MEASUREMENT OF DIGITAL DIVIDE IN ASIA AND INDIA: A FRAMEWORK FOR CROSS-COUNTRY AND INTER-STATE ANALYSIS

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CERTIFICATE

Certified that this Dissertation/thesis entitled "**MEASUREMENT OF DIGITAL DIVIDE IN ASIA AND INDIA: A FRAMEWORK FOR CROSS-COUNTRY AND INTER-STATE ANALYSIS**", submitted by me in partial fulfillment of the requirements for the award of the degree of **MASTER OF PHILOSOPHY** is my original work and has not been previously submitted for the award of any other degree of this or any other university.

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"Technology is neither good nor bad, nor even neutral.
Technology is one part of the complex relationships
that people form with each other and the world around them;
it simply cannot be understood outside of that concept".

—–*Samuel Collins*

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Chapter 1
Why Digital Divide is a Serious Threat?

Concepts of Digital Divide

Information and Communication Technology (ICT) can be viewed as a general purpose technology, which consists of a radical shift in the production functions of a large array of goods along with a significant bias, at least for adopting countries. Technological progress is supposed to be neutral when factor combination remains same with the less use of both the factors, and it is supposed to be biased when factor combination changes with the less use of at least one factor.

When a new technology is biased in favor of more abundant and hence less expensive factor, the effects in terms of productivity growth of more abundant factor will be stronger. Therefore, it is always better for a capital abundant country to use capital intensive technology; and labor abundant country to use labor intensive technology. When a labor abundant country adopts capital intensive technology, it will lead the country to a different productivity growth trajectory and hence there will be an asymmetry.

Such asymmetric effects are reinforced and amplified by the changes of relative prices. When, with a given biased technology, relative factors prices, as distinct from absolute factor costs levels, change, equilibrium factor combination changes. With this introduction of new technology propels a change in organizational pattern. Changes in organizational pattern along with changes in factor combination changes average cost. Specifically, a biased technological change affects both the partial productivity of each production factor and the general efficiency of the production process and thus the production cost. Such changes in production costs, even if are not accounted by total factor productivity measures, have powerful effects upon the comparative advantage on global markets of rival firms based in heterogeneous factors markets.

Introduction of ICT can affect the source of comparative advantages as an additional input even in the regions where most productive inputs are more expensive at least in relative terms. From this viewpoint the introduction of ICT world-wide with their absolute superiority and yet their bias can engender new relevant asymmetries among regions, not only with respect to the pace of diffusion, but also and mainly in terms of the capability of each region to extract appropriate economic benefits from their necessary adoption.

Again in the early stages of introduction of new technologies require higher levels of skills because of the risks and complexities associated with the necessary learning processes. Eventually, however the skill bias should decline as well as the premium associated with the skill contents, and then the adoption of more advanced technologies becomes easier. Therefore, early adopters of new technology will be more capable to adopt advanced technology and move themselves to the higher technological trajectory compared to the late adopters. Thus there will be a situation of divide, termed as Digital Divide, since almost all the sectors of ICT are digitalized, with the ever increasing gap between digital riches and digital poor.

Digital Divide between digital rich and digital poor poses the most significant socioeconomic challenge of the modern world. This is manifested in various dimensions. Some of these are described below:

Productivity

There is over 20 years of accumulated cross-country evidence on the link between telecommunications provision and economic growth. The effect of telephony has a dramatic effect on the income and quality of life of the rural poor. *Forestier, Grace, Kenny* (2002), found that, historically, telecommunications rollout has had a positive and significant impact on increasing inequality and little impact on quality of life variables. A reason for this is tested and preliminarily confirmed that rollout has (historically) only benefited the wealthy. Again examining the role of the Internet in poverty relief and statistics on the access gap in provision between rich and poor, they suggested that this new ICT will also be a force for income divergence. Using the results of the cross-country analysis on telecommunications, they concluded with a discussion of potential policy responses (such as sector reform and universal access programs) that "to turn telecommunications from a source of growth that also increases inequality; it must look to a source of growth that diminishes inequality".

Generally, most of the modern production processes are complex in nature and demands inter and intra firm communication. Use of ICT can provide better network to run these production units better and to increase productivity. When some firms of a sector are familiar with these facilities and are using them effectively but others are not, there will be a problem of imbalances. Due to this imbalance none of the firm will be able to produce its potential level of output.

In this regard *Lorin Hitt* and *Brynjolfsson* (2000) in their survey considered a variety of case studies on ICT implementation, its impact on productivity, and considered in particular, studies that condition these impacts on organizational innovations. They have shown that ICTs improve productivity by enabling complementary organizational innovations. Investments in ICTs are low but the efficiency is conditional on organizational changes, which can be very costly. Whenever the costs of organizational change are not taken into account in firms that get reorganized, the measured productivity impact of ICT, or their impact on the firm's financial value, may be overstated, because these costs are difficult to measure. ICTs are also more frequently associated with increases in the intangible component of output.

e-commerce

Recent studies show that the Internet is still mainly used for marketing purposes and its use for other purposes varies according to the business' position in the value chain (customer or supplier). But from the different surveys (Ecommerce Pilot Survey, 2001; OECD, ICT database, August 2002) it is observed that purchasing is more common than selling.

The propensity to carry out Internet purchases and sales is higher in services than in manufacturing, and financial services; business services and wholesale trade are generally the most intensive users. Internet orders are most frequent in the finance and insurance industry.

Among firms that use the Internet, only a few distribute goods and services on-line or offer interactive electronic payment capability. An analysis (Falling Through The Net, 2001) of the use of computer networks in US manufacturing plants in mid-2000 revealed very limited use of Internet applications to integrate transaction-related business processes. Some plants that do not accept on-line orders accept on-line payments, while some plants that reported no on-line orders provided on-line customer support.

Although transactions among businesses represent the bulk of electronic commerce, most attention has focused on business-to-consumer Internet sales. The share of Internet users buying over the Internet is generally quite low and varies widely. It is highest in Denmark, Sweden, United Kingdom and United States, where about 38% of individuals using the Internet ordered products in 2001, followed by Canada (24%) and the Netherlands (20%). It is lowest in Mexico, where only 0.6% of Internet users purchase over the Internet *(Source*: OECD, ICT database, August 2002).

In Eurostat's *E-commerce Pilot Survey* (2001), sales abroad are broken down by destination within and outside Europe. Initial results for nine European countries indicate that European companies mainly sell over the Internet to locations within Europe. This may partly reflect the overall (intra-Europe) tendency of European trade.

One source of differences in countries' implementation of electronic commerce and in the impact of electronic transactions on business performance and productivity is the extent to which firms incorporate the technology strategically into their business processes. Firms carrying out transactions on line may seek greater efficiency, or speed, in their business processes or production-related efficiency, *i.e.* reduction of transaction costs or of the costs of intermediate inputs by reaching out to more efficient suppliers. Other firms may adopt e-commerce technologies to develop new business practices and change their way of interacting in the marketplace. Still others implement e-commerce technologies as a result of pressures from customers and suppliers or simply to remain competitive.

The products that sell the best over the Internet are not necessarily the same across countries, since they reflect not only the nature of the product[1] but also consumer tastes and habits.

It is clear, through Internet, customer can access producer's database directly and effectively. To maintain a smooth communication and transaction between customer and producer and among different firms, it is important to be connected with Internet. If a portion of the population is out of this network, surely it would create a problem in the effective functioning of e-commerce.

Banking

Introduction of ICT in banking system has changed the financial system of an economy. Introduction of ATM, Smart Card, Credit Card and link with all branches all time has already created a smooth, slick, faster, and cheaper transaction process. Digital divide in banking system demands banking authorities to maintain both the format of banking – manual as well as digital. i.e., more number of employees is required and both the processes are to be maintained, which costs high.

Without being connected, data compiled and analyzed using IT cannot be used for strategic purposes, but can be used for internal control. Lastly, there is marketing. Simply put, pursuing IT means eradicating the asymmetry of information, thereby allowing the buyer and seller to do business on an equal-footing basis. But banks were not able to give up their mindset of being the big guy, and ignored marketing activity for individual clients.

Health

For better health facilities it is very important to track and provide patient information. With this patient information linking research, diagnosis and testing, enable communication for professionals and patients can deliver service despite distances and

[1] digitised products such as music, books and software which are easier to sell and distribute over the Internet.

time barrier. This is what now called telemedicine, which is important for better health facilities. Without being connected, it is not possible to do all these anyway.

Again for faster service, first world countries are sending medical data of their patients and getting reports from third world countries. Though this service creates some jobs in third world countries but in opposite way medical professionals are not being able to track and provide patient information and send it to the first world country. Again without being connected patients can't get required information regarding medical practitioner or institutions in time. Most of the time they are to rely on hearsay or unauthentic sources, which can be fatal.

Education

The contribution of the information economy to overall economic growth assumes that the population has the skills needed to use the technology and ICT skills are particularly important. Access to ICT in schools and use of ICT in education are extremely important for raising ICT awareness and for developing an ICT skill-base in the economy. The use of computers at an early age helps students to learn ICT skills, which can then be used as a tool in the education process. For this reason, it is useful to monitor ICT developments in education systems.

Advent of Internet introduced a new dimension in education system. Concepts, such as Distance Learning, Study Center come into play a major role in raising the standard of education as well as providing facilities for more number of individuals, especially where classrooms are overcrowded and where people get less time for study for their engagement in different works. Research institutions are also collaborating more frequently to be updated with the latest development of the corresponding subjects and accessing huge resources.

The latest ICTs open new vistas, not only for distance education as formerly conceived, but also for new forms of "virtual learning", primarily over the Internet. The interactive capabilities of this medium allow "real-time" conversations among students and teachers across great distances. Multimedia applications permit the development of novel teaching programmes, audio-visual presentations and imaginative problem-solving software. A growing number of Northern universities are taking advantage of these capabilities, not only to change the way traditional courses are taught, but also to create on-line learning opportunities and degrees that are entirely separate from usual procedures and curricula.

Unless a great deal of money can be devoted to distance learning within a country, this form of education is likely to be available only to the small minority with access to requisite hardware, software and the Internet – a situation that increases gaps between haves and have-nots, rather than reducing them. A recent IDRC (2002) evaluation of experiences in Kenya and Senegal has also highlighted problems in developing appropriate local content, maintaining equipment and developing tutorial and student support services.

E-governance

The Internet gives governments the opportunity to offer public services and to provide information and policies more efficiently. The more public services can be delivered through electronic media, such as the Internet, the larger the potential savings. Processing documents, such as licenses, or collecting taxes electronically are examples of such possibilities.

The impact of the Internet on democracy, then, is not standard across regions or even easily explained. Some applications that may be relevant in industrialized countries are much less so in many areas of the developing world. E-governance is a case in point. This is a somewhat fuzzy term. If it simply means improving voting mechanics and the availability of public records through computerizing voter registration and vote counting, and through placing public archives on-line, there is no reason to question its utility anywhere. The same could be said of encouraging government ministries and parliaments to be more transparent in their provision of information to the general public. These can be very important innovations, deserving full support from all citizens and from the development community in general. But as in the industrial societies E-governance means supplementing the usual procedures of representative government with some forms of direct government through use of the Internet, so, the proposition is more problematic. First, access to the Internet in many developing countries is far too limited; and second, the institutional setting for this kind of experiment may not yet exist. Many countries are still struggling to create the network of political parties and the culture of citizenship that underpin representative democracy. Pushing too hard for individual participation could, in some situations, do more to weaken democracy than to strengthen it.

The gap between the technological 'haves' and 'have-nots' has gained credence as one of the today's most significant social challenges. As with the Chinese character for 'crisis', the digital age constitutes both a danger and an opportunity. Some see it as a source of hope that will deliver a safe natural environment secured through 'e-materialisation', progressive innovations in work opportunities, and a democratic renaissance based on technology-enabled, direct citizen participation. Others argue that it spells out increased insecurity, the collapse of geographic communities, the loss of privacy, and an acceleration of poverty and inequality rooted in the so-called Digital Divide.

For mainly these reasons, initiatives that aim at minimising the digital divide have become an important component of regional, national and European policies in different policy areas that address the larger objective of social inclusion. Policies and programmes have emerged across this spectrum to address the so-called Digital Divide, driven variously by the world's largest public and private institutions and its smallest and poorest communities. The digital divide – as a manifestation, cause and effect of social exclusion – plays a role in social and employment policies (*European Commission*, 2000), education policies (cf. *European Commission*, 2001b) and general information society policies, particularly in the framework of the e-Europe initiative, under the heading of "participation in the knowledge-based society" (cf. *European Commission*, 2001a; 2000a).

Objective

Before implementation of policies to minimize Digital Divide it is important to measure Digital Divide. The term digital divide represents the gap between ICT haves and have-not. The gap between have and have-nots always indicates a difference between north and south. But south itself is geographically and economically heterogeneous and so this gap can be present in different regions of south (i.e., Asian countries).

Different efforts have been made to measure digital divide. But all these measures either focuses mainly on actual connectivity or concentrate on ICT literacy and skills, with linkages to knowledge and even social cohesion. While the latter approach is broader in scope, its effectiveness can be enhanced if nested with the former one, that is, if analysis is based on all quantitative information used in both the measures.

Recognizing all these problems along with non-availability of data, it is very important to build up a new measure of digital divide. Here we are interested in contributing our effort to introduce a measure of digital divide for selected Asian countries and for selected Indian states.

Why We Are Considering Asia and India?

