URBAN DEVELOPMENT AND THE INFORMATION TECHNOLOGY INDUSTRY: A STUDY OF BANGALORE, INDIA

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Abstract

The focus of the study is the city of Bangalore, in India, which has over the years become a centre for high technology industries, and in the mid-1990s was home to the largest number of Information Technology (IT) firms in India. This has earned it the title of the "Silicon Valley of India". The city's comparative advantage in the IT industry in India emanates from various factors, of which favourable government policy, high quality work force, and the availability of research laboratories are some of its crucial determinants.

This research aims to understand the reasons for Bangalore's success in attracting both foreign and domestic IT industries (especially between the mid-1980s, when the Indian economy showed the initial signs of opening up, and the mid-1990s), and investigates the extent to which the city can continue to be the most preferred location for IT industry in the country.

Three research hypotheses have been tested in this research study. The *first* is directed towards the global IT industry, and contends that the global IT industry's interest in India goes beyond mere price considerations alone. The *second* proposes that the success of Bangalore in attracting the IT industries is due to a synergy of factors, which include favourable government policies, availability of skilled professionals, and local presence of research institutes and laboratories. The *third* hypothesis is guided towards the industry-institution linkage, and argues that there exists a strong link between the IT industry and the research laboratories in Bangalore, which has helped underpin growth in the local IT industry.

The empirical analysis was conducted at two levels. One at the national level of policy making, and another at the city level. The research is based on both secondary sources of data and primary data collection. The study relied on two types of field surveys, a firm-level survey and a policy makers survey. An understanding of the competitiveness of Bangalore is carried out using a set of indicators which include *inter alia* level of telecommunications infrastructure, government policies, availability of industrial/office space, skilled labour and specialised services.

The study finds that initially the main reason for the industrial growth in Bangalore was to be found in the strong industrial tradition of the region, dating back to the earlier part of the twentieth century and later, by government owned electronics and telecommunication industries that were founded in the city immediately after the country's independence (in 1947). Electronics industries continued to base themselves during the 1960s and through the 1980s in the city. However, when the Indian economic policy was liberalised from the mid-1980s and more perceptibly after 1991, it was the Information Technology industries that began to establish themselves in Bangalore primarily to tap the available professional skills, and to make use of the city's existing base as a prominent centre for high technology industries. The research also found that there are strong links between the research institutes and laboratories and the private IT companies in Bangalore especially in R&D related activities. While many of the interviewed companies felt that Bangalore would continue to be the preferred location for the IT industry in the country, they do not rule out the possibility that an impending infrastructure crisis in the city will undermine its competitiveness.

Contents

PART B STRUCTURE OF THE IT INDUSTRY

PART C BANGALORE'S COMPETITIVENESS IN THE IT INDUSTRY IN INDIA

PART D CONCLUSIONS

List of Tables

List of Figures

List of Appendices

List of abbreviations and acronyms

£	UK Pound Sterling
BEL	Bharat Electronics Ltd.
BIDS	Bath Information and Data Services
BLPES	British Library of Political and Economic Science
CEDT	Centre for Electronic Design and Technology, IISc, Bangalore
CEO	Chief Executive Officer
CII	Confederation of Indian Industry
CLIK	Consortium of Electronic Industries of Karnataka
CRISP	Computerised Rural Information Systems Project, India
DIC	District Industries Centre
EIU	The Economist Intelligence Unit
EU	European Union
FEER	Far Eastern Economic Review
F-JV Firms	Foreign and Joint-Venture Firms
FT	Financial Times
GMCI	The Greater Mysore Chamber of Industry
GoI	Government of India
HMT	Hindustan Machine Tools
ICICI	Industrial Credit and Investment Corporation of India
IIM-B	Indian Institute of Management, Bangalore
IISc	Indian Institute of Science, Bangalore
ITPL	Information Technology Park Ltd., Bangalore
KEONICS	Karnataka State Electronics Development Corporation
KIADB	Karnataka Industrial Areas Development Board
KSFC	Karnataka State Financial Corporation
KSIIDC	Karnataka State Industrial Investment Corporation
KSSIDC	Karnataka State Small Scale Industries Development Corporation
LDCs	Less developed countries
MAIT	Manufacturers Association for Information Technology
NAFTA	North American Free Trade Association
NASSCOM	National Association of Software and Service Companies in India
NCAER	National Council for Applied Economic Research, New Delhi
NIEs	Newly Industrialising Economies
NIUA	National Institute of Urban Affairs, New Delhi
NTTF	Nettur Technical Training Foundation
R&D	Research and Development
Rs.	Indian Rupee
SOAS	School of Oriental and African Studies, London
STP-B	Software Technology Park-Bangalore
STPI	Software Technology Parks of India
TDICI	Technological Development and Investment Corporation of India
TECSOK	Technical Consultancy Organisation of Karnataka, Bangalore
UCL	University College London
US$	US Dollar

Glossary

Ancillary Industries Industrial units in India with an investment of Rs. 7.5 million and below in plant and machinery and engaged in manufacture of production of parts/sub-assemblies/components or rendering services of more than 50 % of production/services as the case may be to one or more industrial units.

Bandwidth The range of frequencies over which a particular communications channel is effective, which determines the maximum rate at which information can be transmitted.

Basic (Telephone) services A regulatory telecommunications term which means providing basic telephony (excluding value added services like E mail, etc.).

BDA (Bangalore Development Authority) A state of Karnataka body, that controls, regulates and plans development within the Bangalore Urban Agglomeration.

BMRDA (Bangalore Metropolitan Regional Development Authority) A state body having planning and development control in the Bangalore metropolitan region, including the areas under BDA's jurisdiction.

C-DOT (Centre for Development of Telematics) Established by the Government of India in 1984 to locally design, develop, and transfer to Indian industries the technology for manufacturing a range of digital switching systems with a capacity of up to 40,000 lines and transmission equipment.

Clients Computers that request and receive information from servers via the network.

DoE (Department of Electronics) The Government of India department that frames policies and co-ordinates the activities of the electronics sector in the country. IT industry is also under DoE.

DoT (Department of Telecommunications) Regulator and the main domestic telecommunications service provider in India.

Download Transferring a file from another computer to one's own computer.

E Mail (Electronic Mail) Exchanging messages from computer to computer-not necessarily on the Internet, but generally accepted to be via the Internet.

EOU (Export-oriented unit) Production unit from which all output is exported.

EPZ (Export processing zone) Designated area within a country, separate from domestic tariff area, in which specific export-oriented regulations apply.

Extranet Connecting Intranet to the Internet and allowing open access.

FDI (Foreign Direct Investment) Investment in the businesses of another country which often takes the form of the setting up of local production facilities or the purchases of existing businesses.

FERA (Foreign Exchange Regulations Act) It regulates the movement of foreign exchange and investment of foreign companies in India.

Fibre optic cable A communication cable containing one or more low-loss, highly transparent silica, glass, or plastic fibres used to transmit information in the form of light, that is, using electromagnetic signals in the visible or near visible region of the frequency spectrum. Also called optical-fibre cable.

Fortune 500 Company Refers to a listing of the 500 largest US corporations complied annually by *Fortune* magazine. The companies are ranked in terms of sales volume, assets, number of employees, and other factors, weighted and averaged to produce an overall ranking.

FTP (File Transfer Protocol) The original and most popular way of transferring files from one system to another on a TCP/IP network.

GDP (Gross Domestic Product) The total output of goods and services produced within a given country in a particular time period. GDP together with income from abroad, constitutes the GNP.

GNP (Gross National Product) The total value of the economic activity of a country in a given time period, including replacement for investment, valued at factor cost or market prices. It is also used as a crude measure of economic welfare.

GUI (Graphical User Interface) A type of computer interface consisting of a visual metaphor of a real world scene, often of a desktop. Within that scene are icons, representing actual objects, that the user can access and manipulate with a pointing device (often a mouse).

Host Any computer directly connected to the network. A host is not as a server.

IIT (Indian Institute of Technology) A set of very prestigious engineering institutes located in Bombay, Delhi, Madras, Kanpur, and Kharagpur

Internet A world-wide "network of networks" connecting more than 50,000 networks and over 60 million users. Common applications include electronic mail.

Intranet Internal system of companies that use Internet technology and standards. Companies are opening up their Intranet systems to their suppliers via secure lines.

ISDN (Integrated Services Digital Network) A 64-Kbps communications standard for transmitting voice, video, and data over a digital line. Very high bandwidth, high speed means of communication.

IT (Information Technology) Is a term commonly used to describe the combined utilisation of electronics, telecommunications, software and decentralised computer workstations, and the integration of information media (voice, text, data, and image).

LAN (Local Area Network) Connecting computers within a limited area so that users can exchange information, share peripherals and draw on the resources of a server.

Mainframe Computer A computer, usually in a computer centre, with extensive capabilities and resources to which other computers may be connected so that they can share facilities.

Market Share The proportion of the sales of an industry sold by a particular firm or a group of firm.

Medium and Large Units Industrial units that are neither SSI nor ancillary, and having investment of more than Rs. 6 million in plant and machinery.

Mini Computers A digital computer that is functionally intermediate between a microcomputer and a mainframe. It is an intermediate-size computer that can perform the same kinds of applications as a mainframe but has less storage capacity.

Modem (Modulator/Demodulator) A device that connects the computer to the phone line and allows the computer to transmit and receive data.

MPPS (Massively Parallel Processing Software) The concurrent or simultaneous execution of two or more processes in a single unit. A computer software that helps run many interconnected processors to access large (*or massive*) amount of data and to simultaneously process a large number of tasks.

MRTP (Monopolies and Restrictive Trade Practices) Act It regulated the activities of very large companies in India

Network An arrangement of nodes and connecting branches. A configuration of data processing devices and software connected for information interchange.

NIC (National Industrial Classification) A classification devised by the Annual Survey of Industries to group various industries under different digits. Similar to the Census SIC in the USA.

NVA (Net Value Added) It is the increment to the value of goods and services that is contributed by a firm and is obtained by deducting the value of total inputs and depreciation from the value of output. The contribution to total production made by an industry, a firm or a worker. In the case of a firm, it is calculated by subtracting from its sales its purchases from other firms

OEM (Original Equipment Manufacturer) A manufacturer of equipment that may be marketed by another manufacturer.

On-line This means that information stored in a computer system can be displayed, used, and modified in an interactive manner without any need to obtain hard copy

OOP (object-oriented programming) A method for structuring programmes as hierarchically organised classes describing the data and operations of objects that may interact with other objects. Object oriented language is a programming language that reflects the concepts of object-oriented programming.

OS (Operating System) Software that controls the execution of programmes and that may provide services such as resources allocation, scheduling, input/output control, and data management. Common examples of OS are Microsoft Windows 3.1, 3.11, or Windows 95, UNIX, and OS/2 of IBM.

PC (Personal Computer) A PC is a microcomputer primarily intended for stand-alone use by an individual. A desk top, floor-standing or portable microcomputer that usually consists of a system unit, a display monitor, a keyboard, one or more diskette drives, internal fixed-disk storage, an optional printer or modem. PCs are designed primarily to give independent computing power to a single user, and hence the name stand alone.

Platform The operating system environment in which a programme runs. In computer technology, the principles on which an operating system is based.

PPP (Purchasing Power Parity) The adjustment for research purposes of data on the money incomes of workers to reflect the actual power of a unit of local currency to buy goods and services in its country of issue, which may be more or less than what a unit of the same currency will buy of equivalent goods and services in foreign countries at current market exchange rates. PPP-adjusted incomes are useful for comparing the living standards of workers in different countries.

Real-time This term is used to describe systems operating in conversational mode and processes that can be influenced by human intervention while they are in progress. The "Next Train" display in the London Underground transport, which shows the time left for the next time to arrive, is a typical example of a real-time system.

Revenue The proceeds obtained by a firm during a given time period for the sale of its goods and services.

Rs. (Rupees) The Indian currency. One Rupee is further divided into 100 paise. In the second week of October 1997, one US $ was Rs. 36.21, and one £ was Rs. 58.75

Servers It is a host computer that distributes information on the network and stores data on behalf of the clients directly attached to it. It performs such services as resource allocation and sharing, file printing, and file downloading. Typical examples of servers are a file server, a print server, a mail server.

Source code The input to a compiler or assembler, written in a source language

SSI (Small Scale Industries) Industries in India with an investment of Rs. 6 million and below in plant and machinery. In case of any SSI, that exports at least 30 percent of its annual production, by the end of third year from the date of its commencing production, the limit for investment in plant and machinery shall be Rs. 7.5 million.

Super Computer Any of the class of computers that have the highest processing speeds available at a given time for solving scientific and engineering problems

TCP/IP (Transmission Control Protocol/ Internet Protocol) A collection of communications protocols that allow dissimilar PCs to "speak" to one another over a network. This is the main building block of the Internet.

Tiny Sector Units Industrial units in India, wherein investment in plant and machinery is Rs. 500,000 or below (irrespective of location of the unit).

UNIX An operating system, developed by Bell Laboratories that features multi-programming in a multi-user environment. The UNIX operating system was originally developed for use on minicomputers but has been adapted for mainframes and microcomputers. UNIX is a popular operating system among the world's scientific community.

Urban Agglomeration A term used in the Indian censuses, which is a continuous urban spread and normally consists of a town and its adjoining urban outgrowths.

Value added services Services that add value to a basic transmission service (in telecommunications industry).

VSNL (Videsh Sanchar Nigam Ltd.) An 85 percent state-owned corporation that provides international telecommunications services on an exclusive basis in India. As of 1997, it has the monopoly in providing Internet facilities in India.

WAN (Wide Area Network) A communications network that covers a wide geographic area, such as a company-wide network that stretches throughout the world.

Work Stations A functional unit at which a user works. A workstation often has some processing capability. Most often a work station is connected to a mainframe or to a network, at which a user can perform applications. A network is a configuration of data processing devices and software connected for information interchange. A group of nodes and the links interconnecting them.

World Wide Web (WWW or Web) The graphical part of the Internet. A system that allows a user to search for related "pages" across the Internet.

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S. Srinivas — October, 1997
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PART A CONCEPTUALISATION

- **Chapter 1: Introduction**
- **Chapter 2: Literature Review and Study Approach**
- **Chapter 3: Research Methodology**

1 INTRODUCTION

1.1 INTRODUCTION

The present research constitutes an analytical inquiry into the reasons for the success of Bangalore, the capital city of the state of Karnataka in India, in attracting a higher share of investment in the information technology[1] (IT) industry than any other city in India. By the mid-1990s, Bangalore had become home to the largest number of IT firms in India, which has led the journalistic literature both within and outside India to describe it as the "Silicon Valley of India". The city's comparative advantage in the IT industry in India emanates from various factors, of which favourable government policy, high quality work force, and the availability of research laboratories are some of its crucial determinants.

This research aims to understand the reasons for Bangalore's success in attracting both foreign and domestic IT industries (especially between the mid-1980s, when the Indian economy showed the initial signs of opening up, and the mid-1990s), and investigates the extent to which the city can continue to be the most preferred location for IT industry in the country.

[1] Information Technology (IT) is a term commonly used to describe the combined utilisation of electronics, telecommunications, software and decentralised computer workstations, and the integration of information media (voice, text, data, and image).

The crucial first step in any research process is to conceptualise an appropriate research design. As an introduction to the dissertation, this chapter provides an empirical background and the rationale of the present research as well as a description of the research design.

This chapter is organised under seven major sections. After the introduction, the second section aims at providing an overview and the context of the research as well as introducing the research problem. The relevance of this research to developing countries in general, and particularly the Indian context, is also discussed in the section. Following this, section three provides a brief understanding of the globalisation process, and the impact of the use of new technologies in urban economic development. Section four provides an overview of information technology's potential role in the economic development process in India. Section five outlines a background of urbanisation and urban development issues in India, which is followed by section six which describes the significance and theoretical contribution of the research. Finally the structure and organisation of the research are described in the seventh and concluding section of the chapter.

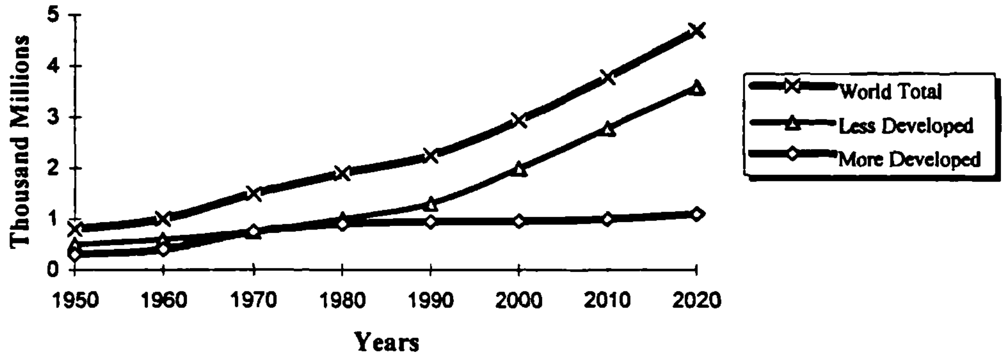
1.2 THE CONTEXT OF THE RESEARCH

Why is it important to understand the economic growth of urban areas or for that matter urban growth itself? An obvious answer is that the present day world has become an increasingly urbanised world. There is a plethora of information and data ranging from reports of various international organisations to national government documents to indicate that about 60 percent of the world's population will be living in urban areas (in whatever way these are defined) by the year 2025, and that most of this urban growth will be taking place in the less developed part[2] of the world[3] (Figs. 1.1 and 1.2).

[2] This term is used for the purposes of analytical convenience. It refers to those countries that are in the "low-income group" as defined by World Bank (1996). These are the countries with a GNP (Gross National Product) per capita of less than US $ 725 in 1994. The terms "developing countries" "less developed economies", and "low income countries" have been used interchangeably in the text with the term "less developed part of the world".

[3] For a thorough discussion on the global trends of urban growth see UNCHS 1996, Chapters 1 & 2

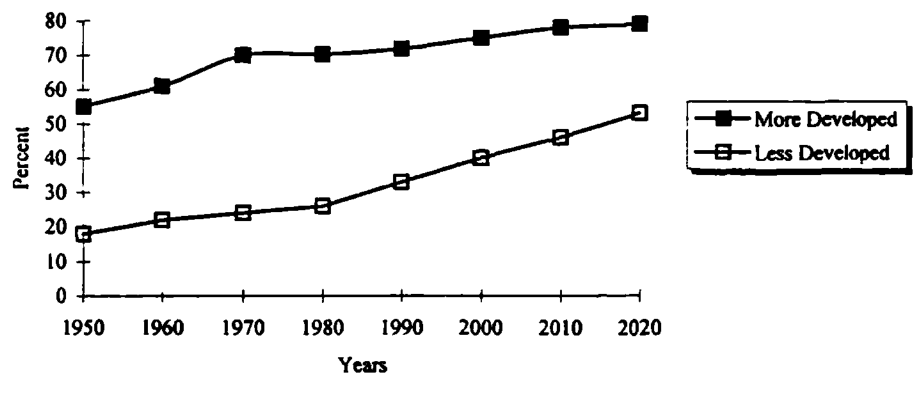
Fig. 1.1 World: Projected population living in urban areas



Devas & Rakodi (1993:2)

Between 1950 and 1990 world's urban population more than trebled, from 730 million to 2.3 billion (Fig. 1.1). Between 1990 and 2020 it is likely to double again, to over 4.6 billion. A staggering 93 percent of this increase will occur in the developing world. That means more than 2.2 billion people will be added to the already burgeoning cities of the developing countries-an increase of 160 percent. In the mid 1990s, around 43 percent of the world's population lived in urban areas. In the developed world, that proportion was around 73 percent; in the less developed world it was around 34 percent (Fig. 1.2).

Fig. 1.2 World : Proportion of population expected to be living in urban areas



Devas & Rakodi (1993:2)

The effects of urban population growth can perhaps be seen most dramatically by looking at the growth of the largest cities in Asia. In 1950, of the 30 most populated cities in the world, six were in Asia, and their average size was 5 million each. In 1990, of the 30 largest cities in the world, 16 were in Asia, and their average size was 10 million. It is expected that by 2010, 19 of the world's 30 largest cities would be found in Asia, with an average population of 15.5 million[4].

Some authors suggest that countries like India still have 'a low level of urbanisation, where since 1951 the percent of the population urbanised has increased from 17.6 percent to only 23.7 in 30 years' (Henderson, 1988:25). Even by 1991, only less than a third of India's population was living in urban areas. It may then be asked, in a country where the level of urbanisation is relatively low and which in no way can claim either high rates of urban population growth or a high index of primacy[5], why the study of urban areas assumes importance?

However, at over 250 million, the urban population of India is roughly the size of the entire US population. Moreover, almost half of the entire urban population of the country lives in a total of 93 urban areas with over 300,000 inhabitants. Out of these, over two-thirds are concentrated in just 23 metropolitan (or "million-plus") cities, whose number, even by a conservative estimate will be over 40 by the beginning of the next millennium (Mathur, 1993; GoI, 1992-b; GoI, 1988).

It is not the sheer size of urban population alone that is important. Equally important is the fact that cities are increasingly becoming the most important dynamic centres of modern production (Harris, 1996:3).

[4] Harris, Nigel: 'Patterns of Asian Urbanisation', Keynote address, 5th Asian Urbanisation Conference, August 26-30 1997, London; and UNCHS (1996).

[5] The "law of primate city" is an empirical regularity in the relationship between the population size of the largest city in a country to the next largest city or cities. A term introduced by Mark Jefferson in 1939, which he attributed to the largest city's pre-eminence in the country's economic, social, and political affairs. He noted that the ratio of population of the three largest cities in a country approximated the sequence 100: 30: 20 (i.e. the third largest is one fifth the size of the largest). The sequence that he identified is now largely ignored, but the concepts of *primacy* and a primate city are still widely referred to. Examples of primate cities from Asia include Metro Manila (in Philippines), Bangkok (in Thailand) and Kabul (in Afghanistan).

This, combined with the increasing role of foreign capital, has important effects in accelerating the technical upgrading of city output and the volume of flows through financial centres in both the developing and the developed world. Where local authorities recognise the importance of foreign capital, it can also force competitive upgrading of infrastructure (to attract investment) and competitive debureaucratisation: 'Some Indian states (Andhra Pradesh, Karnataka, West Bengal) are already competing strongly for foreign investment, and the larger cities are likely to follow suit, as in China' (*op. cit.* p.7). A recent study of metropolitan regions in Europe, notes 'fundamental developments such as globalisation, informationalism, and European integration has lead to increased competitiveness and interaction among metropolitan regions in search for mobile investment and trade' (Berg, et al., 1997:329). They further add 'next to the "traditional" factors, locational factors, and quality of life factors that determine the quality of business environment, the ability of the metropolitan region to anticipate, respond and to cope with internal and external changes is increasingly getting attention' (*ibid.*). Thus cities and regions both in the developing and the developed world are constantly trying to compete with one another for investments.

Some areas of manufacturing (especially heavy industry and certain sectors like textiles and garments) have almost deserted many of the older industrialised countries and regions in favour of newly industrialising parts of the world where new and efficient technology can be allied to lower labour costs. Therefore, these emerging countries and regions must climb a steep learning curve very rapidly in terms of technological and organisational competence, so they are 'able to compete even in sophisticated production formerly believed to be a monopoly of the advanced economies' (Hall, 1996:16). Hall further probes whether a similar pattern would emerge in the case of services as well, and writes 'some processes, such as software production, are migrating to sophisticated enclaves within low income countries (such as Bangalore, in India), while routine clerical processes (airline ticket processing, dictation of letters) are being undertaken in places that combine literacy and low wages' (*ibid.*).

The constant flow of investment into the so called "emerging markets" has been assessed by a recent World Bank report (quoted in Financial Times September, 1997) which states that, at present trends, these developing nations are likely to double their share of global output over the next 25 years. Led by the "big five" nations showing the greatest development, these include three countries from Asia: China, India and Indonesia (the other two are Brazil and Russia)[6].

Cities in both developed and developing countries find themselves facing a new degree of exposure to external social and economic forces. Strong pressures are coming both from the impact of world-wide new technologies and from related international policy developments. 'The relevant technologies have to do with transport and communications, and the policy developments have to do with the reduction of barriers between nations in the traded flow of goods and services and in the varying flows of finance capital' (Townroe, 1996:13).

For Asia's largest cities, it is perhaps worth drawing distinctions between those where urban dynamics are strongly linked to the globalisation of the world economy and those that are much more linked to political and economic functions of the nation-state. For instance, the size of Delhi and its rapid growth are far more linked to its role as capital of India than to its concentration of enterprises with roles within an increasingly globalised economy. By contrast, urban dynamics in Singapore, Hong Kong, *Bombay, and recently Bangalore* are much more shaped by their role within the regional and global economic system than as political and administrative centres. Most of the other cities in Asia come between these two extremes (UNCHS. 1996:83).

The structural adjustment policies adopted by many of the governments around the world, will according to many authors have a profound effect on urban settlements (Harris & Fabricius, 1996; UNCHS, 1996). Cities 'are the most dynamic centres of modern production, and it is understandable that the changes in the national relationship to the world economy as a result of structural adjustment could have the most radical effects on the urban economy' (Harris, 1996:3). Some even argue that 'irrespective of the economic outcome, the regime of structural adjustment being

[6] "Asian Infrastructure " A *Survey*, Financial Times, September 23, 1997

adopted in most developing countries is likely to spur urbanisation' (Mabogunje, 1991:192)[7]. However, in case of India where the importance of structural adjustment policies is largely getting recognised and with successive governments (irrespective of their political ideologies) committing themselves to greater liberalisation of the economy, there is a 'widespread speculation in the country on the likely effects of new economic policies on the pace and pattern or urbanisation' (Mathur, 1993:50).

The new economic policies aimed at stepping up economic growth, improving market efficiency and competitiveness, and integrating the Indian economy with global markets have already placed a heavy demand on all types of urban infrastructure (GoI, 1997-b). The resulting bottlenecks, according the Government of India's annual *Economic Survey* (*ibid.*), are beginning to pose serious impediments to enhancing productivity.

The Indian economy has been projected[8] to accelerate its growth from the current 6 to 6.2 percent (in 1997) to 7.5 percent by 2000-01 and 8.5 percent by 2005-06. Such growth rates would require a rise in the investment rate from the current 25 percent of GDP(in 1997) to about 31.5 percent in 2005-06. Based on these projections, the *India Infrastructure Report* states that the total infrastructure investment requirements are about Rs. 4,000 to 4,500 billion (US $ 115-130 billion) between 1997 and 2001, which would rise to about Rs. 7,500 billion (US $ 215 billion) between 2001-06 (GoI, 1997-a). A large part of this investment will have to flow to the urban areas to finance various infrastructure projects in these.

[7] Mabogunje claims that if structural adjustment actually succeeds in turning around economic performance, the enhanced gross domestic product is bound to attract more migrants to the cities; if it fails, the deepening misery-especially in rural areas-is certain to push more migrants to the city. In either case, therefore, these countries, according to him, face the daunting challenge of confronting urban growth as decisively as possible.

[8] These are based on the GoI's *India Infrastructure Report* released in the first quarter of 1997 (also known as the Rakesh Mohan Report). The exhaustive three volume report examines in some detail all the issues pertaining to infrastructure provision and economic development, and policy reform that can help in greater commercialisation of infrastructure along with the promotion of public-private partnerships.

Therefore the study of urban areas in India assumes great significance in that context. In 1950-51, the contribution of the urban sector to India's gross domestic product (GDP) was estimated at only 29 percent, which increased to 47 percent in 1980-81 and is likely to rise to 60 percent by the year 2000 (GoI, 1992-b:344). On account of different forms of scale, agglomeration and specialisation economies, the levels of labour productivity are uniformly higher in the urban areas (Mathur, 1993). Hence the study of the economic base of Indian cities (especially the large ones) is of enormous importance in understanding the economic development of India as a whole.

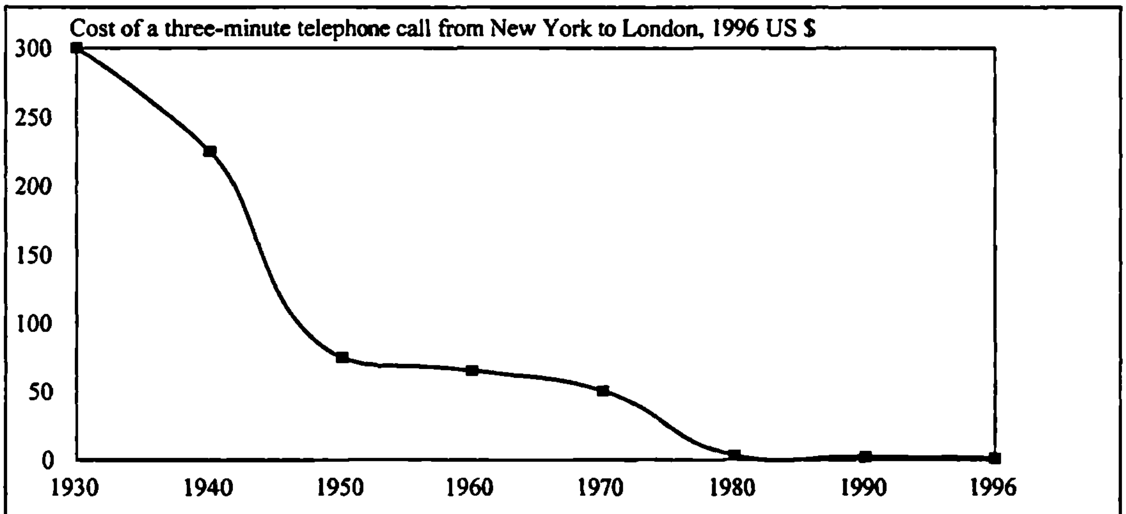
1.3 GLOBALISATION, NEW TECHNOLOGY AND URBAN ECONOMIC DEVELOPMENT

The structural changes within the world economy have helped to reorder the relative importance of cities around the world and, for many cities, to reshape their physical form and the spatial distribution of enterprises and residents within them. Therefore, according to the *Global Report on Human Settlements* (UNCHS 1996), individual regions and cities have proved more flexible than entire nations in adapting to changing economic conditions-and certain key regions and cities have become successful locales of the new wave of innovation and investment- for instance the Orange County in California (often dubbed "Silicon Valley"), Arizona, Texas and Colorado in western United States, Bavaria in Germany, the French Midi-from Sophia-Antipolis via Montpellier to Toulouse, certain cities in the southern Europe, and many cities in south east Asia and China (UNCHS, 1996; Castells & Hall, 1994).

The world is in the midst of what is often termed an "Information Revolution", in which advances in computers and telecommunications technology have transformed the way that many people work, shop, learn, and communicate, and increasingly where they live and work. These technological changes according to some authors (Castells, 1989; The Economist, 1995; UNCHS, 1996 and The Economist, 1997-b), have also changed the way that many goods are made, many services provided and most companies or corporations are organised. These changes are not only driving the increased flows of goods and capital, they are also affecting settlement patterns all around the world-and the scale of their influence is likely to increase.

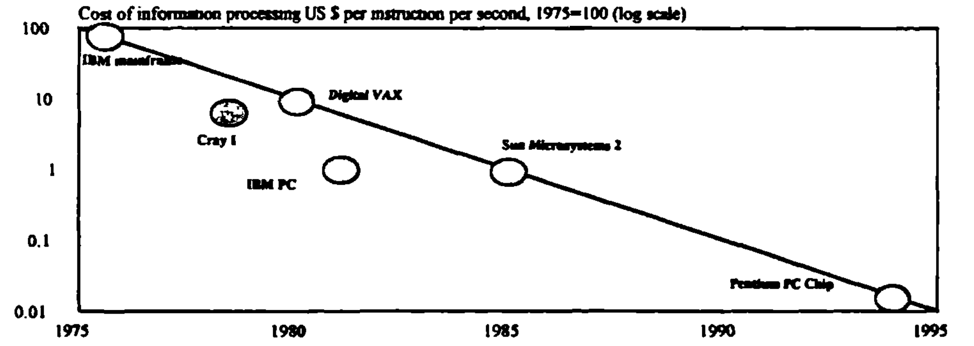
According to a recent study by *The Economist* (October 18, 1997), one of the crucial driving forces that have led to an increased flow of goods and money is technology. With the cost of communication and computing falling rapidly, 'the natural barriers of time and space that separate national markets have been falling too' (The Economist, 1997-d:134). As evident from Figure 1.3, the cost of a three-minute telephone call between New York and London has fallen from US$ 300 (in 1996 US dollars) in 1930 to US$ 1 in 1996. Similarly, the cost of computer processing power has been falling by an average of 30 percent a year in the real terms over the past couple of decades (Fig. 1.4).

Fig. 1.3 The falling cost of telephone calls



The Economist, 1997-d:134

Fig. 1.4 The falling cost of information processing



The Economist, 1997-d: 134

The growing economic importance of what is often termed the "information economy" has meant increased competition between cities for jobs and investments associated with it. The information economy is very large, if taken to include all economic activities and employment primarily associated with the production, processing and distribution of information. This definition also includes teachers and lecturers and the media, and the administrative and managerial staff of private firms and the public sector, as well as those who produce information and those who build and run information infrastructure (Castells, 1989; UNCHS, 1996). In this broad definition, the information economy has long been central to most city economies as for centuries, most large cities have concentrated government bureaucracies, legal services, the headquarters of merchant organisations and banks, schools, and universities. What is new is the much increased economic value of the information and the extent to which many of those working within the information economy need not be in the largest, wealthiest cities.

A crucial aspect is that of a more integrated world economy and important role of information there. Cities and regions are changing under the impact of new technologies. The technological innovation in microelectronics and telecommunications has significantly increased the speed of accessibility to information. According to Castells, these technologies interact with the spatial structure of economic activities in three fundamental ways: (1) The new informationational logic of production and management creates a new space for production, the development of which fundamentally reshapes the regional structure and the dynamics of each city, according to the functional importance of their social, economic, and institutional characteristics of the new production system. (2) The direct impact of new technologies (particularly the communication technologies) on the ways of working and living tends to modify the urban form. (3) Yet the effects of high technology are mediated by broader social and economic processes that frame its uses (Castells, 1985:12).

Perhaps the most direct impact of high technology on the spatial structure of urban areas concerns the emergence of a new space of production as a result of two processes. One, high technology activities have become the engine of new economic growth for many regions and play a major role in the rise and decline of some regions and metropolitan areas. Secondly, the introduction of new technologies in all kinds of economic activities allows the transformation of their locational behaviour, overcoming the need for spatial contiguity. The impact of the current technological revolution is being felt in economic space, and since economic factors fundamentally affect the spatial structure of activities, Castells argues that 'it is mainly through the new economy that high technology is deeply modifying our cities and regions' (*op. cit.* p.19).

When it comes to competition for attracting international capital and high technology production, nations, regions and cities which have good quality telecommunications infrastructure are clearly at a great advantage compared to those that do not. Countries with a well-educated work force that are also able to use computers are also at an advantage, although to attract highly specialised information processing business from the wealthier countries also implies that this work force must speak the language of the wealthier countries, where the information is consumed. Thus 'it is no coincidence that most of the examples of countries in the South (*less developed countries*) which have attracted information-processing jobs from the North (*industrially advanced countries*) are the countries in which English is the first language or a language widely spoken among middle and upper-income groups' (UNCHS, 1996:283).

However the actual form of the rearrangement of economic activities within nations and internationally remains unclear. 'Contrary to early, simplistic expectations that telecommunications would "eliminate space", rendering geography meaningless through the effortless conquest of distance, such systems in fact produce new rounds of unevenness, forming new geographies that are imposed upon the relics of the past' (Barney, 1995:375). But the underlying trend will be that the cost of transport is unlikely to fall (and will probably rise), while the cost of communications is likely to continue falling- implying a tendency towards spatial diffusion[9].

[9] This has been well argued by *The Economist*, in its survey of telecommunications in 1995 and 1997 (The Economist, 1995; The Economist, 1997-b).

Two critical questions for city authorities are first, what do these advances imply for the economy of their city and what steps can they take to promote the diffusion of this technology which can foster economic growth and prosperity of the city. And secondly what do they imply for the spatial distribution of people and economic activities within their jurisdiction. Far-sighted policies on telecommunications can considerably improve the performance of many productive sectors and this strengthens a city's economy. Conversely, excessively high investments based on unrealistic assumptions about the potential of a city's economy to attract new enterprises can prove to be expensive and ineffective as well (UNCHS, *op. cit.*).

Before highlighting some salient features of the urban development issues in India, a brief understanding of the potential role of information technology in economic development is offered in the following.

1.4 INFORMATION TECHNOLOGY AND ECONOMIC DEVELOPMENT IN INDIA

Just possessing cheap labour and raw materials does not make a country competitive any longer. Information, flexibility, product quality, and a capacity for fast response are the key new factors that can offer competitive leverage to a country. According to Hanna, information technology (IT) plays a crucial role in this. And that is why 'policy makers in industrial countries, and in an increasing number of developing countries view IT as a critical infrastructure for competing in an information-intensive global economy' (Hanna, 1994: xi). He further adds, 'these views-of information technology as infrastructure and as core capability for development-resonate with India's aspirations to modernise its infrastructure, transform its industry, and join the global economy' (*ibid.*).

India presents a major case study of the importance of IT to developing countries, the need for national IT strategies, and the adaptation of IT diffusion programmes of advanced economies to the conditions of industrialising countries. India faces pervasive forms of (what Hanna describes as) "information poverty", its infrastructure and financial services are in need of substantial modernisation, and 'its potential for exporting labour intensive software and information services is very promising' (*ibid.*).

India could also become a major supplier of IT applications that address the common needs of developing countries. Already India has developed innovative applications in railway reservations, weather forecasting, agricultural extension, land records registration (in the state of Madhya Pradesh), irrigation control, agricultural extension, medical diagnosis, geographic information, and various expert systems. It is also one of those few developing countries, that has an advanced space research programme.

At the micro level, Madon notes that to aid district planning, the National Informatics Centre is placing microcomputers (that are linked to a network called DISNIC) in 439 districts to support the district planning process (Madon, 1994:1-2). Efforts are also being made to promote the decentralisation of rural development, notably through a project called CRISP (Computerised Rural Information Systems Project) 'based on the experience of a pilot project which was designed to support one District Rural Development Agency (DRDA) in Karwar district of Karnataka' (*op. cit.* p.43).

Another plus point for India is having one of the largest scientific and technical cadres in the world, and Hanna states 'Indians have a world-wide reputation for mathematics and computer programming, and this cadre is critical in the diffusion and customisation of software across many institutional and industrial settings' (Hanna, 1994: xii). Given the strong mathematical and scientific background of Indian IT professionals, IT industry in India, particularly the software segment has an impact far beyond the sector. Hanna continues:

> ' (*IT*) has been a source of dynamism and technological innovation. It has provided demonstration effects for other industries, in terms of export-orientation, strategic alliances and foreign investment. Along with its critical mass of software suppliers, India has an enormous pool of potential users. Well established capital goods, consumer electronics and pharmaceutical industries, large transport and distribution networks, and a growing financial system constitute a substantial source of potential demand for software (*ibid.*).

