important limitation to capacity development. As Credé and Mansell contend, if DCs lack IT infrastructure, they will be unable to exploit the new opportunities these networks provide.¹³⁹ Surprisingly, none of the respondents considered the IT infrastructure in Chile to be inadequate. Perhaps this is because all the respondents reside in Chile's largest urban areas. Were they considering their country more broadly when they answered the question?

The 1998 *World Development Report*¹⁴⁰ showcased Chile as an exemplar of a developing country achieving a state-of-the-art telecom infrastructure. Chile's telecommunications market is one of the most open and competitive in the world.

¹³⁸ Small domestic market size; small firm size, lack of financial resources; quality standards; relative weight of labour costs; shortcomings in qualifications and methodologies/lack of knowledge; infrastructure, marketing requirements; identification of user needs; enforcing intellectual property rights. Correa. p. 173.

Following privatization of the main telecommunications companies in the late 1980s, the number of telephone lines quadrupled to more than two million today. Competition introduced in the late 1980s in data, value added, and cable TV services and private networks, and since 1994 in domestic and international long-distance telephony, has brought about rapid network modernization, new services, and prices that are among the world's lowest. Unbundled yet monopolistic position, Chile is moving toward a multi-carrier structure that is highly competitive.¹⁴¹ In mid-1994, more liberalizing legislation was introduced. Competition in local services is intensifying, mainly from long-distance carriers starting wireline and wire-less local service and from combined voice and cable television offerings.¹⁴²

The Report did not mention that all of this technology was foreign, and its local capacity impact would therefore be minor. Do Chileans have the capacity and resources to maintain and enhance their system? The 1999 Commission on New ITs does not address this question either.

Without the appropriate communication infrastructure, IT might accentuate, rather than ameliorate, existing disparities in income, wealth and opportunity.¹⁴³ Full digitization of networks makes IT infrastructure and its management extremely complex. This may aggravate an already high dependence on foreign expertise and infrastructure. On the whole, Chile appears to have embraced the Western view on the development of IT infrastructure.

¹³⁹ Ibid., p. 19.

¹⁴⁰ World Bank, 1998, p. 28.

¹⁴¹ Compañía de Telefonos de Chile (CTC), Empresa Nacional de Telec (Entel) and Telex-Chile dominate the market.

¹⁴² Galal, Jones, Tandon, and Vogelsang. p. 532.

Van Audenhove summarized this perspective as follows:

At both national and international levels, it supports dynamic competition, encourages private investment, supports flexible regulatory structures and allows for open access to networks and other essential facilities. It is considered a matter of increased investment and continuous innovation to arrive at a fully fledged and equitable information society.¹⁴⁴

This framework is based on two macro-economic assumptions: that consumption at all levels is a precondition for economic growth and prosperity for all; and that intervention by authorities has a restraining rather than an enabling effect, on economic growth.¹⁴⁵

Nonetheless, about 1.5 million people— 10 percent of all Chileans— live in localities that do not even have a public telephone.¹⁴⁶

To help address universal access to info-infrastructure in Chile, there have been two educational initiatives over the last decade which have sought to bridge the “digital divide”.

In one initiative, Pedro Hepp and his colleagues at the Catholic University in Chile began a five-year project called Enlaces (“Links” in English). They began in 1992 with a pilot in six elementary schools, and by 1996, there were 144 networked schools.¹⁴⁷ It has been extended to secondary schools, with 50% linked by 1997. With World Bank

¹⁴³ Credé and Mansell, R.. 1998. p. 19.

¹⁴⁴ Van Audenhove, p. 389.

¹⁴⁵ It is also argued that the diffusion patterns of computer hardware are effected by market forces, rather than by political decisions by centralized authorities. (Bernard, Russell H., and Pertti Peltó. p. 8.) This is a non-sequitor as it is economic policy that shapes market forces.

¹⁴⁶ ACTI. <<http://www.acti.cl>>

¹⁴⁷ Press, Larry, pp 23-30. Also, <<http://www.enlaces.cl/presentacion.html>>

funding, the goal is to reach 100% of the secondary schools and 50% of the primary schools by 2000.¹⁴⁸

The support structure has been decentralized nationally with 15 universities participating. One of Enlace's strong beliefs is that the teachers are at the center of the network, and their training and support budget is 25% of the total project. From the beginning, Hepp understood the importance of supporting low income, rural and outlying areas.

The second example, la Red Universitaria Nacional (REUNA), is a university network that began as a not-for-profit enterprise between the Universities of Santiago, Concepción and Antofagasta. In January 1992, REUNA started a 56 Kbps link to the USA, which was increased to a T1 by 1996 and to 155Mbps in 1999.¹⁴⁹ Co-founder, Florencio Ultreras explains how REUNA was able to fund this growth:

If the universities were the only users of the network it would be simply impossible. Indeed the university members are heavy users but are always lacking money. The only way to do it is through selling services to other institutions. We have become an Internet Access Provider.

By 1994, REUNA was providing connectivity and technical support to public and private institutions and individuals, throughout Chile. With the arrival of five new Internet Service Providers (including CTC Mundo and ChileSat), Chile claims the highest rate of Internet access in the region.¹⁵⁰ Efforts such as these could also slow "brain drain," as users and researchers are connected electronically.

¹⁴⁸ EUI, p. 17.

¹⁴⁹ <<http://www.reuna.cl>>

¹⁵⁰ Measured in terms of number of servers per 1,000,000 inhabitants.

With respect to hardware requirements, microcomputers are considered inexpensive enough to be acquired by individuals and firms. The diffusion patterns of computing equipment are effected by market forces, rather than by political decisions by centralized authorities.¹⁵¹ In terms of cost-accessibility, in Chile, the purchase of personal computer equipment and business software packages is generally two-thirds of the cost in Canada. Internet Service Providers in Chile are equivalent in cost to those in Brazil, Mexico and Argentina.¹⁵²

The prevalence of computer hardware is referred to as “PC density”. In Chile the PC density has quadrupled in the last five years, although it lags behind neighbouring countries. The number of computers per 1,000 inhabitants in Chile is 45, compared to Argentina 43, Venezuela 40, and Colombia 29. This is many times lower than the level for Israel (219), Singapore (316), New Zealand, (320) and Finland (354).¹⁵³

1.2 Financial Capital and Sustainability

There are three main areas that determine financial investment requirements: software development (labour costs), marketing and the relative cost of labour.

1.2.1 Software Development Resources

“Anything that can get financed can be realized in Chile.”
—Respondent

The respondents identified sources of finance capital that are characteristic for start-up companies in Chile. Only three respondents agreed with Correa, that lack of

¹⁵¹ Bernard and Pelto. p. 8.

¹⁵² Intellired, ChileRed, Entelchile.net. Some providers offer discounts at night and off-hours.

¹⁵³ DFAIT. <<http://www.maeci-dfai.gc.ca>>

financing for firm growth constitutes a serious barrier. At the same time, four identified “lack of finances” as a weakness of the industry. Others noted the absence of venture-capital mechanisms, and the reluctance of banks to provide financing to enterprises “whose main assets are intangible, and who lack physical assets to guarantee loans.” Interestingly, no one mentioned FONDEF, a national science and technology fund offered by CONYCIT, a federal agency.

Table 8: Sources of Finance for Chilean Software Firms

#	Source
11	Own capital, or that of their associates
11	Product sales, software consulting, re-selling hardware or software
7	Banks and financial institutions
6	Venture/Risk capital
5	Associations with large, established firms, or contributions from other areas of the company
2	The required capital is relatively low, the major cost is labour.
2	CORFO (Corporación de Fomento de la Prevención)

However, scarcity of financial resources was identified by the Canadians, as software firms often must search for investors, or government support. However, none of the respondents addressed R&D, which, for software, is very labour and time intensive. Could lack of attention to R&D and its required inputs be the cause of firm failure in Chile?¹⁵⁴ Capacity to innovate over the long-term is essential to the iterative process of software development, and consequent competitiveness. Usually, the rapid pace of

¹⁵⁴ There are no available statistics on software investment in Chile, only more broadly, with IT investment per capita. While Chile enjoys relative success in Latin America (US\$58.10 as opposed to US\$44.50), it is well below the global average of US\$117.60. However, according to José Pedro Torres, the president of ACTI, “Chile shouldn’t compare itself with these countries.” If Chile wants to “jump qualitatively, it should look at other countries like Singapore and New Zealand, that invest double what our country does.” <<http://www.acti.cl>>

technological change and the short life-cycle of products force software companies to undertake R&D and to invest in training for new technologies.¹⁵⁵

1.2.2 Marketing Resources

Marketing is an essential and costly production component, especially for packaged software. Eight respondents identified lack of marketing tools as a major constraint for export activities in Latin America. Eight respondents also identified a lack of marketing and sales resources and distribution channels as a weakness of Chilean software firms.

However, one Respondent commented that:

National software products are acquired mainly by “recommendation” of a nearby firm that has already used it. For this reason the marketing factor influences minimally the successful positioning of the product.

The Canadians acknowledged the heavy financial demands of marketing campaigns, although many regarded “sales and marketing” requirements as a burden to the dynamism and inherent value of the software product itself.