Asian countries have played an important and active role in the development of ICT worldwide. In a succession of waves, the industry has spread fairly widely throughout much of developing Asia. The surge began in Japan, the republic of Korea and Taipei, China, which have been among the leaders. These economies have made significant contributions to the world by supplying ICT products and components. Hong Kong, the People's Republic of China and Singapore has added further to the spread of ICT in the region and the world through their contributions in trading and manufacturing. Subsequently Malaysia, Philippines and Thailand have joined through manufacturing and packaging. During the last three to four years, India also has been contributing significantly by supplying softwares to the overseas firms. Cumulative effects of these developments have played an important role in the development of ICT. Asian ICT industry has grown rapidly and performed as a tremendous source of supply for the rest of the world, and using ICT infrastructure Japan, South Korea, Singapore have already shifted to the higher growth trajectory. Following which, other developing countries like India, Indonesia, Malaysia, and Thailand have also implemented ICT infrastructure in their economy, but a huge pocket of populations are still outside the ambit of ICT. This indicates that in the process of development of Asia some of the countries are late adopters of new technology and in these countries entire populations are not being able to access the ICT facilities. This again implied a situation of digital divide. Again Asia, which is considered as "world manufacturing center of ICT", is excessively dependent on US economy because of its large volume of export and it cannot ride out of US slowdown. According to *Kraemer & Dedrick* (2001) this is because although Asia has gained from the production of hardware, it has generally not made much use of ICT to boost productivity. Therefore there is a gap between have and have-nots within the Asian countries. Given that Asia accounts more than half of the world population and has 900 millions living on less than one dollar per day, the issue has much more significance. To come out of this problem it is very important to implement some policies. Different national and international policy makers have recognized and acknowledged the challenge of digital divide and set up different task force such as Dot Force. But before implementation of policies, it is important to measure the digital divide among Asian developing countries.

Similarly rapid expansion of Indian software market in 80's is slowing down as other ICT sectors such as hardware and Telecommunication's development could not match with software market development. This implies that there is a divide. Geographical diversity and economic policy diversity among the states are fuelling this digital divide. Therefore it is important to measure this gap and implement some policies to reduce this divide. But until today there is no such effort have been made to measure the digital divide among different states of India.

Chapter 2

A Review of Existing Literature on Digital Divide

As the concept of Digital Divide gains increasing importance in modern economic literature, the debate regarding its validity intensifies. The topic of "what should be public and private responses to the digital divide" has taken precedence over "what should be measured in determining a divide". But only by addressing the measurement first, policy-makers substantively can debate whether there is indeed a chronic divide or simply a short-term gap, which, like television or VCRs, quickly disappeared through natural forces (Compaine, 2001). According to him digital divide has changing connotations. Contrary to this it can be said that last 20 years, the frontier of economics, without loosing its validity, also has moved from DRS or CRS to IRS, economies of scope and network externalities.

The world of high technology in general and the ICT and knowledge sectors in particular, are charcterised much better through these approaches than the conventional perfectly competitive models. The upshot of these developments is that economists are much closer to understanding many aspects of the digital economy than 10 years ago. Such as Positive Feedback Loop Innovation System (POLIS)[2] model, which applied to South Korea, China, India and Taiwan.

The concept of National Innovation System (NIS) in the field of economics of innovation was originally proposed for analyzing developed technological systems in the advanced

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[2] *Khan* (1998) has formalized the concept and coined the abbreviation POLIS to emphasis both the disequilibrium positive feedback loop features and the politico-social dimensions of the technological transitions.

National Innovation System (NIS) constitutes an interpretive dimension and offers some interpretive flexibility. When an underdeveloped country accepts NIS whose components come from abroad its interpretive flexibility is blocked by closure imposed undemocratically over the rest of the population by the technocratic elite and their modernising allies from outside. Such premature closures can produce success stories. The success stories depend on the deeper understanding of disequilibrium process at work leading multiple equilibrium and the social-cultural implications of the complex economics of production and distribution aspects of NIS. It is with a view towards capturing these complexities leading towards multiple equilibria that an alternative conceptualization of technology system transition has been formulated by some economists (Khan, 1993; James and Khan, 1998). In addition to capturing both equilibrium and disequilibrium features of technological transitions, this broad approach can change distributional issues as well.

industrial countries. Therefore NIS has its connections to modernity and development through this system is entirely technocratic. The argument always proceeds in terms of the function of technologies and their role in increasing GDP/ capita in the most efficient manner. The intense and inconclusive debate regarding the development of East Asia, whether because of a simple accumulation of labor and capital or because of productivity increase through genuine technical progress and technological learning, illustrates neatly this technocratic bias. Neither side is willing to step beyond the economic inputs and outputs, production functions and technology as a black box. It is of course important to know whether technological learning has taken place in ICT sector as it had taken place in case of textiles or electronic sectors (*Khan*, 2002).

Definition of ICT Sectors

Before discussing the relation between ICT sector and economic growth, innovation and development, it is first necessary to clear the definition of the ICT sectors. The most widely accepted definition is the one agreed to at the April 1998 meeting of the working party on indicators for the Information Society (WPIIS) and subsequently endorsed at the September 1978 meeting of the committee for information, computer and communication policy of OECD. The following principle underlines the definition.

For manufacturing Industries, the products of a candidate industry:

1. Must be intend to fulfill the function of information processing and communication including transmission and display.
2. Must use electronic processing to detect, measure and / or record physical phenomena or to control a physical process.

For *Service Industries*, the products of a candidate industry:

Must be intend to enable the function of information processing and communication by electronic means.

Roughly there are three broad categories of the new ICTs :

1. Computing
2. Communicating
3. Internet-enabled communication and computing.

From this it is clear that not all of ICT sectors are digital or least not yet. Even within the digital part, the pre- and post- Internet distinction is historically important and relevant for the developing economies, as *Tschang* (2000) points out.

We can roughly dissect the digital economy's infrastructure into pre-internet and Internet eras. Before the Internet, a host of information technologies came into existence, which provided computing power on a platform-specific system, usually centralized (a central mainframe with terminals) or distributed within local area. The advent of Internet was a critical even because it set up the basic infrastructure, standards and technologies that enabled large scale, distributed and platform-independent information exchange and manipulation. This single system allowed the introduction of literally unlimited sources of information, or access point to it, in a scaleable fashion. i.e., with out increasing the number of constraints or decreasing economic "returns to scale". This unlimited source of information is one of the main pillars of a knowledge base economy.

In a society where knowledge-intensive activities are an increasingly important component of the economy, the distribution of knowledge across the population is increasingly linked to stratification. The mass diffusion of the Internet across the population has led many to speculate about the potential effects of the new medium on society at large. Enthusiasts have heralded the potential benefits of the technology suggesting that it will reduce inequality by lowering the barriers to information. This will allow people of all backgrounds to improve their human capital, expand their social networks, search for and find jobs, have better access to health information and otherwise improve their opportunities and enhance their life chances. In contrast, others caution that the differential spread of the Internet across the population will lead to increasing inequalities improving the prospects of those who are already in privileged positions while denying opportunities for advancement to the underprivileged. *Robert Merton* (1973) called this the "Matthew Effect" according to which "unto every one who hath shall be given" whereby initial advantages translate into increasing returns over time.

Research on information technologies has found support for this Matthew effect. With respect to the Internet Web, the Matthew effect predicts that those having more experience with technologies and more exposure to various communication media will benefit more from the Internet Web by using it in a more sophisticated manner and for more types of information retrieval. Evidence has already been presented regarding the connection between the use of traditional news and entertainment media, and computers and the Internet (*Robinson, Barth* and *Kohut* 1997; *Robinson, Levin* and *Hak* 1998). Such findings suggest that use of the Internet leads to greater information gaps. As more people start using the Internet Web for communication and information retrieval, binary classifications of "who is online" become less important, especially when discussing questions of inequality in relation to the Internet. Rather, we need to start looking at differences in how those "who is online" access and use the medium. Such a refined understanding of the "digital divide" implies the need for a more comprehensive term for understanding inequalities in the digital age; *DiMaggio* and *Hargittai* (2001) suggest that the term "digital inequality" better encompasses the various dimensions along which differences will exist even after access to the medium is nearly universal.

According to *Hal R. Varian* (1995) a greater understanding of the digital divide as based on different "degrees of access" to information technology rather than a simple division between information "haves and have-nots" is needed to successfully address, the problem. Using technology to promote social inclusion is a more productive approach to solving the digital divide. Technology use and skill are "embedded in a complex array of factors encompassing physical, digital, human and social resources and relationships". Thus, at least much attention, planning and resources need to go into the human and social systems that supports technology use.

The existing digital divide framework overemphasises the importance of the physical presence of computers and connectivity. This framework excludes other factors that allow people to use ICT for meaningful ends. Simplistic notions of a digital divide can result in problematic outcomes for technology projects attempting to improve people's lives through ICT. Going beyond the digital divide and understanding the social factors surrounding technology use and inequality in promoting the use of technology for social inclusion will ensure that people maximise their use and enjoy from the benefits of ICT development.

The Digital Divide as a Modern Version of The Knowledge Gap Theory

From a communication research perspective, research about the socio-economic impact of having (or using) access to information is not at all new. The digital divide clearly has its roots in the knowledge gap research of the 1970s, when communication researchers in the United States began to debate the theory of the increasing "knowledge gap": "Segments of the population with higher socio-economic status tend to acquire information at a faster rate than the lower status segments so that the gap in knowledge between these segments tends to increase rather than decrease." (*Tichenor* et al., 1970) The main research question in this tradition was to find out whether and in what way factors such as education level or socio-economic status made a difference in acquiring knowledge. Research was triggered by the findings of *Tichenor* et al. (1970) who proposed that such factors were, in fact, the independent variables by which the level of knowledge was dependent. The intensive users of media services, who tend to be well informed, would continuously increase their information advantage by making optimal use of the information offer available through media compared to those who do not use this information offer.

In spite of a considerable criticism, the knowledge gap theory proved to be very influential in communication research. With the emergence of the digital media, the knowledge gap theory finally experiences a full revival, renamed as the "digital divide". The potentially unlimited access to information and the "sovereignty" of the consumer to select from this information offer brings about a new complexity to navigate in this information offer and to extract benefits. Consequently, there is legitimate concern that – paradoxically – the increased information offer will be used disproportionately by the group who are already advantaged in society and at the cost of disadvantaged groups of society, rather than narrowing the gap(s) between these groups.

This argument is nowadays reflected by the frequently made observation that "info-exclusion" in the digital age is not so much an exclusion *from* information but rather *by* information[3]. The concept of the "digital divide" directly relates to the spiral of uneven access to and usage of information and communication technologies and the socio-economic rebound caused. If so, the digital divide – conceived of as a digital version of the analogue knowledge gap – conflicts with common social policies and visions of an inclusive information society. Although it is not yet quite clear if mere access to new technologies in terms of technical infrastructure and basic ICT skills will be sufficient to prevent the widening of a digital knowledge gap, it is commonly accepted thinking that access to the Internet is in principle advantageous and therefore desirable for all. Keeping this in mind European Union in their Information society policies strongly focuses on bringing all European citizens to the net.

Multiple Dimension of Digital Divide

Some scholars have suggested the way in which we need to distinguish between different types of Internet use. One such approach (Norris, 2001) suggests distinguishing between divides at three levels–

(1) A global divide revealing different capabilities between the industrialized and developing nations;

(2) A social divide referring to inequalities within a given population; and

(3) A democratic divide allowing for different levels of civic participation by means of ITCs.

Keniston (2003) distinguishes four social divisions:

(1) Those who are rich and powerful and those who are not;

(2) Those who speak English and those who do not;

[3] Due to the advent of Internet information is available to all but a group of people use it earliest and others are to consider it for future use as at initial stage they face some problem created by the first group. This attitude creates a divide.

(3) Those who live in technically well-established regions and those who do not;

(4) Those who are technically savvy and those who are not.

Wilson (2000) took this classification one step further by identifying four components of full social access:

1. Financial access, which indicates whether users (individuals or whole communities) can afford connectivity.
2. Cognitive access which considers whether people are trained to use the medium, and find evaluate the type of information for which they are looking.
3. Production of content access which looks at whether there is enough material available that suits users' needs.
4. Political access which takes into account whether users have access to the institutions that regulate the technologies they are using.

Kling (1998) sees the divide from different perspective. According to him digital divides are of two types –

1. A technical aspect referring to availability of the infrastructure, the hardware and the software of ICTs, and
2. The social aspect referring to the skills required to manipulate technical resources.

Kling did not describe the term skill. *Hargitti*(2003) defines *skill as the ability to efficiently and effectively use the new technology*. For this he considered four factors that contribute to one's level of skill, which are technical means (quality of equipment), autonomy of use (location of access, freedom to use the medium for one's preferred activities), social support networks (availability of others one can turn to for assistance with use, size of networks to encourage use) and experience (number of years using the technology, types of use patterns).

Warschauer (2002) has also offered an alternative approach suggesting that in addition to the physical sides of access, other factors such as content, language,. literacy, education and institutional structures must also be taken into consideration when assessing the level of information and communication technology use in a community. These researchers all call for a more holistic approach to the study of digital inequality.

Reasons of Digital Divide

Different studies and survey revealed that most of the time new technology is introduced targeting a particular group of people. These targeted people are urban. This strategy isolated other people from accessing the latest technology. In developing countries like India, a large portion of the population is in rural area, they lack proper education, and they are mostly unaware of this new technology. Without being familiar with little advanced technology it is very difficult for them to use the complex technology. A fear and lack of proper instruction exclude Rural, Isolated or Under Served populations from the benefit of these new technologies *(Quibria, Ahmed, Tschang, Reyes-Macasaquit*(2002).