The experience of most successful industrial countries suggests that government can influence the use of IT through its role as an investor and consumer, and as a catalyst, strategist or regulator (Wellenius, 1993). Countries have also targeted the electronics hardware promotion as a strategic industry, although there is a growing recognition that 'software is now the fastest and most profitable segment of the IT industry, and thus a clear shift of support towards software services and diffusion capabilities' (Hanna, 1994:3). Moreover, within the overall set of technologies that make up IT, software is vital since other aspects of a given (information) system cannot function without it. 'Software has also been forming a growing component of overall value within IT and is increasingly assuming a pivotal role in a vast and highly diversified range of products and services' (Heeks, 1996:23). Software also constitutes the fastest growing segment of the IT market. 'The software sector is targeted by hardware suppliers and specialised firms alike'(Correa, 1996:171). Thus the study of the software industry becomes an important aspect in understanding the growth and development of the IT industry. Section B of this dissertation, provides a detailed analysis of the software industry both at the global level, and more specifically to India[10].

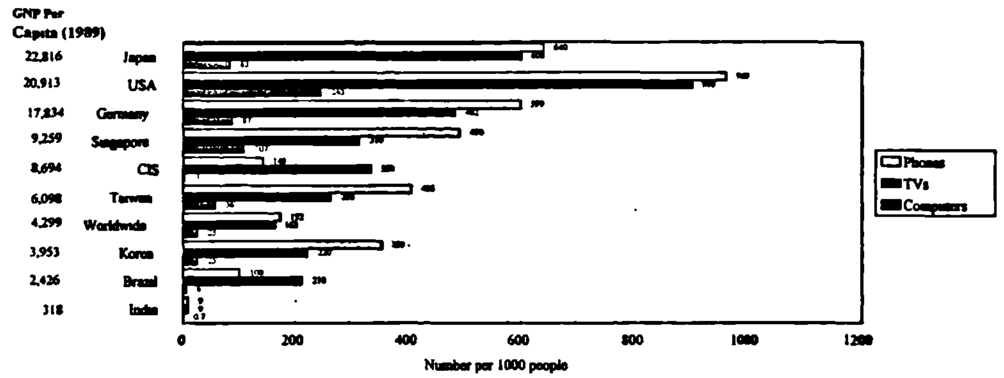
Telecommunications is another key element of the informatics sector. It is driven by advances in software and microelectronics, and in turn, it enhances the benefits and helps diffuse information and information systems. India has an extremely low availability of telecommunications services, less than what most competing countries had in 1987 (0.45 telephone per 100 inhabitant for India in 1987[11], compared with 0.59 for Thailand, 1.76 for Malaysia, and 3.32 for Mexico in 1977). 'In addition to the high (and unmet) demand for plain "old" telephone services, there is a growing demand for many specialised and intelligent services to enable companies (and government agencies) to transfer data. Vital data communication services are impeded by the high cost of leased circuits, restrictive regulations, and poor quality local access circuits'(Hanna, 1994: 26).

[10] Chapter four examines the development of world software industry, and Chapter five that of software industry in India.

[11] As of March, 1997, India had a telephone density of 1.3 lines for every 100 citizens. There are only 12 million installed lines in India, yet it is the 14th biggest telephone network in the world. The Government aims to rise the total telephone lines to 31 million by 2001, and to 64 million by 2006. *Cellphone* (or mobile phone) demand is also seen rising to 2 million by 2001, and 5 million by 2006 (Compare this with the number of mobile users in China to go up to 20 million by 2000) (Financial Times, Review of the Telecommunications Industry, March 19, 1997). The *India Infrastructure Report* estimates that even if the telecommunications network in India is able to grow at the current rate of 20 %, for the next four years (*from 1997*), then by 2001, it would rank among the six largest network in the world.

Fig. 1.5 illustrates the diffusion of IT in a range of countries, including India. It suggests that access to computers and telephones in India are far below worldwide average, and far behind other newly industrialising economies (NIEs) such as Brazil and Taiwan. Although the figure seems to indicates that IT diffusion is related to the level of economic development, it also suggests that the NIEs have diffused IT well ahead of others and thus used IT as a leading growth generating factor. In contrast, the low access to IT may have deprived India from exploiting its technically educated workforce to become a serious competitor in the international software market (*op. cit.* p.14).

Fig. 1.5 Information Technology: Performance and potential



Source: Hanna, N (1994: 14)

Recent industrial, trade and financial policy changes have liberalised what was one of the most closed and regulated economies in the world. However to sustain the reforms, India will have to address the key issues of infrastructure and capability constraints. Informatics is one such constraint and therefore IT needs to be viewed as an infrastructure that can facilitate not only the economic growth in the country, but also enable it to capture a larger share of the global business in the rapidly increasing information related services.

1.5 URBANISATION AND URBAN DEVELOPMENT IN INDIA

As stated earlier in the chapter, although India does not seem to have a high level of urbanisation, it is the sheer mass of the urban population that is important to note. Before proceeding to discuss urbanisation in India, the concepts employed to define urban areas in India are briefly discussed.

1.5.1 DEFINITION OF AN URBAN AREA IN INDIA

The Indian census has at least since 1961 adopted a fairly consistent definition of an urban area. According to the census of India, a place will be designated as urban if it meets either of the criteria: it has one of several urban forms of local government or it has certain characteristics. Thus the definition of an urban area in the Indian census is:

a) a place with a municipal corporation, municipal area committee, town committee, notified area committee and cantonment board;
b) All other places which satisfy the following criteria:
   i) a minimum population of 5,000 inhabitants;
   ii) at least 75 percent of the male working population engaged in non-agricultural and allied activities; and
   iii) density of population of at least 400 persons per square kilometre or not less than 1000 persons per square mile.
c) All places having pronounced urban characteristics according to the superintendent of state (GoI, 1993-c).

The condition (c) has sometimes been shown as clause (iv) of condition (b). Places which satisfy condition (a) are known as *statutory towns* and those that meet criterion (b) are referred to as *census towns* or *non-municipal towns*. When describing urban places, the Indian censuses have employed the following classes of population size as given below:

Class I	100,000 and above
Class II	50,000 to 99,999
Class III	20,000 to 49,999
Class IV	10,000 to 19,999
Class V	5,000 to 9,999
Class VI	less than 5,000

Increasingly the term metropolitan city is also gaining acceptance in India to describe urban areas that have a population of one million and above.

1.5.2 A BRIEF OVERVIEW OF URBANISATION IN INDIA

The earliest urban settlements in India date back at least five thousand years ago, when the Indus Valley civilisation flourished along with many of the earliest settlements in the world. During the British colonial period of two hundred years, emphasis was laid more on the development of port cities, and thus emerged three big port cities, Bombay, Calcutta and Madras. Immediately after the country's independence in 1947, and the resulting partition, the country saw a mass migration of the people in the north and eastern part of India, unprecedented in its history. The post independent era witnessed the most rapid growth of not only the urban population, but also the number of urban areas. The country's annual urban growth in 1951-61 period was 1.8 percent which increased to 2 percent in the following decade. In the period 1971-81, urban population increased annually at the rate of over 2.3 percent, and during 1981-91, this was at 2.5 percent. In terms of percentage, it may not appear to be too high a figure, but in terms of actual numbers, it represented an increase from 41.4 million in 1951 to 217.2 million in 1991.

It is estimated that the country's total urban population was just over 260 million in 1994 (World Bank, 1996). The states of Gujarat, Goa, Karnataka, Maharashtra, Mizoram and Tamil Nadu were the most urbanised states in the country, where more than 30 percent of the population lived in urban areas. Estimates are that the total urban population of the country by the year 2001 will be around 350 million (GoI, 1988). This implies an absolute increase in the urban population of over 130 million in ten years from 1991 (or almost double the total population of the entire United Kingdom).

As table 1.1 suggests an important feature of India's urbanisation has been the dominance of the metropolitan cities (urban areas with a population of 1,000,000 persons and above). As per the 1991 population census, there were 23 metropolitan cities in India. Together they constitute a population of 70.6 million, or one-third of the country's urban population. It is estimated that the number of metropolitan areas in the country would go up to 40 by 2001 (GoI, 1988). Thus there will be high concentration of India's urban population in these cities, and hence their future development, including the social and economic dimensions of their growth and the supply of infrastructure are among the challenges faced by urban managers in India.

Table 1.1 India: The largest urban agglomerations: population size and growth rate, 1975-2015

	Estimates and Projections (*Thousands*)									Annual Growth Rate (%)			
City	1975	1980	1985	1990	1995	2000	2005	2010	2015	1975-85	1985-95	1995-2005	2005-2015
Agra	681	739	831	940	1063	1196	1360	1564	1803	1.99	2.46	2.46	2.82
Ahmedabad	2050	2484	2849	3242	3688	4158	4713	5372	6124	3.29	2.58	2.45	2.62
Allahabad	568	640	733	843	968	1103	1265	1459	1685	2.55	2.78	2.68	2.87
Bangalore	2111	2812	3384	4009	4749	5527	6379	7311	8324	4.72	3.39	2.95	2.66
Baroda	571	722	887	1086	1329	1591	1877	2185	2519	4.4	4.04	3.45	2.94
Bhopal	488	646	819	1032	1299	1591	1903	2228	2571	5.18	4.61	3.82	3.01
Bombay	6856	8067	9898	12223	15093	18121	21208	24273	27373	3.67	4.22	3.4	2.55
Calcutta	7888	9030	9882	10741	11673	12660	13960	15639	17621	2.25	1.67	1.79	2.33
Coimbatore	810	907	1008	1120	1244	1379	1553	1778	2046	2.19	2.1	2.22	2.76
Delhi	4426	5559	6756	8171	9882	11678	13561	15513	17553	4.23	3.8	3.16	2.58
Dhanbad	526	658	735	807	887	974	1094	1252	1445	3.35	1.88	2.1	2.78
Hyderabad	2086	2487	3186	4126	5343	6678	8037	9354	10663	4.24	5.17	4.08	2.83
Indore	663	808	939	1083	1250	1428	1639	1888	2175	3.48	2.86	2.71	2.83
Jabalpur	621	740	811	878	950	1032	1150	1313	1514	2.67	1.58	1.91	2.75
Jaipur	778	984	1207	1475	1801	2153	2533	2941	3382	4.39	4	3.41	2.89
Jamshedpur	538	653	737	822	918	1022	1157	1328	1533	3.15	2.2	2.31	2.81
Kanpur	1420	1612	1829	2076	2356	2654	3011	3443	3941	2.53	2.53	2.45	2.69
Kochi (Cochin)	532	666	855	1102	1420	1773	2143	2518	2905	4.74	5.07	4.12	3.04
Kozhikode	412	528	645	781	646	1124	1321	1540	1780	4.48	3.83	3.34	2.98
Lucknow	892	993	1245	1590	2029	2512	3017	3529	4057	3.33	4.88	3.97	2.96
Ludhiana	479	590	758	978	1263	1579	1912	2249	2598	4.59	5.11	4.15	3.07
Madras	3609	4203	4725	5283	5906	6561	7357	8329	9451	2.69	2.23	2.2	2.5
Madurai	790	893	984	1080	1186	1302	1459	1667	1919	2.2	1.87	2.07	2.74
Meerut	432	523	654	822	1032	1263	1511	1771	2048	4.15	4.56	3.81	3.04
Nagpur	1075	1273	1447	1635	1847	2073	2350	2689	3085	2.97	2.44	2.41	2.72
Patna	643	881	993	1086	1187	1299	1453	1659	1910	4.35	1.78	2.02	2.73
Pune	1345	1642	1995	2422	2940	3493	4089	4725	5407	3.94	3.88	3.3	2.79
Snnagar (J&K)	494	592	709	850	1018	1200	1403	1631	1884	3.61	3.62	3.21	2.95
Surat	642	877	1138	1467	1890	2357	2845	3335	3837	5.72	5.07	4.09	2.99
Trivandrum	454	512	636	801	1009	1237	1482	1739	2011	3.37	4.62	3.84	3.05
Varanasi	682	783	890	1009	1145	1292	1471	1691	1949	2.66	2.52	2.51	2.81
Vijayawada	419	527	658	821	1024	1246	1486	1740	2012	4.51	4.12	3.72	3.03
Visakhapatnam	452	583	769	1014	1338	1703	2083	2459	2840	5.3	5.55	4.43	3.1

Source: UNCHS (1996:452)
Note: Cities in bold had a population of more than one million as per 1991 Census

1.6 SIGNIFICANCE OF THIS RESEARCH

In the last few years since the economic liberalisation and structural adjustment of the Indian economy began, there have been very few research studies on their impact on

Indian cities[12]. One view could be that perhaps, it is too early to comment on the impact. However it needs to be noted that the economic liberalisation has a wide political mandate in the country. While this research does not purport to study the impact of economic liberalisation on a city (Bangalore), it nevertheless does provide an understanding of urban development issues confronting a city that is undergoing rapid change not only as a result of economic liberalisation, but equally important due to the rapid changes taking place in the information technology and telecommunications sectors-which, as this research has found are sensitive to policies concerning foreign investment, trade liberalisation, and other macro-economic and infrastructure supply policies. The study is about one aspect of urban development in Bangalore. It seeks to examine the economic dimension of urban development in Bangalore.

It was noted in section 1.2 that the large absolute size and unprecedented growth of many urban centres in Asia poses one of the biggest challenges to national and local policy makers. The thrust on the urban development policies in these cities until the late 1980s tried to provide, to the extent resources allowed, the minimum basic services to the fast expanding populations in these urban centres. It is, however, now being realised that given the macro economic changes that many of the countries especially in South Asia (including India) are undergoing, one needs to focus attention towards understanding the resulting changes in urban employment that is occurring in many of the cities in this region. Thus some of the recent studies in Asia have called for an 'integration of urban employment planning and especially, the crucial linkages of employment generation with urban planning at the metropolitan level' (Ajmal, 1990:124). Ajmal also argues that such an integration is essential as some of the major constraints to urban employment expansion are the lack of infrastructure and other facilities available to those sectors of the urban economy which provide bulk of the employment, or those *that bring maximum revenues*. Therefore, understanding the new sources of employment generation in these urban areas becomes crucial in this context. This research seeks to provide an

[12] The Bombay Symposium on Structural Adjustment and the City (see Harris & Fabricius, 1996) was one of earliest to discuss the impact of structural adjustment on cities. While the symposium discussed many cities in both developed and the developing world, as regards India, there was a discussion on Bombay.

understanding of how a particular city in a low income country has been able to attract investment into the information technology industry and provide world class information services - something which has been a forte of cities in the rich and middle income countries only. Thus it analyses the reasons for the success of the city of Bangalore in attracting a higher share of investment than any other city in the country into the information technology sector. That, it is hoped, will form a distinct contribution to the knowledge of the body of literature on urban economics and urban development. It needs to be noted that for the primary research, this study examines the "opinion" of 52 IT firms in Bangalore, exclusively selected for the research. Therefore any inference drawn, generalisations made, and conclusions arrived at will necessarily bear that in mind.

1.7 STRUCTURE OF THE DISSERTATION

The dissertation is comprised of eleven chapters organised in four sections: Part A focuses on the conceptual aspects of the study; Part B discusses the structure of the information technology industry; Part C provides an understanding of Bangalore's competitiveness in information technology industry in India; and Part D discusses the conclusions emerging from the study. Following this chapter, the second chapter discusses the literature review and presents the approach to the current research, where the key theoretical formulations governing it and the hypotheses at the core of the study are provided. Chapter three discusses the methodology adopted including the sequence of tasks performed in carrying out this research. Chapter four discusses the geography of the software industry in the world, which is followed by a detailed analysis of the software industry's growth and characteristics in India in chapter five. Chapter six provides a detailed analysis of the geographical distribution of the IT industry in India. Chapter seven provides an analytical account of Bangalore's growth as an important centre for high technology production in India. Chapters eight to ten are based on the primary survey of IT firms in Bangalore. These three chapters provide an appreciation of Bangalore's competitiveness in the IT industry in India. Chapter eight provides the analysis of results from the surveyed domestic firms, and chapter nine the analysis of the non-domestic firms. Chapter ten presents a comparative analysis between the domestic and non-domestic firms. Finally, chapter eleven discusses the conclusions that emerge from the present research.

2 LITERATURE REVIEW AND RESEARCH APPROACH

2.1 INTRODUCTION

The purpose of this chapter is to present the conceptual framework that governs this research. It seeks to provide (a) an understanding of the global shift that has been taking place over the last two decades in the location of economic activity generally and in specific economic sectors such as the electronics and information services. This has been largely aided by the process of globalisation and by rapid innovations in the field of telecommunications. In an effort to understand this process, the chapter examines why certain urban locations attract more activities or industries of a certain type compared to other locations. This suggests that there must be something "competitive" about a particular urban location that it attracts a higher number of activities in one sector than another urban location. This leads to the issue of urban competitiveness and to ask the question: (b) What is urban competitiveness, and why is it relevant in the study of urban development? And finally, the chapter also seeks to address the question: (c) Aided by the modern innovations that allow capital and technology in the technology-related industries to move quickly from one location to another, what potential role do these new (high) technology firms play in helping to shape urban development?

The three issues are examined through an extensive review of the literature available in English. A large number of published and unpublished items including articles, research papers, case studies, country reports, government and private consultancy reports, dissertations and so forth are reviewed and discussed.

Most of the research work on high technology industry including the ones on IT industry have been primarily been carried out in North America, Western Europe and in Japan. However, in recent years some studies from Southeast Asia and Latin America shows that high technology industries, especially information services related industries are growing in the developing countries as well. While this literature review chapter may appear to have drawn examples mostly from Western Europe, North America, and Japan, it has also used cases from East and South East Asia. As the Indian economy is opening up for foreign investment, and is increasingly getting deregulated, the experience of other Asian countries, especially in the high technology sector and infrastructure provision would be of great relevance in this context.

2.2 GLOBALISATION AND THE LOCATIONAL SHIFT OF ECONOMIC ACTIVITIES

Economic activity is becoming not only *internationalised* but, more significantly, it is becoming increasingly *globalised.* These terms are often used interchangeably although they are not synonymous. "Internationalisation" refers simply to the increasing geographical spread of economic activities across national boundaries; and as such it is not a new phenomenon. "Globalisation" of economic activity is qualitatively different. It is a more advanced and complex form of internationalisation which implies a degree of functional integration between internationally dispersed economic activities (Dicken, 1992:1). This has been characterised by the intensification of economic linkages that transcend national boundaries, often reflecting strategic behaviour at the firm level. Business operations are conducted in an increasingly borderless environment, in which production, technology, and marketing are linked in globally integrated value-added chains (UNIDO, 1996:2).

The major changes taking place in the pattern of industrial development throughout the world have intensified the globalisation of production and especially of services. The liberalisation of trade, capital, services, and technology flows has facilitated the process of change, and led to increasing integration of production systems across national boundaries. With these developments has emerged a *new global division of labour*, or a change in the geographical pattern of specialisation at the global scale. Originally, as defined by the eighteenth century economist Adam Smith, the "division of labour" referred simply to the specialisation of workers in different parts of the production process. However, after the industrial revolution, the division of labour took on a geographical dimension. Thus at the global scale, according to Dicken, 'the broad division of labour was between the industrial countries on the one hand, producing manufactured goods, and the non-industrialised countries on the other, whose major international function was to supply raw materials and agricultural products to the industrial nations and to act as a market for some manufactured goods' (Dicken, 1992:4). Such geographical specialisation-structured around a *core* and a *periphery*-formed the underlying basis of much of the world's trade for many years.

The globalisation of manufacturing has been spurred by a number of interrelated factors, including: the changing character of international investment and changes in the forms of corporate activity, organisation and relationships; improvements in transport and communications which have reduced the economic distance between countries; technological advances in production and processing methods; and the adoption of market liberalisation and deregulation policies. The combination of these factors has made the global integration of production, technology and marketing an increasingly dominant feature of the world economy since the 1980s. These factors have also contributed to the locational shift of economic activities.

Industry has relocated in the past as well. A changing international division of labour is not a new phenomenon. What's new, however, is the volume of industrial production that has shifted from the industrialised countries to the newly industrialising countries and the growing integration and interdependence of the world economy. This development allows and encourages capital to move from one location to another (Liemt, 1992:4).

Fig. 2.1 The changing distribution of world manufacturing output by major economic group, 1953-85

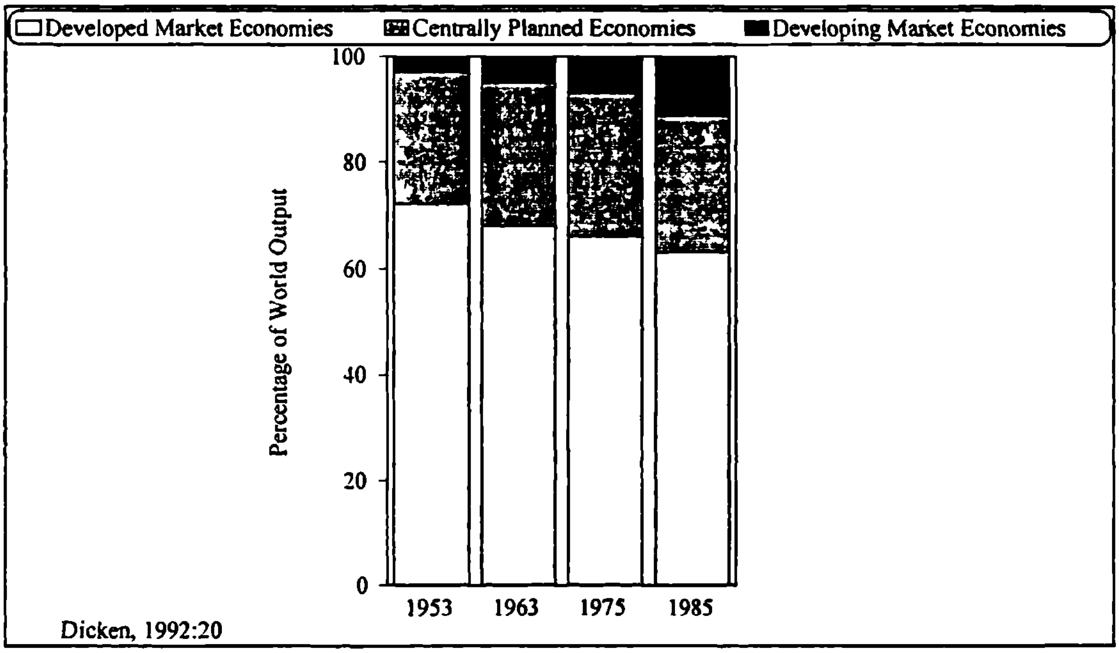


Table 2.1 The share of major regions in world production (1967-89) (percent; GDP at 1980 purchasing power parities)

Region	1967	1973	1980	1986	1989
United States	25.7	22.8	20.9	20.9	20.8
Western Europe	25.9	25.3	23.9	22.4	22.2
Japan	5.6	7.0	7.2	7.5	7.8
Developing Asia (including China)	11.0	11.8	13.8	17.4	19.3
Latin America	7.1	7.7	8.8	8.0	7.5
Africa (except South Africa)	3.1	3.2	3.4	3.2	3.0
Rest of the world[1]	21.7	22.1	22.2	20.5	19.4
	100.0	100.0	100.0	100.0	100.0

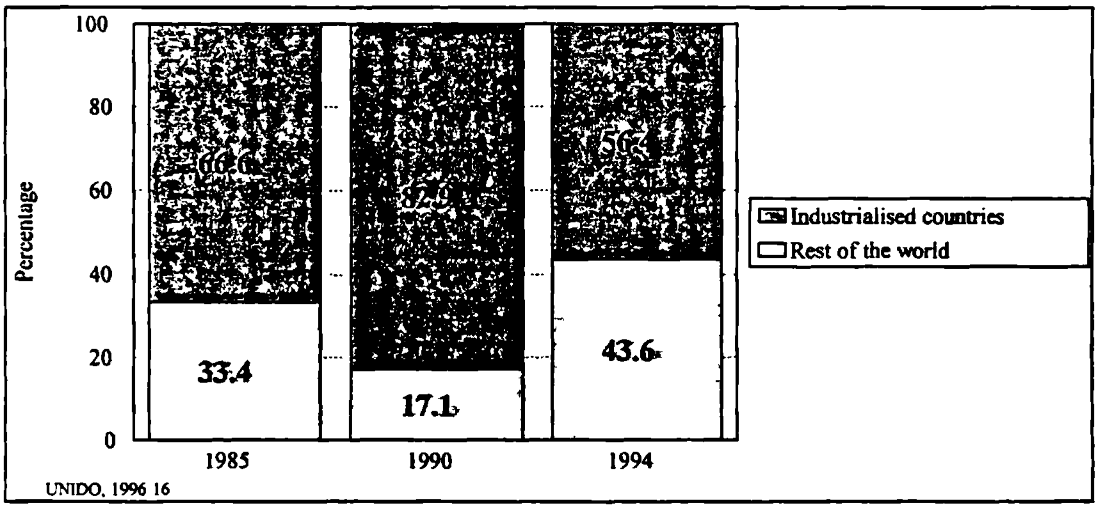
[1] includes Canada, Australia, New Zealand, South Africa; the Gulf States; Eastern Europe and the former Soviet Union

Source: Liemt, 1992:7

Grouping all the countries in the world into three major categories, viz., developed market economies, centrally planned economies, and developing market economies, Dicken states that broad changes have occurred in the relative importance of these three groups as manufacturing producers. Fig. 2.1 shows that between 1953 and 1985 the developed market economies' share of world manufacturing output declined from 72 percent to 64 percent, while that of the developing market economies more than doubled, albeit from a low base level, to 11.3 percent. The share of the centrally planned economies remained stable at around a quarter of the world total.

Such a view has been supported by Liemt also, who claims that there has been a significant shift in the distribution of world economic activities. According to him, the declining share of the United States and Western Europe contrasts with the increase of Japan and the Asian developing countries (Table 2.1). 'The surge of the Asian developing region in a little over 20 years is impressive compared to the other developing regions whose share hardly increased (if at all) as indeed compared to world at large' (Liemt, 1992:6).

Fig. 2.2 Industrialised countries: Shares of FDI inflows, 1985, 1990, 1994



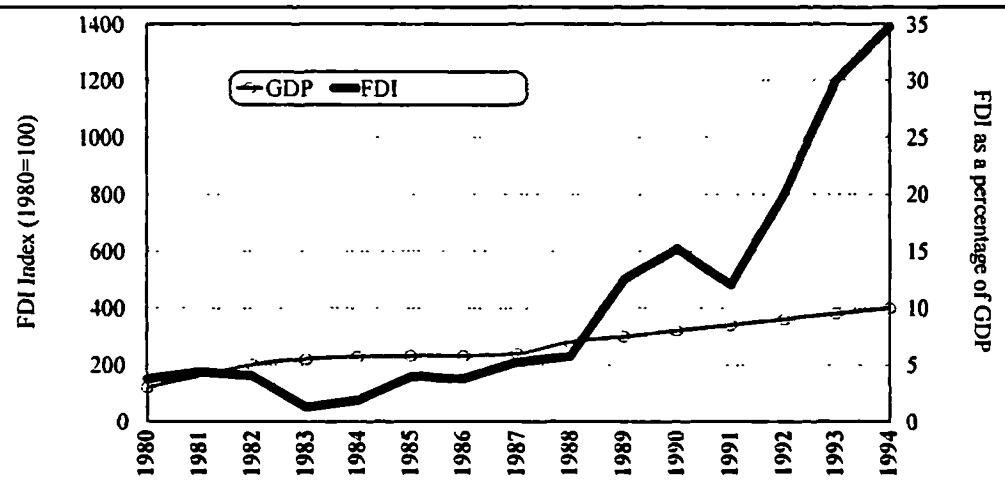
UNIDO states that although the share of world-wide inflows of foreign direct investment (FDI) was boosted by regional integration efforts in Europe and North America up to the late 1980s, however, after 1990 the share of FDI has substantially fallen in these industrialised countries, with a subsequent increase in the rest of the world in recent years (Fig. 2.2).

The domestic policy environment, notably persistent import substitution and strict regulation of FDI, have in the past made South Asia[13] less attractive for FDI than

[13] Constitutes India, Pakistan, Bangladesh, Sri Lanka, Nepal, Bhutan and Maldives

developing countries of South East Asia. More recently, major policy reforms have been followed by significant improvement in economic performance, and as a result this region has attracted a higher share of FDI than what was experienced in the past (Fig. 2.3). The growth in the inflow of FDI in South Asia is a manifestation of the structural changes taking place in the world economy, and the shift in the economic activities to developing countries. The figure also provides the importance of FDI in gross domestic product (GDP) of South Asia, which increased from under 5 percent of the GDP in 1980 to 35 percent of the GDP by 1994.

Fig. 2.3 South Asia: GDP growth and FDI inflows, 1980-1994



UNIDO, 1996:28

Note: *Calculations were based on US $. Investment rate denotes gross fixed capital formation as a percentage of GDP*

Thus, FDI[14] is essential to the establishment or rebuilding of competitive market structures by developing countries and the economies in transition (from a command to a market economy). It provides much-needed managerial skills, know-how, new technologies and, most importantly, market access. It can therefore be an important catalyst for sustained economic growth (UNIDO, 1996). In a study of inter-city competition for FDI, Head and Ries (1996) note that foreign firms in China prefer cities where other foreign firms are already located. Their study was conducted using a sample of 931 cases of foreign investment in 54 Chinese cities. According to them,

[14] There is whole body of literature that discusses the issue of FDI and economic development, and it is beyond the scope of the present research to get into the intricacies of that issue. In recent years a number of studies have explored the issue of FDI, and its impact on the host country's economy. For some of the most recent and interesting works see WTO (1996); Blomström, M; Kokko, A (1997)-a; Blomström, M; Kokko, A (1997)-b; and UNCTAD (1996) (especially pages 75-105). Rayome & Baker (1995) provide a good review and analysis of literature on FDI.

China's "open door" policy (of economic liberalisation) has created a natural experiment for studying agglomeration externalities and the role of incentives designed to attract foreign direct investment. Their study proved that 'agglomeration economies, fundamentals (infrastructure, labour market conditions), and government incentive policies attracts foreign direct investment' *into certain Chinese cities* (Head & Ries, 1996:39). They then put forward a model of self-reinforcing FDI in Chinese cities and state: 'Cities favoured under the "open door policy" were able to attract foreign investment which raised the probability of their receiving subsequent investment by increasing agglomeration' (*ibid.*).

Although the presence of certain basic infrastructure may be significant in attracting the initial interest of potential new investors, success in winning inward investment projects depends increasingly upon the ability of public authorities to produce spaces which are customised to the changing needs of key firms. Using the case of Nissan Motors in northeast England, Peck (1996) demonstrates how inward investment projects can be levered into a region by means of a variety of incentives including promises of rapid infrastructure modifications. Peck's study illustrates how an investor can subsequently engage directly in the production of its own customised space through control exercised over regional authorities.

The mobility of capital from one part of the world to another has also been aided by continuing improvements in global telecommunications[15] and transport, and due to easing of restrictions on international capital flows (compared to what was experienced before). Thus, new investments can be and are located where they are considered most profitable. Combined with that, technologies have also become more internationally mobile than in the past. Innovations are able to move more quickly into production both at the place of innovation and elsewhere, without any considerable delay. And since that means any capable entrepreneur or firm can produce a product almost at any congenial location, this has intensified international competition which encourages companies to adopt quickly the best production practices, including those related to production location. Competition in many industries has internationalised, not only in manufacturing but increasingly in

[15] The Economist, 1995; The Economist, 1997-b

services. Firms compete with truly global strategies involving selling world-wide, sourcing components and materials world-wide, and locating activities in many nations to take advantage of various factors. Thus, globalisation of industries 'decouples the firm from the factor endowment of a single nation' (Porter, 1990:14). Although better communications facilitate improved information about job opportunities, and *virtually* transport workers (by locating the product of their work hundreds or thousands of miles away), yet on the whole many studies claim that workers are at a considerable disadvantage in terms of mobility, compared to capital[16].

Movement of capital (in the form of location of firms) can take many forms. One instance is where a particular plant is closed in one location, and opens at another location. Firms may also relocate for a lack of expansion in the original site. They may want to move to promising markets, which may have lower labour costs. Their move may also be motivated by discoveries of natural resources, and innovative environment. Liemt (1992) claims that once such firms move in, others follow the firm to which they are a major subcontractor. Firms dependent on good communications or attracted by easy access to high quality, affordable telecommunications may move to such locations. They may also move because of lower taxes, and cheaper sites. Due to increasing demand for skilled workers and high quality educational and training infrastructure to ensure a steady supply of them in the future, firms may also move to locations that offer these. 'In most cases, a combination of factors would seem to operate for such a movement of capital' (*op. cit.* p.6).

[16] This has been well argued by Harris (1995) in his book *The New Untouchables*, where he demonstrates that industrially advanced countries have put restrictions on the movement of the workers through immigration controls. However, despite these controls by the industrially advanced countries, he claims that increasing number of workers (whether legally or illegally) are moving between countries. Arguing that increased migration is inevitable in an integrating world economy, he states that few of the fears about immigration are justified, and that increased immigration tends to mean that jobs and incomes expand. Harris further lays stress on the fact that governments will have to ensure the freedom of people to come and go as they choose. Such a point has also been raised by World Bank in its annual *World Development Report* (1995), which states that increased integration between countries, including migration, can benefit workers in poor and rich countries at the same time. Both Harris and the World Bank claim that migrants are often productive-and reduce labour costs-in the host country, and they send remittances to relatives back home, boosting incomes in the home countries.

Viewed at the regional or local (*or urban area*) level, such relocation can bring profound shifts in activity and employment. Thus Liemt states that ideally, the causes and consequences of relocation should therefore be considered from the regional and local (*or urban area*) perspective in addition to the national, company or industry perspectives.

New technologies have also led to the introduction of flexible production systems in the context of mass customisation, a new form of industrial organisation which provides for large scale production while at the same time meeting consumer demand for quality and diversity. Mass customisation is further characterised by the use of flexible machinery, often applying microelectronics based technologies, and by production in small customised batches in response to specific customer requirements.

This kind of flexibility among firms has been researched under the "flexible specialisation" model (Piore & Sabel, 1984). Piore and Sabel argued that industrial economies were dominated by fordist mass production, and are falling behind countries like Japan and Italy, which were adopting more flexible production methods, and taking advantage of new technologies and more co-operative forms of social organisation. Flexible specialisation, according to Holmström, is 'both a matter of economic advantage-the best way to meet consumer demand in fragmented, rapidly changing markets-and political choice' (Holmström, 1994:7).

The emergence of more flexible approaches to production, combined with the escalating costs of research and development (R&D) and shorter product life cycles, has forced firms to search for wider markets and to combine their competitive advantage with those of other firms in strategic alliances and inter-firm networks. Concentration by firms on exploiting their core competencies- that is, their main line of business expertise- has required the forging of new relationships with partners in the private and public sector. The corporate system of affiliates contributes to the competitiveness of a firm in two ways. First, it provides each affiliate with access to competitiveness-enhancing resources-capital, R&D capacity and technological, organisational and managerial skills. Secondly, it provides access to new and larger markets. The conclusion of alliances with other firms enables companies to acquire new product core process technologies, to share the costs, to spread the risks of high capital outlays, particularly for R&D, and to gain access to new distribution channels and markets (UNIDO, 1996:3).

The imperatives of competitiveness have also led many firms to reduce the emphasis on their own value added to final products, and to concentrate on their core competencies. They have contracted out, or "outsourced", non-core value added activities- such as the production of components and the provision of services. This has led to new and innovative subcontracting possibilities with the small and medium industries in developing countries and economies in transition, a process which UNIDO claims should result in a further extension of global manufacturing networks. 'The requirements of production in small customised batches- particularly the flexible input and delivery schedules- and the new emphasis on quality, reliability and zero defects have made it necessary for firms to develop close relationships with their suppliers, both domestic and foreign' (UNIDO. 1996:4).

Indications are that outsourcing will continue to increase. According to Heeks, 'something like US $ 40 billion of IT work was outsourced by US-based organisations in 1995, with a growth rate of around 20 percent per year in the last five years' (Heeks, 1996:110). Unfortunately due to the absence of reliable data, it is impossible to state clearly which locations might have received these outsourcing jobs from the US (mentioned above). A possible explanation is that IT professionals and companies in countries like India, Brazil, and Mexico which have established themselves as location for competitive and reliable quality IT work (Schware, 1992), could be getting a substantial amount of the IT work that was outsourced.

2.2.1 WHY DOES AGGLOMERATION OF ECONOMIC ACTIVITIES TAKE PLACE?

The earliest attempts to explain the agglomeration of economic activities can be found in the classical theories propounded by von Thünen and Alfred Weber. According to von Thünen, activities are arranged in terms of concentric rings around a central urban market with land uses and land values being reduced outward from the centre (Rutherford, 1995). Weberian theory illustrates the idea that an optimal location for a firm can be derived, concentrating on the influence of distance and minimisation of transportation costs related to the location of markets and raw materials. Firms are assumed to be simple, producing a single product, serving only nearby markets. Raw materials appear as the only critical inputs; labour, information, and other inputs are ubiquitous, available everywhere (Johnston et al., 1994).

The location theory as applied to firms' choices of geographical location states that a firm chooses its location to maximise its expected profits. Location decisions thus involve a balancing of demand and cost considerations. For example, steel making involves bringing together large quantities of iron ore, limestone, and coal. Since all these are bulky, and not necessarily found together, minimising the transport cost in the siting of steel mills becomes very important.

The basic rationale for geographic concentration, therefore, relies on the interaction of increasing returns, transportation costs, and demand. Given sufficiently strong economies of scale, each manufacturer wants to serve the national market from a single location. To minimise transportation costs, the firm chooses a location with large local demand. But local demand will be large precisely where the majority of manufacturers choose to locate. 'Thus there is a circularity that tends to keep a manufacturing belt in existence once it is established' (Krugman, 1991:14).

When compared to the body of theory on the location of manufacturing, non-production activities of firms are less well supported by theoretical ideas, despite the fact that 'non-manufacturing facilities comprise one-third of all new corporate facilities' (Malecki, 1994:219). According to Malecki, the location theory literature framework of cost minimisation is also very effective for examining the location of non-routine activities, such as research and development (R&D), company headquarters, and producer services as many of the influences on location resemble traditional efforts at cost-especially transportation cost-minimisation, despite arguments about the footloose nature of such activities (*op. cit.* p. 219).

However, explaining the clustering or the concentration of high-technology[17] industries like IT (which is the focus of the current research) purely on the basis of cost and demand considerations is not easy. Most of the high technology products do not tend to be bulky, and have a high-value to weight ratio. This means transportation costs are unlikely to be decisive in obtaining access to either materials or markets. Therefore, Satterthwaite raises the point of whether location theory should be abandoned in the case of high-growth and high-technology manufacturing due to its failure to explain the agglomeration that is the 'outstanding feature of the geography of most of these industries' (Satterthwaite, 1992:41). However, according to him, there are at least two main reasons why location theory should not be abandoned in explaining the growth of high technology industries.