1.2.3 Relative Weight of Labour Costs and the International Division of Labour

Low labor costs provide certain comparative advantages for developing countries in the international software industry, mainly for services and custom software. When packaged software is at stake, the weight of labour costs in the total price of the product is not as decisive as generally believed. Correa importantly points out that “the advantages derived from labour costs should be adjusted by considering differing productivity levels. This analysis is seldom made, and its absence may lead to very incorrect assessments.”¹⁵⁶

¹⁵⁵ Correa, p. 172.

¹⁵⁶ Ibid., p. 173.

Low labour costs were not identified by the respondents in a significant way. However, four Canadians considered that Chileans could gain advantages from their relatively cheap labour.

Yet, effects of labour costs on employment patterns are complex and shifting. Because of lower wages, Chile can gain skilled jobs by export from industrial countries through “body-shopping”. But this advantage is only temporary, because wages for skilled service jobs will rise with demand, the knowledge content of these jobs will increase, and the advantage might shift to other countries that are more effective in building knowledge and skills.

The long-term structural adjustment of the labour force to productivity-enhanced technological change must be weighed against the likelihood of technology-induced unemployment, and the high cost of labour adjustments to technology change.¹⁵⁷ In Chile, there is significant labor market segmentation. But there is increasing evidence that income differentials reflect the rigidities caused by regulations on formal employment.¹⁵⁸ These conditions could be improved by legislative reforms.

2.0 Human capital

2.1 Quality Standards

DC software firms are not accustomed to applying stringent quality standards, as local demand is not sophisticated enough to require high quality and performance standards. Also, compliance to standards contributes to the costs of technological effort. Quality standards of software vary greatly, affecting the quality of the final product. It is

¹⁵⁷ Credé and Mansell, R.. 1998. p. 8.

¹⁵⁸ IADB p. 6.

presumed that that implementation and diffusion of quality standards increases barriers to entry, and that the management of quality issues is likely to become a key competitive factor in the software field. Implementation, in particular of the ISO 9000 standard, is viewed as a necessary step to compete in the global market.¹⁵⁹ However, some standards, particularly the ISO 9000, are considered as empty shells. In the crucially large packaged software companies, such as Microsoft, there is evidence that structured methods are not being applied to the design process.¹⁶⁰

All of the Canadians considered compliance with quality standards to be important for software development. Only two respondents agreed that Chilean firms had high quality standards, and only one mentioned low standards as an obstacle. One respondent suggested that standards could be raised by applying techniques like CMM, S:PRIME which are offered by technical organizations in Chile. None of the Canadians was familiar with these methods. The Canadians suggested that innovations in technical practice and quality assurance are ways to tackle software development problems. This apparent lack of attention to quality standards may constitute a “glass ceiling” to Chilean software firms, thereby hampering their growth potential.

2.2 Methodologies, Qualifications and Education

Formal, structured analysis and design methodologies provide rigorous, often theory-based, techniques while imposing structure on the project tasks.¹⁶¹ In some Latin American countries, software engineering tools, such as CASE, still have a very limited

¹⁵⁹ Correa., p. 71.

¹⁶⁰ Quintas p. 91

¹⁶¹ Quintas p. 90.

diffusion.¹⁶² For Correa, “this implies that methodologies used probably entail low productivity and quality in software design.” However, it should be noted that CASE tools cost upwards of \$US 200,000 and are not widely diffused in the West, let alone in developing countries.

In terms of qualifications, a nation’s endowment of skilled informatics professionals will strongly affect its ability to meet basic societal needs, to build competitive industries, and to exploit new development opportunities. This endowment depends on public and private education systems in tune with market demands. New demands for education and training must be met, for both developers as well as users of software products. Educating equally the supply as the demand, exhibits hidden “transaction” costs, and adds to relative labour costs. Thus, the need for specialized informatics professionals, computer literate work forces, and lifelong training are challenges for most countries in the face of rapidly changing technology and shifts in job mixes.

Much of the “development industry”, particularly the World Bank¹⁶³, highlight that “knowledge societies” are built on “tacit” knowledge, which is local experience, and on the learning economy. For Credé and Mansell, this includes informal learning by doing and local training, in all social and economic activities like R&D, production,

¹⁶² Computer-Aided Software Engineering (CASE) tools are available to support all aspects of development; upper CASE is focused on analysis and design; lower CASE on programming and testing. Integrated Project Support Environments (IPSEs) and Integrated CASE tools (I-CASE) aim to provide seamless support for the whole software life-cycle.

¹⁶³ World Bank, 1998.

product development, marketing, and the application of innovative technology, that reinforce human interaction and interactive learning.¹⁶⁴

In this context, an underlying tension for software developers occurs between the incidence of programmers with non-formal education, and the cultural barriers to lack of certification, which is evident in Chile.

It is evident that formal education can fulfill only one aspect of human capital requirements for software firm development. In Chile, university-level computing education only reaches a limited population. Increased attention, as the respondents recognized, should be placed on tacit knowledge and informal systems of learning, which could reach a broader section of the Chilean people.

The respondents were roughly split on whether or not formal institutions provide solid computer training, and satisfy industry needs in Chile. It is interesting that only one mentioned the role of universities as centres for R&D, and no one identified technology transfer opportunities. A noteworthy criticism of one respondent was that Chile's educational system:

fails to produce intermediary levels that have specific capabilities (documentation, testing, etc.). Programming is often done by civil engineers instead of "ingenieros de ejecución" because it is thought that the work will be better. The truth is that they don't really teach civil engineers how to program. I think that the levels of "ingeniero de ejecución"¹⁶⁵ and programming require better curricula, which are valid for the industry. This would also lower costs for firms and would lower the turn over of staff.

¹⁶⁴ Credé and Mansell, R.. 1998.

¹⁶⁵ This translates loosely to "engineering foreman". In Chile, it is a mid-level position obtained with a three-year college credential.

The Canadians noted that there is no concept of “*ingeniería de ejecución*” in North America. Most also concurred with the emotive involvement of programmers, evinced by one respondent’s remark that “talents are self-made, in that they love the business.” All commented on the adequacy of the Canadian educational system, some noting that formal education does not constitute that a graduate will be a “good” programmer.¹⁶⁶

2.3 Management Skills

In some Latin American countries, there is a lack of experienced managers for software development above a certain level of complexity. Moreover, as the companies grow from small, highly creative, single-product units into larger organizations, management bottlenecks often arise and firms lose their dynamic qualities.¹⁶⁷

The rapid pace of technological change and the short life-cycle of products force software companies to undertake R&D and to invest in training for new technologies. Technologies for software development are not proprietary, although the use of certain tools, platforms or interfaces may require the negotiation of a license and the payment of

¹⁶⁶ To illustrate that programming skills are not overly intensive to achieve, in India, two boys, aged 11 and 12, passed the Microsoft Certified Professional examination.¹⁶⁶ Meanwhile in Pakistan, a 14-year student has been certified as a Microsoft Certified System Engineer.

<<http://www.brecorder.com/story/S0011/S1102/S1102103.htm>>

¹⁶⁷ ...p. 87. In this sense, software design is an ongoing process that continues even after system delivery. However, the scope for change in the maintenance phase is severely constrained by early system design decisions. Best-practice system design aims to maximize future flexibility by building in the potential for future modification, and by rigorously documenting system design and components.

p. 88. The ability to redesign software when it is in use is essential whether the software is custom-built or a standard package.... The malleability and post-delivery adaptability of software is not infinite, however. The scope for change reduces over time... Furthermore, highly evolved systems, such as those forming the core operations of many large organizations such as banks, insurance companies, and airlines, that have received continuous development over many years, are proving to be a legacy of ‘electronic concrete’ to many organizations. The sunk investment in such legacy systems, together with their complexity, means that organizations find it difficult to replace them or to make significant changes in their ICT strategies. There is therefore a contradiction between the inherent flexibility and modifiability of software, and the electronic concrete phenomenon. This contradiction raises questions about the management and control of the software development process.

royalties. The decision on the use of open or proprietary systems has important commercial implications, as there is no unique way of developing a certain product. Thus, software producers must make strategic choices, taking into account the type of products and markets envisaged.¹⁶⁸ This requires managers to be able to undertake technological assessment, and choose among the production possibilities, such as those presented in Chapter 3.

The respondents were divided on whether a lack of management skills constituted a barrier to entry or not, as they equally identified strengths as well as weaknesses of Chilean software managers. Some of the characteristics identified by the respondents were particularly artful.

Professional Strengths of Chilean Software Managers

- Ability to create imaginative solutions, even under pressure.
- Information as an organizational resource is gaining much value, and with that software managers are increasingly respected within firms.
- They clash with the vices of the old generation which is very stuck on the “papel notarial” (paper pushing) way of any technological innovation.
- Flexibility in decision-making. However, it is very complicated to establish an organizational structure compatible with software development activities, which require respect for the emotional state of the developer. Circumscribing creative workers into the confines of office hours is not always compatible with working towards objectives.
- Capacity for entrepreneurship and engineering.
- It happens very infrequently that the company owners are also the managers, which generally is not good.

Shortcomings of Chilean Software Managers

- Our country doesn't have real managers (like they do in USA or Europe). This is clearly seen at the level of strategic marketing management. The Chilean school of management is lead principally by Codelco (copper producer), if you produce a product that is undifferentiated at the consumer level, your only possible strategy is to reduce costs. You don't get possible differentiation.