Again when new technology is introduced its cost remains high and creates access barrier for poor people. Even if some rural people can afford to access it but it's the lack of infrastructure leaves no room for them to use it. This lack of infrastructure prevails sometimes because of geographical location, where it is extremely difficult to set up a new infrastructure.

It appears that the principal determining factors for the diffusion of ICT in developing countries are income and investments in human resource and infrastructure development. However, the degree of influence of these variables is not uniform across the various types of ICT *(Quibria, Ahmed, Tschang, Reyes-Macasaquit*(2002).

Even if it possible to set up new infrastructure, sometimes it's the lack of good governance, which hardly realize the benefits of introduction ICT technology in an economy. With this hierarchical process takes time to implement the policy and creates a time lag.

It's not only the government but also the lack of intensity to use new technology creates a divide among the people. It's the inertia nature of human being prevent them to adapt new technology and move with time.

Above all, most of the websites are in English. Without knowing English it is difficult to access the benefits of Internet. Because of recent development of software language most of web pages containing graphics leaving visually challenged people out of its benefit.

The first obstacle in research and discussion on Digital Divide is the multifaceted concept of access. It is used freely in everyday discussions without an acknowledgement of the fact that there are many divergent meanings in play. The meaning of simply having a computer and a network connection is the most common one in use today. However, according to *Van Dijk* (1999), this meaning only refers to the second of four successive kinds of access. He distinguishes four kinds of barriers to access and the type of access they restrict:

1. *Lack of elementary digital experience* caused by lack of interest, computer anxiety, and unattractiveness of the new technology ("mental access").
2. *No possession of computers and network connections*("material access").
3. Lack of *digital skills* caused by insufficient user-friendliness and inadequate education or social sup-port ("skills access").
4. Lack of significant *usage opportunities* ("usage access").

According to *Van Dijk* (1999), access problems of digital technology gradually shift from the first two kinds of access to the last two kinds. When the problems of mental and material access have been solved, wholly or partly, the problems of structurally different skills and uses become more operative. *Van Dijk* (1999) does not limit the definition of digital skills to the abilities of operating computers and network connections only. Instead, he includes the abilities to search, select, process, and apply information from a superabundance of sources. In this way, he anticipates the appearance of a *usage gap* between parts of the population systematically using and benefiting from advanced digital technology and the more difficult applications for work and education, and other parts only using basic digital technologies for simple applications with a relatively large part being entertainment. *Van Dijk* stresses that computers and CMC are more multifunctional than previous communication technologies.

Policy Context of The Digital Divide

Considering the still existing uncertainties about the knowledge gap theory and whether any significant progress has been achieved in reducing the gap over a period of about 30 years, it is legitimate to question the relevance of the digital divide debate for contemporary society. If different media demand and usage patterns simply have evolved parallel to the ongoing development and differentiation of the media landscape, it could be argued that the "digital divide" should be treated as a natural differentiation of consumer behaviour rather than be turned into a policy concern. Such a view, however, would contrast the current discourse in European and international policies about social inclusion which have identified the digital divide as a threat to a sustainable information society and are consequently seeking for a remedy against it. According to *H. Selhofer & T. Hüsing*(2002) the arguments justifying such policies can be grouped into three generic categories.

- Improving and securing employability: Basic skills in computing and using the Internet are an indispensable requirement for a growing number of jobs. Consequently, counteracting the digital divide should implicitly have a positive impact on the level of employability in the population.

- Equal participation of citizens in the information society: The second line of argument focuses on the opportunities of the individual citizen to benefit from advantages enabled by ICT. If an increasing number of day-to-day life transactions are performed over digital networks, people who do not have access to these networks will – in the long run – experience disadvantages.

• Economic reasons (demand side economics): Less obvious than the previous two arguments, bringing off-liners and non ICT-literate parts of the population online could also have positive effects on the economy. A growing number of consumers on the net could trigger the motivation of enterprises toward e-business, which is commonly assessed as advantageous for the region's economy.

For mainly these reasons, initiatives that aim at minimising the digital divide have become an important component of regional, national and European policies at in different policy areas that address the larger objective of social inclusion. The digital divide – as a manifestation, cause and effect of social exclusion – plays a role in social and employment policies (*European Commission*, 2000), education policies (cf. *European Commission*, 2001b) and general information society policies, particularly in the framework of the e-Europe initiative, under the heading of "participation in the knowledge-based society" (cf. *European Commission*, 2001a; 2000a).

In the context of social policies, counteracting the digital divide has been identified as an element in the fight against poverty and social exclusion, which was included in the provisions relating to the European Union's social policy through the Articles 136 and 137 of the Amsterdam Treaty. Employment policies of the European Union also focus on e-inclusion. The Communication of the European Commission on "Strategies for jobs in the information society" [2000b] stresses "job potential of the information society" due to opportunities created by the new information and communication technologies, but also points out that the "European information society is still largely exclusive", and raises the issue of "information society skills gaps". Education policies also stress the importance of digital inclusion, since "[...] the knowledge based society implies that every citizen must be 'digitally literate' and (possess) basic skills in order to be on a better footing in terms of equal opportunities (...)." (*European Commission*, 2001b). Finally, the objective of digital inclusion is an integral part of the eEurope Initiative and the related Action Plan of the

European Union (*EC*, 2000a) which states that "only through positive action now can info-exclusion be avoided at European level." eEurope focuses on ten priority areas of which e-education, e-work, e-accessibility and e-health are those with a direct connection to digital divide issues.

It is in relation to these policies that the research presented in this paper (which needs to be further developed) intends to make a contribution. We believe that – although a lot of data about the digital divide are already available – a more systematic and longitudinal approach based on compound indices that allows to measure the dynamic aspect of the digital divide should be taken in order to inform policy.

Chapter 3

Measures of Digital Divide

Existing Measures and Their Limitations

Measuring the digital divide is one of the most important aspects among the various aspects in analyzing ICT development and diffusion. Besides the technical implication of a system of measurement, it is of great importance that information on the divide trend be rapid[4] and correct, in order to establish and promote common policies in favour of the disadvantaged areas.

It is not easy to construct an exhaustive and comprehensive indicator(s) which will be able to present complete and comparable information on this subject. A lot of interesting papers analyze this problem, by monitoring different ICT variables that give important indications, but could underestimate or overrate revealing trends expressed by others variables.

The digital divide serves as an umbrella term for several distinct domains of investigation. Generally the approaches come in two variants.

i) One approach concentrates mainly on actual connectivity –digital or otherwise. It reflects the quest to quantify and understand the factors that separate the 'haves' and the 'have-nots'. While findings from this approach point to potential corrective actions, they come as well to study outcomes and economic or societal impacts. Examples of this approach are the *Falling through the Net* series (US 1995, 1998, 1999, 2000) and *A Nation Online* (US 2002), *Dickinson* and *Sciadas* (1996, 1997, 1999), *Sciadas* (2000).

ii) Another approach ventures beyond connectivity and encompasses aspects such as ICT literacy and skills (e.g. *Castells* 2001, *ETS* 2002, *Sciadas* 2002), with linkages to knowledge and even social cohesion. While the latter approach is broader in scope, its

[4] When we can find out trend from a short period time series data it is called rapid trend.

effectiveness can be enhanced if nested with the former approach, that is, if analysis is based on all quantitative information used in both the approaches.

In reality, many divides exist. A proper appreciation of the issues involved requires an understanding of the role of at least two important dimensions:

i) Individual ICTs, and;

ii) Variable of interest responsible for ICT use.

There are many ICTs and variables, and divides can be identified for any permutation of these.

a) There are old and new ICTs, digital and analog. Each is distinct in its attributes, functionality and numerous other characteristics, including pricing. All these matter.

b) Then, there are many other variables of interest: income, education, gender, age, and geographical location (such as urban or rural). Affordability of ICT use depends on level of income, importance of ICT use depends on level of education, age, and since in some location it is extremely difficult of set up infrastructure, ICT use also dependent on geographical location. Each of these results depends on the different groupings of people, with different size and other characteristics.

Clearly, even on the basis of these two dimensions alone, analyses of digital divides can be complicated with regard to both types of ICT and variable used.

Research on the digital divide has up to now mainly focused on counting "how many are online" and monitoring gaps between different segments of society, i.e. describing "who is (not) online". The forerunner in collecting extensive and systematic data about who is online and who not are the United States, for instance with the "Falling through the Net" series of the NTIA of the US Department of Commerce [2000]. For Europe, findings are that "Internet usage is increasing across all socio-economic categories, but the access gap has grown in absolute terms, over the last months. Digital exclusion is frequently cumulative, affecting various kinds of social disadvantages. Lack of access and training are the main barriers" [European Commission, 2001a].

In this study, we do not go beyond this concept of measuring how many and who is online, although we do not neglect the shortcomings of this approach. However, we want to contribute to the debate by discussing what should be the appropriate measure of the divide. Here it is important to mention the distinction between "digital gap" and "divide index". "Digital gap" is measured as the access difference between different groups in percentage points, and "divide index" is measured as the ratio between the percentages. Since "Percentage point difference"[5] tells about change in the composition (share of the total) of a population over time it can explain dynamics of divide, whereas "percentage difference"[6] tells about the percentage change from the base year i.e., it can explain development of digital divide. Therefore we argue that a combination of both measures is required to better understand the dynamics and the development of the digital divides.

Any study that tries to measure the digital divide has to specify the scope of what is actually measured by taking decisions on at least three levels:

1. The *unit of observation* needs to be defined: There are different types of digital divides, e.g. between citizens, between businesses or between regions.

2. The *independent variables* need to be specified which are assumed as the determinants of digital divide. The sets of variables will be different depending on the unit of observation. For instance, if citizens are the unit of observation, the independent variables could be age, gender, income, education, ethnicity or type of residence.

[5] Percentage point difference = Percent of total at end of period – Percent of total at beginning of period $=\left[\left(\frac{c}{d}\right)100\right]-\left[\left(\frac{a}{b}\right)100\right]$.

[6] percentage difference = $\frac{(a-b)}{b}100$

3. The *indicators*, i.e. the operationalisation of the term "digital divide" need to be selected. The most frequently used indicator is Internet usage. However, the selection of indicators necessarily reflects what is conceived as state-of-the-art technology in the research context. If, for example the digital divide in developing countries is analyzed, it probably makes sense to include more traditional telecommunication indicators (e.g. access to a telephone at home).

Using Lorenz curve *Dasgupta*, *Lall*, and *Wheeler* (2003) measured the inequality of Internet connectivity (per capita internet use). Plotting curve for successive periods allow the measurement of the change of the divide. When from one period to the next, curves are cleanly inside or outside one another, the conclusion is unequivocal – the divide is closing or widening. In case of crossing lines, however, there are trade-offs involving winners and losers and specific areas must be examined. In such cases, an overall measure is provided by the calculation of Gini coefficients. These are effectively measured by the ratio of area A over A+B. Gini coefficients can assume values from 0 (perfect equality) to 1 (extreme inequality). The larger the area between the 45^0 line and the Lorenz curve is the higher the value of the Gini coefficient, and the further away from perfect equality.

But this is not free of problems. Lorenz curve gives more importance on totality of the situation and doesn't directly compare percentile pairs (e.g. highest vs lowest). In addition, any measure that tries to encompass the entire Lorenz curve in a single statistic would inevitably contain elements of arbitrariness. Especially when curves intersect, curves of different shapes (and therefore different patterns of divides) could generate the same Gini. Clearly, these are aggregate measures best suited for an overall assessment. They do not replace detailed comparisons of specific groups.

Again widespread concern about the digital divide reflects the view of *Doncombe* (2000) and others that human resource constraint may significantly reduce Internet use in low-income countries. If they are correct, then income per capita should be a major determinant of Internet intensity.

Another important factor is government competition policy[7], which may reflect both the supply of Internet services and the intensity of their use by local firms. Again it is believed that network economies cause Internet intensity to grow more quickly in urbanized societies.

Using Gompertz Technology diffusion model *Dasgupta*, *Lall*, and *Wheeler* (2003) tested the impact of income, policy and urbanization on internet intensity, where technology adoption rate (n) is directly proportional to the log difference between current use and long run equilibrium use (which is determined by a set of exogenous variables X_j).

i.e.; $\dot{n}_t = \theta[\log n_t^* - \log n_t]$ ....(1)

For estimation we approximate this relation as

$\log n_t - \log n_{t-1} = \theta[\log n_t^* - \log n_{t-1}]$ ....(2)

where $\log n_t^* = \beta_0 +_j \beta_j \log X_{jt}$ ....(3)

Substituting and adding a random error term we obtain the following estimating equation:

$\log n_t - \log n_{t-1} = \theta\beta_0 +_j \theta\beta_j \log X_{jt} - \theta \log n_{t-1} + \varepsilon_t$ ....(4)

Now the complete model is

$\log N_{jt} - \log N_{jt-1} = \theta\beta_{0j} - \theta \log n_{jt-1} + \theta\beta_1 \log U_{jt-1} + \theta\beta_2 \log Y_{jt-1} + \theta\beta_3 \log C_{jt-1} +_k \theta\gamma_k R_k + \varepsilon_{jt}$ ...

................................(5)

[7] For this one can use World Bank's rating of competition policy in its country policy and institutional assessment database.

where N_{jt} = Internet subscriber / telephone mainlines

U_{jt} = Size of urban population

Y_{jt} = income per capita

C_{jt} = Index of competition policy.