First, when it comes to straight manufacturing of already designed products, high-tech firms do act like traditional manufacturers in making their locational decisions. Immigration restrictions to importing inexpensive labour from Taiwan and Hong Kong directly into the Unites States for use in manufacturing, and the relative insignificance of transport costs for moving high-tech products great distances have led the American firms to take the production process to the sources of labour. Therefore, Satterthwaite states 'that the placing of manufacturing facilities offshore has occurred to a substantial degree in high-tech industries demonstrates that the firms involved have the same sensitivity to location specific costs that traditional manufacturers have long demonstrated'(*ibid.*).

Second, for high-tech firms, the design of new products and services and the improvement of existing offerings are as necessary for continued success as is the low cost manufacturing or production of an existing service or product. If the costs of recruitment, for whatever reason, are different in two metropolitan areas, then the

[17] A basic obstacle relates to the very diversity of "high technology". Everyone knows what it is, but no two definitions are alike. The common understanding of the term encompasses a range from state-of-art basic research through the production activities of the chemical and electronics sectors. Thus, it is fair to say that a high degree of heterogeneity is implied by the popularly recognised label of high technology. 'A single definition is difficult, both because of multifaceted perceptions and expectations and because, in practice, available data prevent classification that can be meaningful at the level of the establishment as well as for entire industries'(Malecki, 1994:174). Two indicators are most commonly used to define high-tech industries. First, R&D intensity, or percentage of sales expended on R&D and second, technical workers (scientists, engineers, and, often technicians) as a percentage of the workforce.

area with the lower costs will give the firm located in it a cost advantage that may be quite important if the professionals in question are critical for the firm's success. Yet accounting reports are unlikely to reveal the difference in the two areas' costs because of the difficulty of accurately allocating professionals' time among activities. Thus, 'the reason location theory may not appear to explain the location decisions of high-tech firms may be due to poor data rather than to a failure of the theory *itself*'(*ibid.*).

But a fundamental question that needs to be asked here is: why did this geographical concentration become established in the first place, and what were the forces that led manufacturers to want to cluster together?

Such clustering has often been explained in the economic literature through the notion that, at the regional or metropolitan level, the growth of firms and the city's economic growth is fostered by the economies generated by spatial proximity, the so called *agglomeration economies*. This concept was originally introduced by Alfred Weber in 1907, and has been further refined by other regional economists like August Lösch and Edgar Hoover. Hoover classified agglomeration economies which were external to the firm into: *localisation economies*, which are industry-specific and result from the concentration of a particular industry in a certain place, and *urbanisation economies*, arising from the greater array of services and opportunities available in larger places.

Beeson suggests that there is a role for government to play in creating the agglomeration economies, especially if individual firms do not consider the effect of their production decisions on the productivity of other firms in the area. In this case, government policies designed to increase the level of production in an area, 'such as subsidies to new or existing firms, may be desirable-especially if some minimum level of production is required before increases in production generate productivity growth' (Beeson, 1992: 25).

She also argues that there is a set of institutions that tends to be concentrated in large cities that may contribute to productivity growth, namely, colleges and universities. 'One obvious way in which these academic institutions may contribute to the higher productivity growth in large cities is through their effect on the skill composition of the local labour force' (*op. cit.* p.30). She further adds that a highly educated and trained labour force may generate productivity growth by increasing the ability of firms to implement new technologies and increasing the average level of education, thereby increasing the rate of learning in an area.

She also notes that colleges and universities may also affect productivity by increasing the rate of innovation in the local area. She contends that large cities provide a natural environment for the development of technology and in this way affect productivity growth. Academic institutions may also serve as incubators for new technology. A number of studies provide evidence of links between basic research facilities, such as universities, and technological innovation in private industry (Nelson, cited in Beeson, 1992; Segal et al., 1985; Castells & Hall, 1994; Saxenian, 1996 etc.). This may be related to direct university-industry cooperation, or it may be related to benefits to private industry from technology spillovers (Beeson, 1992). The extent of these spillovers, according to Beeson depends on proximity of the research universities, which has also been corroborated by Saxenian in her study of Silicon Valley and Route 128 in Boston, USA (Saxenian, 1996). The impact of the universities on the urban economic development, especially in the context of high technology industries has been further discussed in section 2.4 of this chapter.

Commenting on the high-growth industries, Satterthwaite asks a question: 'Consider an industry that, for whatever reason, is exhibiting rapid employment growth nationally. Why does this growth tend to occur in some metropolitan areas and not in others, particularly when geography per se is not the dominant determinant of either demand or costs?' (Satterthwaite, 1992:39). According to him, localisation economies explain the lopsided growth across metropolitan areas. The idea is that presence within a metropolitan area of existing firms in the industry reduces costs both for new firms that locate nearby and for existing firms that decide to expand their operations. Therefore, he argues 'growth in employment within a fast-growing industry tends to occur where the industry already has a lot of employment' (*op. cit.* p.40). According to him, strong localisation economies reduce the costs of firms in the industry if they locate in proximity to other firms in the industry.

2.2.2 WHY DO CERTAIN LOCATIONS ATTRACT MORE ACTIVITIES OF A CERTAIN TYPE THAN OTHER LOCATIONS?

Writing on the locational decision of multilocational firms, Malecki states that selection is made, among other things, on the basis to secure the best "package" of incentives. According to him, incentives from government may include the provision of roads, tax incentives, power facilities, and cash, 'all of which were recently offered to, and accepted by, Texas Instruments in connection with a plant in Avezzano, Italy'(Malecki, 1994: 213). Texas Instruments received almost a similar "package", *including a severe simplification of various rules and regulations,* when it launched its fully owned software subsidiary in Bangalore, in 1985.

The focus in Weberian analysis (as discussed in section 2.2.1) on distance as the geographical variable on which location decisions are made greatly distorts the relative importance of manipulative inputs. In partial recognition that distance and transport cost have diminished in importance, Malecki states :

> the most frequent reaction has been the provision of lengthy lists of "locational factors", variables which influence the location decisions...the length and complexity of some lists of location factors have led to a composite variable, "business climate", which is a rough metric of a location's expected ability to maintain a productive environment over the foreseeable future (*ibid.*).

Ó Huallacháin states that often the reasons for similar industries or activities clustering together lie in the dependency on various services by many entrepreneurs. Depending on the needs of the industry, the firm would concentrate at a location, where it can maximise the use of the support services or facilities. 'Such associations are the cornerstones of *today's* metropolitan economies'(Ó Huallacháin, 1992:51). Apart from being dependent on various services and sharing such services, there are at least two ways by which firms in an industry can generate positive externalities for other firms in that industry:

1. High-tech firms that are growing quickly need to be able to recruit specialised, experienced, and skilled professionals who can meet specific requirements. Being part of a large, local intraindustry labour market makes this far easier. Identifying, evaluating, and hiring candidates can be done more quickly and less expensively locally than nationally. From the viewpoint of the candidate, changing employers locally is easier than changing to a new employer in a new city.

2. A firm located within a city that has many other firms in the same industry automatically has easy access to a wide spectrum of suppliers, distributors, and specialised business services. As a result, the growing firm does not have to do everything itself. It can contract with other firms to provide those services that it is not ready to produce in-house. Benería and Roldán (1987) who researched on sub-contracting in Mexico city state that, among the reasons given by firms for sub-contracting, the most prevalent one was the lowering of labour cost. In a study of small engineering firms in Bangalore, Holmström notes that 'the job work which small engineering firms in Bangalore do for large ones is sometimes specialisation sub-contracting, especially in the electronic industry, where some small entrepreneurs with few well-paid workers possess special skills, usually new skills' (Holmström. 1994:28). So when such specialised skills are available outside the firms, that contributes to increased sub-contracting jobs, which enables the firms in a region to evolve themselves into a network of firms.

The effect is that firms located within a city with a high concentration of firms in the same industry have higher productivity from critical professionals and lower costs overall than they would otherwise. Also, 'when a firm is surrounded by other firms, suppliers, and distributors all working in the same industry, its cost of searching for supplies, services, and personnel is reduced' (Satterthwaite, 1992:43). This is very true in the case of Bangalore, where immediately after 1991, when many of the global IT firms decided to move in, they found the ready pool of young professionals working in the already present domestic IT and electronics firms, and engineering graduates coming out of the various engineering colleges in the city as the best *hunting ground* for professionals.

Scott and Storper's (1988) study of regions with high-technology industries state that, these (regions) represent new forms of "flexible production complexes" comprising of tightly linked groups of small and medium-size manufacturing firms. This suggests that the high transaction costs and information intensive nature of high-tech activity requires companies to locate close to one another and co-operate as a production complex.

Once an industry becomes concentrated in a few cities, then the jobs-follow-people[18] phenomenon becomes important in two different ways. First, a firm making a deliberate geographical choice for a new facility is likely to recognise the benefits of the localisation economies that exist in a few cities and make one of those cities its choice. Second, even if a firm does not make a deliberate choice but happens to choose a city with substantial localisation economies, the firm is likely to benefit from the externalities and to be more successful, grow faster, and generate more jobs than it would otherwise (Satterthwaite, 1992:44).

It is also important to note that the attraction and retention of managerial and technical personnel are vital for white collar facilities. 'Locations that have a demonstrable supply of these workers will have an advantage; other locations must prove that the local quality of life factors are such that these workers can be readily attracted to the area' (Ady, cited in Malecki, 1994:220). Quoting a 1986 study by Ady, Malecki states that among the locational factors indicated by 3,000 research engineers in a 1982 survey in the US were: housing cost and availability, climate (warm, coastal, dry, mountain), quality of primary and secondary schools, recreational opportunities, job opportunities for spouse, community attitudes, cultural opportunities, and taxes and municipal services (not necessarily in that order).

However, survey findings such as these should not be taken to mean that worker preferences determine the location of R&D or of high technology firms generally. Rather, they exemplify that urban agglomerations that tend to offer these "facilities" would be a preferred choice than those which do not offer these. The critical point to note is that high technology professionals choose to live only in "distinct type of places", but what sort of places? 'The quality of life factor cited on most lists of location factors for high-tech industry largely represents urban commercial amenities'(Malecki, 1994:221).

An implication of this argument is that the root cause for one city becoming a centre for an industry while a second city languishes may be impossible to determine. The reason is that small, unmeasured differences between the cities when the industry

[18] It is a continuing controversy in regional economic development about whether jobs follow people or people follow jobs.

was in its infancy may have provided the successful city with its initial, and ultimately decisive, productivity advantage. As will be explained in later chapters, one of the crucial aspects of concentration of the high technology industries in Bangalore can be attributed to the locational decision taken by the Indian federal government to site the strategically important electronics and telecommunications industry in the city.

The concentration and agglomeration of certain type of industries have led some researchers to use the phrase "industrial district" (first used by Alfred Marshall, according to Holmström, 1994) to define such a phenomenon. Industrial districts are a particular type of agglomeration, characterised by 'small firms, but firms whose markets are national or international, in contrast to traditional artisan firms and dependent sub-contractors'(Malecki, 1994: 232).

Piore and Sabel (1984) while attempting to explain the success of networks of small and medium firms in certain regions find that in "industrial districts", these network of firms work closely together, sometimes even competing ones to produce a range of similar or complementary products. Holmström argues that, 'new technologies, new products and attitudes towards labour have revived and transformed the industrial district, allowing smaller firms to compete with and even overtake larger firms, filling niches in the market with high-quality goods, while providing high levels of employment at high wages' (Holmström, 1994:6).

The most studied contemporary examples of regional network-based systems, the small-firm industrial districts of the Third Italy[19], specialise in traditional industries

[19] The depiction of a closely knit web of firms, which mutually support one another is often called the NEC (north-east-central) model, after the region of Italy characterised by small and medium size firms, also known as the Third Italy (along the developed north and underdeveloped south). The emergence of this local production system in Emilia Romagna, the centre of Third Italy, has according to Malecki roots in sixteenth century silk production in Bologna. For centuries, according to him, an informal economy in the surrounding region relied on work by women in their homes. It was not until the 1950s, however, that 'employment shifted out of agriculture into manufacturing, mainly shoes, textiles, and machinery, produced by artisans and craftspeople' (Malecki, 1994:233). The informal nature of the economy and society keeps most linkages local, among all other small and medium size enterprises in the district. According to Holmström, Third Italy is characterised by sharing of knowledge, machinery, and trust among specialised innovative firms. He says that 'this part of Italy is relatively classless... and workers and employers are used to discussing questions of quality and innovation with one another' (Holmström, 1994:7). Interdependence arises from the intense specialisation of firms: 'the moment the firm begins to expand and move beyond its original specialty it finds itself dependent on the help of neighbours with complementary kinds of specialties; and because the neighbours can

such as shoes, textiles, leather goods, furniture, and ceramic tiles. Germany's Baden-Württemberg is known for its mix of small and medium sized-markets of machine tools, textile equipment, and automobile components alongside giant electronics corporations. Similar flexible industrial clusters have been identified in Denmark, Sweden, Spain, and in the US (Los Angeles) (Saxenian, 1996).

Of course not all economic activity clusters within a single regional economy. Firms in network systems serve global markets and collaborate with distance customers, suppliers, and competitors. Technology firms, in particular, are highly international. However, the most strategic relationships are often local because of the importance of timeliness and face to face communication for rapid product development. 'Paradoxically, the creation of regional clusters and the globalisation of production go hand in hand, as firms reinforce the dynamism of their own localities by linking them to similar regional clusters elsewhere'(Saxenian, *op. cit.* p.5). Writing on the success of Route 128 (in Boston, USA) and Silicon Valley (in California, USA) in recent decades, Saxenian states that there are important regional sources to the competitive advantage of these regions.

Commenting on the similar success of Japanese industry, Saxenian adds that the causal factors are similarly attributable, at least in part, to network organisational forms. The Japanese corporation, according to her, is more internally decentralised and more open to the surrounding economy than the traditional large American corporation. Producers of electronics, autos, and machine tools, for example, rely on extensive networks of small and medium-sized suppliers, to which they are linked through ties of trust and partial ownership. Although Japan's large firms historically exploited suppliers, many increasingly collaborate with them, encouraging them to expand their technological capabilities and organisational autonomy. 'Like their Silicon Valley counterparts, these producers tend to be geographically clustered and depend heavily on informal information exchange as well as more formal forms of co-operation'(*ibid.*).

never exactly anticipate when they too will need assistance, the help is forthcoming' (Sabel, quoted in Malecki, 1994: 234).

The locational concentration of high technology firms, according to Malecki, favours established regions (especially national capitals). Malecki cites the case of the south east in the UK, Paris in France, and Tokyo in Japan to prove the point that high-tech industries tend to concentrate around the national capitals. Why, then in the case of India, most of the multinational IT firms chose Bangalore, a peripheral city (in that context) to Delhi-the national capital or Bombay- the country's financial hub?

Commenting on the geographical concentration of R&D firms and high technology firms, Malecki also states that studies are available indicating choice of continents or countries, but 'less attention has been paid to the R&D *(and high technology firms)* location decision within individual countries'(Malecki, 1994:224). Firms may choose a particular country based on many macro-economic and technological aspects. but what then, drives them to a particular urban region or location?

This kind of spatial association and concentration of economic activities (and in some cases lack of attractiveness of regions) has been viewed within the framework of *territorial competition* for economic activities (for example, Cheshire and Gordon, 1995; Bramezza, 1996, etc.). A number of research studies in Western Europe and North America since the early 1990s have also studied the competition for economic activities between cities. They use the phrase urban competitiveness to explain the competition between different urban areas for one or number of economic activities. The study of urban competitiveness will also provide urban managers with an understanding of how to make their urban areas and regions more attractive to foreign as well as domestic investment. Thus this leads to the next theoretical element of the present research, that discusses urban competitiveness in detail.

2.3 URBAN COMPETITIVENESS

Why does a city become the base for successful international competitors in an industry? Why is a city often home to so many of an industry's world leaders? And why is a particular city able to create and sustain competitive advantage against other cities or regions in a particular industry? These questions often come to the minds of present day urban managers. It is necessary to understand what it is in a city that is most crucial in determining its ability, or inability, to create and sustain its competitive advantage in national or international terms. The influence of the city on the pursuit of competitive advantage in a particular field is of central importance to the level and rate of productivity growth, the creation of local employment, and improved levels of welfare for its inhabitants.

Porter (1990) suggests that nations gain competitive advantages in four ways. Two are concerned with the environment and refer to demand and supply conditions. The other two are concerned with the organisations located in the country. They comprise the strategies, structures and rivalries of firms, and their related or supporting industries. Porter also recognises two other variables affecting national competitive advantage: chance and government. However, he views their role as influences on the four determinants (the diamond), which he identifies in a system in which interaction between the determinants reinforces sustained competitive advantage or disadvantage, but may also lead industries eventually to lose their competitive advantage or disadvantage. Competitive advantage, therefore, according to Porter is created and sustained through a highly localised process. He further adds that the theoretical explanation should address why 'a region is home base for successful global competitors in a particular industry' (Porter, 1990:19).

Porter builds on a long history of economic ideas about the comparative advantage[20] of nations. However by laying emphasis on the smaller scale (sub-national units), he brings a new dimension to these ideas. For instance, Healey and Dunham mention that some of the macro-economic mechanisms available to nation-states to alter their competitiveness, such as exchange controls and interest rates, are not relevant to sub-national units (Healey & Dunham, 1994:1281). Factors of production, particularly labour and capital, are also generally more mobile within countries, than between them. Still, the smaller the spatial unit of examination, the more it relies on the activities and policies of external actors and agencies. In analysing the sub-national, and urban local areas, emphasis needs to be placed on the behaviour of individual firms and, on the function and organisation of the firms which are located in the area.

[20] Which he advocates as the competitive advantage of nations.

A particularly interesting part of Porter's examination of competition for spatial analysis is the importance that he places on the potential of the geographical concentration of industries to elevate and magnify the interactions within his "diamond". In applying Porter's analysis to localities, the four determinants he discusses may be envisaged as interacting to create a set of competitive advantages and disadvantages, which varies from place to place and changes over time in any particular locality.

2.3.1 UNDERSTANDING URBAN COMPETITIVENESS AND ITS RELEVANCE TO URBAN DEVELOPMENT

Studies[21] related to urban competitiveness or territorial competition have largely been conducted in Western Europe and North America, and as such there is no empirical evidence on urban competitiveness available from the developing countries. In industrially advanced and rich regions (of North America and Western Europe) the recent emphasis on studying urban competitiveness emanates from the importance associated to major urban areas as a result of territorial integration of markets (NAFTA and EU). In such a situation, urban areas have gained significance both as economic actors and are more aware of the greater burden on them to strategically plan for their economic futures.

The study of urban competitiveness in the developing part of the world has its own purpose. Whereas in the developed world, it assumes greater significance as a result of blurring of national boundaries, it becomes important in the developing world as a result of economic dominance of some of the large cities in these countries. Equally important is the large share of a country's urban population that live in these cities of the developing world. It was well established in Chapter one that in India, over two-thirds of the total urban population is concentrated in just 23 metropolitan (or million plus) cities. The economic liberalisation that is now taking place in many developing countries, not excluding India has increased the importance of the urban areas as recipients of foreign direct investment (FDI), and as a result, the study of urban competitiveness in the developing world has its own significance.

[21] Research has focused on different issues like territorial competition (Cheshire and Gordon, 1995), competitive advantage of inner cities (Porter, 1995), and urban competition (Singh and Kresl, 1994; Kresl, 1995; and Bramezza, 1996).

Contemporary literature on economic globalisation and cities focus on explaining why cities score high or low in the international or global urban hierarchy or in competitiveness. Usually the analysis according to Moulaert and Shachar is performed in two steps (1995:206). First, the features of globalisation process are spelled out. In the second step, urban dynamics can be related to the globalisation processes. But there should be a third step, which is sometimes neglected, and which shows how the territoriality of cities and city systems interact with globalisation process.

The relationship between globalisation processes and urban dynamics derives from the observation that institutions and corporations, which induce globalisation processes, are highly concentrated in small number of cities and urban regions, that, in turn relate quite strongly to cities on lower levels of the urban hierarchy with a more limited scope of their economic, social and political functions.

Thus. in this context, the economic and social trajectory of each city will increasingly be affected by its level of integration into the global economy. Cities are becoming more and more involved in the co-ordination of processes and managerial activities. The economic base and the social order of several major cities are shaped by the emerging organisation of the financial sector. According to Moulaert and Shachar, cities will occupy different positions in the international urban hierarchy in accordance with the extent to which they are functionally and spatially involved with the most innovative and most globalising economic activities, and to the degree in which they hold significant control, co-ordination and management functions in these activities (Moulaert & Shachar 1995:207).

This analysis provides a theoretical underpinning for the establishment of the links between the levels in the urban hierarchy and the functional specialisation and integration of cities. But 'in order to understand how cities compete with each other, and relate (in the larger context) to the globalisation dynamics, more research is required' (*ibid.*). Hence it is necessary to include the interaction between the territoriality of the cities, i.e. the way cities' society in these cities and its different spheres are organised, and their insertion in the global inter-urban division of labour. Today urban areas are being challenged on the existing activities that they have been hitherto engaged. Urban areas also have immense opportunities to grow into new areas as a result of the new global economic order. Thus the study of urban competition assumes great significance.

According to Cox (1995:217), the notion that prevails is not explicit but a particular logic of competition (*which is*) entailed by the easy locational substitutability so central to prevailing theories of the politics of local economic development. It is a logic of competitive adjustment to (a succession of) exogenously given conditions which provide new, cost minimising, advantages. Interpreting this view in the context of urban competition, it would mean switching from one location to another as and when depending upon factors which would include, availability of skilled and cheap labour, favourable local government policies, land and infrastructure. Thus competition can be viewed as a constantly changing landscape. It is clear that an urban area cannot for ever offer competitive location for certain types of industries or economic activities. What needs to be understood is *how* a city can hold on to its competitive position, and *how* it can do it for the maximum possible time, without emptying its coffers.

Competition in the context of urban areas is not very easy to understand. Cities are more complex entities than firms, and cannot always be easily divided into strong and weak competitors. The same urban location may emerge in both forms. The coexistence of locationally enduring corporate headquarters, R&D and skilled production locations along with more mobile back offices and assembly work bear testimony to this. The "strong" or "weak" distinction itself needs to be handled with care.

Often, the reason why cities should compete with each other is not clear because competition is mostly associated with contention between rivals. The Latin language suggests a different interpretation: the word derives from *cum petere*, which means searching together. Thus the Latin meaning quite vividly expresses the logic of competition. Due to increased interdependencies and the growing complexity of the urban areas, Bramezza states that competing is better conceived of as searching together the best solution to specific problems, 'in a strategic way, at the right time and in the right place' (Bramezza, 1996:21).

Consequently, cities are competitive if they are able to cope with the negative consequences of economic success, such as exploding land prices, traffic congestion, environmental degradation and social exclusion. Thus 'a balance between the global dimension (the ability to exploit and profit from local resources and diversity) must be struck' (*op. cit.* p.22). Therefore, the search for urban competitiveness should ultimately aim at sustaining and enhancing the welfare of the actors that are already operating and living within the city's boundaries and others that are likely to be attracted to the city by its success.

Implicitly, urban competitiveness operates in different spatial scales: local, regional, supra- and intra-regional scales. There is competition among large cities, among smaller cities and between large and small cities, depending on the target, for instance to attract residents, visitors, specific sectors, head offices of international firms, and manufacturing sites.

Each city, more or less, specialises in one or more functions (Henderson, 1988; Porter, 1995). This could be in trade, financial business, tourism, or manufacturing. Such a specialisation develops when goods or services related to it are an important part of the urban economy and its products are consumed not only by local actors, for instance the inhabitants, but also external actors. These specialisation have been defined as "urban functions" (for e.g. Berg et al., 1995; Benoit, 1995). For some of these authors, the concept of 'urban function expresses the need for a more integral strategy referring to the city as incubator and performer of urban functions an approach that guarantees the integrality of the overall urban development better' (Bramezza, 1996: 22). Some of the locational factors in a city are skilled labour force, and an efficient transport and communication infrastructure. Thus the cumulative effect of the locational factors present in a city determines the city's potential to become an attractive location for specific sectors of economic activity.

Locational factors can be grouped in two categories: basic and bon-basic factors. Basic factors may be viewed as a necessary but not a sufficient condition for a city's competitiveness. They are the primary condition a city has to meet if it is to be competitive. Basic locational factors include: an efficient infrastructure system, an adequate supply of strategic urban services[22], a living and business environment of high quality and efficient and adequate urban management. Non basic factors largely include all other factors that relate to the type of urban function. Thus some authors argue that urban competitiveness cannot be created without the above mentioned basic locational factors (Cheshire & Gordon, 1995; Berg et al, 1995, Bramezza, 1996: Benoit, 1995).

Singh and Kresl use a number of elements to work out the competitive ranking of forty US cities. Their study focused on three indicators of urban competitiveness. According to them, each of these variables 'captures an important aspect of the performance of a city's economy' (Singh: Kresl, 1994:429). The variables chosen by Singh and Kresl and their role in indicating competitiveness are as follows:

- *The growth of retail sales.* Relatively rapid growth of retail sales will be a function of growth of the city's population, of rising income of its inhabitants and of the degree to which it is an attractive location for non-inhabitants to come to for shopping, recreation, cultural events and dining. Each of these components will be indicative of competitiveness.
- *The growth of manufacturing value added.* Relatively rapid growth of value added in manufacturing will be reflective of investments in plant and equipment, in human capital and in infrastructure. It will give an indication of the overall competitiveness of the city's manufacturing sector.
- *The growth of business services.* While services as a category include several items, such as amusement, auto repair, and personal services, which have little or nothing to do with economic competitiveness, business services are essential to any expansion of economic activity and of any transformation of economic activity (*ibid.*).

Similar to the point made by Singh and Kresl, regarding the role of services, Senn argues that the role of service activities in territorial or urban competition may be seen in terms of a cumulative growth process which is at its strongest in large cities (Senn, 1995:122). He further adds that it is the role of the services that has enhanced

[22] Strategic urban services are those which create a comparative advantage that are not shared by many other cities, such as advanced telecommunications, transport facilities, and appealing tourist attractions.

the competitive position of Milan within the European hierarchy of cities vying for investment.

Thus, it can be stated that the specific mix of locational factors determines the city's attractiveness for specific sectors. The relation between those sectors determines the type of urban function potentially supplied by that city.

'The concept of urban function is essential for urban competitiveness because urban functions are indeed the object of competition between cities' (Bramezza, 1996:25). In an increasingly globalised national economies, most of the larger cities seek to perform specific urban functions: they aim at becoming financial centres or logistic nodes, or centres of research, and so on. Thus cities vie with one another for new urban functions and to strengthen those already existing but not yet fully exploited.

2.3.2 WHAT IS URBAN COMPETITIVENESS?

In the previous section of the chapter it was demonstrated that the strength of urban function is closely related to the presence and quality of locational factors for investment and employment. Therefore, the competitiveness of cities in terms of functions is directly linked to the existence of locational factors that are relevant to those functions. Thus, a city where locational factors are available for the fulfillment of a specific function, and more so than in other cities, is likely to be more competitive than other cities in performing that particular function at a certain point of time. Thus urban competition is essentially a dynamic process, and the 'level of competitiveness of a region is always liable to change, both because of the development of new locational potentials in other regions and because of the changing needs of established companies in the region' (Berg, et al., 1995:61).

Cheshire and Gordon define urban competition as a 'locally based efforts to promote the development of a locality in competition with other localities' (Cheshire & Gordon, 1995: ix). According to them these take many forms - place marketing, assisting local businesses, constructing infrastructure designed to make the area more locationally attractive, or simply information provision and networking- and serve a range of goals, but its distinctive characteristic is that it originates from local interests. Thus urban competition seeks to influence the spatial distribution of economic activities from the bottom-up rather than from the top-down and perceives the urban area, the economic performance of which is the object of the policy, as in competition with other cities, regions and localities. There are, however, conceptual difficulties in understanding urban competition as 'it involves both collective actors, including local public bodies and private firms/households, and individual firms looking for a location or seeking to improve their competitive position' (Benoit, 1995:222)

Thus based on the studies mentioned above, for the purpose of the present research, urban competitiveness can be defined as the capacity of an urban area to attract and sustain a particular economic activity or a set of economic activities in a given point of time. As suggested by Humphrey and Schmitz, competitiveness, therefore, has to be necessarily viewed as a dynamic process. 'Being competitive is not a state, it is a process of remaining competitive through improvement. The objective of policy intervention at the micro (*or the city*) level should be to develop the capability of groups of firms to generate processes of improvement deriving from inter-firm linkages and contact with the market' (Humphrey & Schmitz, 1996:1860). Thus competitiveness is a dynamic phenomenon, that will constantly change with changing economic, political, sociological, and technological conditions

The relative competitive position of a city always refers to specific urban functions. This is a result of a gap between (1) the supply of locational factors in that city and the level of supply of those factors required by the sectors related to that function (the level of absolute attractiveness of a city for one urban function), and (2) the supply of locational factors in that city for those sectors relevant to that function and the supply of the same factors in all other cities performing the same function (the relative competitive position of a city for one urban function, with respect to other cities). Further more, as stressed earlier, four basic locational factors (efficient infrastructure, strategic services, high quality of living environment and of urban management) constitute the primary condition for a city to perform any competitive urban function.

Equally important as the definition of the concept of urban competitiveness are the elements that can actually be used to explain the concept of urban competitiveness itself. As discussed section in 2.3.1, these elements could well be used to assess the relative degree of competitiveness of an individual city and to identify both its strengths and weaknesses at a particular point of time. This latter aspect will be of crucial importance in suggesting a specific strategy for enhancing competitiveness of the individual city.

Whereas the definition of the term explains what urban competitiveness is, the determinants are the variables through which urban competitiveness can actually be measured or assessed. According to Singh and Kresl, urban competitiveness is a function of economic and strategic determinants. Economic determinants can further be divided into factors of production, infrastructure, location, economic structure and urban amenities. The strategic determinants are mainly governmental effectiveness, urban strategy, institutional flexibility, and private-public sector co-operation. Kresl and Singh opine that any determinant that can be represented by statistical data will be an economic determinant, and strategic determinants are always qualitative in nature (Singh; Kresl, 1994:434).

Based on various studies, Kresl concludes that 'a healthy and dynamic manufacturing sector is essential for international competitiveness of any region or urban economy' (Kresl, 1995:48). Quoting studies by Scott et al., Kresl states that 'manufacturing remains the core for US competitiveness because it provides higher wages and output per employee, 70 percent of exports (in 1980), and more than 50 percent of imports (in 1980). This is however not so true at least for most US and Western European urban areas in recent years, as the overall economic output of these areas over the recent past has shown that services or the tertiary sector has over taken manufacturing in output and employment terms (Knight 1995:225).

Thus competitiveness is not 'just a question of promoting more growth but rather a process of economic evolution that will generate specific results that are considered especially desirable' (Kresl, 1995:50). A competitive urban economy will depend more on the quality of jobs rather than on mere numbers, in terms of providing employment to people.

The foregoing discussion on the determinants of competitiveness highlighted how various economic activities and industries tend to get concentrated in a particular urban location. A number of studies[23] have highlighted how new high technology firms get concentrated in certain urban locations. Almost all of these studies have been carried in the industrially advanced economies. Nevertheless, there are certain crucial aspects related to urban development that can be learnt from these studies.

2.4 WHAT POTENTIAL ROLE DO NEW HIGH TECHNOLOGY FIRMS PLAY IN URBAN DEVELOPMENT?

The development of new high technology industries, spearheaded by the producers of information technologies, along with the crisis of old lines of manufacturing, is transforming the economic landscape of many countries in the world. In recent years, a growing body of research has focused on the study of high technology industries (Segal et al., 1985; Castells, 1985; Katz, 1988, Castells, 1989; Henderson, 1989; Haug, 1991; Gibson et al., 1992; Castells & Hall, 1994; Malecki, 1994; Bathelt, 1995; Brunner, 1995; Henderson et al., 1995; Heeks, 1996; Graham & Marvin, 1996; Mowery (ed.), 1996; HWWA et al., 1996, Saxenian, 1996, and McDowell, 1997). For some of these authors, the study of high technology based firms has 'special significance to economic performance and policy at national and local levels' (cf. Segal et al., 1985:9).

Numerous state and national governments have concentrated their economic development efforts on attracting and maintaining growth by high-technology industries. Commenting on the importance attached to the high technology production by national governments, and the resulting international conflict and co-operation in national competition for high technology industries, HWWA, et al. comment '... over the last few decades, intervention by governments in the promotion of technology has increased, accentuating the commercial competition among nations' (HWWA, et al., 1996:2). Technology based industries are seen as involving the highest stakes in international competition for high growth industries *(like information technology industries)*.

[23] For examples see Segal and Quince (1985); Moulaert, et al., (1991); Shachar and Felsenstein (1992); Castells and Hall (1994); Saxenian (1996); and Graham and Marvin (1996)

They further state,

> '... the high technology competition among the established industrial powers is being profoundly modified by the emergence of new entrants wishing to compete for the high-technology industries which were previously reserved to the most advanced countries. These new entrants are altering the terms of global economic competition with policies different in important ways from the practices and prescriptions of leading countries. New state-supported producers in Korea, Taiwan, Malaysia, and, China are aggressively entering global markets for high technology products. India is also rapidly emerging as a participant in the global software industry and as a recipient of rapidly expanding foreign investment[24]' (*op. cit.* p.21).

Many of the above cited works have highlighted the factors affecting the location decisions and operations of these high tech firms. 'This evidence provides state and community governments with information for creating and sustaining the tax, labour, transportation, and educational attributes necessary for high-tech industrial development' (Haug, 1991:869).

At the same time in many developing countries and in most industrialised countries, since the early 1980s the economic development of urban areas has emerged as an important policy area for municipal governments (Harris, 1992). It now ranks alongside infrastructure provision, housing, social services and other traditional areas of concern for urban managers. This interest in economic development relates both to those schemes that are locally initiated and executed and those targeted at particular urban areas through the operation of central government urban policy.

In many industrialised nations (such as Japan, the UK, France, Australia, the US) and a few newly industrialising countries (such as Singapore, Israel, Malaysia, India, and to some extent China) these policy responses, at both the local and national levels, include measures to encourage the promotion of local high technology industries and the attraction of external sophisticated production activity.

[24] 'Between 1991 and 1993 the amount of direct US investment approved by the Indian government jumped from $104 million to $1.1 billion ... perhaps more significantly, as a result of the ease of global telecommunications, India has emerged as a major software centre. Since 1990, annual software exports soared to $500 million in the 1994-95 fiscal year. Some estimates expect sales will reach $5 billion annually by 2000... at the same time, US exports to India were $3.3 billion in 1995, up 43.6 percent from 1994...competition between American programmers and equally well-trained Indian programmers, paid four times less than their American counterparts, is a new phenomenon with potentially significant economic and political consequences'(HWWA, et. al, 1996:21).

According to Shachar and Felsenstein, 'the development of a local high technology capability is seen as a key element in an urban economic development strategy but is not necessarily focused solely on intervention at the level of the firm' (Shachar & Felsenstein, 1992:839). More indirect approaches include improving the local scientific educational system, encouraging technology transfer between local knowledge centres and industry, and supporting the upgrading of local capital stock (Malecki, 1994). In industrialised nations, these strategies are seen as offering some form of relief from the structural crises associated with economic restructuring in areas of traditional industries endowed with highly skilled labour. Here, high technology growth has intuitively been expected to generate local multiplier and linkage effects (Shachar & Felsenstein, 1992:839). Similar to this view, Castells states that the "technological revolution", 'has very definite spatial dimensions, with far reaching consequences for the future of cities and regions' (Castells, 1989:33).

Any discussion on the relationship between high technology industries and spatial structure must be grounded in empirical observation of where such industries are located and what the factors are that seem to be at the roots of their location pattern. Based on numerous research studies, Castells suggests a model of location for high tech manufacturing. The characteristics of that model are:

1. As high tech industries are science based and knowledge intensive, they need a close connection to major universities and research units, as well as large pool of technical and scientific labour.
2. High tech activities tend to cluster historically in regions where the military has established its testing sites.
3. High tech companies are generally characterised by a strong antiunion feeling in their management, not so much because of traditional economic reasons such as wages and benefits, but due to fears of bureaucratisation and slowness in an industry that requires constant flexibility and innovation. Thus areas having less union movements have higher chances of having high tech industries, all other things remaining equal.
4. The risk (and promise) of investment in this new field requires the existence of venture capital in the region, that is both a function of a high level of wealth and

of an entrepreneurial culture oriented toward non-traditional financial markets (Castells, 1985: 13).

Researching on the planned centres for promotion of high technology industry around the world Castells and Hall (1994) try to assess how different efforts to create these "high technology enclaves" perform (or fail to perform) their role as engines of the new round of economic development. They call these planned interventions as the technopoles[25].

Based on their analysis of technological complexes around the world, Castells and Hall suggest a typology of technopoles. The *first* type of technopole consists of industrial complexes of high technology firms that are built on the basis of innovative milieux. These complexes, linking R&D and manufacturing, are the true command centres of the new industrial space. These new techno-industrial complexes arise without deliberate planning, though even there governments and universities did play a crucial role in their development. According to Castells and Hall, the most prominent example of this kind of technopole is Silicon Valley.

The *second* type of technopole are the science cities. These are strictly scientific research complexes, with no direct territorial linkage to manufacturing. They are intended to reach a higher level of scientific excellence through the synergy they are supposed to generate in their secluded scientific milieux. The major Japanese experiment in Tsukuba according to Castells and Hall is an example of this kind of technopole.

A *third* type of technopole aims to induce new industrial growth, in terms of jobs and production, by attracting high-technology manufacturing firms to a privileged space. Innovation functions are not excluded from such projects, but they are mainly defined in terms of economic development. Castells and Hall call these as "technology parks". Cambridge in England according to the authors is a good example of this kind of a technopole.

[25] Under this definition they include various deliberate attempts to plan and promote, within one concentrated area, technologically innovative, industrial-related production: technology parks, science parks, science cities, technopolises and the like.

On the issue of potential contribution of high technology industries to local areas, a recent collaborative study states that there are number of benefits attributed to high technology industries that rest on a variety of interlocking observations:

> '*First, high technology firms are associated with innovation.* Firms that are innovative tend to gain market share, create new product markets, and use resources more productively. *Second, high-technology firms perform larger amounts of R&D than more traditional industries.* High technology firms are identified by the very high percentage of their revenue devoted to research-often more than 10 percent-as compared with a three percent level for more traditional industries. *Third, these positive spillover effects benefit other commercial sectors by generating new products and processes that can lead to productivity gains and generate new manufacturing opportunities.* Advances in electronics have made it a key enabling industry responsible for new methods of manufacturing in steel, automobiles, aerospace, and even agriculture, as well as the creation of a whole gamut of consumer electronic products. ***Fourth (and more significant to the present research), the positive spillover effects are often locally concentrated.*** Firms frequently concentrate in particular locations (mostly cities) to benefit from the externalities associated with a qualified labour supply with appropriate skills, specialised suppliers of inputs and supporting services, and informal horizontal information networks for the exchange of the "tacit" knowledge required for the exploitation of new techniques and processes...*Fifth, high-technology firms are associated with high value-added manufacturing and, importantly, the creation of high wage employment.* The firms that innovate rapidly, introduce new technologies, develop new products, and expand exports are also the firms that increase employment and contribute disproportionately to the national (*and local*) R&D effort' (HWWA et al., 1996, 33-35) (emphasis added).