¹⁶⁸ Correa, p. 172

- For software development, one needs a much better level of management of different techniques, those which primarily consider the real needs of the end user.
- Lack of strategic long term vision.
- Lack taking risk in innovative projects.

Why is there is such marked disagreement in these answers? Nearly all of the private sector respondents hold managerial positions in their companies – they are very self-critical. They may be signaling a lack of uniformity in management practices, and this instability across firms may impede their growth and competitiveness.

2.4 Language Differences

This factor was not explicitly treated in the literature, but was raised by the respondents. On the supply side, rigorous and understandable documentation is often as crucial for success of software as the programme itself is, but this requirement increases the burden of technological effort. The vast majority of users in Latin America command Spanish as their only language.

Also, few professionals are fluent in English, and this is a limiting factor in terms of export capacity outside Latin America. The Canadians assumed that Chilean software developers speak English and write code in English. The written (e-mail) communications with the respondents showed that not all had good working levels of English. (None of the Canadians spoke Spanish, although one had previously worked in Venezuela). On the demand-size, as the respondents noted, local customers are slowly becoming irritated with using software in English or in badly written Spanish.

All of these points indicate a need for Chile to develop its own domestic market, with a view to moving into the regional one, as pointed out in the literature. They also point to potential difficulties for product diffusion and end-user adaptability.

2.5 Cultural Differences

As an export market, end-users in industrialized countries often mistrust software originating from developing countries. This feeling was reluctantly acknowledged by six Canadians. For Heeks, the West portrays “fear, uncertainty and doubt” (FUD), a negative image of Third World firms and their capabilities.

This culture of superiority/inferiority, is even espoused by some Chileans. They feel assured of their positive image in the region, but less secure about their abilities globally. One respondent noted:

the Latin idiosyncrasy is personal distrust and control, unlike North Americans who trust and delegate. This is reflected in the way systems are designed.

And another:

It is always easier and less risky to buy imported software, even though it may not be better, for example, that of Microsoft.

Fourteen respondents considered Chilean software products more culturally and linguistically appropriate than foreign ones, particularly for applications like banking, administration, legal and finance. This is largely because Chilean legislation is very specialized and targeted to serve locally-developed systems. Imported high-end software such as SAP, JDEdwards and other maintenance software for factories, are commended as they are entirely translated and tailored to local systems.

There is also the tension between cultural preservation and social disruption, particularly with increased international communications. Chile can both benefit from and contribute to worldwide cultural assets. Yet, without a balance, the information revolution could weaken the cultural ties that bind Chilean communities.

2.6 Marketing Skills

Marketing and sales skills for launching a new software product in both local and foreign markets are high and normally outside the reach of firms in DCs. An additional obstacle is the reluctance of dealers/distributors to commercialize programs from small firms. Six respondents identified a lack of marketing knowledge and experience as weakness in management. These skill requirements are closely linked to availability and access to marketing resources, as described above.

2.7 Identification of User Needs

An understanding of users' requirements is essential for software creation, and is a form of "tacit knowledge". The identification of user needs in foreign countries and the knowledge of practices and cultural features require close contact and a systematic exploration, except if horizontal applications are envisaged (a highly competitive and very difficult field for new entrants) or well-defined niches in vertical markets are targeted. Developers that face unsophisticated users are unlikely to build up capabilities to compete in domestic or international markets.¹⁶⁹

Only two respondents acknowledged the need to understand user requirements. However, the developer-user interaction of most software design processes requires a strong relationship be established. It is an element too often overlooked.

In terms of equality of access to human capital inputs overall, 18 respondents felt that they had equal access to qualified and experienced managers, programmers, and marketing personnel, and to many software engineering tools (such as CASE). Only five disagreed. Four respondents stated that there were no barriers to entry: "One can't pretend to develop a project whose requirements exceed the means."

3.0 *Politico-Economic Environment*

Correa and Heeks determined that there are also external barriers to be overcome by software firms seeking to compete in foreign markets. They include: small market size and access (domestic/foreign), and networking (distribution channels, alliances, technology transfer). These barriers are considered as elements of the political and economic environment, at local and international levels. This paper suggests that these factors should also be viewed as social innovation forces, and are therefore considered with the role of government, and social equity issues.

3.1 Small and Unsophisticated Domestic Market

Insufficient size of local markets is the most commonly cited constraint for DCs to face in the IT sector.¹⁷⁰ In general, services and manufactures lack resources to upgrade their technology; and agriculture and construction sectors represent limited opportunity. A wider market potential could be in the banking and mining sectors, already strongly entrenched in Chile's economy. Six respondents identified the small size of the Chilean market as the most significant barrier to entry.

They also pointed out the additional constraint of lack of local knowledge of own technology needs. The problem of small market size is exacerbated if that market is also un-demanding. The IADB reports that Chile has an inordinate degree of inequality considering the sophistication of its productive sectors.¹⁷¹ Several respondents echoed

¹⁶⁹ Correa, p. 172.

¹⁷⁰ Correa, Baeza, Heeks.

¹⁷¹ IADB. 4th Quarter, 1998, p. 1.

this view. The lack of demand-pull, therefore, inhibits innovation, and jeopardizes product growth.

Most writers, including Correa, emphasize export market-orientation for software firms, to overcome the market-size barrier. Victor Prochnik rightly observes in

Brazil, as in other countries, a growth in demand for software applications as a consequence of the introduction and expanding use of value added services. At the same time, the importance of the software component in telecommunications services is steadily growing. As digital technology advances, the homogeneity of components found in the different types of production increases and the software takes on a more important role in product differentiation.¹⁷²

Several respondents suggested, aside from export-market focus, targeting broader domestic markets, such as small and medium firms, to improve their products and services. These views concern the market scope characteristics identified in the characteristics of the software product-type matrix elaborated in Chapter 3.

3.2 Role of Government and Equity Issues

"The government doesn't support enough. It's sufficient to look at the difference between Web presence of the government in countries like Argentina."

-- Respondent

Historically, governments have seen IT as a social good to be made available to all at affordable prices. The main motive behind this universal service concept is that telecommunications are considered as a strategy for social and economic prosperity. Many studies of DCs have indicated that the provision of basic telephone services in rural areas can have considerable external economic and social benefits. This argument alone suffices to legitimize the introduction of broad national access.¹⁷³

¹⁷² IFIP. <<http://www.iimahd.ernet.in/~subhash/july94.htm>>

¹⁷³ van den Auhoove p. 398.

The underlying assumption in this dominant neo-liberal scenario is that connection to IT itself is sufficient to foster development. This position is based on three basic— but highly questionable— assumptions:

1. that IT are neutral and easily transferable;
2. that information equals knowledge; and
3. that access to information to citizens, (by means of IT) is in itself necessary and sufficient to accelerate development.

However, once in which information is considered the main driving force of economic and social development, the universal service concept may become even more important. A fundamental question within a developmental context remains whether or not private interests can be pursued with public access ones. At the same time, institutional reforms, not just technological developments, are required to pave the way for successful transition to a competitive structure.¹⁷⁴ For Mansell and When, the two keys for development are government policy-driven. First, they emphasize the availability of network infrastructure, essential for provision of applications. And second, they point to the need of capacity to create and administer an enabling environment and to develop the applications that exploit the infrastructure in ways that are consistent with needs in the local environment.¹⁷⁵

As described earlier, the Chilean government has made many reforms to create an open market climate, to provide IT infrastructure, and to act as a consumer of IT products. There are seven government departments in Chile with specific mandates to support the national software industry. Chilean software firms benefit from unrestricted

¹⁷⁴ Bishop, Mody and Schankerman. pp. 37-78.

¹⁷⁵ Mansell and When, p.400.

access to hardware and software, in an open, export-oriented market place. The government also sponsors trade missions abroad, participation in international trade exhibitions, finances promotional materials, and offers several funding sources. Other ways that the Chilean government has supported domestic IT growth were raised in the historical overview of the Chilean software sector.

However, the Chilean government could do much more to decentralize its bureaucracy through administration decrees. Although it undertook in 1994 to raise to 42% the proportion of the national fund for regional development allocated by regional authorities, the proportion is still only 27%, and institutional development required to make this decentralization a success is well behind schedule.¹⁷⁶ Local governments in Chile have no autonomy to contract debts of any kind, contrary to the case in Brazil, Argentina, Colombia.¹⁷⁷

Such centralization could impede popular diffusion of, and access to technology. Also, as noted above, Chile's national IT strategy does not address local capacity-building, and does not focus on software explicitly. This implies that "democratization" and diffusion of firm development through the country is hampered.

Most of the respondents not see the government as playing a supportive and progressive role? The negative public image apparently held by Chilean people surely must be overcome. (It should be noted that and only one survey respondent is in the public sector.)

¹⁷⁶ EIU p. 17.

¹⁷⁷ IADB. First Quarter 1998. p. 6.