R_j = vector of regional dummy variables.

Since internet intensity measures the concentration of internet use of the population and internet connectivity represents the total number of internet connection, any significance difference between Internet intensity and Internet connectivity confirms the presence of digital divide.

Now to explain the diffusion of mobile phone they employed another version of the diffusion model in equation (4) *Dasgupta*, *Lall*, and *Wheeler* included initial income, policy and urbanization. Recognizing that the growth rates of income and mobile phones may be jointly determined, they have tested the impact of mobile phone growth on income growth in a separate instrumental-variables exercise. Finding no significant impact, they have employed a single-equation model (6), which is

$$\log M_{jt} - \log M_{jt-1} = \theta\beta_0 - \log M_{jt-1} + \log U_{jt-1} + \log Y_{jt-1} + \log C_{jt-1}\left(\log Y_{jt} - \log Y_{jt-1}\right) + \varepsilon_{jt}$$

……………………………………(6)

where, Mjt = Mobile telephone subscriptions

Ujt = Size of urban population

Yjt = Income per capita

Cjt = Index of competition policy

θ = Adjustment coefficient toward long run equilibrium subscription level.

The analysis, however, does not identify the relative importance of these factors in contributing to the alarming differences in computer and Internet penetration rates across regions of the country.

Again in this method level of education is not considered, which is an important factor as higher education leaves a room to use Internet better. Again teenagers more frequently use Internet than the older people, as older people are generally reluctant to use new technology. With this geographical location is also an important factor for infrastructure development. Development of infrastructure reduces to the cost of access.

To explore these issues further *Chin, Fairelie* (2004) borrowed from a technique of decomposing inter-group differences in a dependent variable into those due to different observable characteristics across groups and those due to different "prices" of characteristics of groups (Blinder 1973 and Oaxaca 1973). The technique has been widely used to decompose earnings gaps between whites and blacks or men and women using microdata. The Blinder-Oaxaca technique, however, can be used to decompose a gap between any two groups or even countries. In particular, the difference between outcomes, Y, for group *i* and *j* can be expressed as:

$$\overline{Y}^i - \overline{Y}^j = \left(\overline{X}^i - \overline{X}^j\right)\hat{\beta}^i + \overline{X}^j\left(\hat{\beta}^i - \hat{\beta}^j\right)$$

where, $\overline{X}^i$ = row vector of average values for the individual-level characteristics

$\hat{\beta}^i$ = a vector of coefficient estimates for group i.

The first term in the decomposition represents the part of the gap that is due to group differences in average values of the independent variables, and the second term represents the part due to differences in the group processes determining the outcome, which is often referred to as the "unexplained" component. The first term can be further decomposed into the separate contributions from group differences in specific variables and is the focus of the following analysis.

The technique is commonly modified to use coefficients from a pooled sample of both groups, $\hat{\beta}^i$, to weight the first expression in the decomposition (*Oaxaca and Ransom,* 1994 for example). They adopt this approach to calculate the decompositions. In particular, they used coefficient estimates from regressions that include most countries.

We then denote the United States as the base group and calculate the decomposition for computer and Internet penetration rate gaps between the U.S. and each region. Thus, the first term in the decomposition that captures the explained variation in penetration rates between the United States and region j is:

$$\left(\bar{X}^{US} - \bar{X}^{j}\right)\hat{\beta}$$

where $\hat{\beta}^{i}$ are the coefficients and X represents the three-year average of the independent variables included in the regressions. The technique allowed them to quantify the separate contributions from U.S./Region j differences in income, human capital, telephones, and other factors, to the gaps in computer and Internet penetration rates.

Research on digital divide has up to now mainly focused on counting " how many are online" and monitoring gaps between different segments of the society i.e., who is online.

Hannes Selhofer & Tobias Husing (2002) contrasted the "digital gap", measured as the access difference between different groups in percentage points and "divide index", measured as the ratio between the percentages.

Since there are different types of digital divides e.g. between citizens, between businesses or between regions, they defined units of observations first as –

	Citizens	businesses & organizations	regional units
Independent variable	Age	Sector	Location
	Gender	No. of employees	GDP/capita
	Income	Turnover	Size
	Location	Location	Population
	Ethnicity	–	Language

After the selection of independent variable they concentrated on to study the digital divide between different groups of society. For this they used 4 socio economic factors – gender, age, income, and education.

Then they defined "risk group" or disadvantage group and calculate the % of population of each group. But since this procedure is challenged on several grounds they selected 4 indicators to build up a compound indicator.

Indicators	Weight (here % are arbitrary)
% of computer users	30%
% of computer users at home	20%
% of internet users	30%
% of internet users at home	20%

Now simple mean of these 4 indicators gives a compound indicator and considered as digital divide index (DDIX).

But this indicator is also challenged as they are very closely related to each other. They argued that they wanted to follow the current digital divide research paradigm and to focus on those aspects, which can be regarded as preconditions for a wide variety of application. They wanted to include skill indicators, but due to unavailability of data they could not do so.

OECD (2000) index integrate the analysis through the consideration of two elements:

1. The comparison of the divide indicators with a pivot value, being able to furnish information on the absolute level of the divide;
2. To monitor the indicators trend, in order to estimate the evolutive, regressive or stationary tendency of the digital divide.

As far as the first point is concerned, almost all the studies on this subject show a close correlation between the digital divide and the level of welfare in each country. There is a direct link between economic conditions and means of access and use of technologies. The GNP per capita has been chosen as indicator of the level of welfare in each country.

In this paper they used different indexes to measure the digital divide, such as, Secure Servers density, Internet Host density, Personal computer density, GNP per capita, Mobile lines density, Fixed lines density. These indexes are used to measure the divide within the particular area. To obtain an absolute measure of digital divide they used principal component method to combine these indexes.

But here index is indicative. This index does not take into account the other variables, which are important to explain the digital divide such as, level of education, access cost, infrastructure, and competitiveness.

Corrocher & Ordanini(2002) constructed an indicator. Here first they identified the factors of digitization, which represent the dimensions that characterize digital development. After identification of factors of digitization they aggregate those factors by Factor Analysis Method in two steps and obtain index of digitization. Simple standard deviation of the index of digitization among countries gives the synthetic index of digital divide.

Though this index is comparatively better than other indexes as it takes into account most of the variable responsible for digital divide, it is not free from limitations. It takes into account the number of www buyers and secure server, which is very difficult to measure, as it is changing everyday. With this, it is also cumbersome to deal with too many indicators at a particular time. Most importantly this is a comparative index, which does not reflect the absolute level of digital divide.

Proposed Framework of Measure of Digital Divide

Keeping all theoretical and practical problem in mind we inherited basic idea of constructing a measure of digital divide from *Corrocher & Ordanini*(2002).

Before measuring Digital Divide we measured Digitalization of each country or states with the help of a synthetic index. The starting point for the development of the model is the identification of the factors that explain the digitalization of a system, i.e. the dimensions that forms the theoretical background of the concept of a digital economy (or information society). The definition of the six factors, which are described in the next section, accounts for the notion of digitalization that is adopted in this study.

Second, the geographical levels of the analysis, i.e. the context within which the digital divide is calculated and the set of elementary indicators that are potentially able to represent the factors of digitalization are selected.

The final clusters of indicators are synthesized through a factor analysis in order to obtain a measure of digitalization for each factor and, subsequently, a synthetic index of digitalization. This last step, which constitutes one of the most innovative aspects of the present approach, defines the value that is attributed to the patterns of digitalization.

Once a synthetic index of digitalization is developed for each country (or geographical area) it is possible to evaluate the magnitude of the digital gap, i.e. the distances in the levels of digitalization, by calculating measures of dispersion.

The Factors of Digitalization

As mentioned earlier the first step of the analysis concerns the identification of the factors of digitalization, which represent the dimensions that characterize digital development.

According to the conceptual framework of the present study, the factors are meta-variables that not only measure but also explain the differences between the levels of digitalization of different countries: in this way, we constitute explanatory factors of the digital divide.

At the beginning of the use/application of the technology, differences between countries or regions are explained by the speed of adoption. In this phase, the factors that determine those differences are as follows.

1. The communication infrastructures, which identify the availability of the physical resources that allow access to the digital economy and stimulate its development. This factor includes aspects related to the expansion of the Internet and of WWW access devices as well as indicators concerning the penetration and degree of technological advancement of other infrastructures that account for the levels of connectivity in the system, such as broadband cables.

2. The human resources, which account for the absorptive capacity of the system towards technological innovations on the basis of available knowledge and education. In this context, policies and programs of formal education and training play a central role, as well as the employment conditions in the communications sector.

3. The competitiveness of the information and communication providers and the degree of competition among different operators, which have a well-defined role in fostering the provision of new services and in determining the pace of adoption of new platforms and applications.

In the second stage, when the technology reaches a critical mass of diffusion and is accepted as a common standard, differences between countries or regions are still in part explained by their *speed of adoption*, i.e. by their basic infrastructure conditions, but the aspects related to the *intensity of adoption* become more and more important in the process of measurement. When examining the digitalization in this phase, there is a need for measuring the following variables.

1. The diffusion of different devices for the use of digital services and applications that can determine different patterns of digitalization in different systems.

2. The size of the digital market, which identifies the economic value of the technological applications defining the 'digital sector'.

In the third stage, when the technology becomes mature, the measurement priorities become more and more directed at qualitative aspects. In this respect, the phenomena related to the impact of digitalization on social and economic activities, on the structure of production and consumption and on employment become increasingly relevant.

If the current rate of diffusion of digital technological platforms is looked at, the measurement priorities need to focus on the phenomena associated with the speed and intensity of digitalization. The present evolutionary phase is such that most of the inter-country differences in the digitalization process are explained by the basic infrastructure conditions, which in turn lead to different degrees of intensity of adoption in the process of digitalization.

As far as the third aspect is concerned, i.e. the transformations in economic and social systems, the effects have just recently begun to appear, so that any analysis in this respect would be misplaced because of both the complexity of the phenomena, which requires quantitative and qualitative appraisals and the lack of significant statistical information.

The Geographical Context of The Digitalization And Identification of Elementary Variables

The digital divide is a 'relative' concept since it assumes significance only if it is evaluated within the specific context of countries or geographical areas. The asymmetries in the diffusion of digital technologies have a different meaning if, for example, they are examined within a heterogeneous (as it is often the case) or within a homogeneous group of countries in terms of economic development.

In the first case, comparative analysis of digitalization strongly confirms the already existing differences at the level of the economic system: this makes it more complex to understand if the digitalization is a direct consequence of economic development or can instead affect its dynamics. As will be seen in the next two chapters, this approach of measurement of the digital divide allows not only major policy issues to be highlighted, but also important economic and managerial implications for the business arena to be illustrated.

After having selected the factors and the levels of analysis, we prepared a list of potentially useful (26) indicators based upon data deriving from official statistics. These indicators are subsequently classified in the six factors of digitalization identified as Markets, Diffusion, Infrastructures, Human resources, Competitiveness, and Competition. On the basis of this line of reasoning mentioned above, among these digitalization factors, the first two related to the intensity of adoption and the other four related to the speed of adoption. The list of elementary indicators for each factor of digitalization is given below.

Market

(1) Revenue of the IT hardware market.
(2) Revenue of the IT software and services market.
(3) Revenue of the telecommunications equipment market.
(4) Revenue of the telecommunications services market.

Diffusion

(5) Computer hosts per 1000 inhabitants.
(6) Internet users per 100 inhabitants.
(7) Number of secure WWW servers for electronic commerce per 1 000,000 people.
(8) Number of mobile subscribers per 100 inhabitants.
(9) Number of cable television subscribers.
(10) Number of Telephone per 1000 inhabitants.

Infrastructure

(11) Number of personal computers (PCs) per 100 inhabitants.
(12) Number of devices connected to the Internet per 1000 inhabitants.
(13) Number of WWW servers per 100 inhabitants.
(14) Number of ISDN subscribers per 1000 inhabitants.
(15) Penetration of broadband Internet access.
(16) Number of ISP

Human Resources

(17) Share of employment in the ICT hardware sector over total employment
(18) Share of employment in the telecommunications services sector over total employment
(19) Share of employment in other ICT services over total employment
(20) Expenditure on education over GDP.
(21) Number of individuals with a university degree.
(22) Number of schools with an Internet connection.

Competitiveness
(23) Research and development investments in the ICT sector.
(24) Numbers of ICT patents.

Competition
(25) Costs of telecommunications services.
(26) Internet access costs.

Following the choice of elementary indicators, the next step entails the aggregation of such indicators first into the six factors of digitalization and then among the factors themselves in order to obtain a synthetic index of digitalization for each country.

Since we have large number of indicators, we need a method, which can be used to reduce number of indicators . We need a method of transforming data through rewriting the data with properties the original data did not have. The data may be efficiently simplified prior to a classification while also removing artifacts such as multicollinearity. Keeping all theoretical and practical problems we are using Principal Component Method (PCM) to aggregate the indicators.

In our model if principal component is $\mathbf{w}_1$ of a dataset $\mathbf{x}$ then it can be defined as (assuming zero empirical mean, i.e. the empirical mean of the distribution has been subtracted away from the data set).

$$w_1 = \arg \max_{\|w\|=1} E\left\{\left(w^T x\right)^2\right\}$$

Where arg max (or argmax) stands for the argument of the maximum, that is to say, the value of the given argument for which the value of the given expression attains its maximum value. This is well-defined only if the maximum is reached at a single value. Thus $x_0 = \arg \max_x f(x)$ holds if and only if x_0 is the unique value of x for which $f(x)$ is maximized.