In this framework, the principal nodes (cities) exert a dominating influence on the overall settlement system of a region. Thus, shocks and disruptions in a node can have effect on the whole settlement system. Within this heavily interdependent system, the localised growth outcomes that can be expected from high technology industries operating in an international context relate to the linkage and multiplier effects that "leak out" to the local economy.

Thus, similar to HWWA et al., Shachar and Felsenstein also identify a number of linkages and multiplier effects that high technology firms "leak out" to the local economy and those that have a potential for urban economic development. They are :

(1) *employment linkages*, i.e. the amount of employment generated locally, the extent of mismatch between local supply and demand and the income multiplier associated with the increased size of the local labour force.

(2) The *external production (and service) linkages* of the firm and the extent to which the local area benefits from the flows of goods and services to and from the high technology cluster.

(3) Linkages exist that are associated with *local centres of knowledge and research.* The importance of these relationships lies in their potential effect in "seeding" the technological capacity of the local economy.

(4) Firms are also engaged in *contractual and "flexible" linkages* such as strategic alliances, limited partnerships and the like.

However, it needs to be noted that by their very nature these linkages are likely to be non-local, cutting across national and international boundaries, and as such their particular local impacts are hard to specify.

There are at least two distinct ways in which the high technology firms can potentially contribute to urban economic development. These are: (a) through the links with local academic institutions, and (b) the spin-offs that results in the formation of high technology firms, either due to the links with the universities, or from existing high technology firms themselves.

Recent research on industrial and technological innovation has provided many important insights on location and inter-firm relations. The literature on innovative industrial *milieux*, for example, has shown that firms' technological capabilities and the interaction of locally clustered firms can be powerful forces for urban economic development, but the relationship of this concept to metropolitan form has been largely neglected (Suarez-Villa & Walrod, 1997:1344). Similarly, according to the same authors, the relationship between metropolitan form and the internal organisational characteristics of industrial activities has not been explored either (*ibid.*).

Shachar and Felsenstein argue that the international character of high technology operations might also explain why many high technology clusters have not acted as a catalyst for explosive urban growth. Cambridgeshire, UK and the research triangle towns of North Carolina, USA all represent growing centres of high technology activity but without the rate of urban growth that characterised the urban nerve centres of earlier technological revolutions (Shachar & Felsenstein, 1992: 840).

Commenting on the relationship between high technology activity and the urban economy, Shachar and Felsenstein further note: 'an urban economic development strategy grounded in the promotion of high technology faces the uneasy task of trying to reconcile the tensions of the globalisation tendencies of high technology activity on the one hand, and exploiting the potential local growth effects on the other' (*op. cit.* p.841).

In reviewing the empirical evidence on the relationship between high technology development and urban development, Begg and Cameron (1988) note it seems that local areas do not play a role as markets for high technology development. Again the reason is probably the global context in which these industries operate and thus the role of the urban area has more to do with creating the supportive environment for new firm growth and survival (Aydalot & Keeble, in Shachar & Felsenstein, 1992: 841).

However, Castells and Hall do not seem to agree to the above views and argue that these high technology industries do have an impact on the urban economic development. They believe the present world is witnessing the emergence of a new industrial space, defined both by the location of the new industrial sectors and by the use of new technologies by all sectors, and state 'new industrial space is globally interdependent, both in inputs and markets, triggering a restructuring process of gigantic dimensions that is felt by cities and regions around the world'(Castells & Hall, 1994:7).

As mentioned in chapter one (cf. Section 1.3), perhaps the most direct impact of the high technology firms on the spatial structure of urban areas can be felt in two ways: Firstly (and as noted earlier in this section) high technology activities have become the engine of new economic growth; and secondly, the introduction of new technologies in all kinds of economic activities in an urban area allows the transformation of their locational behaviour. And that is why Castells argues that it is through the new economy that high technology is deeply modifying cities and regions (cf. Castells, 1985:19).

a) High technology firms' links with local academic institutions

An important issue concerning the location of high technology firms and their relationship to urban development is the significance of links between these firms and local educational establishments. Much work exists that suggest that the university is a particularly important information source for high technology firms and that efficient use of this information network is enhanced by close physical proximity between local high technology activity and the university.

Thus in some urban areas, science parks[26] have become an important ingredient in urban economic development. The university roots in the genesis of some of the most successful high technology agglomerations (like the Silicon Valley, Stanford Research Park, the Cambridge agglomeration and the Cambridge Science Park, of UK), have only strengthened this view.

However, according to some authors, universities, 'an almost universally cited factor accounting for the location of high-tech firms, must be considered an overstated ingredient'(Malecki, 1994:222). Malecki mentions that the experience of Stanford University (in the case of Silicon Valley), MIT of Boston (in the case of Route 128), and the Cambridge phenomenon (in the UK) all point to the fact that these places become seedbeds of innovation primarily because they were near large urban locations. Malecki's argument seems to be weak in that, if urban locations were to be such a determining factor as the presence of universities, one should have experienced the kind of phenomena that occurred in Silicon Valley to have happened in San Francisco city; instead of Route 128, in Boston city itself; and the Cambridge phenomenon not in Cambridge, but within the M25 in the case London. Similar to

[26] The concept of a university science park is essentially very simple, there is 'no special theory that underpins its design or operation, and equally no magic that makes one successful' (Segal, Quince and Partners, 1985:75). A science or technology park, according to recent study by Segal et al. (1995) is a property based initiative which: (a) has formal and operational links with a university or other higher education institution or major centre of research; (b) is designed to encourage the formation and growth of knowledge based businesses and other organisations normally resident on site; (c) has a management function which is actively engaged in the transfer of technology and business skills to the organisations on site.

the view of Malecki, Shachar and Felsenstein also point to a wealth of studies that report few benefits arising from agglomeration of high technology industry close to a university. There is according to them 'very little empirical evidence of linkages of any meaningful sort between university and the high technology companies in their vicinity (whether science park tenants or not)' (Shachar & Felsenstein, 1992:842).

This is however, debated by Segal et al., who state 'most companies, except those with the most obvious and major links, tend to understate their relationships with and (indirect) benefits from local research establishments' (Segal et al., 1985:37). They further add:

> 'the relationships are diverse and complex and cannot be gauged satisfactorily in the course of a survey *alone*... *structured research projects are the exceptional kind of relationships*; social contact, allowing for easy recruitment and "picking of brains" by the companies as well as a demonstration effect back into the departments (*of universities*) from the companies' evidently successful activities, is undoubtedly more common and of great significance... it is perhaps for these reasons that a number of studies, including the one on Cambridge science park companies, have tended to understate the number and significance of university-industry links in any given situation' (*ibid.*) (emphasis added).

It is true that firms recruit entry level engineers and other professionals quite widely outside any local area. However, as a local source of engineering and high technology labour, universities do have an important contribution to make as shown in the case of information technology (IT) firms in Bangalore. Over 87 percent of the surveyed IT firms in the present study in Bangalore attributed the availability of universities and scientific research laboratories (in Bangalore) as a very important locational factor.

While both of these divergent views may be true, there is no doubt, however, that successful science parks or technology agglomerations do have some form of amenity role to play in the urban area where they are located. Their utility probably lies in their "signalling"[27] function. As already mentioned in section 2.2.1, colleges and universities may also affect productivity by increasing the rate of innovation in the urban area, and academic institutions may also serve as incubators of new technology (cf. Beeson, 1992) It may be that these academic institutions are

[27] Appold, quoted in Shachar & Felsenstein, 1996:843).

unconsciously transmitting signals to other firms engaged in a decision-choice process, and in this way, a local reputation is established.

b) Spin-offs that lead to the formation of high technology firms either due to the links with the universities or because of existing high technology firms themselves

A further form of linkage between the high technology firms and the local urban area is via the spin-off process. Accounts of locally based company genealogies nearly always put the local university at the apex of any "family tree" approach to high technology firm development (Segal et al, 1985). In the Cambridge case in UK, nearly 400 local firms in 1985 owed their ultimate origin to the local university in one way or the other (*ibid.*).

Another form of spin-off results from among the high technology firms themselves. Haug (in his study of software firms in Washington state, USA) states that spin-offs have contributed to the development of many high-tech agglomerations, and 'many software firms in Washington state were established from individuals leaving other software companies' (Haug, 1991:877). His research further provides evidence to the chronic entrepreneurship and high tech development relationship. He adds by stating that Microsoft (one of the largest software companies in the world, based in Seattle, Washington state, USA), has given rise to a number of different software companies (*op. cit.* p.878). The spatial significance of this process is that spin-offs generally locate in the local urban area. They are thus seen as strengthening the local economy. This enables new graduates and experienced professionals from the local area and elsewhere to look for employment opportunities in these cites, which may not be available in other locations.

In their search for the new sources of economic growth and social well being, cities and regions are stimulated both negatively and positively by comparative international experience. Those areas that remain rooted in declining activities, often get ridden by serious economic and social unrest (as was witnessed in the case of textile industry in Bombay). New regions emerge as successful locales of new wave of innovation and investment, sometimes emerging from deep agricultural torpor, sometimes idyllic corners of the world that acquire sudden dynamism. Thus, according to Castells and Hall there emerge, 'Silicon Valley and Orange County in California, USA, Bavaria in Germany, Silicon Glen in Scotland, the electronics agglomeration in Ireland, and above all the newly industrialising countries of Asia (South Korea, Taiwan, Hong Kong, Singapore, Malaysia) that in two decades have leapt straight from traditional agricultural societies- albeit with high levels of literacy and education- to being highly competitive economies based on strong electronics sector' (Castells & Hall, 1994:7).

Interpreting this, the task for city managers in the developing countries become rather clear. The first and foremost task for these city managers in the developing world is to concentrate on urban infrastructure and to improve its supply. It was noted in section 2.2 in the case of China, that, apart from other things, foreign direct investment tends to concentrate in locations which offer better infrastructure facilities (cf. Head and Ries, 1996). It was also mentioned in section 2.3 that cities with better infrastructure supply will be in a more competitive position than those who are not. If one of the aims of urban managers in developing countries is the need to attract investment to generate jobs in the high technology industries, then urban development policies in these countries will need to focus increasingly on providing infrastructure in these areas.

But in a country like India, where even after 47 years of planning efforts there is no concrete national urbanisation policy, it will not be easy to introduce such changes. In the case of urban development policies in India, emphasis has been largely laid on the physical aspects rather than the economic aspects. Most of the efforts have come in the form of five year plans that have often stressed on the aspects about promoting small and intermediate cities, decentralisation of large cities, slum improvement, construction of roads and provision of industrial estates, and provision of water supply. The development plans prepared by the urban development authorities in India have largely restricted themselves to zoning regulations and development control, with very little emphasis on the economic aspects. Issues about urban poverty, providing basic urban services, employment generation, and promoting public-private sector partnership in the urban sector are some of the issues that have been emphasised only recently by the five year plans. Given these thrust areas as identified by the various five year plans, it is therefore not surprising that there has been no concerted efforts on part of the national government to attract high technology industries into specific urban locations in the past.

However, the macro-economic reforms that were launched in the country since 1991, has put major cities in a competitive position to one another. Traditionally the economic activities and industries concentrated around the big cities especially Bombay, Delhi, Calcutta, and Madras. But since the government has done away with many of the earlier existing regulations about location of economic activities, firms are now able to choose locations which make most business sense to them. Harris (1996) notes that some of the Indian states are already competing for foreign investment. Parallel to this process, the opening up of the economy has also uncovered vast potential that exists for investment opportunities, that hitherto were not open to competition. This has given cities like Bangalore (as discussed in later sections of the dissertation) a fillip to vie for not only FDI, but also pull domestic investors from other major cities (like Bombay and Delhi), which in the last decade have been confronted with a myriad of problems as a result of poorly managed growth. Combined with the recent development in telecommunications and information technology infrastructure, the availability of high technology professionals and research institutes and some support from the state government have all contributed to the rapid growth of the IT industry in Bangalore, as highlighted by the present research.

Recognising the need to sustain such growth in urban areas and to make them more attractive for investment, the Government of India launched its *India Infrastructure Report* (GoI, 1997-a), whose basic task was to estimate the infrastructure requirements for the country, its financing and the sources through which the infrastructure could be financed. Among the sectors that the study identified as crucial, most notable ones include, urban infrastructure, power, telecommunications, roads, and industrial parks, all of which are of great significance to the current research.

Along with the efforts made by the report to estimate the infrastructure requirements for urban areas, and the source to fund infrastructure projects in the urban, telecommunications, and power sectors and in industrial parks, it needs to be noted that at the national level, investment in the high technology industries, especially IT[28] has been encouraged by a number explicit policies, and changes in the custom duties and reduction in taxes. All these enable the importing of the IT equipment much easier than before. As already mentioned, since the federal government has done away with many of the earlier existed regulations on industrial location, various state governments in India are now launching their own policies to attract investment, more notably foreign direct investment, and that too in the high technology sector. This is true at least in the cases of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu, and West Bengal, all of which are now simultaneously trying to attract foreign investment into high technology sector.

2.5 THE RESEARCH APPROACH

The foregoing discussion on the locational aspects of economic activities, determinants of urban competitiveness and research on the high technology industries highlighted how certain economic activities and industries tends to get concentrated in a particular urban location. The issue of potential contribution of high technology firms to urban economic development was also discussed. The discussion used a number of examples to highlight how high technology firms get concentrated in certain urban locations. However, most of the research work that were reviewed as a part of the study have been carried in the industrially advanced economies.

How far any of these are relevant to the Indian context or happening in India? The technology available to the vast majority of the population is nowhere near that compared to the ones in the industrially advanced rich countries. Nor is the infrastructure in the country anywhere near that of international standards. In such a circumstance, are the claims made by some of the literature valid that the global IT companies are making a beeline to India, and more so prominently to Bangalore?

Among the major urban locations where the IT industry seems to have concentrated, Bangalore has emerged as the most important centre for IT industry in India, which has the largest concentration of IT firms in the country. Bangalore's pre eminence is

[28] Policies concerning the IT industry, especially the software segment is discussed in Chapter 5.

well illustrated by the fact that during the period 1986-90, almost a fifth of new IT firms founded in the country based themselves in Bangalore. This went up in the following period 1991-96, when a quarter of all the new IT firms which began their operations in the country established themselves in Bangalore (Table 2.1).

Table 2.2: India: Start up of IT Firms by Location

Year	Location								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
1950-59	-	1	-	-	-	-	-	-	1
1960-69	-	6	-	2	1	-	-	-	9
1970-80	10	18	1	9	3	2	5	3	51
1981-85	20	25	2	12	4	14	6	9	92
1986-90	71	64	10	82	26	60	8	26	347
1991-96	104	58	15	82	41	93	9	23	425
Total	205	172	28	187	75	169	28	61	925

Source: Own calculations based on information compiled from Dataquest, 1996

Bangalore not only attracts the domestic IT industries, it has increasingly attracted a large number of multinational IT firms since the mid 1980s. In 1985, when Texas Instruments of USA started its fully owned software subsidiary in Bangalore, it was the first of its kind in Bangalore, and in India. However, within a decade from then, Bangalore became home to the highest number of foreign owned IT firms in India. The city houses almost all the big names in the IT business. Texas Instruments, Intel, Microsoft, Oracle, Tektronix, Bay Networks, Bull, Tandem, Informix, IBM, Novell, HP, Acer, Siemens, Motorola, Silicon Graphics, Sun Microsystems, Digital Equipment, Compaq, Seagate, Citizen, 3M, Honeywell, and Elxsi are just few of the multinational IT firms that are based in Bangalore. This is surely a reflection that the city is integrated into the global system of information technology related production. A higher share of both domestic and multinational IT firms in Bangalore than any other city in India, establishes the fact that it seems to be more "competitive" in attracting IT industries than any other Indian city as of mid 1990s. Why this has happened needs to be explored. Since there are so many multinational IT firms in Bangalore, the issue of ownership is also of paramount importance. It needs to be assessed if firms based on their ownership have behaved differently in selecting Bangalore as the production base. Thus in the primary analysis of this research, the firms will be grouped on the basis of ownership.

Empirical evidence suggests that Bangalore has the highest proportion of the IT industry in the country. Is it matter of just chance that the IT industry concentrate in Bangalore? For that matter, is it just fortuitous as has been discussed earlier, that Silicon Valley, Route 128, Austin in Texas, Silicon Glen, or Cambridgeshire all have a high concentration of high technology industries? It is even more interesting to note that all of these locations are in the industrially advanced countries, so why do firms choose Bangalore? Why do so much of the recent journalistic literature (both within and outside India) addresses Bangalore as the "Silicon Valley" of India?

Limited literature available and reviewed in this chapter on the IT industry suggests that IT and other high technology firms concentrate in regions that offer a high quality work force, interaction with research laboratories, availability of a state of art infrastructure, and favourable state or federal laws to promote such industries. It needs to be proved if any of these conditions exist in Bangalore, and if they have been instrumental in attracting investment in the information technology sector into the city.

The rapidly growing information related industries in Bangalore have attracted work force not only from India, but elsewhere too. However, the infrastructure supply (except for telecommunications to some extent) in the city has not kept pace with the growing demand of the business, industry, and the residents of Bangalore. This poses a serious issue whether Bangalore can sustain its "competitiveness" in the location of IT industries in India.

Hence, based on the literature and from limited previous empirical evidence, the current research has been executed in order to gain an in-depth view of the processes that have led to the growth of IT industries in Bangalore, and to examine if such growth can be sustained in the near future. This induces an examination of the links between the growth of the information technology industry and urban development in Bangalore. The literature survey and the conceptual background to the study brought to the fore the need for a systematic and detailed analysis of the crucial aspects that emerged from this chapter.

2.6 RESEARCH OBJECTIVES, QUESTIONS AND HYPOTHESES

Keeping the major issues that have been discussed in this chapter earlier, the approach to the study has been formulated. It needs to be examined why the IT industry is undergoing spatial restructuring, and how countries like India are placed within this restructuring process. At the national level, it needs to be examined why Bangalore has been able to dominate in the location of the IT industry, and if such growth can be maintained in the future as well. These issues have been translated into research objectives. These objectives have helped in the identification of the research questions that are answered by the research hypotheses. An attempt has been made to answer the first set of research questions in part B of this dissertation, which also tests the first hypothesis of the research. Section 5.5 attempts to test the first hypothesis. The second set of research questions is attempted to be answered in part C of the dissertation. In chapter 10, the other two hypotheses governing the research have been put to test, based on the discussions carried out in that part of the dissertation.

2.6.1 RESEARCH OBJECTIVES

The major objectives of the study are:

- To understand the spatial dynamics of the world IT industry, and the economic opportunities this offers to some of the "emerging economies" of the world.
- To understand how Bangalore achieved a pivotal role in the location of IT industry in India.
- To analyse whether Bangalore can continue to maintain its leadership role in the IT sector in India.

2.6.2 RESEARCH QUESTIONS

The research seeks to address two sets of research questions relating to the issues identified as being the core of this research. These research questions have emerged from the detailed discussions that were carried out in the previous and this chapter. These research questions have been grouped into two sets:

- **The IT industry in the Global Context**

I. What are the spatial determinants of the information technology industry globally ?

II. What are the relative strengths and weaknesses of India in attracting the IT industry?

- **Growth of IT Industry in Bangalore**

I. Does Bangalore control a sizeable share of IT sector industry in India?

II. If so, why has Bangalore been more successful in attracting a relatively high proportion of investment in the IT industry than other Indian cities in the period 1985-1996?

III. Can Bangalore continue to be the centre of pre-eminence in the IT industry in India?

The above mentioned research questions are attempted to be answered by the following research hypotheses.

2.6.3 RESEARCH HYPOTHESES

In line with the research questions this research also addresses the following main research hypotheses:

- *The global IT industry is interested in India as it offers a large pool of high quality IT professionals at competitive wages. The IT industry is a highly skill based industry and would not shift on the basis of cost alone.*
- *The dominant position of Bangalore in the Indian IT industry is a result of a combination (synergy) of various factors viz., availability of skilled professionals, a favourable government policy and a network of research laboratories and research institutes.*
- *The vitality of the IT industry in Bangalore is further consolidated by a strong IT industry-Research Laboratories link, which takes the form of joint R & D activities, and informal networks among them.*

3 RESEARCH METHODOLOGY

3.1 INTRODUCTION

Crucial aspects of any research process are the design and methodology of the study. Appropriate design and implementation of a research methodology[29] are vital as methods of data collection and analysis may impinge upon the validity and reliability of research. This chapter is conceived in four sections. After the introduction, the second section describes the appropriate strategy chosen for this research. Section three outlines the research process followed here, while a final section concludes the chapter.

The basic objective of the present research is to understand how a particular urban location is able to attract higher proportion of investment in a specific sector. In other words, it looks at the competitive aspects of a city in attracting investment in a particular sector. The focus is in fact bi-polar, one addressing the spatial aspects of competition, and another focusing on the industrial sector per se. The research design

[29] Hakim (1987) makes a distinction between research design and methodology. She notes, '*research design* deals primarily with research questions, aims, uses, purposes, intentions and plans within the practical constraints of location, time, money and availability of staff' (Hakim, 1987:1). Moreover, design according to her, is also a matter of style (innovative and traditional). *Methodology*, on the other hand, is more about how the research is conducted once the goal is defined. Thus research design is a first step which leads to the selection of appropriate methodologies based upon the objective of research.

has evolved out of this dual objective. Many of the journalistic articles have written quite a lot about Bangalore. However, to have a more comprehensive picture of what is happening in Bangalore requires an understanding of many cultural and local aspects that may influence the IT industry's growth and development in Bangalore. The cultural and non-commercial aspects of the IT industry is one such dimension. It is, however, beyond the scope of the present study to treat such topics, important as they are, in the depth they necessarily require.

3.2 RESEARCH STRATEGY

The literature shows that there are five major research strategies in social sciences: experiments, surveys, archival analysis, histories and case studies. There are three conditions that distinguish these research strategies: *first*, the type of research question posed; second, the extent of control an investigator has over actual behaviour events; and third, the degree of focus on contemporary as opposed to historical events (Yin, 1994). Table 3.1 highlights relevant situations for different research strategies in social sciences.

Table 3.1 Relevant situations for different research strategies

Strategy	Form of research question	Requires control over behavioural events?	Focuses on contemporary events?
Experiments	how, why	yes	yes
Survey	who, what, where, how many, how much	no	yes
Archival analysis	who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case Study	how, why	no	yes

Source: Yin (1994: 6)

For a long time, according to Yin a common misconception existed in social sciences research that various research strategies could be arranged hierarchically. It was believed that case studies were appropriate for the exploratory phase of an investigation, that surveys and histories were appropriate for the descriptive phase, and that experiments were the only way of doing explanatory or causal inquiries. This hierarchical view, according to Yin (*op. cit.* p.3), however is incorrect. Experiments with an exploratory motive have certainly always existed. In addition, the development of causal explanations has long been a serious concern of historians. Case studies are far from being only exploratory strategy.

The most appropriate view of these different strategies is a pluralistic one. Each strategy can be used for all three purposes- exploratory, descriptive, or explanatory. There is definitely an overlapping, and in many cases, more than one strategy may seem to be appropriate. What actually determine the strategy are three conditions as explained by Yin, which are

a) the type of research question posed;

b) the extent of control an investigator has over actual behavioural events; and

c) the degree of focus on contemporary as opposed to historical events (*op. cit.* p.4).

Table 3.1 displays these three conditions and shows how each is related to five major research strategies in social sciences: experiments, surveys, archival analysis, histories, and case studies.

Following the appreciation and understanding of various research strategies, the case study approach has been considered as the most appropriate strategy for the current research. Since the researcher anticipated the secondary data from diverse disciplinary sources would need to be used in conjunction with interviews and field observations, the case study approach has been chosen as the most appropriate tool. The focus of research warrants undertaking of several in-depth case studies involving multi dimensional data/information. Accordingly detailed case studies of IT firms in Bangalore have been carried out. Substantial secondary data/information have been collected from diverse data sources.

Case study has been widely used in a study of similar kind in the past as well (Segal et al., 1985; Pratten, 1991, Brunner, 1995; Saxenian, 1996; etc.). An important aspect of the research has been to understand the links between the growth of information technology industry and urban development issues in Bangalore. In the past, the case study approach, according to Panneerselvam (1996) has been successfully used by many researchers to analyse urban development and management issues in India, and elsewhere in developing countries.

3.3 RESEARCH PROCESS

This research was commenced in October 1994. As a first stage of the research process, a preliminary literature search and review was completed in London, before conceptualising the research design. The literature review provided guidance on the focus of the research as well as the research methodology to be adopted. Following that, the research has been executed in a series of tasks. The field work in India was carried out between July and October, 1995. The sequence of tasks accomplished to carry out this research study were:

Task I:	Review of literature
Task II:	Analysis of the software industry at the global level
Task II	Evolution of the electronics policy in the Country
Task III	Identification of the IT Firms in Bangalore
Task IV	Selection of case study firms in Bangalore
Task IV	Understanding the causal reasons for Bangalore's success in attracting the IT industry

3.3.1 REVIEW OF THE LITERATURE

The first step in the research is to canvass a wide range of literature of general relevance to the subject and to the method of research as employed in comparable investigations. The literature for review has been identified through a systematic search, conducted using a number of alternate *subject* and *key* words (using the UCL Library Network, BIDS, BLPES, British Library, SOAS Library, University of Sheffield Library, and the University of Strathclyde Library) to scan alphabetical and subject indexes of published books, documents, and periodicals. Extensive use of the Internet as a source for research work has been quite successfully made. This operation yielded an initial reference of relevant work. However, information on the IT industry in India was a hard task to be gathered by being in the UK, largely due to the absence of a systematic recording of the various components of the IT industry in the government statistics that were accessible in London. Therefore, once in India (between July and October, 1995), further literature (mainly in the form IT industry trade magazines, government documents, evaluation studies, conference papers, newspaper clippings), were collected and reviewed.

The review of literature related to high technology firms, competitiveness, and urban development, led to an appreciation of the magnitude of the issues being raised by the literature, and therefore a need to limit the investigation to only the IT firms. Most of the studies that were available (for example, Castells and Hall, 1994; Saxenian, 1996 etc.) were largely confined to the cases of the developed part of the world. Still, with the help of these studies, and with very few studies related to developing countries, the focus of the study was narrowed to understand the causal reasons for Bangalore's emergence as a premier centre for IT industry in India. The literature review, in the form of conceptual background to the study has been presented in Chapter two of this dissertation.

In India, the entire gamut of IT industry is covered under the umbrella of the electronics sector, and the policies governing the sector are made by an apex Government of India department- the Department of Electronics (DoE). As a first step an appreciation of the electronics policy in the country was gained.

3.3.2 ANALYSIS OF THE SOFTWARE INDUSTRY AT THE GLOBAL LEVEL

Chapter two established that in the mid 1990s, Bangalore had the largest concentration of IT industries in India. The study attempts to explain how an urban region in a developing country can attract an industry which is rapidly growing and requires highly skilled labour and high technology inputs for its success. These are factors that have traditionally been not associated with the so called developing countries. Further, it also records the salient factors in the spatial aspects of the IT industry in the world, and more specifically the software industry. One of the reasons for Bangalore's growth as a major centre for high technology industries can be partly explained by the changes and the recent developments that are taking place in the IT industry world-wide, and the opportunities offered by a developing country like India for the IT industry around the world. Therefore, an understanding of what is happening in Bangalore cannot be seen in isolation to the recent developments taking place in the IT industry world wide, and the opportunities offered by India for any IT firm around the world.

3.3.3 EVOLUTION OF ELECTRONIC POLICY IN THE COUNTRY

A picture of the recent evolution of the macro economic policies in India was required to place the study in context. In particular, it needed to be determined, to what extent macro economic decisions were responsible, in the growth of investment in the IT sector. What plans are there to make this more effective at the state and at the urban area level? Information was obtained from variety of sources. As a first step, past studies, official documents, and interviews with people working in the IT sector proved fruitful. A review of past newspapers and various IT magazines, provided very useful information, and allowed to identify issues related to the IT industry in India.

Second, industrial policy at the state and national level were examined in an attempt to outline the change of policies since 1991, when the New Economic Policy was announced. Information was sought from national agencies, local agencies at the state level, consortiums, associations and trade groups on the following issues: the importance of macro economic changes to the IT sector; changes in the state policy towards IT sector; attitudes of the city authorities (of Bangalore), in providing infrastructure to the IT industry; on aspects related to the competitiveness of Bangalore as a base for the IT industry.

Third, data were gathered on the emergence of new firms in the IT sector in Bangalore at least for two points of time between 1991 and 1995. The aim was to gain a dynamic picture of how Bangalore's IT industry developed following India's liberalisation policies. Data obtained from various associations and the District Industries Centre (Bangalore), proved useful, and were complemented by the lists obtained from Karnataka State Electronics Development Corporation (KEONICS). Some case studies at the various academic institutions also provided an insight into Bangalore' s industrial development.

At the time of field work, meeting[30] with two international delegations also facilitated the research process. The first was the meeting with a delegation of Danish entrepreneurs, government officials, including the Prime Minister of Denmark. This delegation was in Bangalore to explore the opportunities for Indo-Danish joint ventures. Discussions with the members of this delegation tremendously benefited the researcher in gaining insight into the thinking of the foreign entrepreneurs wishing to invest in Karnataka. Another important meeting materialised with one of the biggest Japanese electronics firm NEC. The researcher met the members of the International Planning Division, and International Business Co-ordination Division of NEC. The NEC team was in search of a location to start a large scale electronics plant in India, and had already visited Delhi, Bombay-Pune, Hyderabad, before visiting Bangalore. The researcher spent a full day with the team discussing NEC's investment decision globally, and in India. With the NEC team, the researcher visited a number of industrial areas in Bangalore, and also got an opportunity to meet many more entrepreneurs in the electronics and IT sector, some of whom later became case study for the present research.

3.3.4 IDENTIFICATION OF IT FIRMS IN BANGALORE

The research is an exploratory study focused on understanding the reasons why IT firms get attracted to Bangalore. The literature on high technology firms in the developed world suggests that assembling data on the IT industry is a formidable task. This task becomes even more difficult in the context of a developing country like India. In India (as it would be explained in Chapter 5 and 6), there are no official statistics that give detailed information on the IT industry. For example there are no official statistics to indicate the number of IT firms operating in India. The task gets more complicated when the number of firms for an urban area needs to be collected, and that too with different segments of the industry. Keeping this major handicap in mind, the industry associations and computer magazines were approached for the relevant information. Although the information obtained from these sources is only an estimate, still in the absence of any official statistics, these are the main source of secondary data on IT firms in India. However, since the computer magazines bring out their report on IT industry annually, these data are more up to date than the government statistics in any case.

[30] These two meetings were chance encounters, and were not designed as a part of the research. However, the information gathered through these two meetings proved to be very useful.

The list of IT firms in Bangalore were obtained from various sources. But none of these was exhaustive by itself. Nevertheless, between these lists, large number of the IT firms in Bangalore were identified. A major point of source for the IT firms list has been the Consortium of Electronic Industries of Karnataka (CLIK), which listed many of the large, medium and small firms. Lists were also obtained from Greater Mysore Chamber of Industry (GMCI), Karnataka Electronics Development Corporation (KEONICS), Technical and Economic Consultancy Organisation of Karnataka (TECSOK), National Association of Software and Services Companies (NASSCOM), and Manufacturers Association for Information Technology (MAIT), the last two being located in New Delhi.

3.3.5 Selection of Case Study Firms in Bangalore

Since there was limited knowledge on the actual number of IT firms operating in Bangalore, an effort was made to include as many as possible. Bangalore has attracted a number of IT firms from India as well as abroad in the past. In Chapter one, it was stated that increasing role of foreign capital has important effects in accelerating the technical upgrading of city output and the volume of flows through financial centres. Where local authorities recognise the importance of foreign capital, it can also force competitive upgrading of infrastructure (to attract investment) and competitive debureaucratisation (cf. Harris, 1996). Subsequently, in Chapter two it was established that there are number of multinational IT firms in Bangalore. Given the importance of FDI especially in a rapidly advancing industry like IT, and aim of the study (to understand the causal factors behind IT industry's growth in Bangalore), the issue of ownership is of paramount importance. It needs to be assessed if firms based on their ownership have behaved differently in selecting Bangalore as the production base.

A quick analysis of ownership pattern in the IT industry in Bangalore reveals that the IT firms operate on different ownership pattern. These can be broadly grouped into: the domestic firms; the joint venture firms; and the foreign owned firms.

While conducting the research, it was kept in mind to keep the number of case studies equal on the basis of ownership criteria. This was important, as a significant amount of the inquiry addressed the competitiveness of India, and the strength and weaknesses of the IT industry in India. It was assumed that the foreign owned and joint venture firms would be able to react better on the global competitive position of India in the IT sector. Thus it would be possible to compare the views of these firms with the domestic firms on not only the issue of global competitiveness but also reactions to the various government policies, and most important of all, the reasons for being in Bangalore. Thus in the primary analysis of this research, the IT firms have been grouped on the basis of ownership.

Domestic Firms, are those firms whose shares are largely owned by an Indian parent group. Some may or may not have financial collaboration with an overseas firm. In any case the Indian group will control 51 or more percent share of these companies. Examples are Infosys Technologies and BFL Software.

Joint Ventures, are those firms that are equally owned by a foreign and a domestic company. In the most typical case the ownership (if it is two partners) would be 50:50. Examples of these include TATA-IBM (TISL), and Cranes Software.

Foreign Owned, are those firms that are fully owned or a fully owned subsidiary of a foreign firm. These types of firms were allowed in the IT sector in India only from 1985, when Texas Instruments (TI) of USA started its fully owned subsidiary in Bangalore. Other examples include Motorola, and Digital Equipment (India) Limited (both from the USA).

Apart from the ownership status, firms have been categorised on the basis of their product range. These have been grouped as information technology, hardware only, software and services only, peripherals, value added resellers, and training. This nomenclature is study specific, and are working definitions adopted by the researcher to distinguish various firms in the conduct of the research. However the case study firms are from four categories only, and they are : *information technology*; *hardware only*; *software and services only*; and *peripherals*.

IT firms, are those that have diversified interests in hardware, software and services (including system integration[31]), and even peripherals. The turnover of the firm is largely controlled by various segments of the IT industry, and hence been given that name. These employ a large number of software professionals not only for their software production, but also for system integration and system maintenance. Examples of such firms are Wipro, and TATA-Elxsi.

Hardware only firms, are those that are into manufacturing of hardware components, PCs, network cards etc. Advanced Micronic Devices, and Analog and Systems are two good examples of the hardware only firms, from the case study firms.

Software and Services only, are those that deal only with software and its related services. Firms producing customised or packaged software both have been included in these. Firms that provide software support are also part of this group. Examples of this include Hewlett-Packard's International Software Operations, and Netquest.

Value added resellers, are mainly dealers, but employ a large number of software and hardware engineers to tailor the systems as per their requirements. A large number of them do system integration as well.

Training firms are those that impart training in software and hardware engineering. Some of them also provide maintenance training. These also employ a large number of software professionals as trainers.

Peripherals, are those firms that are into the manufacturing of peripherals and other equipment that are required by the IT industry. These include manufacturers of printers, scanners, and VDUs (or monitors). Examples of these are TVSE, and VXL Instruments.

Schoonhoven and Eisenhardt note that participation is a major problem in the study of high technology industries (especially the ones that are in computer industry). They quote a study by Scott and Angel, who received only 10.2 percent return rate to illustrate the difficulties in obtaining information from high technology firms (Schoonhoven & Eisenhardt, 1992:213).

[31] For details on system integration see section Chapter 4 (Section 4.2)

As a first step, contact was made with the firms that appeared in the variety of lists. The usual point of contact was the Chief Executive Officer (CEO), with whom the initial briefing was held. Soon it became clear that many of the firms were extremely reluctant to speak about certain crucial aspects, or divulge valuable information. Initially after many persuasive efforts some firms had to be abandoned. Particular reference must be made to at least three firms, that repeatedly asked the researcher to get back another time. These three cases were pursued for almost a month, with over a dozen phone calls, and a visit to their offices at least 5-6 times. Despite all this, after a month, the researcher was informed that the firms would not give any information[32].

At this point in time, the researcher decided to discuss the abysmally low response rates of firms with the GMCI (Greater Mysore Chamber of Industry)'s Secretary, whose personal contacts with many of the executives in the IT sector broke the ice. The researcher also got help from a friend working in an international software company, with whose help, her friends and colleagues in other IT firms were contacted. The increased success rate became noticeable. This was mainly because the CEOs or other executives in the IT firms were referred to by their friends, former employees, or acquaintances. Thus an enormous amount of trust and confidence was built, which helped in higher response rates. The information collation was a time consuming process, and it became a common norm to get all the information being sought only after two, three or even more visits.

Table 3.2 Case study units : Ownership basis and product category

Category of Firm	**Ownership Status**			
	Domestic	**Joint Venture**	**Foreign Owned**	Total
Information Technology	-	3	1	4
Software & Services only	15	13	14	42
Hardware only	3	-	-	3
Peripherals	2	-	1	3
Total	**20**	**16**	**16**	**52**

Source: Field Survey, 1995

[32] Such cases were many, and often were frustrating and demoralising, as the researcher used to invest precious time and other resources in approaching the firms

Table 3.2 highlights the number of sample units included as case studies in the research. Over 75 IT and electronics firms were contacted in Bangalore and Mysore, and the table includes only those firms, whose complete information could be recorded.

3.3.6 UNDERSTANDING THE CAUSAL REASONS FOR BANGALORE'S SUCCESS IN ATTRACTING THE IT INDUSTRY

3.3.6.1 Secondary data

As is clear from the focus of the research, especially to evaluate the competitive position of Bangalore, it was essential to collect a large number of data on various crucial factors that govern the development of the IT industry in India. Along with that information on the urban area level, and information at the firm level was also gathered.

From the conceptual point of view, the secondary data analysis brought to the fore various factors that have been considered for studies related to the high technology firms' concentration in urban areas, and to some extent the study of urban competitiveness. Secondary level data has also been exhaustively used to understand the spatial dynamics of the IT industry at the global level, and the characteristics of the IT industry in India. It also proved to be a valuable source in attempting to understand the regional variation of the IT industry within India. The secondary data for this research has been collected from the following sources.

- *Global Level*

Datamation Annual Issue, Business Week, Byte Magazine, Financial Times archives (FT-IT Reviews, FT-Telecommunications reviews, and FT country surveys), The Economist, Economist Intelligence Unit (EIU), Far Eastern Economic Review, World Bank reports, documents and research publications, journal articles, books, and Websites of various multinational and Indian IT companies.