3.3 Labour Unions and Institution Building Through Networking, Coalitions and Alliances

Chile has historically had strong union movements in its economic sectors, particularly in manufacturing and mining industries. However, only about 10 % of software firms are affiliated to a union, although these affiliations act more as associations rather than labour organizations. These include GECHS (Grupo de Empresas Chilenas de Software), CEES (Comité de Empresas Exportadoras de Software), ACTI (Asociación de Empresa de Tecnología de la Información), and the Asociación Chilena de Empresas de Software. The lack of union affiliation is similar in software sectors in North America. Seven respondents held that unions exert little force or influence in the local software marketplace. Why is there such little organization in the Chilean software industry?

It is possible that other institutions, such as networks and alliances, are gaining currency.

The movement towards an “information economy” fuels social transformations. Social dimensions, such as class, gender, and ethnic differences can be expected to produce conflicts over resources, definitions, and aims involved in development processes.¹⁷⁸

These changes go far beyond economics and technology to affect society in broader ways. Asserts Biggs,

As a great social leveler, information technology ranks second only to death. It can raze cultural barriers, overwhelm economic inequalities, even compensate for intellectual disparities. High technology can put unequal human beings on an equal footing, and that makes it the most potent democratizing tool ever devised.¹⁷⁹

¹⁷⁸ Biggs, p. 240.

¹⁷⁹ Ibid., p. 41.

Thus, institution-building concepts must be broadened to include coalitions, alliances, and networking at both social and industry levels. The effectiveness of coalitions will often be a key determinant of the long term impacts of promising technological innovation. It follows that coalition-building should be a priority for individuals and organizations participating in technological development. Heeks promotes networking as the key to “success” for DC software firms.¹⁸⁰

For software firms, these factors can contribute to gaining access to finance, strength in partnerships, knowledge sharing through associations, access to technology, and alliances with local re-sellers. Mechanisms for diffusion of technology and organizational knowledge on a global scale. Tapping into such alliances will be crucial for DCs to gain and to maintain access to technology and markets.¹⁸¹

Some of the respondents’ comments reveal their awareness of this need, in terms of access to technology, standards, and alliances internationally, but not in terms of knowledge sharing domestically. At the same time, however, a few software associations have emerged in Chile, notably ACTI, with a mandate of information sharing and promoting Chilean software firms in the region.

There are many examples in developing country regions where locally developed networking solutions can have positive effects. For example, TASKnet (Towards a South Asian Knowledge Network), shares information and resources to promote access and use of knowledge and information as tools of sustainable, equitable development.¹⁸²

¹⁸⁰ Heeks. <http://www.man.ac.uk/idpm/di_wp6.htm>

¹⁸¹ Vonortas, Nicholas S., Safuoleas, Stratos P. pp. 657-680.

¹⁸²< <http://www.tasknet.nic.in>>

The other is an India-based group launched a new Web site that offers users 11 different operating systems and their accompanying documentation, including Linux. The FreeOS.com site is based in Bombay, and staunchly opposes the lucrative practice of charging for operating systems.¹⁸³ Chile would benefit greatly from increasing the institutions, alliances and networking possibilities. It is possible that networks and alliances will overtake unions as an equalizing force amongst software professionals in the future.

3.4 International Environment and Pricing Policy

For developing countries, the most disabling of all the above factors, are global market obstacles, such as the structure of software supply, and of international markets. The world software market is highly competitive and internationalized, and is a rapidly expanding area of IT. It is interesting that none of the respondents addressed such external limitations, although these factors affect levels of foreign market access. Respondents noted 24 positive impacts of Chile's internationalization framework, and only four thought that "looking outward" would have negative outcomes. Two respondents said that globalization would have no impact on Chile.

As mentioned, 13 respondents said Chile's software firms target domestic customers, 11 identified foreign markets, and eight said both.¹⁸⁴ In terms of pricing policies for these markets, 12 respondents cited competitors' prices as the decisive factor. Only five used analysis of own development and production costs, and alarmingly, three respondents did not know how pricing was determined. However, competitive pricing

¹⁸³< <http://www.freeos.com>>

did not figure in the respondents' suggestions on how to increase market share, either domestically or internationally.

Globalization can also affect the process of becoming more equitable societies. It has been argued that globalization drives down the price of unskilled labor, as populous countries such as China and India supply increasing proportions of goods that are labor-intensive. Globalization increases the relative price of Latin America's abundant natural resources to the detriment of labor, promotes technological changes that increase the returns to skilled workers, and limits the ability of governments to tax the now more mobile capital. These challenges, to whatever extent they exist, provide even further justification for a development strategy that emphasizes the accumulation of skills and the use of the natural resource base in order to avoid competing in sectors dependent only on low wages for unskilled labor.¹⁸⁵

At the international level, it can be argued that there is no such thing (yet) as the Global Information Society. It is distorted as more than 95.4% of IT infrastructure resources are in developed countries, which have only 16% of the world population.¹⁸⁶ Neither is there one scenario toward its accomplishment. In the future, there could be different models of the "Information Society", just as today we have different models of industrial society. They are likely to differ to the degree to which they avoid social exclusion and create new opportunities for the disadvantaged.¹⁸⁷

¹⁸⁴ Some respondents mentioned more than one category.

¹⁸⁵ IADB, p. 4.

¹⁸⁶ Ben Petrazzini and Mugo Kibati. p. 31. Also, Network Wizards <<http://www.nw.com>>

¹⁸⁷ Biggs, p. 41.

4.0 Social Equity:

4.1 Distribution of Wealth and Power

Underdevelopment and inequality are two sides of same coin. Political and economic inequality contribute not only to high rates of poverty, but also to social tension and political disaffection. There is a strong correlation between income distribution and support for democracy.¹⁸⁸

An IADB analysis reveals that inequality is largely associated with wage differentials. It does not point to a difference between owners of capital and workers, but of a divergence between incomes among workers. Large wage differentials reflect, among other factors, unequal distribution of the quantity and quality of schooling. The inequality in wages also reflects gender differences, gaps between formal and informal employment and between rural and urban incomes, and other forms of labor market segmentation that are exacerbated by current labor legislation. The IADB evidence does not support the notion that high inequality in Latin America is simply a matter of a few rich families owning a disproportionate share of each country. Much of Latin America's inequality relates to the stratification between the top 10 percent of the population and the rest.¹⁸⁹

¹⁸⁸ IADB, 4th quarter 1998 p. 1. Democracy requires more than just functionally based, institutional separations and laws equally applicable to all (the technical prerequisite of democracy). More importantly, to live in a democracy means that the adoption of rules, and the ends towards which they will be directly, are shaped through spheres of public communication that are open to all, directed toward the discovery of public rather than private interests, and driven by the force of argumentation, not power (the communicative dimension of democracy).¹⁸⁸ Many societies meet the first condition, while, few, if any, satisfy the second, communicative dimension. For Jurgen Habermas, the crucial feature of public spheres of democratic communication is the principle of non-excludability.¹⁸⁸

¹⁸⁹ *ibid.*, p. 2.

Chile has an inordinate degree of inequality considering its per capital income or sophistication of its productive sectors. Statistics from the Central Bank of Chile reveal that income concentration has not improved significantly during the 1990s:¹⁹⁰

Table 9: Income Concentration in Chile
Percentage of Total Households

	1990	1996
Poorest Fifth	4.2	5.3
2 nd Fifth	8.8	9.3
3 rd Fifth	12.9	12.6
4 th Fifth	19.0	18.2
Richest Fifth	55.1	54.6

The wider the societal benefits from any new economic stream, the greater and longer the impact on economic growth and prosperity. If only a handful of people get better off by producing software, for example, the country as a whole will see little (if any) impact. How could software production relate to the distribution of wealth and power in Chile?

The respondents were asked to identify the beneficiaries of software production in Chile. Most saw the software sector itself as the primary benefactor, with some positive gains to users as well. The latter raises a range of assumptions that influence the course of developer-user interactions. The social system that results is not so much an objective representation of “true” user needs, as the result of particular social relations and the exercise of professional power. While the respondents did not see any social impact brought by software companies, several suggested that there could be benefits to the whole society.

¹⁹⁰ Banco Central de Chile. Boletín Mensual. <<http://www.bcentral.cl>>

One approach to enable broader social development could entail the need to focus on R&D investment for software growth. As observe James and Khan, who build on their work in the agricultural sector, labour-intensive technologies tend to be more egalitarian in their social impact than capital-intensive technologies of the manufacturing sector.¹⁹¹

As a labour-intensive sector, can software production help balance social inequalities? People who work in computing in North America tend to be young, well-paid, and highly informed on progressive sociopolitical and environmental issues. It would seem that this segment of population is highly suited to be generous donors to philanthropic causes and charities. Historically, philanthropy has formed a sort of social contract. Unfortunately, most of the respondents did not see any philanthropic or social mandate for the software industry in Chile.

Summary of Contributions by Respondents

Several general statements can be made concerning the respondents' views touching on barriers to entry, and elements of software capacity building. Most apparent is their breadth of knowledge and awareness. They collectively covered all of the factors raised in the literature, in terms of economics of software, as well as other issues. Overall, the respondents corroborated and substantiated the arguments made by Correa, Baeza and Heeks.

¹⁹¹ James and Khan, p. 156-165.

More importantly, the respondents contributed to the knowledge base concerning the various development issues that face the Chilean software sector. These contributions build on identifying “successful” companies and products, and factors related to software capacity-building and broader national development.