With the first $(k - 1)$ components, the k-th component can be found by subtracting the first $(k - 1)$ principal components from **x**: $\hat{x}_{k-1} = x - \sum_{i=1}^{k-1} w_i w_i^T x$ and by substituting this as the new dataset to find a principal component in:

$$w_k = \arg \max_{\|w\|=1} E\left\{\left(w^T \hat{x}_{k-1}\right)^2\right\}$$

Since this method is cumbersome we are calculating the components using the empirical covariance matrix of original standardize variable, the measurement vector.

In our model we have ***n*** observations on ***k*** variables which is represented by **X**, where

$$X = \begin{bmatrix} x_{11} & \dots & x_{k1} \\ \dots & \dots & \dots \\ x_{n1} & \dots & x_{kn} \end{bmatrix}$$

Here observations are expressed in standardized form, for we are concerned with studying the variation in the data.

Now we are transforming the **X**'s to a new set of ***k*** variables which will be pairwise uncorrelated and of which the first will have maximum possible variance among those uncorrelated with the first, and so forth.

Let $z_1 = X\ a_1$ .... (i)

denote the first new variable, where $\mathbf{z_1}$ is am ***n***-element vector and $\mathbf{a_1}$ a ***k***- element vector. The sum of square of $\mathbf{z_1}$ is $z_1' z_1 = a_1' X' X a_1$.........(ii)

Now to maximize $z_1' z_1 = a_1' X' X a_1$ we are imposing constraint $a_1' a_1 = 1$, otherwise $z_1' z_1$ could be made indefinitely large.

Therefore our problem is $\varphi = a_1' X_1' X a_1 - \lambda_1(a_1' a_1 - 1)$........(iii)

where λ is the Lagrange Multiplier.

Maximization of this problem gives $(X' X)a_1 = \lambda_1 a_1$...........(iv)

Thus $\mathbf{a_1}$ is a latent vector of $X' X$ corresponding to the root λ_1.

Now we have to obtain second new variable $z_2 = X a_2$. Therefore now our problem is

max $a_2' X' X a_2$ subject to $a_2' a_2 = 1$ and $a_1' a_2 = 0$ (*since* z_2 *is uncorrelated with* z_1).

Now the covariation between them is given by

$$\begin{aligned} a_1' X' X a_2 &= \lambda_1 a_1' a_2 \\ &= 0 \ \textit{iff} \ \ a_1' a_2 = 0 \end{aligned}$$

Therefore now our problem is $\varphi = a_2' X' X a_2 - \lambda_2(a_2' a_2 - 1) - \mu(a_1' a_2)$, where λ, μ are Lagrange multiplier. Maximization of this problem gives $(X' X)a_2 = \lambda_2 a_2$ and λ_2 should obviously chosen as the second largest latent roots of $X' X$.

Following this procedure we can obtain all *k* roots of $X' X$ and assembling the resultant vector we have orthogonal matrix **A = [$\mathbf{a_1}$ $\mathbf{a_2}$ .... $\mathbf{a_k}$]**. The Principal Components of **X** are then given by the ***n*** x ***k*** matrix **Z = XA**.

Moreover $Z' Z = A' X' X A = \Delta = \begin{bmatrix} \lambda_1 & 0 & \dots & 0 \\ 0 & \lambda_2 & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \lambda_k \end{bmatrix}$

which shows that the Principal components are pairwise uncorrelated and that their variances are given by $z_i' z_i = \lambda_i$ where $i = 1, 2, ...k$. Therefore the total variation in the X is given by

$$\sum_t x_{1t}^2 + \sum_t x_{2t}^2 + \text{..........} + \sum_t x_{kt}^2 = \mathrm{tr}\left(X' X\right)$$

$$= \sum_{i=1}^{k} \sum_{t=1}^{n} x_{it}^2$$

$$= \sum_{i=1}^{k} \lambda_i$$

$$= z_1' z_1 + \text{................} z_k' z_k$$

Thus $\frac{\lambda_1}{\sum \lambda}, \frac{\lambda_2}{\sum \lambda}, \text{..........} \frac{\lambda_k}{\sum \lambda}$ represents thc proportionate contributions of each Principal Component t the total variation of **X's**, and since the components are orthogonal these contributions sum to unity. Therefore our required Principal component will be

$$z_i = \frac{\lambda_{i1}}{\sum \lambda} X_1 + \frac{\lambda_{i2}}{\sum \lambda} X_2 + \text{............} \frac{\lambda_{ik}}{\sum \lambda} X_k$$

In our model indicators are grouped according to an objective method of aggregation, which allow us to go back to the initial set of variables at any time by looking at the factor scores.

We first obtain the factor score of each group of indicators classified as Markets, Diffusion, Infrastructures, Human resources, Competitiveness, and Competition. Each of these factor score is the driver of digitalization. Now it is possible to identify the most important drivers of digitalization at the level of each aggregate group of indicators.

The next step of measurement process is the development of one single measures of digitalization for each country. Once again using Principal Component Method we obtained index of digitalization from a linear combination of six factors.

the outcome of the analysis concerning the complex and multidimensional phenomena associated with the diffusion of digital technologies.

Second, here measurement framework is synthetic, i.e. it has an immediate explanatory power, which derives from the use of synthetic indicators. In this respect, the aggregation of the factors and the construction of rankings for each factor represent fundamental steps in achieving synthetic and comparable cross-section and time-series data starting from indicators that are not always homogeneous. The use of the statistical procedure of multivariate analysis for data aggregation allows some methodological problems related to the establishment of a hierarchy of the indicators and to the subjective attribution of weights in the scaling process to be overcome.

Third, the present methodology is transferable across different contexts of application, i.e. it can be adopted for the analysis of countries or geographical areas different from the ones initially considered. This is particularly relevant when comparing different economic systems in order to provide important policy implications for promoting the growth and development of the digital phenomena.

Finally, this model posse's flexibility as it is developed through statistical procedures: this indicates that it can be adapted and modified over time while maintaining the original structure. This characteristic is particularly useful for analysis of the performance of digitalization over time since it allows the set of elementary variables to be updated, thereby increasing and improving the number and type of indicators following the availability of better statistical sources or the dynamics of technological development.

The proposed method permits the factors that explain the differences in the levels of digitalization among different countries to be highlighted, adopting an objective approach for the measurement. In this case, as the principal component factor analysis is only used for defining the weights of the aggregations, the indicators are grouped without any loss of information, contrary to what happens when the factor analysis is used for purposes of data reduction. In addition, the principal components technique is able to reveal the relative importance of each indicator within each aggregate factor, which is equal to its weight in the linear combination (*Borgata et a*l., 1986).

The final step of the model refers to the measurement of the digital divide. After having calculated the levels of digitalization for each country, the meaning of the digital divide is that of a measure of dispersion. In order to improve the comparison of the relative distances we rescaled indices of digital divide with respect to mean 1. In other words, the index of digitalization is rescaled in such a way that the mean of this rescaled series is unity. This value represents the 'mean level' of digitalization, i.e. the benchmarking value for the whole set of countries.

In our model benchmark value is important, since

(1) The digital divide can be measured through the standard deviation of the rescaled indexes of digitalization of each country with respect to the mean 1.

(2) The relative distance to this value always represents the advantage/disadvantage for each country.

(3) The evolution of the digital divide can be assessed over time, as represented by the value of the mean for each year.

Characteristics of Model

This model is characterized by some distinct elements. First, This model is a composite as it takes into consideration of the existence of several 'layers' in the digital economy and aggregates the elementary indicators into six 'drivers of digitalization' that represents

Chapter – 4

Digital Divide in Selected Asian Countries

In our analysis we selected Asian countries South Korea, Japan, Singapore, Thailand, China, Indonesia and India are selected on the basis of their significant contribution in ICT production to the world economy. In a succession of waves, the industry has spread fairly widely throughout much of developing Asia. Asian ICT industry has grown rapidly and performed as a tremendous source of supply for the rest of the world, and using ICT infrastructure Japan, South Korea, Singapore have already shifted to the higher growth trajectory. Following which, other developing countries like India, Indonesia, Malaysia, and Thailand have also implemented ICT infrastructure in their economy, but a huge pocket of populations are still outside the ambit of ICT. This indicates that in the process of development of Asia some of the countries are late adopters of new technology and in these countries entire populations are not being able to access the ICT facilities. This again implied a situation of digital divide. Again Asia, which is considered as "world manufacturing center of ICT", is excessively dependent on US economy because of its large volume of export and it cannot ride out of US slowdown. According to *Kraemer & Dedrick* (2001) this is because although Asia has gained from the production of hardware, it has generally not made much use of ICT to boost productivity. Therefore there is a gap between have and have-nots within the Asian countries. Given that Asia accounts more than half of the world population and has 900 millions living on less than one dollar per day, the issue has much more significance.

After selection of countries, next step is collection of data. We collected data for the period 1998-2002 mainly from World Bank ICT database and from ministry of statistics of different countries. After observing all available data, a list of potentially useful indicators (approximately 100) based upon data deriving from official statistics is prepared. Information coming from nonofficial institutions is not taken into consideration in order to avoid problems related to the reliability and comparability of data sources as much as possible. The initial data set was subsequently analyzed and censored according to the following rationales: the existence of data for all of the countries, the homogeneity of the data across different sources of information and the quality and reliability of the data sources and of the data themselves.

The outcome of the selection process is a database of 26 indicators for the geographical areas previously identified. These indicators are subsequently classified in the six factors of digitalization identified in the previous chapter.

In our proposed framework we used principal components (factor) analysis first to aggregate the elementary indicators into the six "drivers of digitalization", i.e. Market, Diffusion, Infrastructure, Human Resources, Competition and Competitiveness and then to aggregate such drivers/factors in order to obtain a synthetic measure of digitalization. Principal Components Analysis is a multivariate statistics technique that allows the transformation of a given set of variables into a group of new components through linear combinations of the original variables.

This technique ranks the new components according to decreasing shares of explained variance: each of these components is the outcome of a linear combination of the initial variables through different factor scores (Rummel, 1970; Hair *et al.*, 1998). In this case, the share of explained variance (factor loading) represents the weights assigned to each component in explaining the phenomenon. (In this case the factor analysis is used simply as a hierarchical procedure for assigning weights to a set of indicators and not as a data reduction technique for simplifying the analysis. With this approach, the final set of components has the same informative power as the initial one (Gorsuch, 1990; Dillon *et al.*, 1989).)

The Outcome of the Model: The Digital Divide

Here **Table-1** shows the ranking of different drivers of digitalization and ranking of index of digitalization of selected Asian countries for the period 1998-2002. In the year 1998

South Korea was at the top of digitalization whereas, in the year 2002 China was at top and India was at third position among the selected Asian countries.

TABLE –1

Rank of Different Drivers & Digitalization									
For The Year 2002									
	MKT	**DIFFU**	**INFRA**	**HR**	**COMPTV**	**COMPTN**	**DGTN**	**Mean Ranking**	**SD of Ranking**
Korea	3	7	4	2	5	5	4	4.28571	1.60357
Japan	5	4	3	6	6	2	6	4.57143	1.61835
Indonesia	7	2	7	4	2	1	7	4.28571	2.69037
India	4	3	5	7	7	6	3	5	1.73205
China	2	1	1	1	3	3	1	1.71429	0.95119
Singapore	6	6	6	5	1	7	5	5.14286	1.9518
Thailand	1	5	2	3	4	4	2	3	1.41421
For The Year 2001									
Korea	7	1	2	5	3	3	6	3.85714	2.19306
Japan	5	4	5	4	6	7	1	4.57143	1.90238
Indonesia	4	6	3	1	1	1	2	2.57143	1.90238
India	1	5	1	6	7	4	3	3.85714	2.34013
China	2	7	7	7	2	6	7	5.42857	2.37045
Singapore	3	3	4	2	5	2	4	3.28571	1.1127
Thailand	6	2	6	3	4	5	5	4.42857	1.51186
For The Year 2000									
Korea	3	1	5	7	3	3	4	3.71429	1.88982
Japan	7	4	3	1	2	7	3	3.85714	2.34013
Indonesia	1	6	2	4	5	5	1	3.42857	2.0702
India	4	5	4	2	7	2	7	4.42857	2.0702
China	6	7	7	6	4	6	6	6	1
Singapore	2	2	1	3	6	1	2	2.42857	1.71825
Thailand	5	3	6	5	1	4	5	4.14286	1.67616
For The Year 1999									
Korea	2	1	7	2	2	6	6	3.71429	2.49762
Japan	7	2	3	7	7	1	2	4.14286	2.73426
Indonesia	1	5	1	4	3	7	7	4	2.51661
India	5	6	5	1	1	4	1	3.28571	2.21467
China	3	3	2	3	6	3	4	3.42857	1.27242
Singapore	6	4	6	6	4	5	3	4.85714	1.21499
Thailand	4	7	4	5	5	2	5	4.57143	1.51186
For The Year 1998									
Korea	7	1	3	2	7	1	1	3.14286	2.73426
Japan	1	6	6	1	1	4	5	3.42857	2.37045
Indonesia	6	3	7	5	5	7	2	5	1.91485
India	5	4	4	7	6	5	7	5.42857	1.27242
China	3	2	1	3	2	2	6	2.71429	1.60357
Singapore	2	7	5	6	4	6	3	4.71429	1.79947
Thailand	4	5	2	4	3	3	4	3.57143	0.9759

In the year 2002 China with its proper utilization of human resources, infrastructure development and highest rate of diffusion could acquire top position. Largest populated country China with its huge human resources was at 6th position in digitalization in the year 1998. Enriched with cheap labor and large market they had an edge to compete with other Asian countries and could raise their level of digitalization. But unfortunately next few years they slipped to the lower rank in almost all aspects. Realizing their fall in ranking of digitalization China utilized their economic system to improve all the drivers of digitalization and as well as level of digitalization and could acquire top position in the year 2002.