- *National Level*

Department of Electronics (DoE), Ministry of Commerce, Department of Telecommunications (DoT), Census of India, Software Technology Parks of India

(STPI), Delhi School of Economics Library, National Council for Applied Economics Research Library, Confederation of Indian Industry (CII), Indian Institute of Foreign Trade library, Offices of Dataquest, PC Quest Magazine, Computers Today and Business Today, and Information Technology in Delhi, NASSCOM, and MAIT.

- *State and City Level*

Consortium of Electronics Industries of Karnataka (CLIK), Greater Mysore Chamber of Industry (GMCI), Technical and Economic Consultancy Organisation of Karnataka (TECSOK), Indian Institute of Management (IIM- Bangalore), Indian Institute of Science (CEDT- Centre for Electronic Design and Technology, IISc Library, and Centre for Management Studies), Karnataka State Electronics Development Corporation (KEONICS), Karnataka State Financial Corporation (KSFC), Karnataka State Industrial Investment Development Corporation (KSIIDC), Karnataka Small Industries Development Corporation (KSSIDC), Karnataka Industrial Areas Development Board (KIADB), DoE's Software Technology Park in Bangalore (STP-B), Office of the Commissioner for Industries, Information Technology Parks Limited (ITPL), Corporate office of Bharat Electronics, Bangalore. Offices of Business Line, Hindu, and Business Standard Newspapers in Bangalore, British Trade Office in Bangalore, District Industries Centre (DIC)- Bangalore, and NTTF Electronics Training Centre at the Electronics City.

3.3.6.2 Interviews

The aim of these interviews was to gather an in-depth knowledge about various aspects of the IT industry's function; the competitive position of the Indian IT industry in the global market; the support available to the IT industry at the national, state and the local level; reasons for choosing Bangalore as a production base; and opinion on the infrastructure availability in Bangalore to sustain the growth of IT industry in the city.

- *Interviews with major decision makers*

As a first step, the Department of Electronics (DoE), Government of India (GoI) was the major point of contact. In-depth discussion about various aspects of competitiveness of Indian IT industry was held with the Senior Director of the *Information Technology Group and Computer Development Division.* On the specific issues of software and providing the necessary infrastructure to the Indian software industry, the Director of *Software Technology Parks of India (STPI)* was contacted. The discussions with the Director of STPI at the centre level, and with Director STP-Bangalore proved to be extremely useful, in placing the Indian software industry in the context of the global competitors.

Major decision makers at the state level were also met. They include the Managing Director of *KEONICS*- nodal agency for electronics development from the Government of Karnataka point of view, Managing Director- *Karnataka State Financial Corporation (KSFC)*, which is the main agency for funding the small scale industries (as defined by the Government of India) in the state. The promotion and development of small scale industries is looked after by the *Karnataka State Small Industries Development Corporation (KSSIDC).* The Executive Director of KSSIDC provided an outline of promotional schemes for small scale manufacturing units in the state, and gave information about various thrust areas identified by Government of Karnataka. The Chairman of *Karnataka State Industries Investment Corporation (KSIIDC)*, provided the much needed information about the industrial infrastructure in Bangalore, and the state as a whole. Technical aspects about the industrial scene of electronic industries in Bangalore have been obtained from the *Technical and Economic Consultancy Organisation (TECSOK).* The advisor for electronics sector in TECSOK was an extremely useful contact and his help was enlisted in selecting some of the case study units. The *Commissioner for Industries, Government of Karnataka*, provided information about the overall industrial scenario in Bangalore and the state, and helped in placing the study in a more contextual way. The Business Development Manager at the *Information Technology Parks Limited (ITPL)*, provided a detailed account of IT infrastructure being provided in the Information Technology Park in Whitefield area of Bangalore. ITPL is a joint venture where Singapore Consortium, the TATA, and KSIIDC have shares of 40:40:20 respectively.

These "elite" interviews varied in length, locale, degree of respondent openness, and overall success. Most fruitful were those interviews obtained by referral from a close colleague of equal status. On few occasions when, despite all efforts to secure at least an hour-long conversation, it became obvious that only a very short time was made available. Hence, at that level, questions were confined to the most critical issues and request was sought to get referred to lower-level personnel, who could provide additional information.

An unstructured interview format was used whereby the respondent was encouraged to talk freely on selected topics. Interviews were not recorded. Instead, brief notes of names, data cited and key words to facilitate recall were taken and a full transcript of the interview was written up the immediately after the interview. The time and care spent in setting up these meetings proved extremely rewarding. Invaluable too were the interviews carried out with lower level officials. Here, an in-depth understanding of specific decisions taken were carried out.

- *Interviews with Industry Associations*

Different kinds of organisations emerge at different stages of industrial growth in a region. This fact meant that several organisations had to be met. The main concern was to describe the attributes of the organisations, their motives, and functions. They were asked about the causes behind the organisation's formation. The support of governmental agencies. The problems encountered in getting the necessary infrastructure for the IT industry. Many of the industrial leaders had been involved in the association affairs over a long period of time, and it was interesting to get their views about how they perceive the industry-government relationship has changed over the years.

Most of the members of the associations were willing to meet and to be interviewed. Indeed, their support and approval was carefully sought before embarking upon detailed field work of the industry. The main reason being that the IT industry is very competitive all over the world, and firms are generally very reluctant to speak about anything, unless they are assured it will be kept confidential, and will not be used against their interests. It was only under this condition, all the firms contacted were willing to speak. As a result none of the firms allowed any video recording of their facility or even photographs. There was a need to convince the firms that the research was not to jeopardise their competitive position, and that the findings of the study would not prejudice the interest of other entrepreneurs.

Once good relations were established, it was possible to become closely involved with some of the firms. Discussions again at the association level were kept unstructured, and like interviews with agency heads, a free and open format was kept. Similarly, only brief and occasional notes were taken and the interview was written up immediately afterwards. Insights that were gained from them about the association-government relationship proved a critically important ingredient in the analysis.

3.3.6.3 Firm level study

The aim of the firm level survey was to obtain information about the origin, growth and problems faced by firms at different location in the city. The questionnaire was organised under seven major themes. A semi-structured format was adopted in the questionnaires which had both structured and open ended questions. These questionnaires were piloted in Delhi for their content, and later in Bangalore for their context. Considering the feed back from the pilot survey, the final questionnaire was designed.

More specifically, the questionnaire sought information on the following issues: (1) general information of the firm (2) product profile, (3) main factors influencing the firm's decision to choose Bangalore, (4) industry-research Lab interaction on R & D and new product development, (5) issues related to government support, (6) infrastructure support for the IT industry in Bangalore, and (7) major problems faced by the IT companies in Bangalore. This formed the crucial aspect of the study based on which Bangalore's competitive position has been appreciated in the study. Appendix 1 outlines the questionnaire administered to the case study firms.

There were a number of questions that had a yes and no answer. Research studies have indicated that in such a YES-NO situation, there is often an order bias. This basically means that, if the researcher has "No" as the first option for a question, due to such a bias, it is likely that there may be more respondents answering "No". There were a number of crucial questions that were structured on a YES-NO format, often followed by supportive statements. There was no way such a bias could be accounted for in the study. Hence, both the order of the questions and that of the attributes were rotated from respondent to respondent in order to avoid any kind of order bias that could distort the results.

3.4 CONCLUSIONS

Based on the crucial analysis of the secondary and primary level data complemented by interviews from industry associations, and policy makers, a detailed understanding of the causal reasons for Bangalore's pre-eminence in the IT industry in India has been offered. The secondary level data facilitated the crucial macro level and meso level analysis of understanding the spatial dynamics and characteristics of the IT industry at the global and the national level.

Together with those analyses, and with the detailed study of the 52 IT companies in Bangalore form the crux of the present research. In the next section of the dissertation (Section B), first an analysis of the IT industry at the global and the national level is provided.

PART B STRUCTURE OF THE IT INDUSTRY

4 GEOGRAPHY OF THE WORLD SOFTWARE INDUSTRY

4.1 INTRODUCTION

The focus of the present research is to investigate how Bangalore has emerged as the most preferred centre in India for the location of the information technology industry. As a backdrop to the study, this chapter describes the geography of software industry in the world. It sets the context of the research which leads to the next chapter, in which an in-depth discussion on the software industry in India is carried out.

Within the overall set of technologies that make up IT, software is vital since other aspects of a given (information) system cannot function without it. 'Software has also been forming a growing component of overall value within IT and is increasingly assuming a pivotal role in a vast and highly diversified range of products and services' (Heeks, 1996:23). Software also constitutes the fastest growing segment of the IT market. 'The software sector is targeted by hardware suppliers and specialised firms alike' (Correa, 1996:171). Thus the study of software industry becomes an aspect of great importance to the current research. Moreover, an analysis of all the aspects of the IT industry at the global level would be too general, and beyond the scope of the current discussion.

A detailed discussion on the global software industry is deemed essential, as it analyses how the "geography" of the industry is changing (albeit slowly) from traditional strongholds like United States and Western Europe to Asia and other parts of the world. Although United States is still the world leader in software industry, countries like Brazil, India, and Singapore are emerging regional powers. An investigation of world-wide software industry would help in explaining why certain countries in the developing world have been able to emerge as leaders.

This chapter is organised in nine sections. After the introduction in the first section, the second section provides an overview of the software industry in the world. Since the discussion is about software industry, it is essential to clarify certain terminologies and data sources which have been used in the chapter (and elsewhere in the research), which has been done in the third section.

The technical and market related aspects of software industry have received considerable attention over the years, but the economics of software production have been studied to a very limited extent[33]. Some issues related to the economics of software production are discussed in section four. The fifth section is devoted to the growth of the global software industry, which is followed by a discussion on the major trends occurring in the industry in section six. The changing nature of global competition in the software industry is the focus of the seventh section. An overview of the major software producing countries (including India) is presented in the eighth section. The last section provides some concluding remarks about the issues examined here.

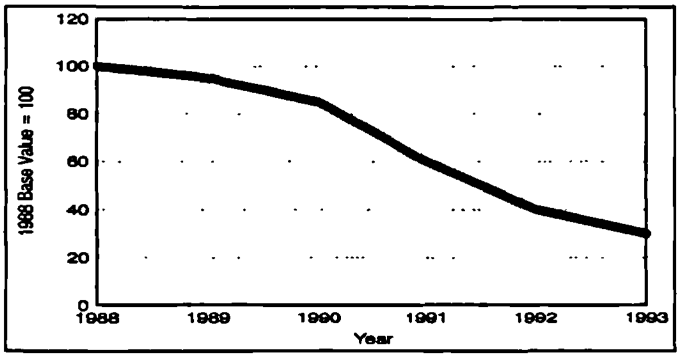
4.2 AN OVERVIEW OF THE SOFTWARE INDUSTRY

Today's world is a world of information, and it is an information age. Anyone who has access to information and controls information sources is in a better bargaining situation than someone who lacks it. As computers become more and more common, and coupled with continued fall in their prices, information technology (IT) is diffusing rapidly into all industrial and service sectors and is now seen as one of the most crucial technologies determining the economic growth and development of any

[33] A detailed discussion on this subject can be found in Correa (1996)

country. It was mentioned in chapter one that the cost of computer processing power, has been rapidly falling rapidly. Fig 4.1 depicts the rapid decline in the cost of personal computers (PCs) that has taken place since 1990. As evident from the figure, the base price of the PCs (in this case in France) has fallen from 100 in 1988 to 30 by 1993.

Fig. 4.1 The plummeting cost of personal computers



Source: Graham and Marvin (1996)

The software engineering field is rapidly evolving, and the production of software is becoming less labour intensive and more technology intensive. The key questions for countries wanting to reach the leading edge of software technology are: 'What are the trends in international competition? What are the characteristics of new technologies that affect software production? In the face of serious software backlogs and shortages of labour, what types of skilled labour are most needed' (Schware, 1992: iii).

Although it is indeed true that access to the latest technology definitely has an enormous effect over a country's capacity to produce software, still other factors (for example, availability of software professionals) do play an important role in determining the competitiveness of firms. An important issue in this regard is the organisation and management of software production. The alliances that help penetrate the world software market and deliver competitive advantage are also vital in this regard. The prospects of countries entering the software business will depend a great deal on the way software firms mature organisationally and technically, as well as on ways in which firms can build alliances with foreign partners. This must be kept in mind today, when planning or building the software industries of tomorrow.

'If these industries are to become internationally competitive, the strategic alliances that are now unfolding in software development cannot be ignored' (*op. cit.* p.2).

Software industry is still a nascent industry, in which US, Japan and some western European countries have had almost exclusive control since the beginning. But now the industry is rapidly developing in Asia and Southeast Asia. 'In 1990, the world-wide market for software was to the tune of US $ 100-120 billion' (Siwek & Roth, 1993 : 28). But most of these are just estimates, and should be treated with utmost caution. Schware, in his work on global software industry projected that the software market would reach a figure of US $ 340 billion by 1996 (Schware, 1992:1).

Schware identifies five major forces that are operating to govern changes in the global software business:

a) 'a severe software personnel constraint, with software and software related support activities now accounting for the overwhelming percentage of total system costs;
b) the global battle for operating system standards;
c) the move away from single vendor solutions as the typical way for organisations to meet their information system needs toward customised integrated, multi-vendor hardware and software solution;
d) the increasing emphasis on software production and sales by hardware vendors, leading to increasing concentration within the industry of large and medium-sized firms; and
e) at the same time an expansion and fragmentation of the industry resulting in a growing number of independent software vendors' (*ibid.*).

These factors no doubt do govern the nature of software industry developed in the different regions of the world. However, as mentioned by Schware, shortage of professional skills and very high wages in the developed world are the most important factor governing the shape of industry, as it is primarily because of these factors that the industries from the developed world are moving to regions where the same high quality software professionals are available in abundance, and who could be hired at comparatively low wages.

Before proceeding to discuss the software industry in detail, the next section seeks to provide an understanding of how to study the industry, including data sources, and the various terminologies used in the industry which are relevant to the study.

4.3 UNDERSTANDING THE SOFTWARE INDUSTRY

In order to understand international trends in the software industry, it is also essential to understand the basic words and key terminologies (that are relevant to the current research) used in the industry. In the discussion that follows, only those terms[34] have been used which have a direct relevance to the present research. It is beyond the scope of present research to provide an overall view of major trends occurring in the global software industry. The concentration, therefore is mainly on the sales figures. In certain cases, market share[35] has also been used. Unless specifically stated, wherever prices are mentioned, it is current prices only (in US $).

4.3.1 Definitional Aspects

Software is all or part of the programmes, procedures, rules, and associated documentation of a data processing system. 'Software is an intellectual creation that is independent of the medium on which it is recorded' (IBM, 1994:632). '*Software engineering* is the systematic application of scientific and technological knowledge, methods, and experience to the design, implementation, and testing of software to optimise its production and support' (*op. cit.* p.633). The term software refers both to the instructions that direct the operations of the computer equipment, and the information content, or data, that computers manipulate.

There are generally two types of softwares:

1. *Systems Software*- which is 'an application- independent software that supports the running of an application software. It is that software which is part or generally made available with a computer system and determines how application programmes are run; for example an operating system- that controls input and output operations' (*op. cit.* p.676) and;

[34] The IBM Dictionary of Computing (1994), offers a comprehensive list of terms used in the industry
[35] Market share is the proportion of the sales of an industry sold by a particular firm or a group of firm

2. *Application Software-* that 'is specific to the solution of an application problem. It is a software coded by or for an end user that performs a service or relates to the user's work. Software products, such as games, spread sheets, and word processing programmes designed for use on a personal computer, fall under this category' (*op. cit.* p.29). Each type of software can be distinguished by the use to which it is put- *systems software* solves computer problems, *application software* solves user problems.

Systems Software is an integral component of an information system. Its function is to control the hardware, including any peripheral equipment like printers, keyboards, scanners, modems, displays, and memory storage devices, and to schedule and regulate the execution of application software depending on how much processing time and memory capacity they require. According to Schware, 'a recent trend encouraged by the spread of personal computers and independent software vendors, has been toward the standardisation of system software so that a large number of applications programmes can run on different types of computers'(Schware, 1992:2). As the IT companies continue to develop products that are more powerful, more versatile, and less expensive than earlier ones (Fig 4.1 provided an illustration), most hardware manufacturers and systems software vendors consider this versatility -or portability-of systems software a priority. Schware opines that, 'without the portability of systems software, these firms would forfeit their substantial investments in software development whenever a new generation (estimated by some in the computer service industry at two years) of more powerful and capable systems replaces an older line. Since portability of systems software ensures that a ready supply of applications programmes is immediately available for a new system, thus providing firms with a considerable market advantage' (*op. cit.* p.92).

Applications Software, is largely developed by trained software designers, computer programmers, and system analysts, knowledgeable about computer systems and the need of end users- who have no particular interest in the technology itself, but only in its capabilities and results. Since they are user specific, applications software can vary from a personnel data base management system on a small micro computer to a complex, real-time system that calculates stability and control characteristics of aerospace vehicles on a large mainframe computer.

The global software industry is too diverse to be placed in the above mentioned two categories alone. It is necessary to understand and recognise that there are considerable amount of softwares which are between these two extremes. Such knowledge makes firm more competitive, and allows for innovation based on the latest development in the field of IT. Often the needs of the computer users are very specific limiting to an organisation, platform, environment, or a geographic region. This allows firms to carve out a niche for themselves in the selected software segments. And since IT business and the needs of the computer users are growing globally, the relative importance of firms able to cater to specific software requirements is also likely to grow.

4.3.2 DATA SOURCE PROBLEMS

Anyone doing research on world software industry has to confront a multitude of data sources which appear to contradict one another. Information about the industry in the last decade (1985-95) is not difficult to obtain. However, to build a time-series analysis of the industry is the most difficult task, given the unreliability and inconsistency of data sources.

Most of the sales figures about software companies are primarily based on market surveys. Systematic data on sales of software and software services exist only in few countries, and even these data are suspect, largely due to the methodology adopted for their collection. The International Data Corporation (IDC) regularly collects and publishes internationally comparable data on software sales, based on surveys conducted in the US and in some western European countries. Schware finds IDC's research methodology to be haphazard. He claims that 'some of IDC's surveys do not look at the performance of US based companies outside the US, including the activities of subsidiaries and plants. Its US Census includes only 200 or so of the 9,000-12,000 US Software companies' (Schware, 1992:7).

The lack of government and industry statistics makes it practically impossible to make cross country comparisons. For example, in the US, the software industry is officially classified by the Census Bureau's Standard Industrial Classification into: (a) custom software programming and consulting, or "professional services"; (b) packaged software; (c) systems design and integration, or "turnkey systems". However, in Korea the software industry is divided into five categories: (a) system programmes (control programmes and language processing programmes); (b) library programmes (numerical analysis, statistics); (c) utility programmes; (d) application programmes (business, management, science, etc.); and (e) others (*op. cit.* p.5). Since official production and trade statistics are not available for the software industries in most economies, one must rely instead on data from industry sources, which in most cases are scanty, inconsistent and unreliable.

Some information industry journals, such as Datamation and Software Magazine (both published from the US), collect information mostly on the revenues and earnings of companies on a so called "world-wide" basis. But figures listed in the annual "Datamation 100" survey are limited to 200 companies only. Software Magazine's annual ranking of the top 50 independent software vendors is based on revenues only from packaged software products and that too from US vendors alone. Consulting, training, and other services are not included, nor are hardware vendors that sell packaged software such as IBM, or DEC. Hence many other computer magazines use the expression IT[36] to encompass software, hardware, peripherals and services in their annual rating (for example Dataquest Top ranking of IT firms in India uses this kind of comprehensive methodology). Fortune Magazine and Business Week[37] also provide listings of top companies.

It is important to note that each magazine has its own format and style of presentation. While some follow sales or market share figures as a yardstick, other treat revenues as the major criteria for ranking. All this makes it an extremely difficult task to compare and provide a meaningful analysis of the global software industry. The problem is further compounded when such an analysis has to be carried out over a period of time. It is indeed very important to bear in mind the handicap of data sources while carrying out an understanding of the global software industry.

[36] Throughout the text, the expression "IT" is used to include computer hardware, peripherals, software and services.
[37] These are not specific to the IT industry, and include all other industries as well.

The measurement of software sales and services[38] (including customised software, systems support, time sharing, on-line[39]services, real time[40]services, training, documentation, and database access) is made more difficult by the parallel phenomena of consolidation and overall industry growth that blur the distinction between the software and service market segments. Software firms are expanding the services parts of their businesses, and services companies are increasingly stepping up their packaged software efforts in order to build stronger bases.

Having described the basic definitions used in the research in the context of the IT industry, and having explained the problems, a researcher will face in analysing the global software industry, an understanding of the economics of software production is provided in the following section.

4.4 THE ECONOMICS OF SOFTWARE PRODUCTION

The software development process has several characteristics determined by the nature of its technology and its products. Correa (1996:180) identifies seven major characteristics of the software development process:
'*Firstly*, software development is skill-intensive. The availability of qualified technical personnel clearly is the key factor, albeit not sufficient, to ensure commercial success. Capital investments required- including hardware and software engineering tools are not as substantial and do not constitute an entry barrier as in other areas of IT.' However, already indications are available that capital costs are increasing with the growing automation of software development tasks.

'*Second*, the technology for software development is largely available at universities and research institutions. The basic knowledge to create computer programme is

[38] The term software services has been extensively used in this and the next chapter. Although there are country variations in this, the definition for software services adopted by the study include: customised software, systems support, time sharing, providing real time solution, training, documentation, and database access.
[39] This means that information stored in a computer system can be displayed, used, and modified in an interactive manner without any need to obtain hard copy.
[40] This term is used to describe systems operating in conversational mode and processes that can be influenced by human intervention while they are in progress. The 'Next Train' display in the London Underground, which shows the time left for the next time to arrive, is a typical example of a real-time system.

accessible to individuals with some level of mathematics[41]. The knowledge involved in software development, however, constitutes a more complex technology where other skills (like computer architecture etc.) are also required.'

'*Third*, despite the high degree of formalisation of knowledge involved in software development, a lot depends on a person's creativity. *Fourth*, time and monetary investments necessary to develop systems software are also generally higher than for application software.'

'*Fifth*, like the capital goods industry, software may be produced to meet a particular client's demand (custom) or as a standardised product'(package). '*Sixth*, an understanding of users' requirements is essential for software creation. *Finally*, the rapid pace of technological change and the short life cycle of products force software companies to undertake research and development (R&D) and to invest in training for new technologies'.

Since the traded software market is rapidly expanding, technology for software development and production is becoming much sought after. Software development is skill intensive, rather than capital intensive, and not only that, it also depends heavily on the training support for software industry available locally.

Since the industry is primarily governed by the availability of skilled software professionals, the industry will concentrate and move to regions where such professionals are available and that, according to Correa (1996), explains at least partially the reasons why some developing countries have been able to develop a domestic as well as a globally competitive software industry.

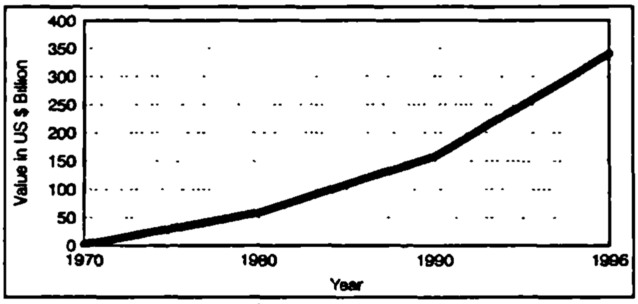
4.5 GROWTH OF THE GLOBAL SOFTWARE INDUSTRY

In the early years of the computer industry manufacturers supplied all the required softwares 'free' with their machines. But International Business Machines (IBM) realised in the late 1960's that software could become a golden stream of new

[41] In India, mathematical skills are emphasised among the children both at the schools and at home by parents. Thus a "tradition" of mathematical learning in general is imbibed on any educated individual in India.

revenue, and it started to charge separately for hardware and the software. By doing so, it gave birth to the independent software industry, giving other companies a chance to supply programmes for IBM computers more efficiently than IBM itself. It was only from the late 1970s onwards that a substantial global software market came into being. Till the late 1970s, the global software market was worth less than US $ 50 billion (Fig 4.2). The world market for software and services increased from approximately US $ 50 billion in 1982 to US $ 108 billion in 1987. It continued to grow in the 1980s, and took off from 1990.

Fig. 4.2 Growth of world software market (current prices)



Source: Siwek & Roth (1993); Dataquest (1996)

In the mid 1990s, the global software market was worth more than US $ 350 billion (Dataquest, 1995). Table 4.1 illustrates the growth of domestic software market in selected countries between 1985 and 1987. Although US, Japan and Western Europe were still world leaders, other countries like, Singapore, Taiwan and India also recorded an impressive growth of around 50 percent between the period 1985-87 (Table 4.1). Table 4.2 and Table 4.3 shows the leading software vendors around the world in 1987 and 1989.

Table 4.1 World software* market (sales in US $ millions), 1985 and 1987

Domestic Markets	Software		Growth Rate (%)
	1985	1987 **	1985-1987
United States	16,546	23,610	29.9
Japan	2,861	3,999	28.4
France	2,159	3,157	31.6
United Kingdom	1,831	2,771	33.9
Germany	1,864	2,730	31.7
Italy	1,071	1,677	36.1
Netherlands	575	833	30.9
Canada	598	783	23.6
Sweden	344	534	35.5
Switzerland	341	501	31.9
Spain	305	518	41.1
Belgium	300	440	31.8
Denmark	209	316	33.8
Norway	188	300	37.3
Finland	186	282	34.0
Austria	188	275	31.6
Australia ***	500	737	32.1
Total	**30,066**	**43,463**	**30.8**
Others ****	**860**	**1,652**	**47.9**
TOTAL	**30,926**	**45,116**	**31.45**

Note:

* Software data include related consultancy and software bundled with hardware by hardware manufacturers.

** 1987 figures are estimates.

*** Australian figure reflects unbundled software only. Software values also include facilities management.

**** Israel, India, Brazil, South Africa, Mexico, Korea, Singapore, Taiwan

Source : Adapted from Schware (1992)

Table 4.2 World : Leading software vendors in 1987 (revenues in US $ millions)

Name of the Company	Revenues (1987 Prices)
TRW, Inc.	1,780.0
Automatic Data Processing Inc.	1,467.0
Electronic Data Systems	1,440.0
Computer Sciences Corporation	1,133.0
Unisys Corporation	1,120.0
Societé Generale	898.4
Control Data Corporation	896.4
International Business Machines (IBM)	850.0
McDonnell Douglas Corporation	830.2
Arthur Andersen and Company	705.9
Martin Marietta	685.7
Cap Gemini Sogeti	682.3
Nippon Telegraph and Telephone Corporation	565.6
General Electric Company	450.0
Emhart Corporation	404.8
NCR Corporation	396.0
Wang Laboratories, Inc.	218.9
Digital Equipment Corporation	171.5
Xerox Corporation	85.0
Honeywell Bull Inc.	82.4
OKI Electric Industry Co., Ltd	75.7
AT&T Corporation	50.0
COMDISCO, Inc.	43.0
National Semiconductor Corporation	20.0
Total US	**13, 831.1**
Total Japanese	**641.3**
Total European	**1,580.7**

Source: Schware (1992)

Table 4.3 The Top 10 global sellers of software products and services (1989)

Firm	Country	Software Revenue (US $ Million)	Total IS* Revenue (US $ Million)	Software as % of IS* Total
IBM	US	8,424	60,810	14
Fujitsu	Japan	1,450	11,380	13
Computer Associates	US	1,290	1,290	100
NEC	Japan	1,065	11,480	9
Unisys	US	875	9,400	9
DEC	US	825	12,940	6
Microsoft	US	821	953	86
Hitachi	Japan	725	8,720	8
Siemens	Germany	638	6,010	11
Hewlett-Packard	US	600	7,800	8
Total Top 10		**16, 713**	**130, 783**	**13**
Top 10 Share of World's Software Revenues		**37%**		
Top 10 Share of World's Total IS * Revenues			**43%**	

Source: Science Council of Canada (1992)
IS* : Information System (constitutes the complete information system package, like the hardware, software, and peripherals)

Table 4.4 Big 11 Software companies world-wide (sales in US $ million)

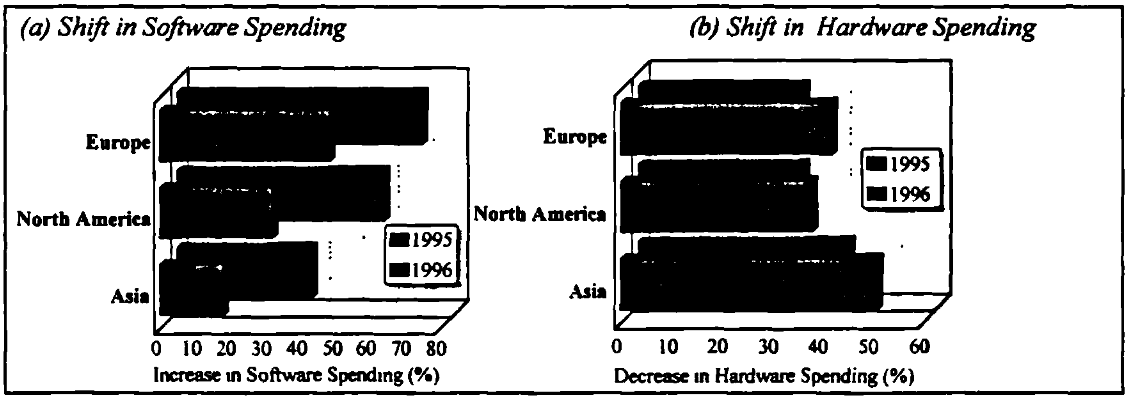
Name of the Company	1992-93	1993-94	% Change
Dun & Bradstreet	4,760	4,896	2.86
Microsoft	4,110	4,649	13.11
Computer Sciences	2,500	2,583	3.32
Automatic Data Processing	2,340	2,469	5.51
First Financial Management	1,673	2,208	31.98
Computer Associates	2,050	2,148	4.78
Comdisco	2,036	2,098	3.05
Oracle	1,690	2,001	18.40
Novell	1,120	1,998	78.39
First Data	1,500	1,652	10.13
Equifax	1,215	1,422	17.04

Source: Computers Today, June 1995 :167

The predominance of US software companies is well illustrated by Table 4.3, where six of the top ten software companies are American. By the middle of 1990s, the world leaders (companies) in software industry (within USA) had changed, and included names like Microsoft, Dun and Bradstreet, Oracle, and Novell among the top software companies in the world (Table 4.4).

Thus software has become a commodity with a world-wide market, and it has continued to grow and has become relatively more important than the computer hardware. In a survey of IT Companies (Computers Today, September 1995:119), it has been found that spending on software will increase from 35 percent in 1993 to 58 percent of the total expenditure in IT by the end of 1996. By region the study projected an increase (in software spending) from 48 to 70 percent in Europe, 32 to 59 percent in North America, and in Asia from 18 to 38 percent. The study[42] also highlighted that there will be a drop in hardware spending during the same period, which has been replaced by spending on software. The study points that such a trend is likely to continue in future as well. It also forecasts a fall in hardware spending in Europe from 42 to 33 percent, in North America from 38 to 33 percent and in Asia from 51 to 42 percent (Fig 4.3)

Fig. 4.3 Europe, North America, and Asia : Shift in spending by IT industries



Source: Computers Today, September, 1995 : 119

[42]The research was conducted by the X/Open Company with the international market research firm Dataquest (**not the Indian one**) and involved 57 prominent computer-user groups in Asia, Africa, the Middle East, the Americas, and Europe. Those surveyed were senior IT managers from more than 750 enterprises representing over 40 countries and six continents.

4.6 MAJOR TRENDS IN THE SOFTWARE INDUSTRY

The main purpose of this chapter is to provide an understanding of some of the major trends in the global software industry and of the role played in this by main players (companies and countries) in the industry. It is beyond the scope of the present research to discuss all the emerging trends in the software industry. The discussion focuses on issues that are of direct relevance to India and to Bangalore. The progressive reduction in the physical size of computers over the years has made it less expensive, which has led to an increase in the user base. That in turn has led to a rise in demand for software and for software professionals to design software products for various business and technical purposes. At the same time, there is a severe shortfall in the supply of software professionals in the developed countries, and to avoid any serious delays in the projects, many of the software companies in USA and western Europe are outsourcing various aspects of the software development activity to countries that have demonstrated technical competence. While making a decision, firms have chosen countries that have comparatively lower wages than the country of its operation along with the technical competence of the professionals. These are some of the crucial factors that are redefining the geography of the software industry, and are discussed here.

4.6.1 THE PHYSICAL SIZE OF COMPUTERS IS COMING DOWN

Technologically, the development of software industry is intrinsically linked to the hardware industry. Continued Research and Development (R&D) in the field of computer sciences, has enabled to reduce the physical size of computers that were used in the 1960s and the 1970s. Combined with a reduction in the physical size of computers, there has been an enormous increase in their computing power as well.

Table 4.5 World: Computer sales by system type (in US $ billion)

System Type	1991	1992	1993	1994*	1995*	1996*	1997*
Super Computers[1]	4	4	4	4	5	4	5
Mainframes[2]	73	72	78	80	80	79	82
Mini Computers[3]	62	61	64	65	63	63	66
Work Stations[4]	18	20	24	28	32	36	40
Servers[5]	9	11	13	18	26	34	38
Personal Computers[6]	144	159	178	200	223	243	264

* Estimates

[1] Any of the class of computers that have the highest processing speeds available at a given time for solving scientific and engineering problems

[2] A computer, usually in a computer centre, with extensive capabilities and resources to which other computers may be connected so that they can share facilities.

[3] A digital computer that is functionally intermediate between a microcomputer and a mainframe. It is an intermediate-size computer that can perform the same kinds of applications as a mainframe but has less storage capacity

[4] A functional unit at which a user works. A workstation often has some processing capability. Most often a work station is connected to a mainframe or to a network, at which a user can perform applications. A network is a configuration of data processing devices and software connected for information interchange. A group of nodes and the links interconnecting them.

[5] A functional unit that provides shared services to workstations over a network; for example a file server, a print server, a mail server.

[6] A PC is a microcomputer primarily intended for stand-alone use by an individual. A desk top, floor-standing or portable microcomputer that usually consists of a system unit, a display monitor, a keyboard, one or more diskette drives, internal fixed-disk storage, and an optional printer. PCs are designed primarily to give independent computing power to a single user, and hence the name stand alone.

Note Source: IBM (1994)
Table Source: Computers Today, June 1995: 166

Thus mini and personal computers are now used to collect, access, and change data once processed only on mainframe computers. Computer users also find it to their advantage, that, with downsizing total operating costs are reduced. Added to it, mini and personal computers offer on-line, real time, performance, as opposed to the queue system imposed by central mainframe computers. Between 1991 and 1995, the combined PC and mini computer market grew by 42 percent, and the PC market alone grew by over 35 percent (Table 4.5).

4.6.2 WAGE DIFFERENTIALS AND SHORTFALL OF PROFESSIONALS AMONG COMPETING COUNTRIES

Consequent to the fall in the hardware prices, which has increased the user base, there is a rise in the demand for software also. This allows software suppliers to lower prices by amortising development costs over larger unit sales. According to

Schware, 'although the demand for software is increasing at an annual rate of approximately 12 percent (between 1982 and 1992), yet the number of software professionals grew at only about 4 percent annually (in the same period)' (Schware, 1992:8). At the same time, according to him 'productivity in developing software has increased slowly- perhaps 5 percent per year - leaving a significant annual shortfall of software developers' (*ibid.*). This has been significant to the development of the global software industry, and its geographic spread,[43] in the last ten years as companies (especially in the developed world) kept in mind the backlogs in the turnover of the professionals, and planned their investments in regions/countries which offered increased availability of good quality software professionals.

The backlog of software professionals in the developed world has resulted in a software productivity bottleneck and has forced the software companies to focus their attention on world-wide productivity in the generation of software. In addition, software and software related activities such as training, documentation, and maintenance increasingly account for a far greater percentage of total system costs than in earlier years (Nolan et al., 1988).

It is here that countries like India can offer very competitive location for software and support activities (Dataquest, 1995). Nolan et al. (1988) estimate that more than 50 percent of personal computing direct costs are consumed by such support activities. The increasing demand for software, and increasing shortfall of trained professionals in many parts of the developed countries have led the firms to look for suitably trained professionals overseas, or start off-shore activities. In many cases, software professionals are invited from another country to work on a client site (which has been very commonly referred to as *body shopping*[44]).

[43] Especially to countries like India, and Brazil

[44] "Body shopping" is very cost effective for companies, as well trained software professionals can be hired at almost a fraction of the cost paid to local software professionals. Although since 1994 countries like the United States have imposed stricter work permit rules to reduce body shopping, the trade of "body shopping" continues unabated.

Table 4.6 USA and India: Difference in the annual salaries of software professionals (1995) in US $ and in PPP terms

Professional Category	USA (US $)	India (US $)	Annual salary in India at PPP [1]
Programmer	72,000-84,000	3,480-3,600	22,968-23,760
Programmer with 2-4 Years Experience	84,000-96,000	4,560-5,160	30,096-34,056
Systems Analyst	120,000-150,000	7,320-8,640	48,312-57,024
Project Manager	150,000 +	9,000+	59,000+

Source : Originally from Heeks (1996:115 and 117), PPP equivalent calculated by the author

[1] The adjustment for research purposes of data on the money incomes of workers to reflect the actual power of a unit of local currency to buy goods and services in its country of issue, which may be more or less than what a unit of the same currency will buy of equivalent goods and services in foreign countries at current market exchange rates. PPP-adjusted incomes are useful for comparing the living standards of workers in different countries. 'In 1995, 1 US$ = $ 6.6 PPP in India' (World Bank, 1995).

Table 4.6 shows the difference in annual wages between software professionals in India and US in US $ terms[45]. As evident from Table 4.6, companies looking for good quality software professionals could potentially save enormous sums of money by hiring Indian professionals instead of the ones from the US.

Ever since hardware manufacturers started marketing software products, the IT industry has undergone rapid standardisation all over the world. This has enabled software industry to produce and market large quantity of software in a relatively shorter time, as the platforms on which these software are executed are themselves largely standardised. With the standardisation of job activities, programming languages and hardware environments, the technology and skills within software production have become sufficiently stable to allow internationalisation of software services. Internationalisation of software services has further been fuelled by the severe shortage of software skills.

[45] A World Bank Report (1992) using 1990 data reveals that there has been a nominal increase in the annual salary of programmers in India in US $ terms. The Report quotes a figure of US$ 3,000 for a programmer in India. The annual salary of programmers in Ireland (US $ 25,000), Singapore (US $16,000), Israel (US $ 15,000), and Mexico (US $ 10,000) were far higher than the wages of programmers in India. A programmer in China, according to that report received an annual salary of US $ 1000 in 1990. Thus even in the span of three years, the average salary of a programmer in India did not rise sharply in US $ terms.

Table 4.7: UK, USA, and Japan : Estimated backlog of software professionals (1989-1993)

Country	Backlog of Software Professionals
UK	16,000 (1989)
USA	87, 000 (1992)
Japan	400,000 (1993)

Source : Heeks, 1996 : 108

The consequence is a huge backlog of software projects postponed or taking longer to complete because of lack of personnel to work on them, and a great desire of organisations in these countries to find all possible sources of available skills (Table 4.7). An understanding of wages of software professionals in the developing countries, and continued backlog of software professionals in the developed countries is crucial to the understanding of the geography of world software industry, and to the present research on Bangalore.