The software firms identified by the respondents as successful differed from those identified in the literature. As the REA was conducted several years later than the benchmark, the deviation could be highlighting high firm turn-over characteristic of the industry, or uncommon definitions of “successful.” Clarifying this definitional gap would greatly enhance the understanding of national software industries, and patterns of firm development.

The respondents’ perspectives of the strengths in Chilean software sector echo support for those identified by Correa and Heeks. The respondents’ observations about weaknesses in the sector showed more emphasis on lack of firm confidence and credibility that expressed in the literature, which are factors which could greatly affect a firm’s ability to position itself in a foreign market.

More valuable contributions by the respondents were made in terms of software capacity building issues. Considering the extent to which information infrastructure has been the predominant focus of the thought on IT for developing countries, it is remarkable that the respondents disregarded its importance. While Chile has made considerable strides in terms of telecommunications services, Internet access, and PC density, universal access issues are largely absent from the discourse on national IT strategies. At the same time, several respondents pointed out that Internet access provides new opportunities previously reserved for big business.

The respondents identified sources of finance capital that are characteristic for start-up companies in Chile. In particular, they noted the absence of venture-capital mechanisms, and the reluctance of banks to provide financing to “virtual” enterprises and intangible assets. Interestingly, no one mentioned federal funding sources. However, none of the respondents addressed R&D, which, for software, is very labour and time intensive. Could lack of attention to R&D and its required inputs be the cause of firm failure in Chile? The respondents focused more on the lack of marketing resources, which could reflect increasing influence by North American marketing-focused enterprises. With a view to technological assessment, it is notable that the respondents did not perceive that they have comparative advantage from their relatively cheap labour.

Compliance with quality standards is another issue that was elucidated by the respondents and by the Canadians. There appears to be incongruence internationally between methods and techniques and their importance for software development. The Chileans’ apparent lack of attention to quality standards may constitute a “glass ceiling” to their software firms, thereby hampering their growth potential.

It is evident that formal education can fulfill only one aspect of human capital requirements for software firm development. While adequate, university-level computing education only reaches a limited population. Increased attention, as the respondents recognized, should be placed on tacit knowledge and informal systems of learning, which could reach a broader section of the Chilean people. The also made a valuable contribution in raising concept of “ingeniero de ejecución,” which is not known in North America.

Nearly all of the private sector respondents hold managerial positions in their companies, yet they were divided on the strengths and weaknesses of Chilean software managers. They may be signaling a lack of uniformity in management practices, and this instability across firms may impede their growth and competitiveness.

The language barrier issue not explicitly raised in literature but underlined by respondents. Cultural differences were raised by Heeks, and were recurrent in the respondents' perspectives. These factors indicate a need for Chile to develop its own domestic market, with a view to moving into the regional one, as pointed out in the literature. They also point to potential difficulties for product diffusion and end-user adaptability. Indirectly identified language and translation issues, as many respondents lacked English writing skills.

In general, the respondents acknowledged the positive politico-economic environment in Chile. Conversely, most respondents not see the government as playing a supportive and progressive role. The negative public image apparently held by Chilean people surely must be overcome. The respondents also identified the small market-size barrier to entry and the export-orientation solution espoused by the literature. Further, several respondents suggested targeting broader domestic markets, such as small and medium firms, to improve their products and services. They also linked the small domestic market problem to education, which results in a lack of QA experts, documentation writing skills and testing skills. At the same time, they stressed the appropriateness of locally produced software, due to local legislation variances, and also because of similar business practices and needs for similar software. Local

appropriateness also implies that targeting the regional Latin American market makes marketing also easier.

For developing countries, the most disabling of all the above factors, are global market obstacles, such as the structure of software supply, and of international markets. The world software market is highly competitive and internationalized, and is a rapidly expanding area of IT. It is interesting that none of the respondents addressed such external limitations, although these factors affect levels of foreign market access. The respondents also raised the problem of the “RUT” (unique role identifier) number as a barrier for internationalization.

At the demographic level, personal nuances of the respondents added flavour to the discussion. For example, they included managers and owners, senior staff; most at a higher level than would have been expected from North American firms. There was a notable lack of academic or government interest in participating. Those with personal foreign experience were more critical of local management abilities; other capacities. And finally, one respondent said that he was answering on behalf of his firm of 15 people as a “collective view” of his firm.

Chapter 5: Conclusion

In a growing body of thought debating the means for developing countries to develop capacities in information technology, software is increasingly promoted as *the* target area. The debate commonly centres on technology transfer, roles and interventions of governing agencies, and economic consequences and impacts on employment, education and other factors.

This paper departs from this literature by considering software development issues with ones of socio-economic development, sustainability, social equity, participation, and social innovation, particularly in the context of internationalization. Certainly, the current thinking on IT does address such issues, while the literature on software specifically, does not. The primary objective of this paper was to explore this gap.

First, explaining the political economy of software in detail can contribute to filling this field. The very nature and characteristics of software differ from those of other IT areas, and require examination and analysis. It can then be seen that existing models for entering the software industry are overly simplistic and, thus a broader typology of software production options was produced, to capture the intricacies and implications of software production and relative market potential for developing countries.

One contribution of this paper is to describe the nature and history of software creation. The software production possibility matrix also advances the understanding of both capacity-building and technology assessment issues. At the same time, the study reveals several conceptual limitations. The definitions of software types are somewhat

imprecise, and it is often difficult to concretize such “virtual” and iterative products and services. Determining correlation between software characteristics and development outcomes remains disorderly and elusive. Also, software is continuing to evolve and there will likely be software products launched in the future that have not been conceived of today. This uncertainty precludes the advantage of hindsight, which is so valuable to a rigorous explanation of a software sector, and of developing theoretical models in this regard.

Second, the inclusion of political and social dimensions requires that the subject of software for development be examined in a theoretical framework that captures social, international and political dimensions, in addition to purely economic ones. The empirical research showed that by viewing the standard factors required for capacity-building through a democratization lens, implications for broader development became evident.

It also opens the possibility of new hybrid theoretical frameworks as pragmatic for basing social research in the new century, to capture the dynamic and multi-faceted dimensions of both new technology and socioeconomic development. However, a composite theoretical approach presents limitations in terms of levels of abstraction. This research, particularly that related to social innovation, is confined to the level of micro-industrial planning and management, as espoused by Schwabe. Other levels, such as long-term development strategies, problem-based development solutions, and scoping dimensions of a “good” society, were not attained.

The empirical and theoretical data collection method motivated the second purpose of this paper. The methodological objective was to test the Internet as an

effective vehicle for conducting social science research. The primary data were thus collected using a technique described as Rapid Electronic Appraisal

The research results suggest that several inferences can be drawn with respect to the political economy of the Chilean software industry. Chile has made progress, particularly during the 1990s, in establishing some local software capability, but has not successfully established a stable nor sustainable one. It became apparent that attention to long term development and to local capacity-building were key influencing factors. Most software firms in Chile engage in re-selling or consultancy services. Very few are dedicated to software development, or maintain programming as a core function.

The inquiry into capacity building, politico-economic environment issues, and social implications also bear implications for understanding the health and characteristics of Chile's software sector. First, the information infrastructure was considered adequate for basing software enterprises. However, universal access and local capacity to maintain and expand systems are more important inputs to democratizing IT than is the sophistication level of telecommunications technology. These elements have not received due consideration.

In terms of financial sources, the recognition of the value of alliances and networked initiatives may become a trend in information enterprises, particularly as globalization expands. Additional benefits may be seen in terms of technology transfer and diffusion vehicles. More focus will need to be made on innovation and R&D, since the software development process is iterative and labour intensive. Labour costs can become an increasingly important variable in the international market.

From a “human capital” standpoint, tacit knowledge, language, marketing and management skills are gaining importance in Chile over strict views of computing training, gained through formal educational systems. The understanding of user needs, and of encouraging constructive user-developer relationships are vital to software development, while overcoming language barriers are necessary for marketing and market penetration. As well, Chileans recognize the value of strength in knowledge of local legislation and business practices, which may give an edge to developing countries seeking local market access. Cultural differences and national identity are also important. All of these assets apply to participating in both domestic as well as foreign markets, as Chile is interested in pursuing.

Chilean software actors recognize the importance of developing broad domestic market opportunities, as well as of the related issue of sophistication of local users. Lack of demand-pull forces inhibit innovation and therefore hampers product growth.

In terms of the role of the Chilean government, there has been ongoing efforts in opening market policies, internal reform measures for transition to a competitive market structure, encouraging infrastructure development, and playing a consumer role. It is important that it decentralize the bureaucracy, so that regional authorities can enable capacity-building initiatives that are appropriate to local needs.

Chileans do not seem concerned that there is little labour union presence, as have been historically important in the Chilean economy. Associative institutions, networks and alliances are increasing in importance, in a pattern similar to that in other Western countries. What effects will that have on local labour rights?

In terms of pricing policy and target markets, Chileans do not seem overly attentive to the structure of pricing, nor of the structure of the software market – either nationally or internationally. As software is highly competitive and internationalized, these issues are central to firm longevity.

Finally, the Chilean respondents are not overtly concerned with issues of social equity. Wage differentials constitute a major factor in influencing the distribution of wealth and power in Chile. There is little view of the software sector playing a philanthropic role, nor of who the beneficiaries are. Overall, Chile has not got all the inputs for a (stable) sustainable software industry. A national software strategy would undertake technology assessment, to strategically position local software firms.