China's prodigious telecommunications growth and the slide-rule precision with which the government has attempted to oversee network development-has made the country a manufacturers paradise. Massive investments in best technology, and plenty of it, meant that vendor strategies for China have increasingly formed a cornerstone of their global business strategies. Foreign operators, however, have largely been excluded from China's boom. They found China's market is increasingly tough going because of competition from local players. With this Bureaucratic rivalry and a government that uses lack of transparency to its own policymaking advantage have meant that a basic telecom law still does not exist in what is now by some measures the world's largest telecommunication market. Moreover, it doesn't exist after 15 years of trying to develop it. China also continues to lack key planks in its regulatory regime: the Ministry of Information Industry (MII) has neither implemented a suitable interconnection regulatory regime nor developed a regulatory framework for broadband and convergence issues. Both of these vacuums have been purposeful. Due to this reasons China was loosing its grip in the world ICT market in the year 2002. Realizing that fall China immediately changed their attitude: In the past, China's telecom legislation was structured toward outlining what was not allowed instead of what was allowed. This inverse approach to regulating the industry created industry gaps, or "grey areas," within which players could operate. The government not only closely watches these grey areas—to regulate the pace of competition or prevent significant foreign influence—but also actively employs them as a means of stimulating market activity. A simple guiding hand is at work: show the government that there is opportunity for positive growth, and sooner or later, the regulatory structure will catch up with you.

Among others selected Asian countries Thailand was at 2nd position in the year 2002. Mainly Thailand is contributing to the world economy by producing computer peripherals and through packaging industry. Even when Thailand is not better enough in the development of other drivers of digitalization, especially with its large market and infrastructure development they could increase their level of digitalization from the 4th position in the year 1998. But still they need to develop their rate of adoption of new technology and better utilization of cheap labor to increase human resources to increase the level of digitalization.

In the year 2001 and 2002 India was at 3rd position in the process of digitalization. Early realization of the benefit of digitalization and its implementation helped India to capture the top position among the selected Asian countries in the process of digitalization for the year 1999. The most important milestone and instrument of telecom reforms in India has been the New Telecom Policy 1999 (NTP 99). It aims at creating an ideal investment environment to enable setting up of a world-class telecom infrastructure. It also aims at creating a level playing field, strengthening the regulator, attracting private investment, catering for convergence and leveraging on technological advancements. All the commitments made under NTP 99 have been fulfilled; each one of them, in letter and spirit, some even ahead of schedule, and the reform process is now complete with all the sectors in telecommunications opened for private competition. Due to these initiative taken by government India could come back to track despite the fall to the 7th position in the level of digitalization in the year 2000. But still India needs to develop its competitiveness, competition and increase human resource to go for further development of ICT sector.

Despite significant improvement in the digitalization India suffers from the human resource problem, even when different initiative and incentive provided by the government. Comparatively less number of schools and educational institutions are connected with Internet in India, resulting less informative people; with this declining growth rate of employment in ICT sector was the key factor responsible for inability to use human resource properly. With this India was also lacking competitiveness. To overcome this shortcomings India removed the restriction on the number of ISPs and there is no license fee payable up to October 31, 2003; thereafter a token license fee of Re.1 per annum is payable. ISPs are free to fix their own tariff. But unfortunately only 80 out of 400 license holders ISP commenced providing Internet service in the country.

South Korea was at the top of rank of level of digitalization in the year 1998 but slipped to 4th position in the year 2002. From the very beginning of the privatization of the telecommunications service market in the 90's, the government has consistently promoted market competition and private investments in the IT industry. The introduction of competition in the telecommunications market in 1990, 1994 and 1995 resulted in structural change in the IT industry. The government has implemented various programs to facilitate R&D and training of IT human resources. Finally, the government is actively nurturing IT venture companies through the organization of an investment fund, establishment of support centers for new business establishment at universities, as well as software support centers.

From the **table –1** it is observed that in case of diffusion South Korea slipped from 1st position to 7th position in the year 2002. It is not surprising enough as they are at the third stage of epidemic diffusion model, where majority of the population already adopted the new technology. South Korean ICT policies and their culture specially Korean people's "Pari Pari"("quick, quick" in Korean) nature pushing them to adapt new technology leaving the old technology behind. From the ranking of human resources it is also observed that Korea has improved its human resources drastically and secured 3rd position top position among selected Asian countries in the year 2002. But from the **table-1** it is also observed that South Korea was lacking competitiveness and competition. Despite the several efforts South Korea was still suffering from lack of competition and competitiveness. These limitations were dragging South Korea behind to improve their level of digitalization compare to other selected Asian countries.

Among other selected Asian countries Japan was at 1st position in 2001 but due to the slow down of the ICT market which is partially caused by US market slowdown and reduction in the level of employment in ICT sector which results a lower rank in human resources, it slipped off to the 6th position in the year 2002. Due to this slowdown of the market, which is partially caused by US market slowdown, employment in different ICT sector also declined. To overcome this problem Japan has to increase their ICT market worldwide and to increase their market they needed to take initiative to improve the level of digitalization of other Asian countries. And to do that recently (March 28, 2003) Japan initiated an action program, "Asia Broadband Program (ABP)", to promote deployment and use of broadband in Asia and it has built a fund to curb the digital divide among the Asian countries.

In an effort to properly adapt to the changes in socioeconomic structures that have been taking place on a global basis as a result of the utilization of information and communications technologies (IT), a new Basic Law on the Formation of an Advanced Information and Communications Network Society (IT Basic Law) came into effect in January 2001. IT Strategic Headquarters, which has been set up within the government in accordance with the aforesaid law, has established an e-Japan Strategy, which is aimed at making Japan the most advanced IT nation in the world within the next five years. In addition, the e-Japan Priority Policy Program was launched in March 2001 with the aim of executing the aforementioned strategy, followed by the e-Japan 2002 Program, an annual program which was created in June 2001 and incorporated the preceding e-Japan Priority Policy Program into national policy for fiscal 2002.

Among the selected Asian countries Singapore was at 3rd position in the year 1998 and 2nd position in the year 2000, but they slipped to 4th position in the year 2001 and then to 5th position in the year 2002. Other than competitiveness Singapore was suffering all most all aspects of digitalization. Market slow down coupled with lower rate of diffusion and low rate of infrastructure development was slowing down the process of digitalization.

For the past few years, the Republic of Indonesia – the world's fourth most populated country - has been through its biggest turmoil. It has not only had to contend with a regional financial crisis beginning in 1997, but a socio-political as well. The effect of these crises is clearly visible. The capital, Jakarta, is littered with abandoned skyscrapers and its previously metamorphic skyline basically unchanged since1997. In this situation it is very difficult for further investment and implementation of policies to improve digitalization and to cope up with this financial turmoil Indonesia ends an era of free Internet service. Despite these problems Indonesia could improve their competitiveness and competition and rate of diffusion to improve level of digitalization while, lack of infrastructure and smaller size of market were the main drawbacks which they need to improve to increase their level of digitalization.

Table–2

Index of Digitalization									
Year	**Korea**	**Japan**	**Indonesia**	**India**	**China**	**Singapore**	**Thailand**	**Mean**	**SD**
2002	1.227	0.985	-0.6839	1.238	1.5067	1.15962	1.2716	0.95784	0.7402
2001	0.587	0.872	0.75074	0.71	0.4282	0.63854	0.6148	0.65741	0.1398
2000	0.087	0.243	1.13973	-0.23	-0.203	0.26302	0.0808	0.19655	0.4595
1999	-0.543	-1.095	0.08292	-1.33	-0.811	-0.86603	-0.8049	-0.7659	0.4481
1998	-1.359	-1.006	-1.2895	-0.39	-0.921	-1.19515	-1.1622	-1.0459	0.327
Rescaled Index of Digitalization With Respect to Mean 1									
Year	**Korea**	**Japan**	**Indonesia**	**India**	**China**	**Singapore**	**Thailand**	**Mean**	**Digital Divide (SD)**
2002	1.281 (4)	1.028 (6)	-0.714 (7)	1.293 (3)	1.573 (1)	1.2106 (5)	1.327 (2)	1	0.7728
2001	0.893 (6)	1.326 (1)	1.142 (2)	1.080 (3)	0.651 (7)	0.971 (4)	0.935 (5)	1	0.2126
2000	0.441 (4)	1.236 (3)	5.798 (1)	-1.191 (7)	-1.034 (6)	1.338 (2)	0.411 (5)	1	2.338
1999	0.708 (6)	1.429 (2)	-0.108 (7)	1.730 (1)	1.058 (4)	1.131 (3)	1.051 (5)	1	0.5851
1998	1.299 (1)	0.961 (5)	1.233 (2)	0.372 (7)	0.880 (6)	1.143 (3)	1.111 (4)	1	0.3127

Table–2 shows the index of level of digitalization, mean level of digitalization and index of digital divide in upper part and in lower part rescaled indices of digitalization rescaled with respect to mean 1 are shown. Ranks of indices of level of digitalization are shown in parentheses. The relative distance of the value of indexes of digitalization from mean always represents the advantage/ disadvantage for each country and Standard Deviation of the Index of Digitalization of the selected countries is the measure of digital divide.

From **Table–2** it is observed that in the year 1998 Korea, Indonesia, Singapore, Thailand were above the mean level of digitalization whereas rest of the selected countries were lying below the mean level. In the year 2002 other than Indonesia each of the selected country were above the mean level of digitalization. Therefore India and Japan improved their level of digitalization compare to other selected Asian countries.

China has the greatest distance from mean value in the year 2002. Since its index value of level of digitalization is greater than the benchmark value of digitalization, it has an advantage than other selected Asian countries.

In the year 2002, only Indonesia was far below the mean level of digitalization i.e., Indonesia had to improve its level of digitalization to match up with other Asian countries. Very recently Indonesian Government started implementation of new policies and programs to foster digitalization.

From the lower part of the **table-2** it is observed that value of the index of digital divide was 0.3127 in the year 1998 and 0.7728 in the year 2002. And it was at maximum with the value 2.338 in the year 2000. In this year Indonesia could improve its level of digitalization comparatively better than other selected Asian countries and with this slump down in the process of digitalization in India, Korea and China was the main reason of this wide gap. But latter on countries other than Indonesia and Singapore could come back to the track to increase level of digitalization by implementing different policies and reduce the gap among themselves.

Table–3

SD of Drivers of Digitalization							
Year	**Korea**	**Japan**	**Indonesia**	**India**	**China**	**Singapore**	**Thailand**
2002	1.351943	0.7395737	0.753627	0.9787709	1.001582594	1.1453239	0.993822792
2001	0.526751	0.62299	0.2609172	0.6036174	0.699448531	0.1769506	0.604535525
2000	0.475693	0.6215118	0.5891121	0.3031029	0.268583731	0.1705907	0.399578588
1999	0.460353	0.9457968	0.4077084	0.8585573	0.650039358	0.581601	0.617505135
1998	1.190806	1.1216424	0.3144297	1.1005586	0.886790305	0.7028208	0.989913982

Table-3 shows the Standard Deviation (SD) of different drivers of digitalization among countries. If the country's value of index of digitalization is above the mean value 1 then lower the SD greater the advantage in the process of digitalization. Whereas when country is below the mean value then lower the difference tougher will be the process of digitalization. In the **table-3** South Korea has the highest difference and its value of index of digitalization was above the mean value in the year 2002, which implies they need to develop some of the drivers of digitalization. Among the countries above the benchmark value Japan has the lowest standard deviation, which indicates it has an edge for digitalization. Whereas in the year 2002 Indonesia was below the mean value and its SD is also low, which implies it need to improve all of its drivers of digitalization to increase the level of digitalization.

From the above analysis it is clear that there is an imbalance in the level of digitalization among the selected Asian countries and this range of this divide is fluctuating because of the policy difference and difference in the implementation of those policies in different countries. With this nature of the people is also important in the diffusion of new technology as some people are eager to adapt new technology earliest where others lag behind. In modern circumstances, especially in case of new technology, there is significant interdependence among countries. Therefore to get the maximum benefit from the adoption of new technology one has to develop its own level as well as it has to help others to improve their level of digitalization.

Chapter –5

Digital Divide in Selected Indian States

Expansion of analysis for Indian States needs some modification in the selection of variables, as it is nearly impossible to get all the selected variables that we have considered in case of selected Asian countries. Even when national level data are available there is no proper tabulation of state level data and available dataset raises a question on its authenticity. It's also very surprising that while different state governments are trying to popularise ICT, they are not keeping any of the statistics that relates state ICT industry. Ministry officials are also seems not much interested to keep contact with other ministries or organization to get required statistics and sometimes they suggested disaggregating national level data on the basis of state's share of NDP. Most of the states ministry keeping records of some definite projects that are implemented. But most of these projects cover only a particular area and target a very less number of people.