4.6.3 SYSTEM INTEGRATION

A major trend in today's software industry is to offer clients an integrated system, which involves integrating a number of different products from software vendors which are designed to work together as a single system. Now system integration services have begun to bring together different types of software and hardware and integrate them to provide a unique configuration more or less bespoke to end users' requirements.

The ever decreasing prices of computer hardware has enabled firms to take on system integration, or the progressive assembling of system components into the whole information system (IBM, 1994). A systems integrator combines standard hardware components with custom software- or certain standard software packages modified appropriately- in a unique configuration more or less tailor-made to end-users' requirements. This is a common trend all over the world. Even in India, the erstwhile PC manufacturers like Wipro, Tata-IBM, and Digital are providing system integration, rather than PC manufacturing. According to the Association of Data Processing Service Organisations (ADAPSO, 1987), systems integration is the process of identifying and bringing together various technologies in order to define and deliver a complete information package that will fulfil specific design, operational and management objectives.

Today such integrated systems are possible, largely due to efficient and latest satellite communication, modern networking technologies, and the growing use of multi-user, multi-tasking operating systems. Even a decade ago (in 1987), it was not economically feasible and technologically possible to cater to large number of users from a single operating system. Now it is possible to integrate the hitherto disparate components of a system: large and small computers from different manufacturers, packaged and custom-designed software. This is significant, because the greatest gains from the use of IT, in principle, come when components are integrated into a single networking entity. These technological developments throws open new opportunities for developing countries like India, which can now receive a particular aspect of system integration from a client, and through satellite communication send it back to the clients, any where in the world to be integrated into the overall package or system being developed. The system integration has also helped in the standardisation of many platforms, which again allows different tasks of the software development process to be carried out in different locations. Cities and regions that offer good telecommunications links, and that has a steady supply of professionals thus can receive many of those activities.

4.6.4 OUTSOURCING

Outsourcing really means finding new suppliers and new ways to secure the delivery of raw materials, goods, components and services. It means that 'you use the knowledge, experience and creativity of new suppliers which you did not use previously' (Rothery & Robertson, 1995:4). In fact according to same authors, the term "outsourcing" is itself 'too restrictive to describe what is really going on, and suggest that titles like "lean management", "subcontracting", "joint manufacture ventures" could also explain the process' (*ibid.*). The *outsource* could be defined as a service outside the company acting as an extension of the company's business but responsible for its own management, while *outsourcing* could be defined as employing an outside agency to manage a function formerly carried on inside a company.

Brief indication about IT outsourcing that was mentioned in chapter two is worth reiterating here. According to some authors, IT outsourcing will continue to increase. For example, 'estimates of market size vary but something like US $ 40 billion of IT work was outsourced by US-based organisations in 1995, with a growth rate of around 20 percent per year in the last five years (Heeks, 1996:110). Unfortunately due to the absence of reliable data, it is impossible to state clearly where the outsourcing jobs (in this context-the US based organisations mentioned above) would have been sent to. A possible explanation is that software professionals or companies in countries like India Brazil, and Mexico which have established themselves as location for competitive and reliable quality IT work (Schware, 1992), could be getting a substantial amount of the IT work that was outsourced.

Research on outsourcing

This discussion is largely based on two different sources, viz. McFarlan and Nolan (1995), Rothery and Robinson (1995) (Appendix 2, 3, and 4 provide details of IT outsourcing). Long-term sustained, management of a strategic alliance is turning out to be the dominant challenge of effective IT outsourcing. From a relatively unusual entrepreneurial activity, IT outsourcing has recently exploded across the global software business. According to McFarlan and Nolan, 'these arrangements are much easier to enter than to sustain or dissolve' (McFarlan & Nolan, 1995:9). One of the reasons why IT outsourcing alliances are difficult is because they are structured for long periods of time. 'In a world of fast-moving technical and business change, ten years is the normal length of the contract, at a time, when computer chip performance is shifting by 20 to 30 percent a year' (*ibid.*).

According to a study by Price Waterhouse (quoted in Milner, 1993), many managers dislike contracting out software development work but they do it because it offers their companies the flexibility to cope with fluctuating staff needs or changes in business direction, with freezes on in-house recruitment, with the skills shortage, and with the need for cost savings. It can also help focus in-house resources on strategic activities. There are some limitations: innovative and strategic applications are unlikely to be outsourced; and too much outsourcing may lead to protectionist reactions in some countries (Milner, 1993). However, the main indications according to Heeks (1996), are that the level of outsourcing will increase during the 1990s, and countries like India are well positioned to make best use of it.

4.6.5 APPLICATION DEVELOPMENT BACKLOGS

The current software development situation is such that the demand for computer applications is outstripping the ability of the principal software suppliers to supply programmes in a timely and cost-effective manner. According to Schware (1992), the mainframe users waited an average of 16 months for software system development, mini computer users 12 months, and personal computer users held steady at six months. Increasing demand for software coupled with the shortage of resources for providing it will give good opportunities, to the emerging software firms. Already software backlogs and personnel shortages are forcing certain European, American and Japanese companies to look offshore. Most of these firms have resorted to outsourcing to avoid any serious delay in their projects. Again, India and many other developing countries are likely to benefit from this. A good example of this is the so called "millennium bug[46]" (also referred to as the Y2K problem). A report by *The Economist* on October 3, 1997 estimates that the eventual cost of correcting the system clocks world-wide will be over US $ 300 billion (The Economist, 1997-c), and some estimate that up to '30 percent of IT budgets is likely to be spent on trying to fix the problem'(McCarthy, 1997:46).This is one of the most crucial task that companies need to undertake before the end of the year 2000, and there is a shortage of professionals (or in some cases the professionals rather prefer such tasks to be "outsourced") in the developed world, a large part of this conversion job will come to countries like India.

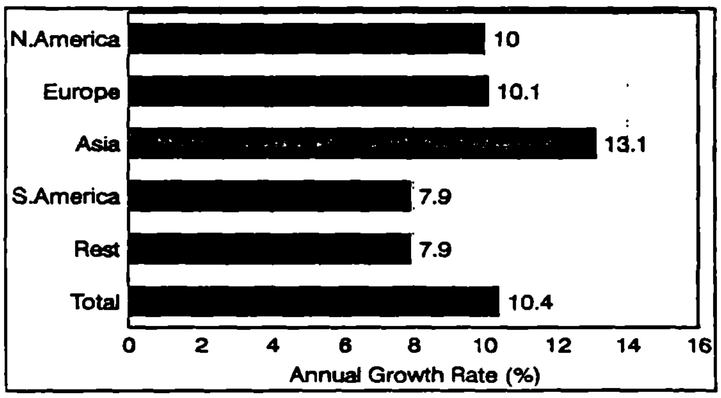
[46] The first generation of computer programmers in the late 1950s to save precious space on their punch-cards, recorded years as two digit numbers (for e.g. instead of 1960, they recorded it as 60). It was useful at that time, as it freed costly storage capacity for better uses. However, unless they are reprogrammed, many computers will crash or start to function incoherently on January 1st 2000, a date they will mistake for 1990. A number of consultancy documents are now afloat, trying to sell advice on how to swat the "millennium bug", that are predicting a nightmare day when the clock literally is turned back-affecting, the banking, transportation, and governmental operations world-wide, unless these systems are corrected.

4.7 THE CHANGING NATURE OF GLOBAL COMPETITION IN SOFTWARE INDUSTRY

Until few years back, software was largely an area of complete American dominance. 'The European and Japanese software industries have always had difficulty competing with the US because of the large US customer base and the homogenous nature of its market, which has no linguistic divisions and few differences in specification from state to state (Siwek & Roth, 1993). This has definitely provided US suppliers greater economies of scale in development' (Schware 1992:16).

In the early 1990s, North America was the largest market for computer software and services in the world, and was worth US $ 80 billion. 'However, between 1990 and 1993, the North American market has not grown as rapidly as the markets of Europe, and the Far East, and most experts expect these trends to continue in the future also' (Siwek & Roth, 1993:29). The trend is continuing. For the period 1980-90, the North American market (as measured by sales) grew at an annual rate of 10 percent in real terms after accounting for inflation, European market grew slightly more rapidly (10.1%), and Asia recorded the fastest growth of 13.1 percent (Fig. 4.4).

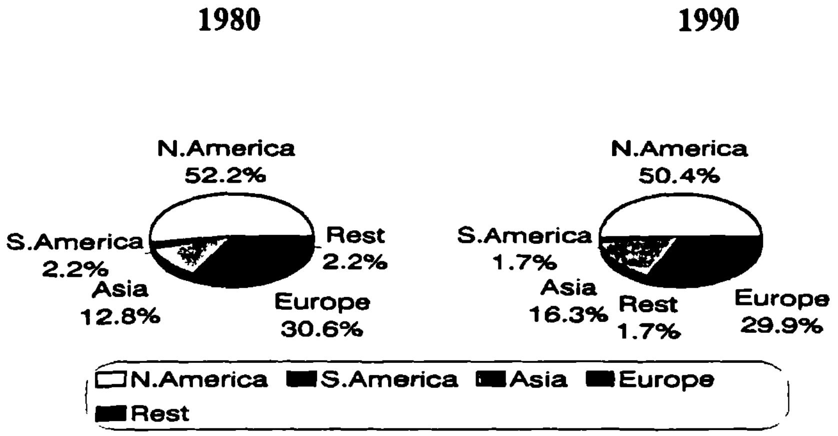
Fig. 4.4 World: Annual growth rate of software market by region (1980-1990) (sales)



Source : Siwek and Roth (1993)

Among the markets outside the US which has experienced rapid growth, Europe and Asia are the two important ones (Fig 4.5). Between 1992 and 1997, the European market is estimated to grow at 24 percent compared to a growth of 22 percent in the US (Schware, 1992). The Asian market is growing even faster. For example, the Indian software market is growing (sales figure) at an annual rate of above 35 percent during 1993-94 and 1994-95, and is estimated to grow beyond 50 percent during 1995-96 period (Dataquest, 1994 and 1995).

Fig. 4.5 World: The geographic share of software market by region (based on sales)



Source : Siwek and Roth, 1993

Further, 'while suppliers in Europe and Japan have previously played an important role only in their respective domestic markets, they will increasingly establish themselves in important overseas markets, particularly in the United States' (Schware, 1992:18), the French Software company CAP Gemini Sogeti, for instance, now has more than 2000 people in its US based subsidiary, CAP Gemini America, which in 1987 generated about 22 percent of the company's total revenues.

The causal factors for the expansion of software market (which has been described as changing geography of software industry in this chapter) in the less developed part of the world warrants careful understanding. The development of local software industry leads to many positive externalities, and is seen as a necessity for developing countries to be able to adapt software technology to suit their particular local needs. 'Software production is nowadays an industry, essential for the growth of the economies of the developing countries; and the launching of programmes to promote strong and indigenous software industries is a priority task' (Fialkowski, 1990:187).

Heeks states that 'software is seen as the best entry point for developing countries into the IT production complex' (Heeks, 1996:24), and to mark a presence in the international market. Compared to hardware production, 'software production has much lower level entry barriers, being less capital-intensive, and more labour-intensive, far fewer economies of scale' (*ibid.*). Countries like India enormously benefit from such situations. India has the third largest turnover of science graduates after USA and Russia, and high-paying sector like the software industry is one of the most preferred choices for these graduates (Computers Today, 1995). All of these factors assist developing countries like India, and software's labour-intensity production offers a clear opportunity for them compared with many other production process.

Hence, according to Heeks (1996), it is not surprising that in the developing countries interest in both the production and the use of software is becoming more intense. and actual production is increasing. India, China, Brazil, Mexico, Singapore, Hong Kong, Taiwan, South Korea, and the Philippines, all have a notable software industry, with annual growth rates of 30-40 percent in most of them (Heeks, 1996). Whenever, the software firms in the developed part of the world plan for expansion, or new production sites, these are the countries that become their natural choice.

4.8 MAJOR PLAYERS (COUNTRIES) IN THE GLOBAL SOFTWARE INDUSTRY

This section examines the prominent countries engaged in the software industry. The first part of the discussion is based on the three largest markets for software in the world, viz., the USA, Japan and Europe. In the later part, which looks at the emerging nations in the software industry, the cases of Taiwan, South Korea, and India are discussed.

4.8.1 THE US SOFTWARE INDUSTRY

One of the dominating factors that lead to the rapid growth of commercial computer industry in the United States has been government- sponsored R&D. The US defence needs was the initial force, that led to large scale R&D work in software production. The Department of Defence (DoD) projects[47] represent a very significant effort by the US in software engineering.

[47] For example, the Strategic Computing Initiative, the Software Technology for Adaptable, Reliable Systems (STARS), and the DoD's Software Institute

According to Schware, 'as a customer of software and services, the US government represents between 15 and 20 percent of the total revenue of the industry' (Schware, 1992:22). The software and services industry has grown substantially during the 1970s to 1990. On a current dollar basis, production grew at a compound annual rate of 17.9 percent from 1965 to 1985. Employment in the industry experienced a 10.1 percent compound annual growth rate. Of some 429 industry groupings in the US, employment growth in the software and services industry is projected to rank second over the period 1986-96 (ADAPSO, 1987).

On the reasons for success of the US software industry, Siwek and Roth remark, that the American software industry has succeeded partly from favourable supply conditions, partly because of historical circumstance, and partly from favourable demand conditions in the US and world markets.

According to same authors, the favourable supply conditions that benefited the industry included the following: access to the largest market in the world, economies of scale in producing software, location of rapid technological advance, and favourable government policy on intellectual property. 'Moreover, the US market offers firms a critical mass of resources to develop software, efficient markets to distribute software, close support for academic centres, and an active capital market to support risky enterprises that would have little financial backing in other countries' (Siwek & Roth, 1993:7-8).

The factors responsible for the US leadership in software begin with the vast domestic market, which is driven by a hardware base that is by far the largest in the world, and extend to strong R&D programmes with substantial government funding, particularly for the defence applications. The US still continues to be the leading consumer of software industry products although, Europe, Japan, and East Asia seem to be catching up fast. According to ADAPSO, in the US, business services, finance, insurance, miscellaneous services (health, education, social services) and wholesale and retail trade account for approximately 60 percent of software industry output. In 1985, the federal government purchased US $ 5.5 billion in output from the computer and data processing industry, and state and local governments purchased US$ 4.2 billion (ADAPSO, 1987). These combined purchases, according to Schware, amount to over half of all European software and services revenues in the same year. The software industry employment increased by over 238 percent during the period 1978-87, compared to only 36 percent for computer hardware and 44 percent for the entire US economy' (Schware, 1992:22).

Foreign sales for US software companies have become an increasingly important source of revenue. 'Software exports have increased from around US$ 100 million in 1978 to US $ 4.9 billion in 1987' (*op. cit.* p.23). In the case of many of the largest companies, the rest of the world contributes nearly half their income. For example, Computer Associates International derived more than 40 percent of its revenue from sales abroad in 1988; Oracle Corp.'s (which is one of the leading software company in the world)., foreign revenues accounted for 47 percent of its total. International revenues are expected to grow more rapidly than domestic revenues during the period 1984-1990 (*ibid.*). Appendix 5 lists the major IT companies in the United States, by sales as of 1995.

US Companies seeking to capitalise on opportunities overseas are beginning to develop software for foreign markets and, in some instances, for use in the US as well. Schware mentions of a survey of over 400 US software industry executives co-sponsored by Software News (of US) and Industrial Development Board of Northern Ireland. The survey showed that a significant number (47 percent) of companies are planning to set up operations in Europe, 28 percent in Asia, 22 percent in Australia, 14 percent in Latin America, and 9 percent in Africa and the Middle East.

In selecting overseas sites, companies clearly place importance on the quality of the work force, including skill and productivity levels as the highest priority. Low start-up costs are another important consideration in selecting an overseas site, as is the importance placed on access to other markets. For example, Microsoft Corp., announced its intention to establish a software development centre in India, to design and develop software for the Indian and Asian markets. 'The centre will be based on Microsoft research and development centres in Japan and Ireland and will employ Indian engineers trained initially at Microsoft's US headquarters' (Schware, 1992: 24). Finally, in selecting an overseas site, considerable importance is placed on the local view of copyright and patent protection, which no doubt reflects a central concern of the US firms (Leong 1989). All these factors are very important, especially in the present day context, when, in the US the wages of software professionals have increased very swiftly[48], and the demand for them is also very high. One of the main reasons for these companies to start overseas operation is to ensure continued production of good quality software, at a fraction of cost compared to that in the US.

4.8.2 THE JAPANESE SOFTWARE INDUSTRY

Japan's *National Computer Policy*- first of its kind[49] in the world-was published in 1972, with a perspective for the year 2000. Japan has had a software engineering effort since 1970. The Information Technology Promotion Association (ITPA), a consortium of private companies and the government, together with long-term credit banks, provided US $ 25 million in 1983 for software R&D and technology transfer, which, according to Schware definitely stimulated the early growth of the Japanese software industry.

The Japanese approach has lead to a software industrial revolution in which developers stop fabricating software from scratch and instead assemble applications from reusable software components. In a comparative study of Japanese and American software companies, Cusumano highlights the efficiency of Japanese firms in reusing the codes to design new software (Table 4.8).

Table 4.8 also summarises key performance differences between US and Japanese software firms. Japanese firms are about 70 percent more productive than US firms and have about half as many serious defects in their software. They reuse about twice as much code as US firms. Based on these data, Japanese software-development firms are substantially superior to US firms in productivity, quality, and ability to reuse the codes (Cusumano, 1991:459). A primary reason for Japanese superiority in software-development processes, according to Cusumano is 'Japan's factory approach. 'This is modelled more after Toyota assembly line than after the high-tech traditions of California's Silicon Valley.' (*ibid.*)

[48] See Table 4.7 for a comparison of wages between US and Indian software professionals.

[49] However it is not certain whether it is first of its kind, as Heeks (1996) claims that India has had a software policy since 1970

Table 4.8 Japanese and US performance in software development (1989)

Factor	USA	Japan
Mean Productivity (FORTRAN-equivalent source lines of code/ work-year)	7290	12477
Failures/ 1000 source lines of code during the first 12 months after delivery	4.4	1.96
Code Reuse (% of delivered lines)	9.71	18.25

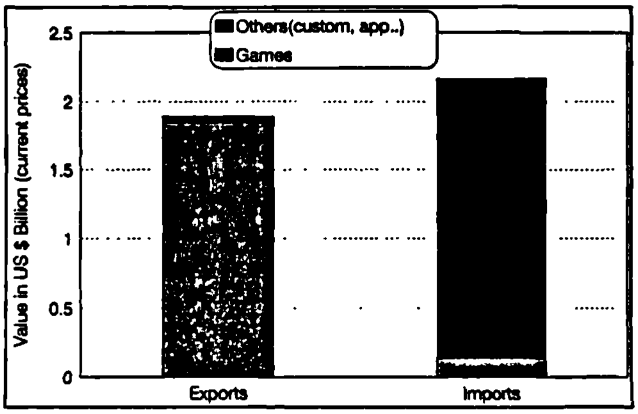
Source: Cusumano, (1991):459

However, much of the Japanese computer industry has been developed in isolation from rest of the world (Far Eastern Economic Review, 1996). Within Japan, rival computer fiefs co-operated with each other as little as possible, primarily writing software customised for big corporate clients. This created profitable long-term relationships, but cut Japan off from the IBM standard, the rest of the world was adopting. It also discouraged competition and hindered the domestic development of a significant open market for software.

As a result, 'Japan never became strong in off-the-shelf, packaged software, which today is where the money is. Though Japan's large computer companies have thousands of software programmers- Hitachi alone has around 20,000- they perform mainly invisible, in-house roles' (FEER, 1996). The study also illustrates that in the mid- 1980s the ratio of packaged to customised software sold was more than 3:1 in the US, and around 3:2 in West Germany and Britain. In Japan the ratio was 1:9. Now Japan's computer makers are moving towards software compatible with world standards, allowing them to participate in international markets and encouraging some to come up with their own products (FEER, 1996).

Even now, the Japanese stronghold lies in the video games. One consequence, however of this has been that, Japanese software hardly created a ripple in other fields. When games are included, Japan' s software exports equal 78 percent of its software imports. Without games they equal 5% (Fig 4.6).

Fig. 4.6 Break up of Japanese software trade (1994)



Source: Far Eastern Economic Review, 1996

The Japanese software factories of Hitachi, Toshiba, NEC, and Fujitsu have a number of elements in common. Each firm attempts the strategic management and integration of activities required in software production to achieve planned economies of scope. 'These are cost reductions or productivity gains that come from developing a series of products within one firm (or facility) rather than building each product from scratch in a separate project' (Cusumano, 1991: 457). Appendix 6 lists the top 10 IT vendors in Japan in 1994.

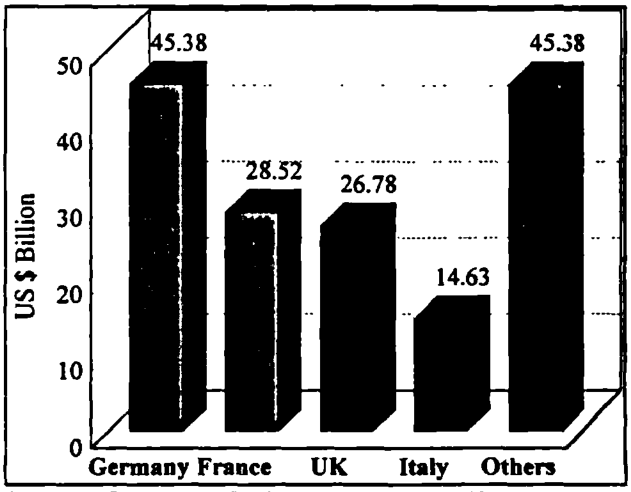
The successful Japanese factories are now moving beyond mass production and becoming full-fledged lean production facilities. These facilities combine some of the flexibility of craft or job shops-adaptable enough to make unique or custom design-with some of the efficiencies of mass production. Cusumano states that the successful Japanese software factories go much further with systematic reusability than their counterparts elsewhere in the world' (Cusumano, 1991).

In conclusion, the effort and resources devoted to technological change in software production (including the use of automated tools and of technological information and knowledge to assimilate, adapt and create software) leave little doubt about the commitment of Japan to expanding the field of competition in software. 'The large Japanese software factories are unlike anything seen in the US, and so are the government promotional efforts and support to the software industry' (Schware, 1992:28).

4.8.3 THE EUROPEAN SOFTWARE INDUSTRY

The European market is highly fragmented and does not have the large, homogenous domestic market as in the US on which to develop a strong base of application system and market knowledge. The major players are Germany, the UK, France and Italy (Fig 4.7) 'European sales of custom software and software consulting services, packaged software, processing services, and training came to US $ 15 billion in 1985' and by 1995 was worth US $ billion 95.4 (Table 4.9).

Fig 4.7: Europe: The IT market in selected countries 1995 (in US $ billion)



Source : Computers Today, August 1995: 63

Software customisation remains more common in the European Union than in US and dominates some markets such as France where a surprisingly high proportion of users still favour the internal development of customised software rather than ready-made solutions. But according to Schware, this is likely to change soon, and 'packaged software is expected to outsell custom software by a substantial margin, and could account for over half of Europe's revenues in software' (Schware, 1992:31).

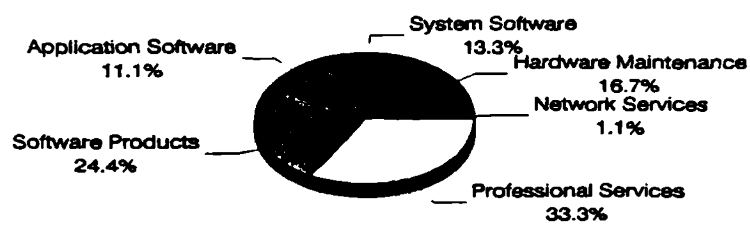
Measured by software revenues and the number of active firms- more than 3000-Germany currently has one of the strongest software industry in the world (Fig. 4.8). 'Software sales have averaged 25 percent growth a year in the last decade. The hardware manufacturers Siemens AG and Nixdrof Computer AG had a combined software revenues in 1987 of US $ 966 million' (*ibid.*).

Table: 4.9 Europe: Software and services market by product category (1995)

Category	US $ Billion					Annual Growth Rate (%)			
	1991	1992	1993	1994	1995	1991-92	1992-93	1993-94	1994-95
Systems Software	12.30	13.16	13.96	14.78	15.77	7.0	6.0	5.4	6.6
Application Software	8.99	9.98	10.82	11.75	12.87	11.0	8.4	8.8	9.4
Software Products	**21.30**	**23.15**	**24.77**	**26.54**	**28.53**	**8.7**	**7.0**	**7.2**	**7.9**
Professional Services	27.92	29.97	31.94	35.81	35.81	7.3	6.6	6.4	5.4
Processing Services	10.14	10.57	10.98	11.34	11.70	4.3	3.8	3.4	3.1
Network Services	1.57	1.79	2.02	2.28	2.57	14.0	13.3	12.2	13.0
Hardware Maintenance & Support Services	15.83	16.12	16.21	16.38	16.69	1.8	0.6	0.9	1.9
Services	55.49	58.47	61.19	64.00	66.78	5.4	4.7	4.6	4.3
Total Software & Services Market	**76.79**	**81.62**	**85.98**	**90.56**	**95.43**	**6.3**	**5.3**	**5.3**	**5.4**

Source : National Association of Software and Service Companies (NASSCOM), 1995

Fig. 4.8: German software market (1994)

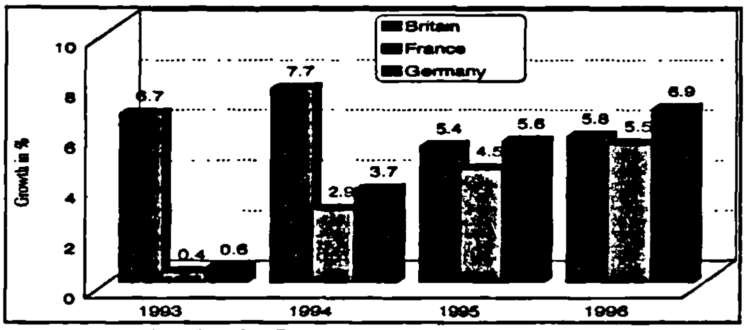


Source: Computers Today, August 1995 :60

Measured by market penetration, however, 'France probably has the most competitive software industry outside the United States' (Schware, 1992:33). 'About half of the 20 largest software suppliers to the European market are French' (OTA, 1987). Figure 4.9 highlights the projected growth of software industry market in Britain, France and Germany.

'Rather than compete directly with many of the large and fast growing US software companies in micro computer programmes that require mass marketing, European companies will rely increasingly on enhancing existing products and standard products for their customers' (Schware, 1992:31). Although most of the R&D in software is done in the US, but its capability as one of the world's leader in the software industry should not be undermined.

Fig 4.9 : Europe: Projected growth of software market in selected countries (1993-96)



Note: 1995 and 1996 figures are Projection
Source: Computers Today, August 1995 :63

4.8.4 OTHER ECONOMIES

The size of the software and services markets in other economies is obviously small compared to the US, but some of them are already playing an important role in the global software industry (Table 4.10). The industry is rapidly growing in Brazil, India, Singapore, and Taiwan. A wider spread of US and Japanese investment, as well as varying degrees of state involvement in the process of fostering software industry development, could stimulate the development of such industries in these economies even further. Again, sources of information are a problem for the analysis, due to lack of any standard classification among all economies. Table 4.10 provides the size of other markets in software and services.

Table 4.10 Other economies: Software and computer services market (US $ million)[1]

Countries	1984			1987		
	Software	Services	Total	Software	Services	Total
Brazil	363.5	337.7	701.2	2186.2	2031.4	4217.4
China	175.0	n.a	n.a	968.0	n.a	n.a
Hong Kong	25.0	n.a	n.a	61.0	n.a	n.a
India	**18.3**	**92.8**	**111.1**	**37.7**	**289.9**	**336.6**
Malaysia	20.0	n.a	n.a	67.0	n.a	n.a
Mexico	59.0	6.0	65.0	117.0	13.0	130.0
Saudi Arabia	25.0	n.a	n.a	49.0	n.a	n.a
Singapore	27.0	21.0	48.0	71.0	58.0	129.0
South Korea	40.0	20.0	60.0	107.0	40.0	147.0
Taiwan	26.0	29.0	55.0	57.0	51.0	108.0

Note: 1 The data assumed to be value-added marketed, which exclude captive sales and hardware sales related to turnkey systems, and expressed with an approach similar to "apparent consumption" (i.e., domestic production less exports plus imports).
2 The 1987 figures are projections based on various assumptions
3 n.a means not available

Source: Adopted from Schware(1992)

Taiwan

'Since 1980, the government of Taiwan has considered the information industry among its 'strategic' industries in the sense that it: a) has ties with other industries, for example, through contract programming of custom software or database management; b) holds attractive market opportunities; c) is technology-intensive; and d) offers high value-added services' (Schware, 1992 : 33).

The information industry in Taiwan is comprised mostly of software companies, commercial data processing companies, and hardware companies whose operations involve assembly, manufacture, and sales of personal computer equipment and peripherals. There were an estimated 250 software firms in 1986, employing some 4000 persons, producing and selling software valued at US $ 93 million (Chaponnaiere & Fouquin 1989). 'In 1987, the number of software firms increased to 300, and sales of software nearly doubled to US $ 170 million. Exports have risen dramatically from US $ 3 million in 1986 to US $ 11 million in 1987' (Schware, 1992:34).

The software industry is growing very rapidly, 'with an annual growth rate of 48 percent, which is faster than for the US industry during its 'boom' period between 1981 and 1983. Custom software production accounted for nearly a third of total revenues in 1986, followed by sales of services in data processing (30 percent), turnkey system development (20 percent), and software packages (17 percent). Domestic demand for applications software is very high, particularly for general purpose management and application programmes for particular trades. The future market for packaged software for micro computers is promising. Over half of the software companies are engaged in packaged software development. As more small and medium businesses begin to use micro computers, software packages for these enterprises will be needed' (Schware, 1992 : 34). According to Schware system integration will also be a promising area in Taiwan.

Despite its growth, the software industry in Taiwan is sill in its infancy. For example, 'the majority of software firms are less than 5 years old; of the 4000 persons in the software industry, over half have less than three years experience, and automated software development tools are not fully utilised, which contributes to relatively low productivity in software development' (*op. cit.* p.33).

South Korea

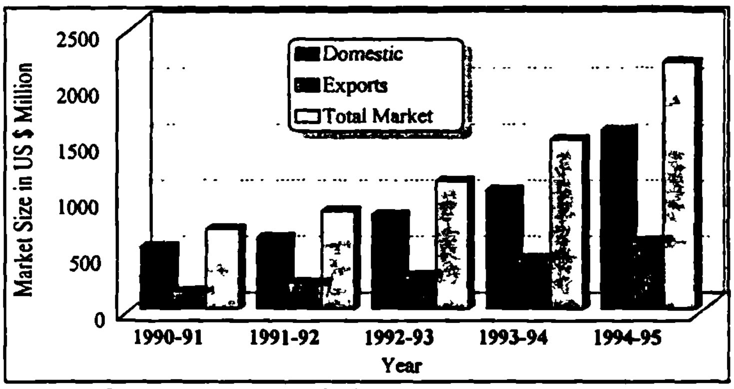
Korea's National Technology Promotion Congress was established in the early 1980's to help the nation into high technology related products (Mately & McDannold, 1987). Korean software industry appears to be more mature than Taiwanese, albeit young. 'There are some 400 companies that make up the Korean information industry. Over half of these firms have been in business for more than 5 years; slightly more than 20 percent were formed before 1980. Twenty percent of these firms are dedicated to software services only; the remaining 80 percent produce combinations of hardware and software and offer key punching services' (Schware, 1992:34).

'The domestic production of Korean software is estimated at US $ 30 million in 1985, which grew to 36.8 million in 1986, and to US $ 50 million by 1987' (Schware, 1992: 34). Domestic demand for software grew between 38 and 44 percent annually between 1984 and 1990.

India

India is one of the emerging leaders in the software industry, and is now increasingly playing a very vital role in redefining the geography of world software industry. Chapter five provides an in-depth analysis of the software industry in India. However, in the context of the present chapter on the global software industry, a brief overview of the industry in India is provided.

Fig. 4.10 India: The size of the IT industry (1995 prices) in US $ billion



Source : Dataquest, August 1995

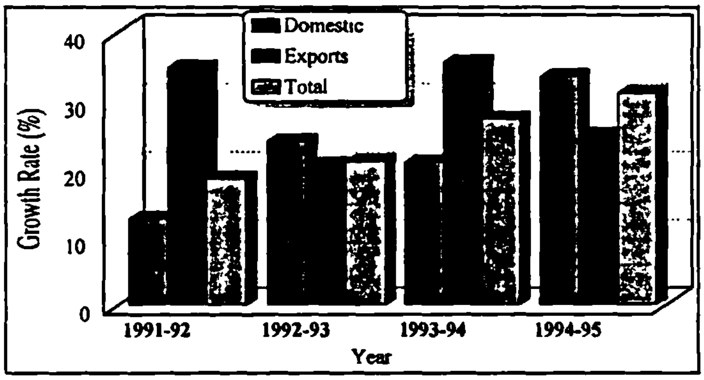
The size of the Indian software industry in the late 1980s was very small (exports in 1988 were US $ 59 million), but by 1994-95 was exporting software worth US $ 472 million (Computers Today, 1995). The total size (based on turnover) of the Indian IT industry[50] at US $ 2 billion[51] is today comparable with the rest of the Asian countries (Fig 4.10).

[50] The Indian IT industry constitutes computer hardware, peripherals, data communication, software and services

[51] US $ Exchange Rate used as on August, 1995 (1 US $ = Rs. 31.2)

It is the size of the market and the growth which is acting as the magnet to attract many multi national corporations to India. Between 1989-90 and 1994-95, the Indian IT industry recorded an annual growth rate of around 30 percent, which is roughly double the growth rates of developed countries (Dataquest, 1995). The software segment (both domestic and exports) has also been growing at around 30 percent (Fig. 4.11).

Fig. 4.11 India : Growth rate of domestic and exported software (1991 to 1995)



Source: Dataquest, August 1995

The Indian Government adopted economic reforms policy since 1991, which according to some IT industry magazines (Dataquest, 1996, Computers Today, 1996) has led to an increase in foreign investment especially in the IT sector. Many of the overseas informatics corporations, realising the potential of vast pool of technical work force in the country (that speaks English), have established themselves all over India. In a study conducted in 1990, only 8.1 percent of US software vendors had plans to enter the Indian market by 1992 (Siwek & Roth, 1993:41). However, by 1995 the foreign brands had a market share of 30 percent in the Indian IT industry (Dataquest, 1995). The foreign investment in the Indian IT industry[52] varies from as large as US $ 1.2 billion by Hewlett Packard to US $ 300 million by Ingres. It includes almost all the major players Like IBM, Digital, Compaq, Sun, Microsoft, Apple, Dell, Silicon Graphics, Motorola, Acer, AT&T and others (Dataquest, 1995). This clearly indicates the importance attached to India by the US and other global IT companies now.

[52] Compiled from firm-wise information that is available in Dataquest, 1995

According to Dataquest (1995), India has not been much of an innovator as far as generic packaged software applications are concerned. With the exception of software packages for vertical segments, the country has not bred any packaged software developed locally. Consequently the Indian software market is increasingly being ruled by foreign software markets. Since 1991, import duty has been cut from over 200 percent to less than 85 percent[53]. Stricter measures to combat piracy[54] and corporate level mandates have all led to increasing availability of foreign software.

According to Schware, Indian firms have been quite adept at sourcing technology. Nevertheless, as the Indian exporters acquire larger shares of the world market, their need to acquire new tools will increase. A significant barrier to the efficiency and productivity of the small, independent firms is the inability to finance and access relevant software tools during the important phases of the software development life cycle, such as rapid prototyping.

Financial support is still a major, difficult challenge to many software firms, even for those firms with good products. The Venture Capital scheme by the ICICI[55] which has been exclusively introduced for the IT industry in 1995, should provide some help in this regard. Small software firms, the majority, have found particularly difficult to obtain finance[56]. First, long-term funding even by the innovative venture capital funds such as the TDICI, has been geared largely to cover assets, with lenders tending to advance loans only against the security of fixed assets. Among the IT firms, software companies[57] typically have low fixed asset bases, relying instead on human skills and intellectual property. Moreover, 'sweat' equity (the equity value of a promoter's organising efforts, ideas, and knowledge) is not yet recognised in India,

[53] By Indian standards, this is no doubt a dramatic fall, still the rates are very high compared to world market.

[54] The NASSCOM has been operating Anti-Piracy hot line since 1994, and has been very successful. News about NASSCOM raids all over India to combat software piracy is frequently reported in the press.

[55] ICICI : Industrial Credit and Investment Corporation on India. It started the TDICI (Technological Development and Investment Corporation of India), which is exclusively meant to facilitate venture capital for IT industries.

[56] The problem is not confined to India alone. Most small software firms in the industrially advanced rich countries have had difficulties in securing finance (cf. Hanna, 1994:38 and Segal et. al, 1985)

[57] Venture capital represents less than 1 percent of the sources of funding for software companies compared with over 30 percent in the United States. Indian venture capital companies are new and lack the industry and technical knowledge required to properly assess software markets and products or the merits of professional software firms (Hanna, N 1994: 38)

and there is thus no practical 'exit route' for venture capitalists. Second, 'lenders of funds for working capital (the commercial banks) have strict norms of lending only against the collateral of raw material stocks, work in progress, and finished goods' (Hanna, N 1994: 38). Third, some venture capital companies also have minimum investment limits that do not allow them to invest in small software companies (which has also been reported by Segal et al, in the case of Cambridge in the UK). Fourth, the rapid expansion of software companies in India, presents expansion risks unfamiliar to financial institutions in India, and further increases the need for working capital.

Response to these new initiatives has been generally positive so far. The policy framework, while far from ideal, is better for electronics in general, and software in particular than many of the other industries. The recent focus and emphasis that has been placed on promoting software exports, through the creation of Software Technology Parks (STPs) all over India, is likely to bring in even higher foreign exchange, and investment in this sector. This would help India consolidate her position as a major centre for software production in the world.

4.9 CONCLUSION

The software industry has relatively low barriers to entry in terms of capital requirements. As the estimated number of independent software firms world-wide (some 40,000 according to Schware, 1992) and the variety of successful niche markets with packages in accounting, banking and language indicate, it is a business that is relatively easy to start. The industry remains largely labour intensive, although the usage of automated productivity tools is increasing. But the world software industry is at present in the process of a major restructuring and consolidation as a result of technological and organisational changes that are altering the manner in which software is produced and the types of hardware, telecommunications, and non-software firms entering market.