The conclusions drawn from the Chilean software sector can also bear implications for the political economy of software in other developing countries and its relationship to development/poverty reduction. Such assertions must bear in mind the weakness of the REA: that it does not provide data from which generalizations can be made about populations. Rapid Appraisal helps to enrich our understanding, but it does not provide information about the extent or pervasiveness of a phenomenon.

An analysis of the nature and economics of software and history of programming leads to a more complete understanding of the technological assessment to be undertaken in order to determine possible ways of entering the software industry, and moving down a growth path.

The nature and economics of software reveal the main commonalities between software product types. However, each of the characteristics, market scope, market force, labour intensity, skill intensity, firm intensity, and user-developer interaction, differs in

terms of relative difficulty and relative costs, which helps determine the relative size of barriers to market entry.

The key for DC enterprises seeking to develop software capacity, is to be able to systematically undertake technology assessment, that is to assess these options and markets, and evaluate them within the context of the various barriers to entry, and contexts of their own societies. They can then determine appropriate levels of technological effort, as required for capacity-building. This view of software production possibilities as more diverse, bears implications on software innovation in developing economies. A country must carefully evaluate its own relative position in the global software market.

Increasing attention should be paid to the social relations between software developers and users; and between the importance of accreditation (the valuation of professional software development against that done by amateurs).

Software production, as it is currently structured and oriented, does not directly link to poverty reduction. The sector must address issues of universal access, and breadth of beneficiaries. However, as software development is labour-intensive, it has the potential to be egalitarian in its social impacts. Benefits to the whole society can only come about with concerted social innovation measures. For example, there is a need for more enterprises, such as Enlaces of FreeOS.com, to undertake social mandates.

From the methodological aspects of this research, Internet services were viewed as an opportunity to open up new frontiers for conducting social science research. The process of Rapid Electronic Appraisal methodology had no precedents to draw from, and

therefore presented a test case, designed to determine the effectiveness of conducting RA approaches via the Internet, as a social science research strategy. Like other research methods, REA has both strengths and drawbacks.

To date, most of the research conducted electronically has been focused on searching and gathering information on the Web. Yet, with electronic surveys, researchers can conduct primary research, and reach countless potential interviewees, crossing barriers of distance and time. The obvious constraint of online research is the availability of Web sources, and the connectivity of desired interviewees. And, none of these services can replace personal interaction between the researcher and the interview candidates. As there were over 200 Web sites related to Chile's software sector in 1998, there was a large enough "wired" population to conduct the REA. The response rate was 9.5% of the total possible contacts, or 23 respondents from a possible 242 sources.

REA is also limited in terms of reliability, which can be undermined as it does not employ probability sampling and therefore may be criticized for producing results that are unrepresentative. Also, because of the need for respondents' anonymity in this research, gains from triangulation were limited. However, observations were gathered from Canadian software professionals with both academic and entrepreneurial backgrounds. There was more possibility to triangulate among data collection methods, as sources include literature, baseline data, virtual (Web) observations of organizations, and qualitative information collected from survey respondents.

The information gathering process flowed between several steps including: analysis from secondary sources, survey responses, feedback to Chilean respondents, follow-up interviews with certain respondents, presenting information to Canadian group,

synthesizing their input, and informing Chileans of latest findings, and engaging in electronic dialogues based on virtual observations.

Nevertheless, the approach to conducting REA showed some success in creating a “research community” online by building an information sharing Web site that extended the parameters of static Web sites, which are limited to passive information collecting. The participants engaged in a process that is dynamic and evolutionary, rather than in a one-sided communication process. It also improved on the schema of traditional extractive research which engages in one-on-one communication. REA is more participatory and interactive. It offers a broader exchange of information to capture local knowledge.

The approach contributed to our understanding of software in Chile, and offered ways of making connections, while providing anonymity to the respondents. It therefore represents a vehicle for generating communication flows between South and North. As it crosses geographical boundaries and distance/time constraints, it can reach a potentially broader population of respondents, and connect them together no longer just as interviewees, but rather they are transformed into an integral part of the development of the knowledge base. In this information exchange, Internet technology is the enabler of developing this process.

In these regards, the empirical methodology for this research can be evaluated as effective as a social science research strategy. Using Chat services would enhance the successfulness of creating a “research community,” as will be explained below.

This thesis should be regarded as a step to further inquiry into software for socioeconomic development in developing countries. Similar case studies of the political

economy of software could be undertaken for other Latin American countries, as well as for North Africa, the Small Island States of the Pacific and the Caribbean, and Central Asia. Such research is particularly conducive to countries which have labour-intensive economic strength, rather than manufacturing-driven economies; and whose populations have historically invested in their educational systems, and that have some access to telecommunications services and infrastructure.

More importantly, establishing the links between software production, development and poverty reduction require more detailed analyses of software firms, products and innovation cycles for any given geographical domain. Further empirical effort could concentrate on how to measure the impacts of software on a given economy, and further defining concepts of successes and weaknesses.

Other areas of software products, such as the inhouse/customized and embedded tools sectors of software production possibilities could also be explored. However, both of these areas are very difficult to quantify and analyze, as they are hidden within other products and services.

Additional IT areas could also be examined in a similar framework. In terms of network infrastructure, strong growth in Latin American Internet use has given rise to frequent speculation regarding the potential for Web commerce to flourish in the region.¹⁹² The perceived commonalties shared by the region's countries— culture, values, history, economics, language— are numerous enough to believe not only in the strong

¹⁹² User growth in Latin America leads the world with 4.8 million users in 1998 and an estimated 19.1 users by 2003. IDC, June 3, 1999

potential for Web commerce, but also in the possibility that Web commerce may enable a truly unified, albeit virtual, regional market.

Obstacles impacting the region's ability to foster Web commerce include weak credit card processing infrastructures, the high cost of basic Internet access to the end user, existing tariff barriers, and the high cost of logistics (i.e., shipping). Because of these obstacles, while consumer Web users in Latin America are making online purchases, the heavier momentum is behind the corporations in and out of the region already investing in business-to-business commerce solutions. These are possible weaknesses overlooked by the Chileans, particularly if looking to export to the Latin American region.

As well, other elements of the politico-economic environment could be included. For example, the evolution of IPRs and mechanisms to enforce them both domestically and in foreign markets; domestic and foreign consumption patterns; as well as environmental and gender impacts of software industries are other areas with merit further research. These inquiries could be undertaken within the framework of global sustainable development, in which poverty in the South and over-consumption in the North mark the most visible economic trends.

These trends are also evolving in the context of “globalization” and the growth of the “information economy” and “knowledge society.” In this regard, new theoretical hybrids may be increasingly necessary to explain 21st century IT developments. The inclusion of political and social dimensions requires that the subject of IT for development be examined in a theoretical framework that captures social, international and political dimensions, in addition to purely economic ones.

This research drew on the “new techno-economic paradigm” to characterize software innovation and social innovation elements. The “unconventional” approaches inquired into mechanisms and implications of technology transfer, and theories of international political economy were applied to issues of market share, pricing strategies, and internationalization efforts. Other theoretical frameworks, such as social feminism, may also contribute to, and enrich, theoretical debates on IT and development. A more systematic approach to developing a theoretical paradigm for new technologies should be developed and applied.

Lastly, there are also avenues for further enhancing Internet research techniques. This research represents a beginning point for REA. RA techniques of the systems perspective, triangulation and iterative data collection, could be more rigorously applied, thereby creating a stronger conceptual basis for an REA. Other Internet technology, particularly Chat services would contribute significantly to the creation of electronic research communities, or REA networks. There are significant opportunities for testing REA on a larger scale, or on a wide-range of issues. Given the rapid evolution of Internet technologies to date, other applications of REA are likely to emerge in the near future. These technologies themselves may also become the subject of further inquiry as examples of IT software for sustainable development.

Annexes

Annex 1

Definition of Global Information Infrastructure/Society

The concept of global information infrastructures-global information society (GII-GIS) encompasses the development and integration of high speed communication networks, and a set of core services and applications in digital format, into global integrated networks capable of seamless delivery. Such networks provide fully interactive access, to network-based services within countries and across national borders. These services may be traditional voice services, data, video services, or more sophisticated combinations of these services (multimedia services) destined for business, government and residential users, as well as for social purposes. The physical infrastructure of GII-GIS is not limited to any one technology; on the contrary implicit in the GII-GIS concept is the interconnection and interoperability of a range of competing and complementary infrastructures, applications and services made possible by digitalisation. Communication and computing technologies form the basis of GII-GIS, but hardware, software, multimedia skills, content and information also play a key role. A harbinger of GII-GIS is the explosive growth of the Internet.

The concept of GII-GIS also encompasses the notion of the transformation of existing economic markets to a market place where communication networks bundling together transport, access and market transactions will play a major role. The driving forces behind economic growth and development in such a networked economy will not be natural resources or physical goods but based on information viewed as providing the foundation for the transformation of existing social and economic relationships.

Source: Committee for information, computers and communications policy 1997. p. 7.