Collection of state level time series data is the toughest hurdle to overcome especially when we are dealing with an industry like ICT in India. To extend our work we had to calculate statistics from different report and from the list of question-answer in Rajyasava. We had to collect required data from different organization and different ministry to make our analysis reliable/ significant. Data collected from different sources have shown a significant difference and insisted us to choose the right one depending on the closeness of corresponding ministries or department/ association. Due to these problems we reduced the number of selected variables as well as altered some indicators. In this modified model we are using "number of tertiary student" instead of "number of students completed their Masters level" and since there is no state level data on "number of school connected with Internet" we had to drop it. Again since there is no state level data on "cost of telecommunications services" and "Internet access costs", we had to drop "competition" class. With this in our model we included one additional variable "Number of STPI (Software Technology Park of India)" in the competitiveness class.

In our extended analysis we are considering the time period 1998-2000 since most of the states came up with their separate ICT policy only after the year 1997 and it's also true that data for the other time period is not available for all states. In our analysis we selected states Andhra Pradesh, TamilNadu, Karnataka, Kerala, Maharashtra, Delhi, Haryana, West Bengal as leader, aspiring leader and as expectant in ICT industries in India assuming that different studies conducted by different commercial organization and institution and media reports are right.

Outcome of Our Model for Selected Indian States

From the **Table –4** it is observed that ranking of drivers of digitalization are fluctuating and it is very difficult to explain the reasons of fluctuation. As in case of diffusion Tamil Nadu was at the top for the year 1998 and 1999 but in the year 2000 it slips to 8th position and Delhi was at top in the year 2000 despite the its 8th position in the previous year. Even though in case of diffusion there was no constancy of rankings among the states, it's Maharashtra who was maintaining the more or less same position among the selected states.

From the **table -4** it is observed that Andhra Pradesh was continuously holding the top rank in ICT market, which is why mainly because of explosive development of software sector. Delhi was at 2nd position in ICT market in the year 1998 and in the year 2000 despite a sharp fall in the year 1999. Growth of this ICT market incorporated the development of hardware sector and software sector. Being at the capital of India and facilities provided by the government to set up industries in New Organised Industrial Area (NOIDA) insisted most of the MNCs which initially have set up their firm in south India to consider Delhi as their second home.

Table - 4								
Ranks of Drivers of Digitalisation & Rescaled Index of Digitalization								
Market								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	1	4	6	5	8	2	7	3
1999	1	6	4	5	2	8	3	7
2000	1	4	6	5	8	2	7	3
Diffusion								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	8	6	3	5	1	2	7	4
1999	2	4	7	5	1	8	3	6
2000	7	5	2	4	8	1	6	3
Infrastructure								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	7	6	4	5	2	8	1	3
1999	2	3	5	4	7	1	8	6
2000	7	6	4	5	2	8	1	3
HR								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	8	1	2	3	5	4	6	7
1999	7	8	6	5	3	4	2	1
2000	1	2	3	4	6	5	7	8
Competitiveness								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	8	5	4	1	7	2	6	3
1999	1	4	5	8	2	7	3	6
2000	8	5	4	1	7	2	6	3
Rank of Rescaled Index of Digitalization								
Year	**AP**	**Karnataka**	**Kerala**	**Maharashtra**	**TN**	**Delhi**	**West Bengal**	**Hariyana**
1998	2	3	4	7	1	6	5	8
1999	7	6	5	2	8	3	4	1
2000	7	6	5	2	8	3	4	1

Being close to Delhi, Haryana also could develop its ICT market especially when Delhi is expanding /progressing towards Haryana. But despite an explosive development in the software industry due to the sharp decline in telecom growth as well as a sharp decline in hardware sector development Tamil Nadu was at the lower part of the rank table. West Bengal was also at the lower part of the rank table because of the decline in the share of hardware sector revenue in GDP and share of the revenue of software sector in GDP. Introduction of new technology and use of more digital technology insisted people to go for foreign made telecommunication apparels with which India made apparels are no match. With this continuous sharp decline in the price of telecom equipments and reselling of old models in the gray market is also one more reason in the declining share of telecom hardware revenue in GDP.

In the case of infrastructure, West Bengal was at the top in the year 1998 whereas it slipped to 8th position in the year 1999. Realizing the fall West Bengal Government constituted an IT Task Force in March, 1999 to deliberate on the strategies required to promote growth in all aspects of the IT sector. Leaders from Industry, Academia, Government Departments/Agencies, Chambers of Commerce and the IT Industry including Software and IT Education majors were consulted extensively for suggestions and advice. A fruitful interaction was also held between the Nation level (IT) Task Force and the State Government. According to the proposal of this task force government is going for partnership with industry and educational institutions to promote the growth of the IT industry in the State. This offer benefits of Information Technology applications for all types of industry, enterprises, private and public organizations and institutions. Increasing information appliance access to the people of the State was a major goal. The Government also orchestrated a conducive policy environment that can provide efficient growth in all important sectors including software development for the domestic and international market, help in creation of a durable multimedia, as also Web-enabled technologies and promote setting up of Venture Capital companies. Because of these incentives West Bengal could regain its top position to set up infrastructure in the year 2000.

Tamil Nadu was at 2nd position in infrastructure development in the year 1998 and regains its position in the year 2000 despite its fall in the year 1999, whereas Andhra Pradesh, Karnataka and Delhi maintained their position at the lower part of the rank order.

Tamil Nadu government in their first information technology policy (1997) to encourage ICT sector decided to use ICT in Government institutions and Departments with a view to improving productivity and efficiency of Government services, revenues and tax collections, and assist in the process of decision-making by Government, and monitoring of Government programmes. A separate policy paper was prepared on this for speedy implementation.

Since there is no system of Entry Tax or Purchase Tax in Tamil Nadu, ICT Industry continued to enjoy facilities of unrestricted movement of capital equipment including hardware, peripherals, captive power gensets, UPS sets and Telephone Exchanges, subject only to Sales Tax payments as per orders in force.

The Tamil Nadu State Government decided to set up Information Technology Parks (ITPs) at Chennai, Coimbatore, Tiruchirapalli and Madurai in a phased manner through ELCOT during the IX Plan period in association with the private sector. Government of Tamil Nadu was encouraging setting up of Venture Capital Fund for development of ICT Industry through TIDCO in association with private sector partners. And with this the facility of uninterrupted power was continued to be offered to ICT industry.

Tamil Nadu has also established a set of very progressive and forward-looking institutions - ELCOT (Electronics Corporation of Tamil Nadu); GUIDANCE (Tamil Nadu Industrial Guidance & Export Promotion Bureau); TACID (Tamil Nadu Corporation for Industrial Infrastructure Development Limited), SIPCOT (State Industries Promotion Corporation of Tamil Nadu Limited), SIDCO, TIDCO (Tamil Nadu Industrial Development Corporation Ltd) -- all of which provide institutional and infrastructure support to various industries that the state government seeks to invite or foster in the state. All these initiative taken by Tamil Nadu government was fruitful which is reflected in our results.

Andhra Pradesh was continuing their lower rank in infrastructure set up development for ICT industry because of their faulty policy prescription. At initial stage (in the year 1997 policy prescription) Andhra Pradesh government was willing to help IT industry mostly by supplying uninterrupted power. Other than this there was no incentive to promote IT industry, as policy makers used to believe IT sector is such a sector, which grows automatically. Since this is not true, they had to suffer. With this most of the initiative taken by Andhra Pradesh government to encourage ICT industry were centralized to Hydarabad (Cybarabad) city only. This is one of the reasons of lagging behind when it comes in comparison with others states as a whole. This is also true for Karnataka. Different organization and intellectuals are also still protesting Karnataka government's this centralized incentive around Bangalore to encourage ICT. This problem is so severe that a large pocket of people of Karnataka wants to divide Karnataka into north-south Karnataka to foster the development of other parts of Karnataka (*B.M. Manjundappa report*).

In case of creation of Human Resources Andhra Pradesh and Karnataka was at the upper part of the rank table in the year 2000 whereas Tamil Nadu, West Bengal and Haryana were at the lower part of the table. Development of Human Resources in Andhra Pradesh was significant as they were at 8^{th} position in the year 1998.Recognising that human resource development is the key to sustained growth in the sector, the Andhra Pradesh Government embarked on major initiative, the establishment of the Indian Institute of Information Technology (IIIT), Hyderabad. This Institute has been established as an autonomous industry-led and driven institution supported by the Government. Major IT companies including several Multi National Companies (MNCs) have participated in the establishment of the institution. As a result of this joint effort, the IIIT is endowed with state-of-the-art facilities and highly competent faculty. With its emphasis on IT enabled and distance education, the Institute is expected to make a major contribution both directly and indirectly (in conjunction with the technical institutions in the state) to the continuous generation of the increasing number of skilled personnel that the industry needs. A large number of training institutions that have sprung up in the state in general and Hyderabad in particular, have seen the emergence of Hyderabad as a major IT training Centre of the country. Students of these institutions are working as Professionals in the state ICT sector.

The Andhra Pradesh Government has been actively and constantly monitoring the incentives necessary to foster the rapid growth of the industry. A major growth area identified is IT Enabled Services (ITES) or 'Remote Services'in the year 1999. The ITES sector, like the software industry, requires a conducive environment and access to large pools of skilled to semi-skilled professionals. ITES afforded a unique opportunity for providing employment to large numbers of qualified unemployed youth in the state as well as business opportunities for budding knowledge entrepreneurs. Keeping in view the intensely cost-competitive nature of this sector globally a specific set of incentives tailored to the requirements of this sector had been considered by the Government in order to attract the maximum employment potential of the industry to the state. An employment-linked incentive has accordingly been worked out to link the incentives given by the State directly to the employment generated.

Karnataka Government proposed to meet the demand for professionals by organizing Human Resource Development schemes. These schemes were implemented to train people at different levels like unemployed graduates, engineering college students, college students, polytechnics, ITI as well as schools. Government also offered several incentives for companies that create employment in Information Technology. These incentives were either in the areas of cost of land, registration charges, FAR, zonal regulations, etc. The new companies that provide employment of more than 250 in Bangalore and 100 in other areas are eligible for these concessions. Government also established numbers of training centers all over the state, primarily for the purpose of training the unemployed educated youth in various IT skills. The Government also encouraged private sector initiatives in setting up such centers. These centers are receiving appropriate concessions from the Government.

The schemes are allowed the usage of such centers for partial commercialization. The Government of Karnataka has established this autonomous Institution, which has world-class infrastructure and state of the art facilities. The Institute has laboratories sponsored by Sun Microsystems, IBM, Microsoft, Informix, Oracle, Apple & Abode, Novell, Compaq, PTC, CISCO, Ramco, SAP, and Computer Associates. The Institute offers advanced courses in post graduation and Doctoral programmes. The Institution is playing a pivotal role in the human resources development in producing high quality professionals as well as training consultants and helping Karnataka to be at the top of rank table in Human resource development.

Even when Kerala is having higher percentage of educated people it could not improve its Human Resources significantly compare to other states. Their first ICT policy was criticized on several grounds. Policy makers concentrated on PC penetration only and they used to believe since percentage of educated people in Kerala is higher, use of Internet and diffusion of digital technology would increase automatically. But unfortunately that did not happen.

Keeping these things in mind Kerala Government in their next ICT policy (2000) have set up the IIITM-K as a center of excellence in IT education, for imparting training in high-end and emerging technologies. The Institute leveraged as a key resource center for upgrading the quality of technical education in the State. State Govt. have embarked on a major policy initiative of liberalizing the professional and higher educational sector of the State and increased the number of technical seats in the IT sector (including Engineering and MCA). Realizing the fact that basic IT skill is a sine–qua-non for exploring any branch of knowledge, they incorporated fundamental IT module as an essential component of the curriculum for all degree courses in the state, including the Arts & Humanities courses. The Govt undertook career aptitude assessment programmes in cooperation with private organizations with proven expertise in the area to help develop cost effective programmes that provide appropriately trained human resources for the IT industry. The whole assessment process is monitored by a group of eminent experts from industry, academia to ensure that the objectives are substantially met, without compromise in quality. In this case Kerala's strategy was a success as they could improve their position from 6^{th} place in the year 1999 to 3^{rd} place in the year 2000.

West Bengal also had the similar problems. Despite there is large numbers of educational institutions and geographical advantage to develop industries it could not raise its human resources required for ICT development. Realizing the drawbacks West Bengal Government decided to set up a high level Information Technology Development Board (ITDB)(ICT policy 2000) to focus on Research & Development efforts of the State and encourage meaningful linkage between academic, R & D Organizations and IT Industries. Awards will be given to Institutes for achieving excellence in R & D in IT related subjects.

With this West Bengal Government realized that lack of English knowledge, they started permitting English medium school to come into operation and at the same time government have set up a board (WEBEL) to monitor and take the necessary action to develop ICT sector.

In case of competitiveness Maharashtra was at the top of the rank table in the year 1998 and in the year 2000 despite a fall in the year 1999. Since their first information technology policy (1997), Maharashtra government is encouraging ICT industry by providing both fiscal and non-fiscal incentives to make Maharashtra globally competitive in ICT market. But Mumbai being a metropolitan city and gateway of India enjoying most of the benefits. To diversify this centralization of ICT sector Government of India has selected Pune for locating one of the five high-tech habitats. This is an example of policy coordination of state government and central government. From the data set it is observed that due to this incentive number of STPI increases rapidly and research expenditure as a share of GDP also increases to increase competitiveness.