Based on the analysis of the geography of world software industry, the following can be concluded:

- Ever since the software industry came into the existence, US has been the world leader. It is only since the beginning of the 1990s that the geography of the global software industry has undergone some significant change.
- Severe shortage of software professionals in the developed world, and their ever increasing wages has contributed to the shift in the location of software industry.
- This has been complemented by favourable policies to attract software industries by some developing countries.
- The software industry will continue to shift to locations that offer high quality professionals at competitive wage rates, and where there is continuous government support in terms of policies to attract software industries from all over the world.

For the nations that are still trying to penetrate further into the international software market, the experience of the leaders would become very important. But such an experience cannot be gained in short time, and that is why some authors lay emphasis on long term management commitment to understand and manage software development more effectively among the emerging players of global software business.

Software development methods are becoming capital intensive, marketing costs are escalating, and as the rate of technological change also gains momentum. the R&D cost will also go up. Unless there is substantial collateral to secure loans, software firms have little access to funds from conventional financial institutions for the large, long-term investment required to develop software and expand marketing and maintenance.

In the coming years, software firms in the newly industrialising countries will have to adopt a marketing position and market stance that enables them to compete against leading software firms- including many multinationals. This will necessitate continued favourable government policies, improved infrastructure for software industries' growth, good promotion of products and services in the market. In summary, it will take a long-term, concerted effort among the software engineers, as well as support from either corporate or government funds, to keep up with developments in software engineering, so that firms from the newly industrialising countries may also become leading software producing nations in the world.

Given these global trends occurring in the software industry, the following chapter discusses the software industry in India.

5 THE SOFTWARE INDUSTRY IN INDIA: GROWTH AND CHARACTERISTICS

5.1 INTRODUCTION

The preceding discussion on the changing geography of the world software industry highlighted the nature and causes of the global shift in the industry. The factors that have led to this shift and higher growth in Asia can be broadly grouped into demand factors (for example increased use of computers in a wide variety of sectors), and the supply factors (like the backlog in the availability of software professionals in the developed world and the competitive wage rates and increased availability of well qualified software professionals in the developing countries). To understand the shift more clearly, not only the factors that led to the growth of the industry in the developing countries need to be understood, but also the "environment" in which these have grown. Similarly, a focus on the growth of the software industry in these countries provides a more meaningful analysis as to why certain countries in the developing world have performed better than others. The focus of the present chapter is to explain the variables of growth and growth characteristics of the software industry in the case of India.

The Indian case helps illustrate the changing geography of the world software industry. There are primarily five reasons why the Indian case warrants careful scrutiny. *First* of all, India has one of the long-established and largest software industries among the developing countries (Schware, 1992; Correa, 1996; Heeks, 1996). *Secondly*, it has also 'had a software policy since 1970, much longer than other developing countries' (Heeks, 1996 : 25). *Thirdly*, India's software policy has continually stressed exports but was substantially liberalised during the mid-1980s, when the Department of Electronics[58](DoE) identified software as a thrust area (GoI, 1986-a). This relatively long history of both policy and industry according to Heeks can provide valuable lessons for other countries, and would be helpful in explaining the changing geography of the industry. *Another reason* to study software industry in India stems out from the debate surrounding the idea that a strong domestic oriented software industry is a necessary pre-requisite before a country can move into exports (Fialkowski, 1990; Schware, 1992), as this will form the base on which software production skills and capabilities can be built; the experience of the Indian software industry, according to Heeks appears to contradict this argument. *Finally*, the study of Indian software industry acts as a bench mark, for it signifies a structural shift in the philosophy on the part of the national government which has adopted a more liberalised stance towards the software industry since the mid 1980s. Thus the study of software industry in India, is unique in that it goes in contrary to the picture of Indian industry in general, 'which for most of its history was seen as inward-looking, protected, working within an environment of all-pervasive government controls, and using obsolescent technology' (Heeks, 1996:26).

The reason to study Indian software industry in a research about urban competitiveness of Bangalore is considered essential, as Bangalore is the premier centre for software and the IT industry in India. An understanding of the software industry in India is therefore essential in gaining an understanding of the competitive advantage of Bangalore in the IT and software industry over the other Indian cities.

[58] Department of Electronics, Government of India, which oversees the policy formation and implementation in all segments of the electronics sector.

This chapter is organised under six sections. After the introduction in the first section, the second discusses the history and growth of the software industry in India. The various policies related to the electronics sector in general and software industry in particular is the theme of next section. The competitive aspects of the Indian software industry in the global context, and an overview of the Indian software industry is provided in section four. The first research hypothesis put forward in chapter two will be tested in section five, which will be followed by concluding remarks in the sixth section.

5.2 HISTORY AND THE GROWTH OF THE SOFTWARE INDUSTRY IN INDIA

As mentioned in the previous chapter, there is always a paucity of reliable data on the IT industry in general. The problem persists in India as well, where there are no reliable government statistics on overall software production within India. The coverage of most other figures is also ambiguous- for example, whether they include software exports, re-sale of imported software by local distributors, and software production by system integrators. All the figures are given in the Indian numeric system (like lakh[59], crore[60] etc.). For comparative analysis at the international level, these figures need to be converted to US Dollars, and also account for the ever-changing exchange rates between US Dollar and the Indian Rupee. Appendix 7 provides exchange rates between the Indian rupee and the US dollar from 1980 to 1996. Probably the least inaccurate figures are those presented by the IDC, Dataquest, and Computers Today and recently published research works on the Indian software industry. Other sources (Brunner, 1991; World Bank, 1992; Bagchi, 1995; Subramanian, 1992; NASSCOM, 1995; Heeks, 1995; Heeks, 1996, etc.) also provide some valuable information on the growth of the Indian software industry.

[59] Lakh is 100,000
[60] Crore is 100 lakhs or 10 Million

It was in the 1970s that the computer system as a productivity tool started to emerge in the Indian industrial scene. But, in a country that gave the world its decimal system[61], it took almost another decade, for the planners, and analysts to realise and understand the potential of Indian talent in computer software. This realisation led to the formulation of various policies. The current section describes the growth of the industry, since the beginning of planning era in India (in the 1950s), when development of computer software was very closely linked to the computer hardware to the current situation of the industry in India to the mid 1990s.

5.2.1 1950s TO MID 1970s: CLOSE LINKS WITH HARDWARE

During the period 1950s to mid 1970s, both the computer hardware, and software were provided by multinational hardware companies like IBM and ICL. The development of software industry[62] at that time was intimately linked to the development of the Indian hardware industry. Any software that was sold by these multinational companies was developed by workers outside India. Similar to what happened in the industrially advanced countries, it became difficult for the computer manufacturers to provide full support or applications software to make efficient use of their hardware. That led to the development of software outside the multinational hardware manufacturers.

The government and academia during the 1970s in India relied partly on their own software developers and on the imported software. However, with the increasing use of computers by other commercial organisations, there was an increased demand for software, which led to the development of software by outside organisations. This enabled the formation of a domestic software market in India. With the growth in India's hardware industry, indigenous manufacturers began developing an increasing range of compilers[63] and application packages.

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[61] India is credited with the contribution of giving "zero" to the world scientific community, on which the modern day decimal system is based. The ancient Indian mathematicians wrote numbers in columns, and they used the zero to represent a blank column. The Hindi and Sanskrit word for zero is SÚnya, meaning empty, or void; this word, translated and transliterated by the Arabs as sifr, is the root of the English words cipher and zero.

[62] This early history of software development in India, according to Heeks predates the existence of anything that might be called a software "industry"

[63] A computer programme that translates a source programme into an executable programme (an object programme). It is also a programme that decodes instructions written as pseudo codes and produces a machine language programme to be executed later.

5.2.2 MID-1970 TO 1980S: THE ORIGIN OF SOFTWARE EXPORTS AND SOFTWARE PRODUCTS

The first firm to agree to export software in return for permission to import hardware was the Tata Consulting Services (TCS)[64] in 1974. This can be treated as the birth of Indian software export industry. Many other companies followed suite making an entry into the software export. Many were more interested in leasing the imported hardware to eager domestic users than in exports. 'Some of those who did export gave up once they had fulfilled their export obligation' (Heeks, 1996:69). TCS formed an alliance with the American hardware company Burroughs, and a separate company came into existence as Tata Burroughs Limited (TBL)- in which the Burroughs had a 40 percent equity holding. TCS and TBL (now Tata Unisys Limited), are still one of the largest software export companies in India (Dataquest, 1996).

At the same time, some of the large companies and software groups of some Indian hardware manufactures began trying to sell their in-house software through their data processing departments. They were attempting to sell to the nascent domestic market for software products. As they came to recognise the revenue-earning potential of software, 'some of these firms made their software units more out-ward looking, sometimes hiving them off as a separate company within the overall business group' (Heeks, 1996:70).

The exit of IBM[65] from India in 1978, gave the software industry an added boost, with several of the 1200 ex-IBM employees setting up small software companies, which often began as computer bureaux but then graduated into software development for local clients. All these led to a gradual increase in the number of

[64] Set-up in 1968, belongs to one of the biggest business houses in India- the Tatas

[65] This was the time the socialist government took control of India, which imposed strict controls on foreign companies, and wanted IBM to have 60% Indian share. IBM was also blamed for not complying with the FERA (or Foreign Exchange Regulation Act)- an Act that regulates movement of foreign exchange and investment of foreign companies in India. Subramanian (1992, 160-176), has provided a detailed study on IBM's exit, and notes that there were many more reasons behind IBM's exit. These according to him were quite similar to the nature that led to the exit of Coca Cola. Subramanian strongly feels that IBM's closure could have been easily avoided, if the Government could have granted an exemption to IBM from various FERA regulations. However, he notes that 'IBM was short-sighted and the government dogmatic' He further adds that the whole thing became a big ego issue. He states that FERA was promulgated in countries like Nigeria, Indonesia, Malaysia and others. Yet IBM did not close down in any of these countries, and India, is the solitary example.

computer bureaux and software services, software product exports and software exports companies.

5.2.3 CONSOLIDATION OF THE INDUSTRY DURING THE 1980s

The growth of the industry remained slow and often erratic, but exports began to grow after 1981, primarily due to increasing export awareness and increasing availability of skills in India. The government's insistence that all export obligations (as explained in section 5.3) be fulfilled also led to the growth of software exports. Heeks, however points that 'small and medium- sized domestic-oriented companies tried to break into exports as the computer bureaux market stagnated and as they found difficulty making other domestic operation profitable' (Heeks, 1996:70).

With the introduction of the 1984 Computer Hardware Policy[66], a large number of PCs[67] made their way into India, which led to the subsequent creation of a large number of software companies, especially small ones, seeking to meet the service and product needs of new computer owners (GoI, 1986-b; Subramanian, 1992; Heeks, 1996). Table 5.1 provides evidence to the rapid growth in the industry that took place between 1984 and 1988.

Table 5.1 Indian IT industry : Production and exports 1984-88 (US $ million in current prices)

IT Segment	1984	1985	1986	1987	1988
Computer Production	80.0	127.5	222.2	290.6	342.8
Hardware Exports	0.8	0.6	3.1	3.7	34.2
Software Exports	21.0	23.0	33.3	45.0	61.0

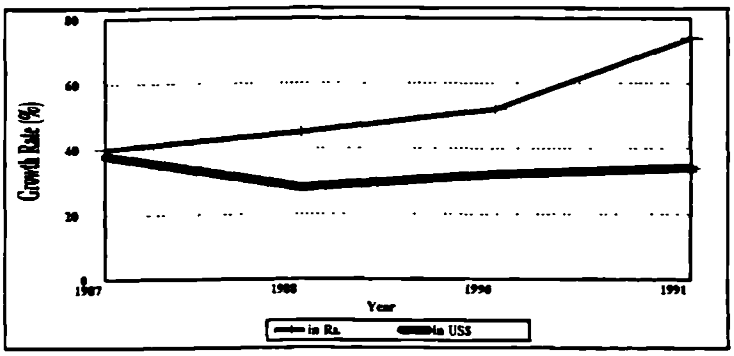
Source : Evans (1992:2)

[66] The Government of India was under heavy pressure from industrial groups to review the existing policy for the manufacture, import and export of computers and computer-based systems. This revised policy of 1984, broadly aimed to: (i) enable the manufacture of computers based on latest technology in the country itself; (ii) simplify existing procedures to enable users to obtain computers for their requirements from domestic or overseas market; and (iii) promote appropriate applications of computers that will have a catalytic effect on country's economic development.

[67] The volume cannot be compared to any of those in the developed countries. But for a country that had not had many computers, the policy did enable the growth of the PCs.

It was the policy changes in the mid 1980s that made India attractive for the multinational companies to take a renewed interest in India, after the departure of IBM. These multinational companies took a serious interest in India as a software development source and as a market for software products. They set up distribution agreements with local companies, contracted work out to Indian software houses. Others set up their wholly owned software development subsidiaries. Texas Instruments, was the first such overseas corporation to setup a wholly owned software company in India. This was soon followed by Citicorp., and Motorola, all of which chose Bangalore as their production base. From the late 1980s, there was a significant increase in the local and multinational interest in exports alone with a number of large Indian firms spinning off software divisions. In rupee terms, the software industry grew at an average rate of more than 50 percent between 1987 and 1991 (Fig. 5.1).

Fig. 5.1 India: Software industry annual growth in turnover (1987-91)



Source: Dataquest 1993

5.2.4 THE 1990s: PERIOD OF RAPID GROWTH

By the mid-1990s, even those firms which initially focused on hardware were moving into software exports[68]. Table 5.2 provides the value of software produced in India in rupees and in US dollars. It is evident from the Table that the total growth of the software production (both including domestic and exports) has been more than 30 percent every year (except, 1992-93). As can be seen, a substantial part of the

[68] By 1996, all but two of India's top ten IT firms were significant software exporters, as were all but three of the top ten hardware companies (those which made more than 50 % of turnover from computer sales). In these largest hardware firms, combined software exports grew by 170 % between 1992/93 and 1994/95 (DATAQUEST, 1995)

reported growth in software exports has come about through devaluation of the rupee against the US dollar, particularly since 1991.

Table 5.2 Growth and value of the Indian software industry (1990-91 to 1995-96)

Year	Domestic				Exports				Total			
	Rs. bi	GR	US $ mi.	GR	Rs. bi	GR	US $ mi.	GR	Rs. bi	GR	US $ mi.	GR
1990-91$_A$	1.87	-	104.6	-	2.35	-	131.50	-	4.22	-	236.18	-
1991-92$_B$	2.96	33.6	120.98	13.4	4.25	38.7	173.69	23.4	7.22	36.8	294.67	19.4
1992-93$_C$	4.09	26.3	134.18	9.7	6.70	33.4	219.81	20.4	10.79	30.8	353.99	16.4
1993-94$_D$	5.27	21.7	168.28	19.7	9.85	29.9	313.98	28.3	15.13	27.2	482.11	25.4
1994-95$_D$	8.36	33.7	266.28	33.6	15.10	32.1	481.04	32.1	23.46	32.6	747.32	32.6
1995-96$_E$	13.2	33.5	411.25	32.5	23.04	31.9	718.00	30.7	36.24	32.5	1,129.2	31.4

Notes

GR	Annual Growth Rate (%)	A	US $ = Rs. 17.90	B	US $ = Rs. 24.50
bi	Billion	C	US $ = Rs. 30.50	D	US $ = Rs. 31.40
mi	Million	E	US $ = Rs. 32.10		

Source: Compiled from Dataquest 1992-1996

Table 5.3 Number of software companies in India (1981-1995)

Year	DoE registered software export companies	Estimated total no. of active software export companies	Estimated total no. of software companies
1981	21	-	-
1982	15	-	-
1983	20	33	-
1984	35	-	-
1985	35	-	-
1986	60	-	271
1987	85	-	360
1988	90	-	560
1989	-	120	-
1990	120	-	700
1991	-	160	-
1992	150	-	-
1993	-	-	-
1994	-	200	>1000
1995	-	220	>1200

Source: Heeks, 1996: 87

The economic liberalisation policy has definitely provided a growth impetus to the software industry in the country. In sheer numbers itself, the industry has grown from under 600 firms in 1988 to more than 1200 by 1995 (Table 5.3). One must keep in mind that it is not mandatory for the software companies to get registered with DoE and this is why the number of registered units with DoE is so low. As emphasised in the last chapter, the data on number of software companies not only in India, but elsewhere too, needs to be treated with utmost caution, as these are the only available estimates[69]. A similar problem was experienced by the researcher in obtaining the number of IT companies that exist in Bangalore. As explained in the methodology chapter, and referred to in the later chapters, information has been collated from a number of agencies/organisations and sources to get a realistic picture of the actual number of IT companies in Bangalore as well.

Table 5.4 The Top 20 software companies in India (1996)

Rank 1995-96	Rank 1994-95	Company	Turnover (US $ Million)		
			1994-95	1995-96	Growth 1995-96 (%)
1	1	TCS	109.74	160.25	30
2	-	HCL Consulting	-	84.27	-
3	2	Wipro	41.11	58.53	28
4	3	Tata Unisys	33.67	39.91	15
5	6	Pentafour	18.59	33.58	39
6	9	Silverline	17.07	28.03	35
7	7	Infosys Technology	17.97	27.58	32
8	8	Fujitsu-ICIM	17.60	27.41	33
9	5	ECIL	19.58	25.23	22
10	16	TATA-IBM (TISL)	10.59	19.11	39
11	14	Siemens Information (SISL)	12.57	18.84	50
12	11	NIIT	16.13	18.50	13
13	13	Square D	12.90	17.86	27
14	20	Oracle Software	9.66	16.12	36
15	-	Satyam Computer	7.54	15.72	108
16	17	Mastek	10.19	15.01	30
17	-	IMR India	10.04	14.94	31
18	4	CMC	20.09	14.75	-34
19	12	DIGITAL	15.51	14.69	-6
20	-	Hexaware	7.80	13.72	38

Source: Compiled from Dataquest, July 1996

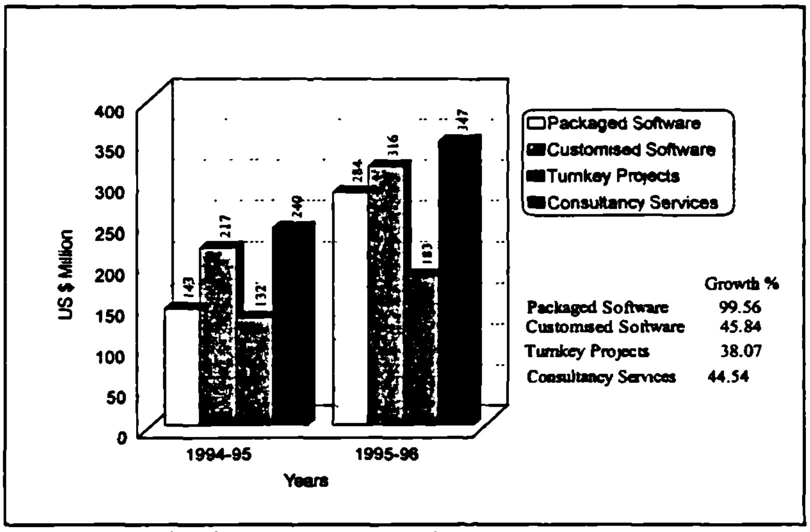
The top 20 software companies in India as of 1996 are given in Table 5.4. The major companies as evident from the table have remained more or less the same in the two years. Two major companies, CMC and ECIL (both in public sector) have suffered serious set backs, with CMC falling from 4th rank to the 18th between 1994-95 and 1995-96. In the private sector, the software division of Digital India has fallen from 12th position to the 19th position during the same time period. Tata-IBM (TISL),

[69] However, in the absence of any reliable sources, researchers on IT industry will need to depend only on these estimates, and use them with the full knowledge of the limitations that these data have (cf. Schware, 1992).

Oracle Software are two companies that have been able to improve their ranking during the period 1994-95 and 1995-96.

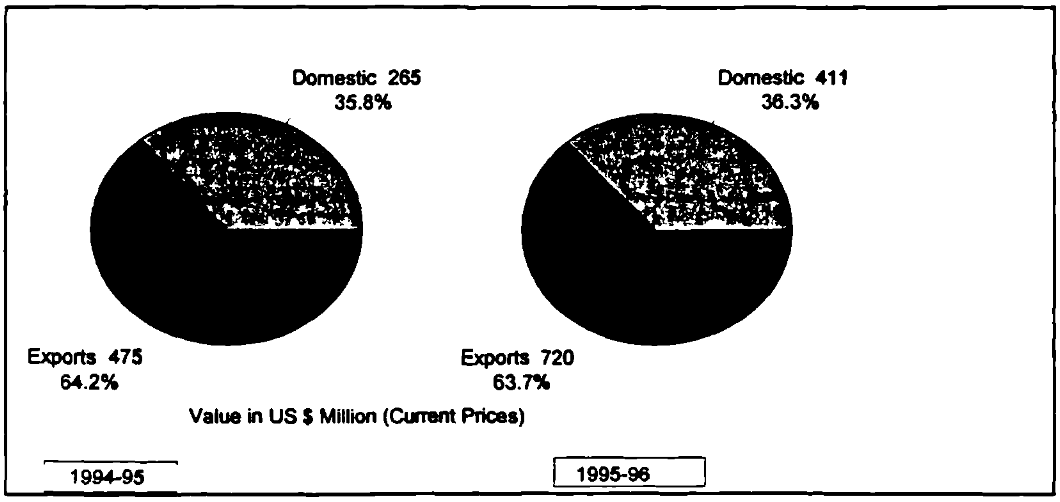
Packaged software[70] has a very small base in the Indian software industry. But since 1994-95, it has shown signs of growth. Between 1994-95 and 1995-96, the packaged software segment of the Indian industry almost doubled, yet it is very small, accounting for only US $ 284 million (Fig. 5.2).

Fig. 5.2 The Indian software industry split in 1994-95 and 1995-96



Source: Compiled from Dataquest, 1996

Fig. 5.3 India: Growth patterns of domestic and exported software (1994-96)



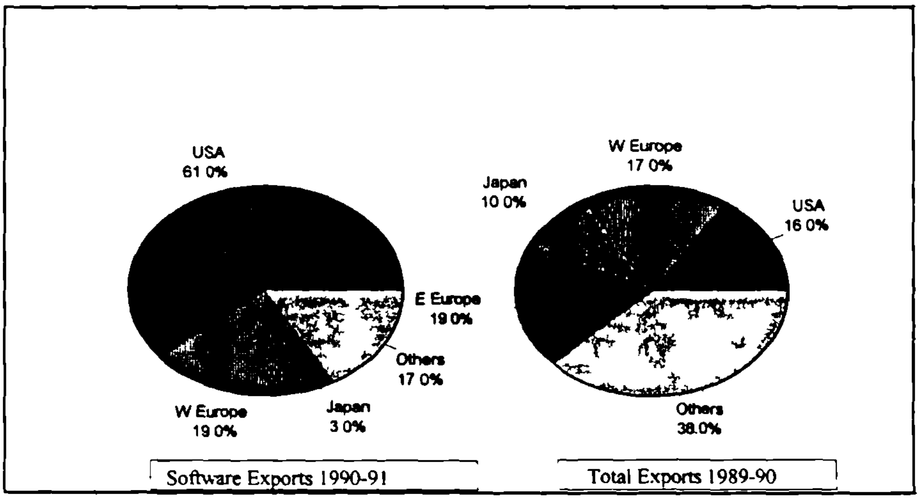
Source: Compiled from Dataquest, 1996

[70] It refers to the software that can be bought off the shelf of a shop and installed on a computer depending upon the needs of a computer user. Best examples of packaged software include Microsoft Word, Lotus 123, various anti-virus software etc.

Given its small base it is therefore not surprising that packaged software has recorded the highest growth rate among all the software segments during the period 1994-95 and 1995-96. As made evident in Table 5.2, software exports have continued to surpass the growth of domestic software. Export rates have been almost twice the domestic growth rates (Fig. 5.3).

India's major trading partners (USA, Western Europe, and Japan) account for 83 percent of India's total software export. USA is the major destination of Indian software exports, accounting for more than 60 percent of the total Indian exports in software and services. These three partners, however, account for only 43 percent of total exports (Fig. 5.4). In contrast to the software exports to the USA, the general exports to that country account for only 16 percent of the overall Indian exports. This reflects the strong dependency on Indian software products or services by these trading partners.

Fig. 5.4 India : Trading partners in software exports and in total exports



Source: Compiled from Dataquest, 1996
Also see Fig. 5.7 for 1996 Software export figures to major countries

5.3 SOFTWARE INDUSTRY POLICIES IN INDIA

According to Heeks (1996), the software industry policy exists at three different levels- which is moulded by the overall industrial development policies. The software industry policies have tended to be largely a series of actions implemented by various government bodies. He groups the range of policies under different time periods, and the following section is largely based on his work. The periods as classified by Heeks are: Pre-1980s;1980-84; 1984-86; 1986; 1987-90; and 1991-96.

5.3.1 PRE-1980s: BUILDING SOFTWARE EXPORTS

During the 1970s, government software policy restricted itself largely to the question of providing imported hardware for the would-be software exporters. In the mid-1970 a Department of Electronics (DoE) was created, which was given the charge[71] of the software industry including the software industry policy. In September 1970, a 'largely unsuccessful programme for promoting the generation of computer software, particularly for exports came into existence, which consisted mainly of newspaper advertisements asking interested companies to submit their ideas to the DoE' (Heeks, 1996:42).

That scheme was amended in 1972 as the "Software Export Scheme", allowing hardware to be imported for use in software export work. The main condition attached was that the importer had a commitment to earn the import price of the computer in foreign exchange via software export within the following five years. In June 1976, the policy was partly liberalised but mainly expanded and re-launched. Hardware import duties were reduced from over 100 percent to around 40 percent; banks were advised to extend loans for software projects; and software exporters were promised faster clearance of their applications. It was also made clear that software was eligible for export incentives such as location of production in export processing zones (EPZs), tax concessions, and export subsidy of cash compensatory support (first offered at a rate of 10 percent of the value of software exported).

5.3.2 1980 TO 1984: PUNISHING MISUSERS

'By 1980 it had become clear that most computers imported under software export schemes were actually leased out for domestic market use' (*op. cit.* p.43). The DoE had already reacted by temporarily banning the import of second hand machines, but new policy guidelines were issued in January 1981 which, in theory, emphasised the generation and export of software using the existing computer capacity in the

[71] Software continues to be under the jurisdiction of DoE even in 1997

country, rather than the import of computers. The actual policy was rather contradictory.

DoE still did not appear to play the role of facilitator. On the contrary to make things worse, import duties were raised and tighter government inspection controls established, with the threat that the DoE could confiscate computers if importers defaulted on their export commitment. Soon the DoE realised its folly and it recognised that an imported computer's capacity could not all be taken up with export-related work alone. That led to further changes in the policy and loosening of controls which allowed firms to use two-thirds of their machine time on domestic work with the remaining third dedicated to exports. However, export commitments (now called export obligations) remained the same for category A (ordinary import), and category B (import by Non-Resident Indians). Another category (called C) was added, which allowed the import of loaned hardware, with only limited export obligation or import duty.

Between 1982 and 1984, the DoE tried to push software exporters into importing computers on a loan basis under category C. Heeks mentions that the numbers in the other categories declined from nineteen approved in 1981-82 to four in 1983-84 and only a handful were even allowed under C. The whole process according to him was also painfully slow: 'the DoE built up a history of delays and confusion that must have had few parallels, even in this country, with import applications taking over two years'(*op. cit.* p.44).

This tightening of one element of import policy was a reaction to the perceived misuse of computer imports at a time when the government wanted to build up the local hardware industry. This did not affect the DoE's training and investment efforts or its desire to promote exports. For example, it was during this period that the Engineering Export Promotion Council, later joined by the Trade Development Authority, began offering export marketing assistance to software companies.

5.3.3 1984 TO 1986: INITIAL SIGNS OF LIBERALISATION

By 1984, it had become clear that policy was not keeping up with the development of the IT industry. The new Computer Policy was introduced in November, 1984. While the thrust of this policy was primarily towards hardware, some major policy liberalisations were directed at the software industry. In trade terms, the procedures for importing hardware (to develop software) became quicker and easier. Imports also became cheaper as basic customs duty on hardware was reduced from 135 percent to 60 percent and on software from 100 percent to 60 percent, with an allowance of duty-free import for source code[72] on paper. Other measures were announced which aimed at improving access to imported software and spares.

As regards state controls and foreign investment, software was recognised as an industry and entry into it was delicenced. As with hardware, companies with up to 40 percent foreign equity holdings (covered by FERA[73]) and very large companies (covered by the MRTP[74] Act) were also allowed to become software producers. This was a landmark in the history of the software industry development in the country, for it allowed for two provisions: firstly, large foreign companies were allowed to invest in the Indian software industry. Secondly, it allowed the large Indian companies (which now had many of the executives trained in the developed countries) to set up their own software companies. Texas Instruments (TI) of USA, was the first foreign company to start fully owned operations in India. It began its operation in 1985, at Bangalore.

There was also some interventions and promotional aspects. Software was placed under the Copyright Act, bringing the threat of fines or imprisonment of software pirates. A Software Development Promotion Agency was planned, and 50 percent software export earnings over and above the obligation in any given year could be used for a foreign exchange permit to buy a range of goods, including more computers, in following years. The policy was almost entirely one of liberalisation for software, because it made imports of hardware and software, entry into the industry, and access to foreign exchange easier.

[72] The input to a compiler or assembler, written in a source language.

[73] Foreign Exchange Regulations Act, which regulates the movement of foreign exchange and investment of foreign companies in India. The 1997-98 budget of Government of India (on 28th February, 1997) has suggested modifications to the existing FERA, including a proposal to modify its name to Foreign Exchange Management Act (FEMA) to deal with the changing economic situation in India.

[74] Monopolies and Restrictive Trade Practices Act- which regulated the activities of very large companies in India

5.3.4 1986: THE NATIONAL SOFTWARE POLICY

The Computer Software Export, Software and Training Policy appeared in November 1986, and following were some of its objectives:

1. To promote software exports to take a quantum jump and capture sizeable share in international software market.
2. To promote the integrated development of software in the country for domestic as well as for export markets.
3. To simplify the existing procedures to enable the software industry to grow at a faster pace.

What the policy gave with one hand, took away with the other (Heeks, 1996). Import of hardware was made easier and quicker through some procedural changes, and regulations about domestic-oriented use of imported hardware were dropped. The import of software was also delicenced (changed from quota to tariff protection) so that anyone could import it if they paid the 60 percent import duty[75]. On the other hand, hardware imports became more risky because the attached export obligations were strengthened. In general the obligations increased by 50 percent; they had to be achieved in four years rather than five; they were to be more stringently adhered to using bonds and guarantees; and they had to be earned from net rather than gross export earnings.

Availability of foreign exchange to software companies was eased. It was also confirmed that wholly foreign-owned software companies could be set up, so long as their entire output was sold as exports and not in the domestic market. This, according to Heeks (1996) was not actually a policy change, but several regulations had to be altered in order to permit this, particularly in regard to export via satellite link. More importantly, the policy implementation procedures were altered to speed up foreign company applications.

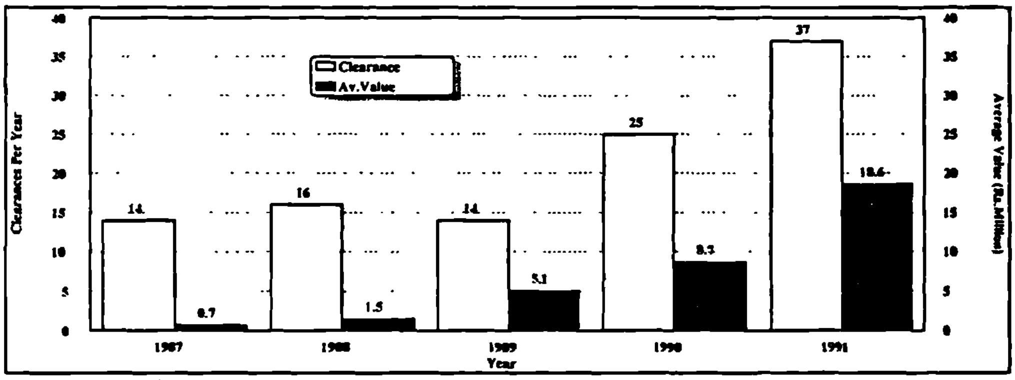
5.3.5 1987 TO 1990: LACK OF DIRECTION

During this period no specific policy was issued, but a number of modifications to the 1986 Policy were announced 'which gave rise to a feeling of loss of direction in

[75] Software was therefore said to be imported on Open General Licence (OGL)

policies (Heeks, 1996: 46). Between 1987 and 1991, an average of 21 clearances were given per year to set up software companies (Fig. 5.5).

Fig. 5.5 India: Number of clearances given to set up software companies per year and their value (1987-91)



Source: World Bank, 1992

The modifications to the 1986 policy covered three major areas governing the software industry in India. They were:

Trade: Indian companies were allowed to become distributors for foreign software- a process known as "stock and sale"-but this privilege was effectively restricted to large software exporters in early 1987, excluding the trading and hardware companies which had earlier hoped to become software distributors. Large software companies also benefited from a ruling in 1988 that any company exporting more than US $ 7.1 million of software per year could pay off its export obligations in whatever manner it chose. Smaller companies were restricted to exports that made use of the imported computer which had attracted the obligation in the first place. Some revisions in the policy were made towards the import of computers, still there were too many obligations to fulfil, and very high taxes to pay for importing a computer.

The 1988-89 budget allowed for some changes in the policy, which enabled the accompanying software and start-up spares imported under the software export policy to have duty levied at the same rate as the main hardware, rather than the 250-300 percent previously used. However, in 1988 the ability to import source code software on paper without paying duty was dropped because of perceived misuse and, in June 1989, import duty on software was raised to 107 percent.

State controls: From 1978, software companies had to register with the DoE to receive certain export promotion assistance. The export turnover threshold for those eligible to register was reduced from Rs. 5 million in 1987 to Rs. 1 million in 1988 and to Rs. 0.2 million in 1989. In that year's budget, it was announced that there would be a 15 percent tax levied on all outgoings of foreign exchange associated with travel overseas. This, according to Heeks (1996) affected the software industry quite considerably because of its spending on travel and living allowances for software developers working at their clients' sites

Promotional measures and interventions: The DoE's Software Development Agency was proposed to setup in 1986 with the aim of co-ordinating formulation and implementation of software-related policy measures, and of promoting the development of the software industry. Further in 1988, a separate Electronics and Computer Software Export Promotion Council was created to help increase Indian exports of electronics goods and software, mainly by helping with marketing.

An insurance scheme was introduced in 1987 to cover the clients of Indian software companies against malpractice or lapses, and export shipment credit and credit guarantees were made available. In April 1988 a one year visa for visiting trainers from overseas was announced. Venture capital funding for software companies also became available, as did overseas telecommunications links. At around this time, the concept of Software Technology Parks (STPs), first mooted in 1986, began to take more concrete shape-as an export processing zone under DoE control (Section 5.3.9 discusses more details about the STP).

5.3.6 1991 TO 1996: RENEWED LIBERALISATION

During this period the software industry was affected by general changes in industrial policy. Early in 1991 its imports became more difficult due to the devaluation of the currency (rupee), raising of software import duty to 112 percent. Simultaneously, there was an effort to encourage exports by streamlining the process for export incentive payments and for creation of export-only units.

With the announcement of substantial policy of liberalisations from July 1991, software policy was again affected, principally by raised foreign equity limits; partial currency floatation (which also removed the much-disliked foreign exchange travel tax), and then to full trade account plus, later, full account convertibility; devaluation of the rupee; extension of normal export and domestic sales incentives to export units, and their subsequent ability to retain part of their earnings in foreign currency accounts.

There were some software-related promotional measures during this period, including reduction in telecommunications charges for satellite links; duty free, obligation free import of telecommunications equipment into Export Processing Zones (EPZs), STPs and the like; and export obligations could be met from earnings of staff to work overseas at the client's site.

In 1992, certain specific software activities were declared to be areas of "extreme focus" for export thrust by the Ministry of Commerce. In none of these identified activities India had any significant presence. But till date there is no plan of action (not even in the paper) to achieve presence in these activities. At the end of 1992 the DoE was reorganised to emphasise its promotional rather than regulatory role (though the intended Software Development Board has yet to materialise till date). It amended and updated interventions in areas such as training and research and development. The Copyright Act was also amended, confirming that raids, fines and prison sentences could be used against software pirates, that site licensing was legitimate, and that possession of pirated software was an offence. As a result, 'India has one of the toughest copyright laws in the world' (NASSCOM, 1995: 64).

Import rules changed, with liberalisation gathering pace for software. Duty for software import was reduced to 110 percent in 1992, 85 percent in 1993, slit in 1994 to 20 percent for applications software and 65 percent for systems software, and then reduced to 10 percent for both categories in 1995[76].

[76] Government of India: Various Economic Surveys (1992-93 to 1995-96)

Source code on any media attracted only 45 percent duty. From April 1993, duplication of software in India was permitted for the first time. Indian companies could enter into an agreement with an overseas software package producer to import a single master copy of the package at normal import duty and then pay a taxable royalty on each copy made and sold in India. If the royalty was less than 30 percent of the Indian price, prior DoE approval was not required.

5.3.7 THE IMPACT OF MACRO-ECONOMIC LIBERALISATION POLICY ON INDIAN SOFTWARE POLICY

Having described the changes seen in the software policy from 1970 to 1996, one may ask to what extent these changes can be described as liberalisation. Heeks (1996) argues that there has been some degree of liberalisation. The process has been strongest in software imports, which were delicenced in 1986, though the tariffs later increased before substantially decreasing. Hardware imports for software production remain linked to a government certification system, 'but there has been a good deal of procedural and tariff liberalisation since the 1970s'(Heeks, 1996:50). Both the 1984 and 1986 policies contained measures aimed at encouraging greater foreign investment in the Indian software industry, and procedural barriers were decreased. Post-1991 changes were in line with general liberalisation.

Analysing the changes that have taken place in the software policy over the past twenty-five years, Heeks (1996) opines that it can best be described as some indication of liberalisation rather than a reverse. This is primarily because the trend has been patchy and has progressed quite far in some areas, yet hardly at all in many others. The variations in both the extent and the timing of liberalisation suggests the need to focus on particular policy areas, rather than on policy as a whole, when trying to understand the impact, liberalisation policy has had on software industry.

5.3.8 INDIAN SOFTWARE POLICY: COMPARISON TO OVERALL INDUSTRIAL POLICY

Heeks also outlines three major factors in comparing the software policy to other policies. First, the trends in policy change within software have broadly followed those of overall industrial and technological policy, with some initial liberalisation in the late 1970s, more substantial liberalisation in the mid-1980s, a period of relative stability, then renewed liberalisation from 1991. 'Whatever idea there may have been that the software industry might somehow be different from other Indian industry is certainly not reflected in the trends of policy change' (Heeks, 1996:52). In the post-1984 period, for example, these trends quite closely followed the aforementioned phases. The 1984 policy was liberalising in almost all its measures. The 1986 policy liberalised some elements such as software import but reversed liberalisations on foreign exchange allowances, export obligations, etc. From 1987 to 1990, though there were no significant changes in the direction of policy, there was substantial modification of the existing measures. It is hard to classify these modifications. From 1991, software policy has largely swung with the prevailing wind of policy change-import clampdowns followed by liberalisations plus export promotional measures, though change was less substantial than that in the mid-1980s.