Annex 2**Respondents and Response Statistics**

	Respondent	# Request E-mails sent	Response date	# days to respond after last request	Reply medium
1	Ricardo Baeza	1	Tue, 09 Mar 1999 20:23:52	4	Web form
2	Tania Bedrax-Weiss	1	Sat, 06 Mar 1999 16:11:49	0	Web form
3	Sonia Zavando	1	Fri, 23 Apr 1999 16:27:29	48	e-mail
4	Claudio Ramirez,	2, 6 th , 22 nd	Tue, 6 Apr 1999 18:13:08	15	e-mail
5	Eduardo E. Maldonado S.	1, 5 th	Tue, 13 Apr 1999 01:01:10	39	e-mail
6	Jean-Pierre Melville	1, 5 th	Mon, 8 Mar 1999 15:04:15	3	e-mail
7	Andres Avila	2, 5 th , 21 st	Thu, 25 Mar 1999 18:17:58	4	Web form
8	Aquiles Manhey	2, 6 th , 22 nd	Mon, 29 Mar 1999 16:00:30	7	e-mail
9	Eduardo Bonzi Correa	1, 22 nd	Wed, 24 Mar 1999 10:22:15	2	Web form
10	Manuel Figueroa B.	1, 12 th	Mon, 07 Jun 1999 09:39:13	56	Web form
11	Celeste Aguayo	2, 5 th , 22 nd	Mon, 12 Apr 1999 16:42:27	21	e-mail
12	Adolfo Diaz	2, 5 th , 22 nd	Mon, 22 Mar 1999 20:36:30	0	e-mail
13	Alfonso Mazzarelli	1, 5 th	Fri, 5 Mar 1999 17:50:32	0	e-mail
14	Rodrigo Peña A.	1, 6 th	Tue, 09 Mar 1999 10:56:51	3	Web form
15	Carlos Fuentealba	1, 29 th	Tue, 30 Mar 1999 10:11:53	1	Web form
16	Mariano Burgos	1, 6 th	Sun, 28 Mar 1999 18:20:55	22	Web form
17	Phillip Roe	1, 5 th	Thu, 11 Mar 1999 17:21:33	6	web form
18	Cristian Valenzuela	1, 29 th	Mon, 5 Apr 1999 22:28:20	7	Web form
19	Jorge Jiménez	1, 5 th	Tue, 9 Mar 1999 12:00:46	4	e-mail
20	Oscar Antonio Fuentalba	1, 22 nd	Tue, 23 Mar 1999 04:23:23	1	e-mail
21	Ricardo Solis Alvarez	1	Tue, 9 Mar 1999 23:11:33	3 or 4	Web form
22	Rodrigo Ceron	0	Mon, 22 Mar 1999 19:01:06	0	Web form
23	Dr. Pablo Straub	0	Mon, 8 Mar 1999 21:09:33	2 or 3	e-mail

Annex 3

Solicitation E-mails

First E-mail – Introduction and Solicitation

> -----Original Message-----
> From: Sabrina Barker [SMTP:sabrina@igs.net]
> Sent: Viernes 5 de Marzo de 1999 03:54 PM
> To: info@nsi.cl
> Subject: investigación de software
>
> Buenos Días,
>
> Favor de dirigir esta mensaje a todos que les interesán:
>
> Soy estudiante en Canadá, y hago una investigación muy distinta sobre
> la industria de software chilena. Creo que mi trabajo le interesará
> mucho. Se trata de informarse sobre las condiciones actuales y sobre
> los efectos socioeconómicos del sector de software chileno. Se
> distingue porque no tengo ningún alianza chilena, es decir que no
> represento ningún interés en particular. Por eso, el recurso puede
> resultarse en un análisis imparcial. También se distingue porque hago
> todo el trabajo sobre el Internet.
>
> Le invito a participar en este estudio. (Encontré su correo
> electrónico sobre el sitio Web "La Brujula.") Busco las opiniones e ideas de
> programadores, gerentes, académicos, entre otros que trabajan en
> computación.
>
> Le pido de responder a un cuestionario de 15 preguntas. A cambio de
> su esfuerzo, recibirá los resultados del estudio, cuando sean compilados.
>
> También, puede aprovecharse de la página de fuentes Web que tiene
> todos los recursos que encontré sobre la industria de software chilena.
>
> El recurso se encuentra en el sitio Web
> <http://www.igs.net/~sabrina/tesis> que se llama el "Knowledge
> Exchange."
>
> Le agradezco mucho de participar en esta investigación.
>
> Sinceramente,
>
> Sabrina Barker

Second E-mail – Reminder with Survey Included

-----Mensaje original-----
De: Sabrina Barker <sabrina@igs.net>
Para: ies@ies.cl <ies@ies.cl>

Fecha: Lunes 22 de Marzo de 1999 03:29 PM

Asunto: sigue la encuesta

>Buenos Dias,
>
>Favor de dirigir esta mensaje a todos que les interesán:
>
>Hace dos semanas, le envié un mensaje que habla de una encuesta sobre la
>industria de software chilena.
>
>Mi estudio depende de su participación. (Encontré su dirección sobre el
>sitio Web "La Brujula.") Busco las opiniones e ideas de programadores,
>gerentes, académicos, entre otros que trabajan en computación.
>
>Soy estudiante en Canadá, y creo que mi trabajo le interesará mucho. Se
>trata de informarse sobre las condiciones actuales y sobre los efectos
>socioeconómicos del sector de software chileno. Se distingue porque no
>tengo ningún alianza chilena, es decir que no represento ningún interés
>en particular. Por eso, el recurso puede resultarse en un análisis
>imparcial. También se distingue porque hago todo el trabajo sobre el
>Internet.
>
>Le pido de responder a un cuestionario de 15 preguntas. A cambio de su
>esfuerzo, recibirá los resultados del estudio, cuando sean compilados.
>También, puede aprovecharse de la página de fuentes Web que tiene todos
>los recursos que encontré sobre la industria de software chilena..
>
>La investigación se encuentra en el sitio Web
><http://www.igs.net/~sabrina/tesis> que se llama el "Knowledge Exchange."
>También las preguntas están abajo..
>
>Le agradezco mucho de participar en esta investigación..
>
>Sinceramente,
>
>Sabrina Barker
>
>
>Nombre:
>Título:
>Tipo de negocio:
>Sitio Web:
>E-mail :
>
>(Esta información sólo será usada para acreditarle y contactarse-- es un
>compromiso).
>
>I -- La Industria de Software Chilena
>
>1. Hay por lo menos 200 empresas de software en Chile, y seguro que
>este total crece..
> ¿Cuáles son las fortalezas de la industria?
> ¿Cuáles son sus debilidades?

- >
- >
- >2. Las nuevas empresas siempre necesitan de un valor líquido igual
>como el activo fijo.
- > ¿Cómo se financian su desarrollo?
- >
- >3. Las empresas de software latinoamericanas sufren de infraestructura
>inadecuada, de un mercado doméstico muy pequeño, y de estándares de
>qualidad muy bajos.
- > ¿Cuáles son los obstáculos ante las empresas de software
> chilenas?
- > ¿Cómo se pueden superar estas dificultades?
- >
- >4. Al parecer, las filiales de las empresas extranjeras tienen mejor
>acceso a gerentes, programadores y vendedores acreditados y
>experimentados, al igual que a muchos instrumentos de computación (como
>CASE).
- > ¿Tienen las empresas chilenas acceso igual a los recursos y
> las habilidades que necesitan?
- >
- >5. ¿Qué papel desempeñan las instituciones educativas en el desarrollo
>de software?
- > El sistema de capacitación satisface las necesidades de la
> industria de software local?
- >
- >6. ¿Es el gobierno un agente activo en software?
- >
- > ¿Cómo interactúan los gremios con el sector de software?
- >
- >7. ¿Cuáles son las fortalezas y las debilidades de la gerencia
> en el sector de software chileno?
- >
- >8. Chile está orientándose más y más al extranjero, con su nueva bolsa,
>y la cuestión de NAFTA..
- > ¿Qué efectos podrían resultar en el sector del software a
> causa de estas esfuerzos de internacionalización?
- >
- >9. ¿Cómo podrían las empresas de software realizar una
> participación del mercado doméstico?
- >
- > ¿Cómo podrían participar en el mercado internacional?
- >
- >Muchísimas gracias de sus respuestas. Favor de seguir a la parte
>siguiente.. Quedan sólo algunas preguntas...
- >
- >II -- Productos de Software Chilenos
- >
- >10. ¿Cuáles productos de software chilenos han tenido éxito hasta la
>fecha?
- > ¿Cuáles tipos han perdidos?
- >
- >11. ¿Están los productos de software chilenos más apropiado
>culturalmente y lingüísticamente que los productos extranjeros?
- >

- >12. ¿Se dirigan los productos de software chilenos a clientes
> domésticos o a los extranjeros?
- >
- >13. ¿Cómo se fijan los precios de los productos de software
> chilenos para concurrir en los distintos mercados?
- >
- >III -- Igualidad Social
- >
- >14. ¿Quién beneficia de la producción de software en Chile?
- >
- >15. ¿Se encargan las instituciones de software algún mandato social?
- > ¿Hay un papel filantrópico para la industria de software?
- >
- >Comentarios: ¿Tiene Ud. algún comentario o reacción?
- >
- >
- >Muchísimas gracias de completar este cuestionario. Su participación vale
>mucho. Favor de comunicar este sitio con otros que podrían interesarse..
- >No olvide de volver para ver los resultados, cuando sean compilados..