In case of competitiveness Delhi was at the 2nd position in the rank table in the year 1998 and 2000 despite its fall to the 7th position in the year 1999. As we have mentioned earlier different MNCs started considering Delhi as their second home to set up new firm here, number of software technology park (STPI) increases rapidly. With this several research institution are there in Pusa came up with number of patent application and raise competitiveness. Delhi government is also providing incentive to these research institutions by increasing R & D expenditure as a share of GDP.

Despite different initiative taken by Andhra Pradesh and Tamil Nadu they could not raise their competitiveness and occupies the lower order in the rank table. Even though Andhra Pradesh provided incentive to encourage hardware sector and software sector but at the same time they reduced the expenditure on R&D as a share of GDP and as a result number of S&T could not increase rapidly compare to the other states.

Table - 5

Index of Digitalization

Year	AP	Karnataka	Kerala	Maharashtra	TN	Delhi	West Bengal	Hariyana	Mean	SD
1998	-1.0493	-0.9908	-0.9502	-0.90742	-1.1513	-0.9291	-0.9297	-0.88443	-0.974	0.0881
1999	0.1071	-0.01814	-0.0931	-0.1647	0.4991	-0.1293	-0.1282	-0.2007	-0.016	0.2293
2000	0.9421	1.00895	1.0433	1.07213	0.6522	1.0584	1.0579	1.08513	0.99	0.1438

Rescaled Index of Digitalization With Respect to Mean 1

Year	AP	Karnataka	Kerala	Maharashtra	TN	Delhi	West Bengal	Hariyana	Mean	Digital Divide (SD)
1998	1.077 (2)	1.017 (3)	0.975 (4)	0.932 (7)	1.182 (1)	0.954 (6)	0.954 (5)	0.908 (8)	1	0.0905
1999	-6.698 (7)	1.134 (6)	5.822 (5)	10.297 (2)	-31.204 (8)	8.085 (3)	8.014 (4)	12.548 (1)	1	14.337
2000	0.952 (7)	1.0191 (6)	1.053 (5)	1.083 (2)	0.658 (8)	1.069 (3)	1.068 (4)	1.096 (1)	1	0.1452

Table –5 shows the index of digitalization in the upper part of the table and in the lower part rescaled indices of digitalization with respect to mean 1 are shown along with corresponding rank in the parentheses. Last column in the lower part of the table shows index of digital divide (SD). When we are dealing with the index, rank is not important enough to explain the results. In our analysis in the year 1998 level of digitalization of these selected states are very much similar and average level of digitalization is -0.974. Among these states only Andhra Pradesh and Tamil Nadu were below the average level of digitalization in the year 2000. This result is not surprising enough, as despite being early starter of ICT implementation these states had centralized their development towards the capital of the states. These two states invested huge amount for the promotion of ICT more for official purpose rather than using it to increase productivity, especially when their suburban and rural people were lacking English knowledge and dying for food (....*Government of Tamil Nadu will also facilitate setting up of a T-Net with an "Information Back bone" connecting all District Head Quarters, using the Cable T.V. network all over the State whose penetrating at present is 4 times that of Telephone lines* –ICT Policy, TamilNadu, 1998*)*. With this media hype added color to glorify ICT development in Andhra Pradesh and Tamil Nadu. In case of overall digitalization Andhra Pradesh was lagging behind mainly because of infrastructure development, lesser competitiveness and lower rate of diffusion, whereas Tamil Nadu was suffering from smaller hardware market and lack of competitiveness. Myth of the development in ICT sector is only because of software sector development. But these two states have to understand that without developing hardware sector and telecom sector and improving computer literacy, whole ICT sector cannot go further in long run.

Similar can be said in case of Karnataka. Explosive development of software sector and centralized ICT policy creating digital divide along with social divide.

Competitiveness was the main drivers of digitalization in case of Maharshtra in the period 1999-2000. Despite the smaller size of the market and lower rate of diffusion it could raise its level of digitalization and secure 2nd position in the year 1999 and 2000. Realizing their faulty 1st ICT policy Kerala modified their policy and could balance among the different industries of ICT sector but still it has to develop its ICT market. Delhi is a mix-culture society, varieties of mentality and stratification of income level is also wide enough to make it difficult to go for a popular common policy. Still Delhi government implemented different projects under the banner "Bhagidary" and helped the lower strata income people to access free Internet ("Hole in the Wall" is such a programme) and at the same time providing incentives to different MNCs to come up.

Table–5 shows that among the selected Indian states Kerala, Maharashtra, Delhi, West Bengal and Haryana could improve their level of digitalization from below the average level of digitalization to above the average level of digitalization. Improvement of ICT sector by these states is reducing their gap with other states and emerging them as aspirant leaders of ICT sector in Indian Economy.

From **table – 5** it is observed that in the year 2000 value of digital divide index is 0.1452 while it was 0.0905 in the year 1998 and it was maximum with the value 14.337 in the year 1999. This gap is wide mainly because of the sharp decline in the level of digitalization of Andhra Pradesh, Tamil Nadu and sharp development of Maharashtra.

Finally we can say that almost all the states sooner or latter realized the importance of ICT sector and started popularizing digital Technology among the people providing different incentive. They also have learned from mistakes committed by Andhra Pradesh, Tamil Nadu and Karnataka. Constant policy evolution, modification and its implementation and balancing act among different ICT sectors helping these states to bridge the gap with the early starters and proving media wrong.

Chapter 6

Conclusion

The ICT industry is characterized by technological innovations, short product cycles, high profits, and extensive investments in research and development, which have become pivotal factors in attaining a competitive edge in modern times. Since the last decade, the role of the ICT industry has become increasingly more significant with the creation, spread and usage of knowledge to create economic value in the knowledge-based economy. ICT connects individuals and enterprises via networks, facilitating the production, distribution and consumption of information through overall economy as well as enhancing the development of the intangible economy. In particular, any further advancement in the use of the Internet by the business world depends largely on the development of the ICT industry. Moreover, the continuous development of the ICT industry fuels the explosive growth of electronic commerce and business re-engineering.

The paradigm shift toward a knowledge-based economy has focused the spotlight on the significance of information technology more than ever and in response, governments across the world are scrambling to formulate a policy framework for this strategically important industry.

Here in our analysis Korea blossomed into an industrialized nation as a result of the ambitious industrialization efforts launched in the 1960s. Phenomenal economic success was achieved on the backs of such physical factors as capital and labor. However, with the current paradigm shift toward a knowledge-based economy, the greatest concern for Korea is to enhance its competitiveness through greater productivity via the promotion of the ICT industry and informatization of the society as a whole. In the 1990s, along with private investments in the ICT sector, a wide variety of policies tailored to promote the ICT industry and informatization has been actively implemented. Currently, the ICT industry stands as the most crucial sector in the Korean economy with its sustained development tabbed as an indispensable element of economic growth.

In 2001, ICT imports declined as the Korean economy slowed due to slow down of world ICT market. In 2002, the rebound in prices of semiconductors and LCD coupled with rise in exports of mobile handsets, satellite broadcasting signal receivers, and LCD monitors boosted ICT market and Korea regain their position among Asian countries.

Process of Digitalization is also going good in case of Singapore. Although in case of Singapore outsourcing remained a threat towards the employment of infocomm manpower as organisations sought to locate jobs where it offered best value for money in order to achieve long term productivity gains to counter the ever-changing market conditions. However, most companies which had outsourced infocomm jobs indicated that they did not reduce the number of infocomm manpower due to outsourcing. This policy is helping them to maintain their momentum.

India among the rest has taken different initiative to popularize ICT, even when a group believes introduction of ICT reduces total employment and has an adverse effect on the economy, especially country like India where labor is comparatively cheap. The most creative uses of ICT's in development may not entail computers, e-mail, or Internet access, but rather the use of other computer-based technologies, including embedded chips, satellite based information, etc. in order better to meet local needs. As for example, Fishermen on the Andhra Pradesh, coast of the Bay of Bengal and the Kerala coast of the Arabian Sea are enjoying the benefits of ICT. In both areas, scientists associated with Indian Space Research Organization (ISRO) download information on ocean temperatures from satellites. Ocean temperatures help predict where fish will be most likely found offshore. ISRO scientists translate the digital satellite information into maps of the offshore fishing areas, which are transmitted by telephone or fax to the coastal regions, in turn increasing the probability that fishing expeditions will produce profitable results. Here, sophisticated satellite technologies are placed in the service of local fishermen to improve their livelihood. Another example is Gujurat dairy where they introduced computerized butterfat-assessing machines, so suppliers need not to wait for payment.

Technologically high ending country Japan is suffering of market slowdown problem. Slow down in the ICT market of other countries causes a slow down in Japan ICT market as it is highly dependent on other countries. To solve this problem Japan has set up a committee and engaged a large fund to help other technologically backward countries to improve their digitalization.

China's Ministry of Information Industry (MII) has neither implemented a suitable interconnection regulatory regime nor developed a regulatory framework for broadband and convergence issues and because of this China was loosing its grip in the world ICT market in the year 2002. Realizing that fall China immediately changed their telecom legislation outlining what was allowed instead of what was not allowed. This inverse approach to regulating the industry reduces industry gaps, or "grey areas". The government not only closely watches these grey areas—to regulate the pace of competition or prevent significant foreign influence—but also actively employs them as a means of stimulating market activity.

Even though ICT is considered as general purpose technology and helps to offer better education and health facilities which are the basic needs along with the increase in the productivity, Indonesia could not implement this because of financial crisis. With this, poor use of Internet, lack of English knowledge and passive business approach creating a gap with other countries. Realising these problems USAID suggested that process should be driven by market rather than government policies and include private sectors in the regulatory process.

When some Asian countries are striding towards knowledge based economy others are lagging far behind. It is apparent from above discussion that effectiveness of ICT can be enjoyed when majority of the economic units are connected. Realizing that fact big players are offering their hands to help others and some countries formed a group and managing fund to help themselves such as ASEAN. With this some organization like DOT Force, Digital Divide org etc came up with their technology and fund to help those who are lagging behind. From our analysis it is evident that during 1998 digital divide was wide among the selected Asian countries. Realization of the importance of ICT and so Investment in ICT sectors and help from other advanced countries reducing this gap.

When we extended our analysis for selected Indian states, we were surprised enough to see the shocking myth created by media. Explosive growth hype of ICT industry in some states is not true. Study for selected Indian states is important enough as there are central ICT policies and state ICT policies simultaneously play the pivotal role to promote ICT.

Multicultural and multilingual country like India desperately needed separate policy for separate geographical area and for separate cultural people. When most of the people of a country are in rural area going without any English knowledge and struggling to keep fire on in their kitchen, it would be overoptimistic to expect them to use ICT especially when it does not help to increase their productivity. Contrary to this basic popularizing formula states are investing for e-governance and providing incentives to set up new software firm which eye for foreign market only. These software firms are not guided to meet the local need. Again when most of the websites are in English there are very less incentive had been taken either to improve English knowledge or to create local language website. These state governments have to understand without developing computer literacy and without developing ICT hardware manufacturing sector it is difficult to maintain the balance among the different sectors of ICT. And to popularise ICT among the majority of the population it is important to use it to increase productivity. In this regard ISRO helping costal people to increase their productivity by providing information through satellite.

Without going for a network or joint venture with adjacent states, providing rosy picture of ICT industry of the corresponding states and gloomy pictures of other states only, a state can not develop its ICT sector. This strange hush-hush attitude is reflected when we approached different state governments for data.

But it's also true that late starter states are fast learner and they modified their policy realizing the mistakes committed by early starter states. Hardware sector in Haryana is developing faster and competing in world market such as Moserbear Company, whose research units is a front runner in the world portable drive devices sector. Very soon they are going to launch paper made compact disc which will be cheaper, disposable and will have higher capacity. They are also launching highest ever data capacity (100GB) DVD.

Kerala, West Bengal started providing special computer literacy training and permitting new private English medium school to come up to improve English knowledge and technical schools to come up to increase the supply of ICT professionals. Clearly this is an approach to keep balance on both demand and supply side to popularize ICT.

Other than urban people, unwillingness to adopt new technology help Indian people to stick to old technology even when newer version is not complicated enough (such as people still uses floppy to carry soft copy despite the cheaper price and higher capacity of compact disc), whereas snob effect drives urban people to go for latest communication accessories. Again here people usually think of short run only and reluctant for initial high investment to reduce per unit cost in long run. Realizing this problem several computer manufacturing company came up with lower price PC and receiving government incentive to reach majority of the people. *Amaar PC* in West Bengal, *Amchi PC* in Maharashtra, *Naadi PC* in Andhra Pradesh is such an example.

From our analysis it apparent that despite the difference in geographical location, social and cultural aspects, selected states were competing with each other to improve their ICT sector and reducing the divide between early and late starter. But in most of these states, development of ICT sector is centralized and leaves a room to realize that there is digital divide among the people of any state. To measure and to determine the factors responsible for, we need some stratified data which are currently unavailable, which again demand high monitoring of ICT sector by corresponding states. Very recently (April 2005) a sector report published by World Bank is also echoing the same voice.

In order to develop strategies to respond to the challenges and opportunities of the early twenty-first century, companies and countries as well as states need a good understanding of the impact of ICT on economic growth, on corporate performance, and on the process of globalization. This is particularly true for the Asian region, which enters the new millennium in the wake of an unexpected economic crisis that has raised crucial question about what countries and companies must do to return to growth and profitability. Several studies and surveys suggested bringing more people in the network and that can be done only if we can make digital technology affordable to the majority and bridge Digital Divide. Measuring digital divide is the first step of it.

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