Third E-mail—Last Chance

-----Mensaje original-----

De: Sabrina Barker [mailto:sabrina@igs.net]

Enviado el: lunes 12 de abril de 1999 12:41

Para:

Asunto: ultima semana

(Nombre):

Hace varias semanas, le envié un mensaje que se trata de mi encuesta sobre la industria de software chilena.

Mi estudio depende de su participación, porque necesito sus opiniones. Pero, ya se acaba el semestre, y tengo que terminar el estudio.

Le pido de responder al cuestionario de 15 preguntas. A cambio de su esfuerzo, recibirá los resultados del estudio, cuando sean compilados. También, puede aprovecharse de la página de fuentes Web que tiene todos los recursos que encontré sobre la industria de software chilena.

La investigación se encuentra al sitio Web
<http://www.igs.net/~sabrina/tesis> que se llama el "Knowledge Exchange."
También las preguntas están abajo.

Le agradezco mucho de participar en esta investigación. Favor de enviar sus respuestas antes de viernes, el 16 abril.

Saludos,

Sabrina

Annex 4**Information collected from Web sites and Respondents**

	Respondent	Title	Sector	# ?s answered*	# Words in Response
1	Ricardo Baeza	Professor	Academic	12	284
2	Tania Bedrax-Weiss	Ph.D. Student	Academic	14	317
3	Sonia Zavando	Project Leader	Association/Software	12	374
4	Claudio Ramirez	Product Manager	Government	15	781
5	Eduardo E. Maldonado	General Manager	Software	15	671
6	Jean-Pierre Melville	Quality Manager	Software	13	761
7	Andres Avila	Development Manager	Software	15	988
8	Aquiles Manhey	General Manager	Software	10	248
9	Eduardo Bonzi Correa	Electronic Engineer	Software	14	286
10	Manuel Figueroa B.	General Manager	Software	15	211
11	Celeste Aguayo	Development Manager	Software	15	822
12	Adolfo Diaz	Ingeniero Ejecución	Software	15	584
13	Alfonso Mazzarelli	Operations Manager	Software	15	351
14	Rodrigo Peña A.	Vice Commercial Mgr	Software	15	520
15	Carlos Fuentealba	Software Consultant	Software	15	281
16	Mariano Burgos	Development Manager	Software	14	141
17	Phillip Roe	Manager	Software	15	440
18	Cristian Valenzuela	HR Manager	Software	14	434
19	Jorge Jiménez	Head of R&D	Software	15	814
20	Oscar Antonio Fuentalba	Computing and Informatics Engineer	Software	15	920
21	Ricardo Solis Alvarez	Manager	Software	15	326
22	Rodrigo Ceron	Civil Engineer	Software	13	374
23	Dr. Pablo Straub	Manager	Software	15	759

"Don't know" *does* count as an answer.

Annex 5

Web Profile of Respondents

	Sector	Location	Corporate Information	Comments on Web site
1	Academic/ IEEE	SantiagoChile.	President of the Computer Chapter, IEEE. Professor at U. of Chile, Computer Science Department. Member of ACM. Ph.D. in Computer Science, University of Waterloo, Ontario, May 89 On-line C.V.	Personal Web Page
2	Academic	Eugene, Oregon	Ph D Student at the University of Oregon and a Student Researcher at the Computational Intelligence Research Laboratory.	Personal Web page in WWW Ciencia Chile. Electronic list of Chilean scientists around the world.
3	Association / Software	Santiago	Software Process Improvement Network de Chile. Spin-Chile is an organization for the Chilean software industry, non-profit, whose mission is the diffusion of technologies for improving processes of software development. Also project leader of Intec-Chile, a non-profit organization created by CORFO. 30 years in operation. www.intec.cl	Server down when going back to get more information. 8, 10 June. Intec page excruciatingly slow.
4	Government	SantiagoChile.	ProChile is the Chilean Trade Commission within the Ministry of Foreign Affairs, and has 35 commercial offices world wide. The organization's role is to support and advance business interest in the global marketplace by assisting in the development of the export process, establishing international business relationships, fostering the exchange of goods and services, attracting foreign investments and forging strategic alliances. Search engine for export products and companies, for 1997 and 1998. No information found when "software and product" searched as keywords. 3 matches found for "software and company" as keywords. One of them is Aisoft. (who responded)	Pro Chile page under construction. Points to www.chileinfo.com, in New York.
5	Software	Providencia, Chile.	VAR (Value Added Reseller) for Workflow, Metro 3.0, from Actiontechnologies Inc., in Chile and South America. Certified in San Francisco, California U.S.A. No corporate information. No job postings information	Well designed Web site.
6	Software	SantiagoChile.	Catalogues and lines of support. Developers of solutions for office administration. Products include Flexline. Goldflex. No corporate information, no job information. Offices around Latin America.	one page not found.
7	Software		Outsourcing in Informatics. Founded 1992. 300 employees.	Server down when went back for more information.(June 1 and 8, 9)

8	Software		Software for Construction, Architecture and Engineering.. Distributor for Presto 7 from Soft S.A., Spain. CAD32 from Argentina, Asta Development Corp., USA. And others. 6 years in operation.	Lots of broken images
9	Software		Web sites, ATMs, cd-rom, etc. Prizes and Recognition Committee of Region 9 of IEEE	Site only runs with plug-ins I was 1st visitor.
10	Software		Software development.	Server down when went back for more information. (June 2, 10)
11	Software	Santiago Chile.	Designers and manufacturers of hardware and software. Products: Access Controls, ATMs. on American and Japanese products. Systems integration. No software information. Hardware for bank machines and things. 1987. No job information. Chile and Peru	Site not navigable. Went to Hannover Messe.
12	Software	Santiago Providencia.	Job information. 1993. Training, Web design, telephone systems, IP and IVR	Good Web site.
13	Software	Santiago	Representative of ATC Networks, products for the integration of voice, fax, data and communication. Resellers with alliances with IBM Tivoli, Microsoft	No links for About, Support, Links etc. pages.
14	Software	Santiago	1994. Joint ownership 50% each CTC (Compañía de Telecomunicaciones de Chile owned by Telefónica de España.) and Sonda. Product is mainly Customer Care and Billing System. Sistema Alianza. CONCRE Alicación de Control de Límite de Crédito. SEAT/TOL Sistema de Extracción de Archivos para Tasación. SIS Sistema de Interfaz al Switch. AUTOATENCION Estación de Autoatención a Clientes. ALIANZA GESTION Sistema de Gestión de Clientes ALIANZA. SPIA Sistema de Detección y Control de Fraude SPIA. Doesn't say who developed them. No job information.	
15	Software	Providencia, Santiago.	Software development. 1994. Consulting on computer needs, independent of hardware and software providers. Development of MDDM Multi Dimensional Data Mining, Client/Server stuff for Windows, and Internet.	Problems with accents. Page last updated 28 July 1998.
16	Software	Concepción, Chile	On-line support	Server down when went for more information, 2, 9 June.
17	Software	Santiago	Software developers. Participation in METAmorphosis, Comdex '98. Partners with Optimisa S.A. member of Associations. No job information	Good site.
18	Software	Los Angeles, Chile	1994. Founded by three informatics engineers. Informática Integral. Systems development, computational support, Web, dynamic intranet, administration data bases. Services and support,	

			not development. 15 staff. No job information.	
19	Software	Viña del Mar, Chile.	Develop tools, resellers for American products. No job or corporate information.	Whole employee e-mail list . Removed by 2 June, though.
20	Software		Support and asesoría, sales, armado, installations. Training, system development, operating systems, technical service. No corporate or job information.	Various US servers for free Web hosting. Annoying ads result. Broken images. Pages not nav'ed.
21	n/a			
22	n/a			
23	Software	Santiago Chile	Chilean Center for Software Technology Motorola Semiconductor Products Sector. Respondent gave Motorola's site, but Chilean branch is at http://global.motorola.com/Chile/ US Multinational.	US Web site.

Annex 6

Landmarks in Chilean IT industry¹⁹³

Date	Event
1962	first computer (U of Chile)
1964	First data processing company: ECOM (state owned)
1967	First data processing network: Banco del Estado
1969	First Computer Science program (U of Chile)
1974	First Computer Science Department and M.Sc. program (U of Chile). Latin-American Informatics Conference is launched in Chile (Catholic U. of Valparaiso)
1981	Governmental research grants program begins. First International Computer Science Conference.
1984	First Unix system (U of Chile, U. of Santiago), Chilean Computer Science Society is born.
1985	International electronic mail (UUCP) followed by Bitnet in 1987 (U of Chile)
1987	First automatic banking teller network (union of banks)
1989	First Unix workstations laboratory (U of Chile)
1990	First IT industry participation in CEBIT (Germany)
1991	Digital data networks. Internet connectivity (Catholic U. and U of Chile)
1993	First Ph.D. program in Computer Science (Catholic U.) Digital telephone switching system goes from 80% to 100%
1994	Experimental ISDN service. First ATM network (U of Chile) Multicarrier system for long distance telephone calls.

¹⁹³ Baeza-Yates, pp. 24.

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