The second factor is that, while the trends of software policy change have been broadly in line with the changes in overall industrial policy, the actual end points of that change in terms of the policy measures themselves were different during the 1980s and even the 1990s. 'While software policy has not been radically different from that of other industrial sectors, it has arguably lain at the neo-liberal edge of the range of sectoral policies' (*ibid.*).

Although this is not a small industry, entry into software production and changes in size and type of production has not needed government permission since the mid-1980s. This and continuing controls in other sectors, has enabled the software industry to become more liberal than others even in 1995. Foreign investment has been continually encouraged, and wholly foreign-owned companies allowed since the mid-1980s. One of the main products, in the form of software packages, and one of the main production inputs, in the form of software tools, can be imported on OGL (Open General Licence) without government permission, or can be purchased locally from distributors. Primarily OGL is an Indian equivalent of decentralised imports

One of the significant steps taken by the government is reflected in its non-interventionist stand towards the software industry that it has no plans for a dominant public sector role in this industry and has not intervened in prices or industrial relations. Of course, the policy still has enough scope for further liberalisation. There are still licence controls on some hardware imports and some foreign investments. There are still tariffs (albeit very low ones) on imported software. There are also substantial interventions in the provision of finance, training, infrastructure and marketing assistance.

Even so, 'one can say that in the Indian context the software industry has operated under one of the most liberal policy regimes (though the difference from other industries is one of degree rather than of kind and has been reduced in the 1990s)'(*op. cit.* p.53). It is therefore illustrative of the general process of policy change within India but provides an extreme example of where that change might lead. 'Software can thus provide a pointer to the kind of impact likely in other industries in the wake of the liberalisation of the 1990s' (*ibid.*).

The third and most important factor outlined by Heeks is about the general industrial development policy in India. According to him, it is the objectives of industrial development that constitute the highest level of policy, and where software policy has differed quite radically from the bulk of Indian industrial policy is in government objectives vis-à-vis export and domestic sales. By and large, the government's principal objective has always been one of earning foreign exchange through software export as a way to help compensate for the costs of importing hardware and electronics items. This objective has been continuous throughout the history of the industry, though it has been gradually strengthened through policy measures since the 1970s.

Within exports as a whole, software has been specially targeted. Software was seen as suitable for export promotion because of the large, growing world market; the perceived low investment requirements; and the availability of skilled, English-speaking, relatively low-paid workers by global standards.

However, all this, according to some authors (Subramanian, 1992; Sen, 1995; Heeks. 1996) left production for the domestic market neglected. The main software policy, in 1986, paid only lip service to its aim to promote the integrated development of software in the country for domestic as well as exports markets. Of the policy's fifty-six measures, twenty addressed software development in general, and thirty addressed exports, and only six were specifically concerned with the domestic market (Heeks, 1996).

No major policy measures have been introduced with the domestic software market solely in mind. General measures. which therefore happen to cover domestic software market, include those on entry into the industry, copyright, finance, training, and software import. The only ones that related specifically to the domestic market, were those covering government encouragement of R&D, and the floating of local tenders. Those concerned with just the export market include hardware import, export obligations, export incentives, foreign exchange permits, export processing zones, software technology parks, telecommunications, and overseas marketing. The situation differs significantly from that in most other industries, where there is general agreement that policies have held back the development of exports.

5.3.9 THE SOFTWARE TECHNOLOGY PARKS (STP) SCHEME

To provide a conducive environment as well as to give boost to the software exports, the DoE launched the Software Technology Scheme (STP) scheme in 1986. The STPs can be either zones or individual companies and are like EPZs/EOUs[77] except that that they are controlled by the DoE. The STPs have easier access to international telecommunications links. The principal incentive available to all exports units (STPs, EOUs, EPZs) are fast, duty-free import and export; a quick, "single window" for all bureaucratic dealings; exemptions and subsidies on sales and excise tax, rent, power and water; a five-year tax holiday; greater access to foreign exchange and infrastructural facilities than domestic units and permission for wholly-owned foreign firms which can freely repatriate profits.

The performance of these export oriented units has been good. 'By 1989, there were over 30 software companies operating in EPZs or EOUs and by 1996 there were roughly four times that number of companies with export units, of which more than half were STPs' (Heeks, 1996: 142). He further notes during the late 1980s and early 1990s they contributed about 20 percent of all software exports from India, but this

[77] EOU: Export-oriented unit: production unit from which all output is exported. EPZ (Export processing zone) is designated area within a country, separate from domestic tariff area, in which specific export-oriented regulations apply.

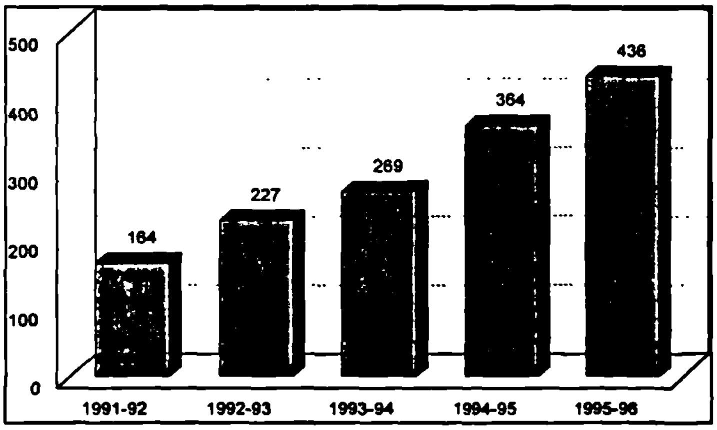
proportion rose thereafter as more and more STPs were created 'STP exports were claimed to be US$ 32 million in 1993, and as much as US$ 75 million of exports may have been attributed to STPs in 1994/95' (Heeks, 1996:142).

The STP scheme is a 100 percent export oriented scheme for the development and export of computer software using data communication link or in the form of physical media including export of professional services. The STP was set up with the following objectives:

- To establish and manage the infrastructural resources such as data communication facilities, core computer facilities, built-up space, common amenities etc.;
- To provide services (import certification, software valuation, project approvals, etc.) to the entrepreneurs who develop software for exports;
- To promote development and export of software and software services through technology assessments, market analysis, market support etc.;
- To train professionals and to encourage design and development in the field of software technology and software engineering

As of 1997, over 400 (Fig. 5.6) software units have been given approval by the government to operate under the STP scheme. The DoE's STPs are located in Bangalore, NOIDA (near Delhi), Gandhinagar, Trivandrum, Hyderabad, Pune, and Bhubaneswar (See Fig. 6.6 in the next chapter for their location).

Fig. 5.6: Growth of software units in the STPs



Source: Software Technology Parks of India, New Delhi

Centralised computing facilities are available in the STP complexes for use by the member units. An efficient and reliable data communication facility has been established, which provides global connectivity, including video conferencing facilities in all the STPs, except in NOIDA, where it is planned for the future. An integrated network service called "SoftNet" was designed and has been in operation in the STPs to provide a wide variety of value added services that are needed for software development, and export operations. It provides SoftPOINT, which is leased channel digital-to-point service, where channels are available from 9.6 Kbps[78] to 2 Mbps[79], and SoftLINK, which is a TCP/IP[80] based multi-vendor network providing access to the Internet.

5.4 COMPETITIVE ASPECTS OF THE INDIAN SOFTWARE INDUSTRY

Software industry in India is one of those few sectors of industry which has thrived on a competitive environment, although 'Indian software companies were fortunate during much of 1980s as they faced relatively little competition from companies in other countries'(Heeks, 1996:113). It may be difficult to define which countries may be treated as competitors, as most of the software producing countries would appear to be India's competitors. A study conducted by the World Bank (World Bank, 1992) identified Ireland, Israel, China, Hungary, Singapore, Philippines, and Mexico as India's competitors in the software industry. Other significant competitors include Hong Kong, Brazil, South Korea and Taiwan. What is India's standing by international standards, on various components of the software industry? An attempt is made here to compare India with some of the other competing countries,[81] and to understand its position vis-à-vis its competitors.

[78] Kilobytes per second
[79] Megabytes per second
[80] TCP/IP (Transmission Control Protocol/ Internet Protocol) is a collection of communications protocols that allow dissimilar PCs to "speak" to one another over a network. This is the main building block of the Internet.
[81] Ireland, Israel, Singapore, China, Hungary, Philippines, and Mexico. These countries have been identified as India's main competitors in the IT industry by the World Bank (1992), and it is these set of countries that compete on the same aspects of software industry, that India competes on internationally.

5.4.1 STRENGTHS OF THE INDIAN SOFTWARE INDUSTRY

Table 5.5 shows recent software export figures and growth rates for some competing countries in the software industry. Table 5.6 provides an international comparative analysis of Indian computer industry (hardware only). A simple comparison of India with the United States, Brazil, and South Korea in terms of sales of domestically produced mini-and microcomputers during 1975-87 puts India in the fourth place. In 1985-86, the United States dwarfs India, having a sales volume of 7-7.5 million computers worth US $ 30-35 billion, whereas India's computer production then had barely broken through the 10,000 unit barrier, with proceeds totalling somewhat less than US $ 150 million. In 1990-91, the hardware industry was worth about US $ 500 million, which grew to US $ 1.10 billion by 1995-96. These figures show the rapid growth that has been experienced in the Indian computer industry in general. The growth in the software industry has been even more impressive in the 1990s, and the industry is estimated to be worth US$ 5 billion, by the year 2000, where exports and domestic market will have an equal share (NASSCOM, 1995). This reflects the vibrancy and diversification of the Indian software industry. At the moment, the Indian share of US software market is 1.75 percent (Table 5.7).

Table 5.5 Software exports from India and from its competitors

Exports			
Country	**Year**	**US$ Million**	**Annual Growth rate (%) in the last year**
Ireland	1990	185	38
India	1990	120	34
Singapore	1990	89	43
Israel	1990	79	39
Philippines	1990	51	32
Mexico	1990	38	30
Hungary	1990	37	53
Russia	1993	30	-
China	1990	18	43
South Korea	1990	15	40
Taiwan	1987	11	48
Egypt	1994	5	-
Argentina	1990	4	-
Chile	1990	2	98
Cuba	1993	1	40

Source: Heeks, 1996 :113

Table 5.6 India's computer industry (hardware only) in international comparison (sale figures in US $ million)

Country	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
USA	719	1190	1964	2694	3526	4591	8843	13625	19679	26469	30977	34188	38558
India	4 2	4	5.9	8.8	15.7	26.9	32.3	49	58.2	79.3	107.3	137.7	270.1
Brazil	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	316.7	n/a	n/a
South Korea	0	0	0	0	0.2	2	30.2	47.4	6701	147.2	n/a	486.5	n/a

Note: n/a stands for Not Available
Source : Brunner, 1991:1739

Table 5.7 The US software market and Indian market share

Year	US Software Market (US$ Million)	Indian Exports to US Market (US$ Million)	Indian Share of US Market (%)
1981	2450	4.4	0.18
1982	2760	8.8	0.32
1983	3100	11.8	0.38
1984	3490	16.4	0.47
1985	3940	18.0	0.46
1986	4690	24.9	0.53
1987	5580	34.6	0.62
1988/89	6940	41.2	0.59
1989/90	8260	62.3	0.75
1990/91	9250	76.3	0.82
1991/92	10400	101.2	0.97
1992/93	11960	126.6	1.06
1993/94	13630	180.8	1.33
1994/95	16080	274.1	1.70

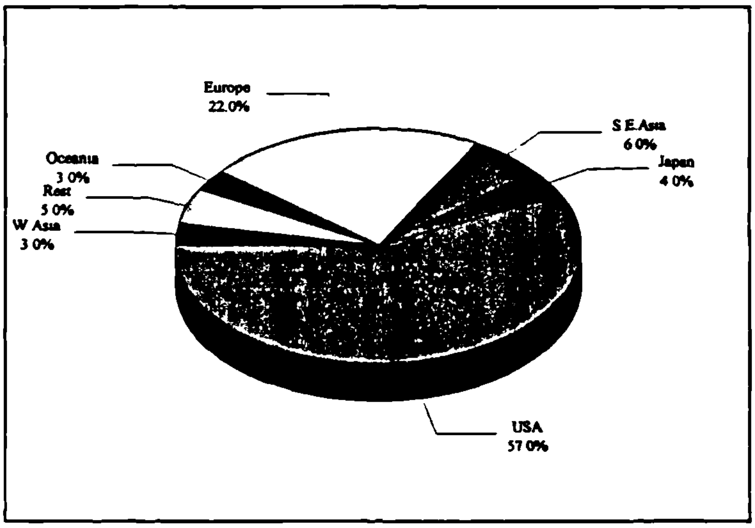
Source : Heeks (1996:74)

Critics are of the opinion that at the moment the high volume of exports of the Indian software industry are mainly due the cost advantage enjoyed by India, and opine, it would wane soon. But if the growth of the domestic software industry is any indication (the growth in rupee terms has been over 30 % , and in dollar terms around 30% since 1990-91), then it becomes clear that India's competitiveness in the software industry may be more long lived, at least until export conditions change dramatically, an unlikely event in the next few years.

Since the mid-1980s there has been a shortage of software engineers in North America and Western Europe. This coupled with the pronounced trend towards contracting-out or "outsourcing" the non-core operations among US and European corporations, has been one of the main driving forces behind the growth of the Indian software industry (Financial Times, 1996). 'One hundred and four out of the *Fortune 500* Companies have outsourced their software requirements from Indian software companies during 1995-96' (NASSCOM, 1995: 31-32).

Indian software companies now sell their services to an expanding international customer list which now includes Japanese and South Korean clients as well as those from North America and Europe, on the basis of quality, speed, innovation and skills as well as price (Financial Times, 1996). However even in 1996, US accounts for the largest share of India's software exports (Fig 5.7).

Fig. 5.7: Major destinations of Indian software exports (1996)



Source: Financial Times, 1996

India, it is claimed today has the second-largest English speaking scientific manpower pool in the world, after the United States[82]. There are over 1670 educational institutions including engineering colleges, technical institutes, and polytechnics that train more than 100,000 people annually. This is in addition to the

[82] While there are no official statistics to prove this fact, this is based on a report published by a French newspaper *Le Monde Diplomatique* (in January 1997). While many other similar magazines else where too have been euphoric about the growth of software industry in India, one needs to treat such statistics with caution.

graduates coming out of the Indian Institute of Technology (IIT)[83]. On the whole about 115,000 fresh engineering graduates come out of the Indian engineering colleges/institutes. The software industry employs about 140,000 professionals (Dataquest, 1996). The quality of technical training is comparable to the best in the world (NASSCOM, 1995). 'The availability of a huge pool of relatively low-cost, highly qualified software professionals, and a time zone advantage with both Europe and the US have enabled India to exploit the rapidly expanding international market for outsourced software services including the expanding market for remote maintenance' (Financial Times, 1996).

India's emergence as an important development centre in the global software industry has coincided with some fundamental changes in the way information technology is used, including the trend away from mainframe-based computing to client-server computing based on desktop PCs and inter-networking-an area in which India, traditionally a UNIX[84]-based computing environment, has particular strengths. While these changes have generated strong demand for skilled computer professionals from the IT industry itself, 'they have also spurred many end-users to re-write, convert and upgrade their existing software to take advantage of new technologies, such as graphical user interfaces (GUI)[85] and object-oriented programming (OOP)[86]' (Financial Times, 1996).

In 1995-96, the Indian software exports were worth over US $ 700 million or Rs. 23 billion. According to many industry observers, even this figure of Rs. 23 billion of software exports is undervalued as most of the multinationals operating in India are invoiced by their parent companies at cost plus 10-15 percent. Moreover, software services costs are much less in India. Therefore, this export figure clearly

[83] IITs are the best Engineering Institutes in the country, and admissions to them are one of the toughest in the world.

[84] UNIX based operating system was originally developed by Bell Laboratories that features multiprogramming in a multi-user environment. The UNIX operating system was originally developed for use on minicomputers but has been adapted for mainframes and microcomputers. UNIX is a popular operating system among the world's scientific community.

[85] A type of computer interface consisting of a visual metaphor of a real world scene, often of a desktop. Within that scene are icons, representing actual objects, that the user can access and manipulate with a pointing device (often a mouse).

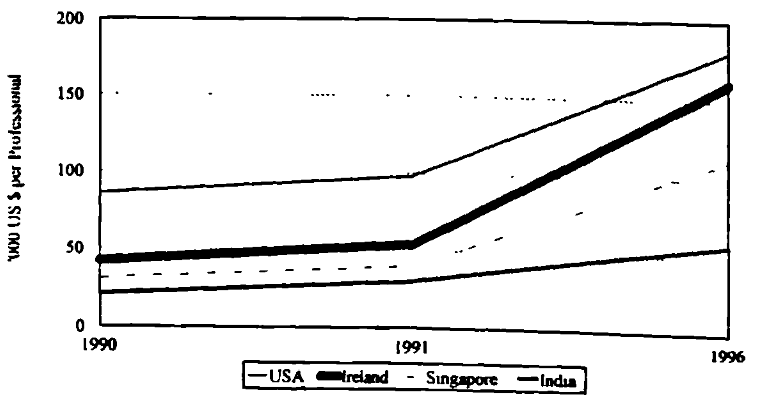
[86] A method for structuring programmes as hierarchically organised classes describing the data and operations of objects that may interact with other objects. Object oriented language is a programming language that reflects the concepts of object-oriented programming.

underscores the actual quantum of software development. If these variances are taken into account, then Indian software exports are worth at least Rs 100 billion (US $ 3.2 billion), and that 'India now has almost 16 percent market share of global customised software market' (Dataquest Vol. 2, 1996: 44).

For a long time it has been argued that the only niche that Indian software companies enjoy is cost[87]. However, increasing evidence is available to suggest that it is not the whole truth. 'Using past salary figures, one can estimate that Indian software salaries rose roughly 10-15 percent per year in rupee terms during the 1980s; a rate of increase that was faster than in most Indian industries... in the 1990s software salaries rose 20-40 percent in rupee terms'(Heeks, 1996: 116).

Another aspect of competitiveness of Indian software professional is its high level of productivity. The World Bank (1992) estimates that between 1990 and 1996, the annual productivity growth of Indian software professionals was 20 percent, which is same as Ireland and Singapore (Fig. 5.8). Thus it is clear that to stay competitive in the software industry, country and companies have to move beyond cost factors alone, and emphasis has to be laid on the quality of the product, and the level of skills involved in software development.

Fig. 5.8 India and competing countries: Projected growth in productivity

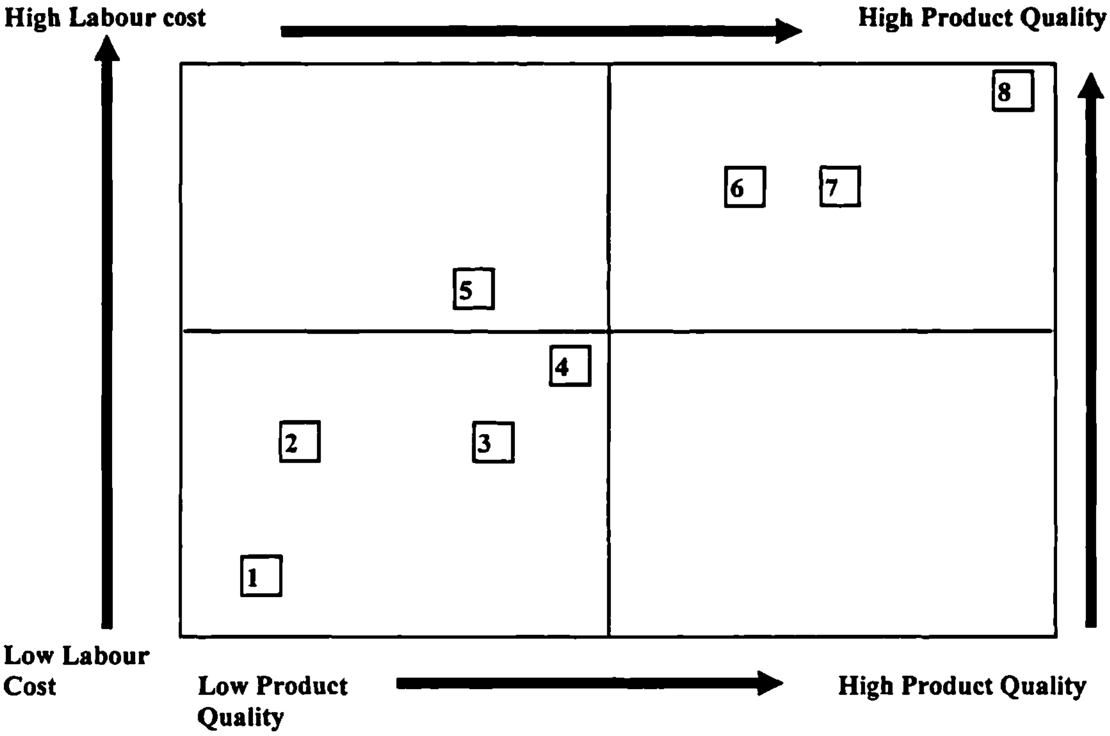


Annual Growth (1991-96)	
USA	7%
Ireland	20%
Singapore	20%
India	20%

Source: World Bank, 1992: 25

[87] 'India's Business-Blinking in Sunlight: Bangalore, Bombay, and Delhi', *The Economist*, April 9, 1994, pp. 88-90.

Fig. 5.9 India and competing countries: Cost of labour and quality of products



1-China 2-Hungary 3-Philippines 4-India 5-Mexico 6-Singapore 7-Israel 8-Ireland

Source: World Bank, 1992: 55

Reliability of a product is universally one of the determining factor of customer satisfaction[88]. Similarly, quality of the product for the price charged is one of the crucial determinants of competitiveness in the global software industry. The World Bank study (1992) shows that all the competing countries primarily fall in two categories of relative cost versus relative quality, with Mexico, and India offering the best of both quality and the cost of software. (Fig 5.9).

Another universally acceptable method of assessing software development process and capability is by using the Software Engineering Index (SEI). Since its introduction in 1987, the SEI model for assessing software processes-the level of management and development maturity-has become the first popular metric for evaluating an organisation's capabilities. The SEI has defined a five-tier scale to assess process maturity. Each of these levels is described in Appendix 8. Each level

[88] This is based on the discussions held with various IT companies in India and in the UK.

of the index signifies the level of skills offered in software development, with the SEI level of 1 being the lowest, and SEI 5 signifying the highest level within the SEI ranking.

Indian software companies over a period of time have consistently improved their quality of work. The 1992 World Bank study mentioned that none of the Indian software companies got a SEI score of more than 2, and that too unverified, by the SEI. However, by 1995-96, there was a tremendous improvement. The Motorola software unit in Bangalore, is one of the only two organisations in the world that has been given a SEI scale of 5, the other one being NASA of USA. At SEI 4, India now has one of the four organisations in the world. India has four organisations which have SEI 3, and 15 units that have SEI 2. (NASSCOM, 1995/1996[89]). All these are a reflection of the growth and maturity of the Indian software industry especially since 1991.

One of the vital factors determining competitiveness in the software industry is in providing OEM[90] (Original Equipment Manufacturer) professional services (World Bank, 1992:55). India and Ireland are the clear leaders in providing OEM professional services. With increasing power of the present-day computers, parallel processing software hold key to competitiveness in the global IT industry. India and Israel have emerged as the strongest countries among the group in the Massively Parallel Processing Software[91] (World Bank, 1992: 60).

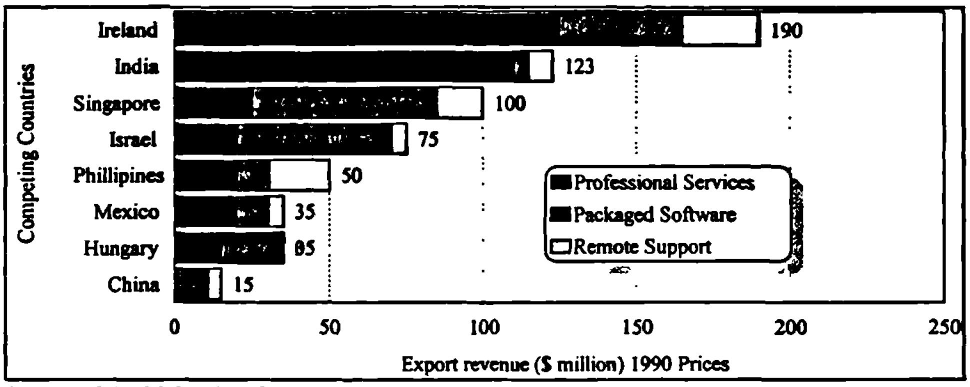
India ranks second next to Ireland among all the competing countries in the overall export of software and services (Fig. 5.10). India still enjoys cost advantage over many of its competitors, although its wages are not as low as China (Fig. 5.11). Among the overall revenue earnings in the industry, India is one of the highest among the competitors (Fig. 5.12).

[89] Presentation by Dewang Mehta, Executive Director NASSCOM, India at the SoftDev 96 WebDev 96, November 27-28 1996, Olympia 2, London

[90] A manufacturer of equipment that may be marketed by another manufacturer

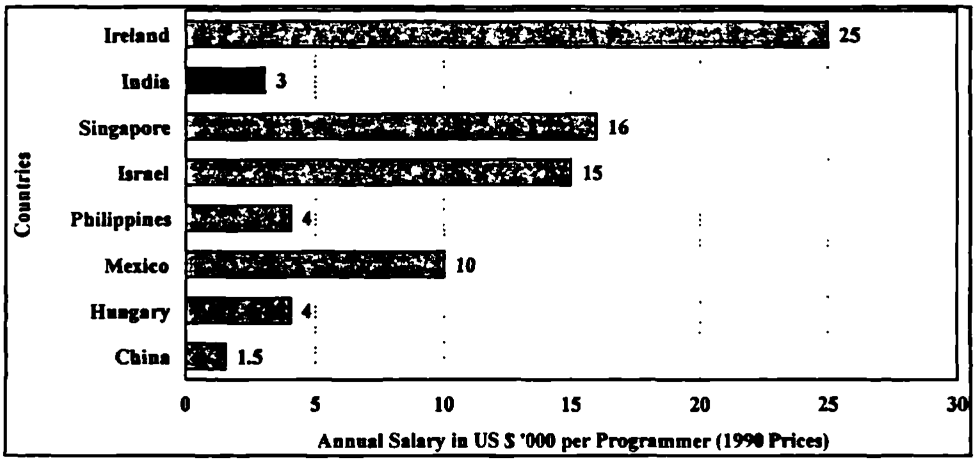
[91] The concurrent or simultaneous execution of two or more processes in a single unit. A computer software that helps run many interconnected processors to access large (*or massive*) amount of data and to simultaneously process a large number of tasks.

Fig. 5.10 India and competing countries: Software and services exports, 1990



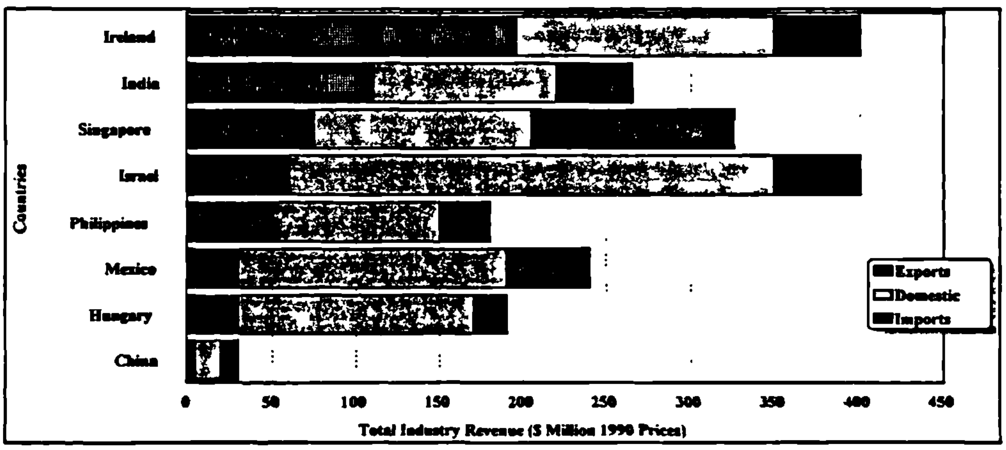
Source: World Bank, 1992

Fig: 5.11 India and competing countries: Annual salary of programmers (in 1990 US$ 1000s)



Source: World Bank, 1992

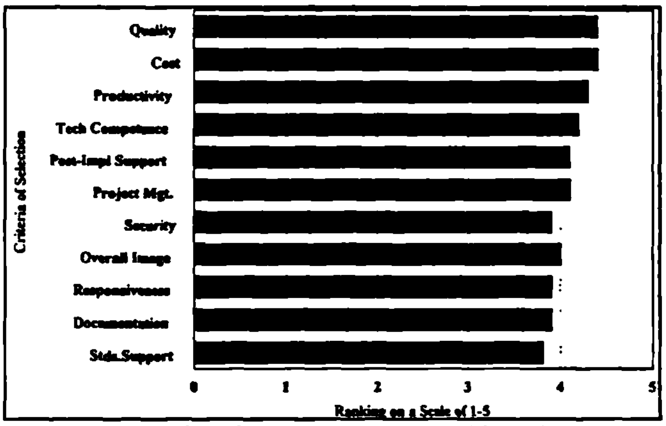
Fig. 5.12 India and competing countries: IT industry revenues (US $ million in 1990 prices)



Source: World Bank, 1992

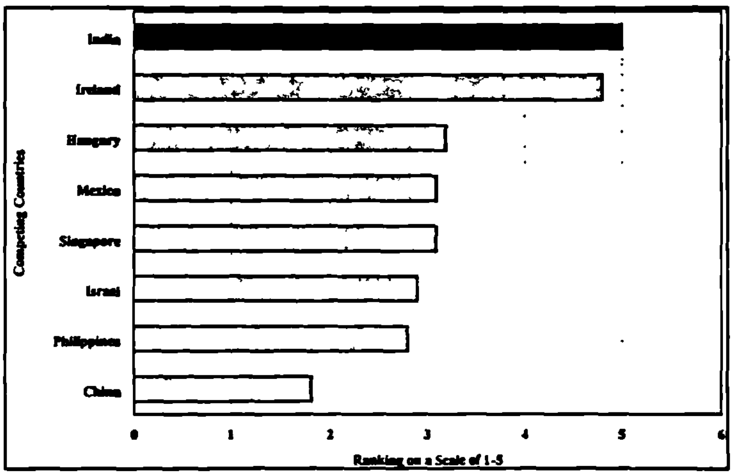
World Bank (1992) cites the survey conducted by IDC-Maxi-Micro (of USA) among the US vendors, which asked vendors in the US about the criteria on which they would decide to subcontract software work globally. These vendors were asked to rank the factors on which a foreign firm (other than Indian) and an Indian firm would be chosen for subcontracting. Quality and cost were among the top most criteria (Fig. 5.13) in deciding the Indian subcontractors.

Fig. 5.13: India: Major criteria for selecting Indian subcontractors in the US, 1992



Source: Maxi/Micro Survey quoted in World Bank, 1992

Fig 5.14: India and competing countries: Ranking of on-site software development

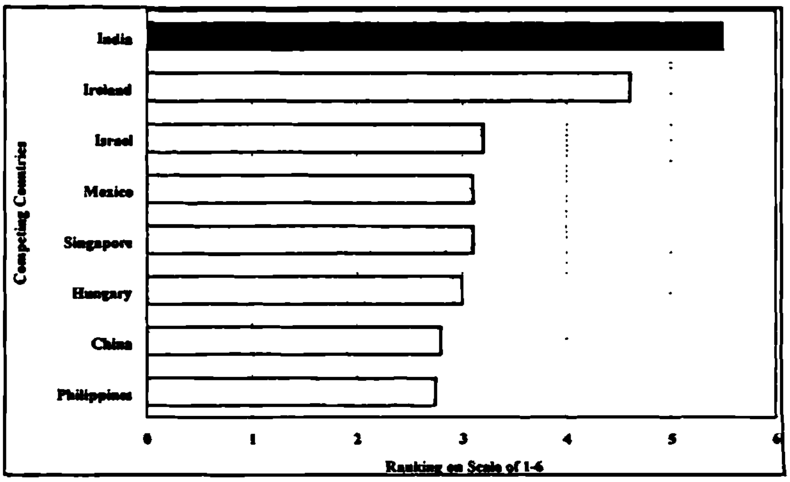


Source: Maxi/Micro Survey quoted in World Bank, 1992

Among the various aspects of software development, the vendors preferred India for on-site and off-shore software development work. In fact, India ranked top among all the competing countries with regard to on-site and off-shore software development

(Fig. 5.14 and Fig. 5.15). Vendors felt a need to improve the ease of doing business with India. Among the vendors, who were already doing business with India, gave higher scores to India, than those not doing business with India. This is the reflection of the recognition of competency of software services from India (World Bank, 1992).

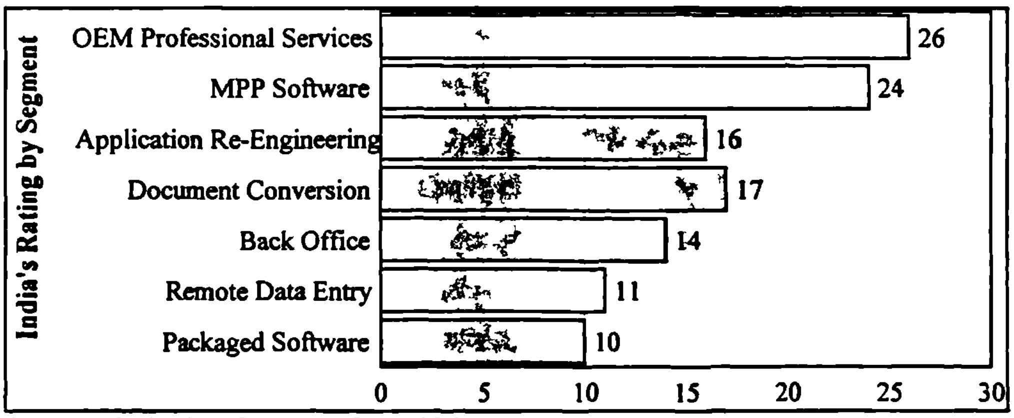
Fig. 5.15: India and competing countries: Scores on securing off-shore software development work



Source: Maxi/Micro Survey c. f. World Bank, 1992

A comparison of India on various segments of software industry vis-à-vis its competitors reveals that India's greatest strengths lie in OEM Professional Services and MPP software, and it weaknesses are remote data entry and packaged software (Fig. 5.16).

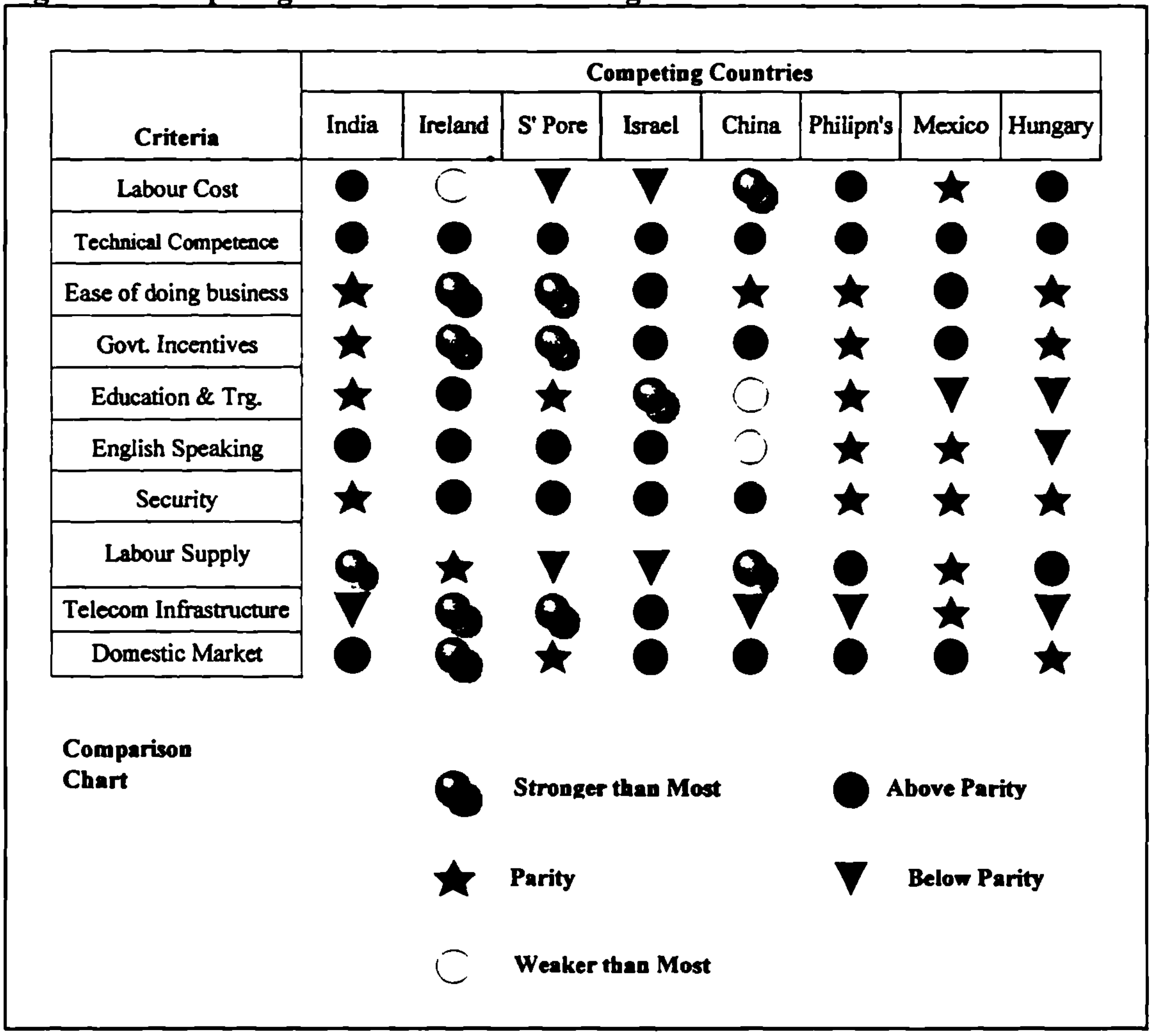
Fig. 5.16 India: Overall weighted ranking by segments (numbers denote weighted ranking scores by segment)



Source: Maxi/Micro Survey c. f. World Bank, 1992

A cross-comparison on various criteria governing the software industry among the eight competing countries puts Ireland at the top of all the countries, labour cost being the only negative factor. India's position reflects its strong position in the global software industry, and in almost all the segments it compares well with competitors or even performs better (Fig. 5.17). However, its telecommunications infrastructure according to the World Bank study is below parity.

Fig. 5.17: Competing countries: Overall rating on different criteria

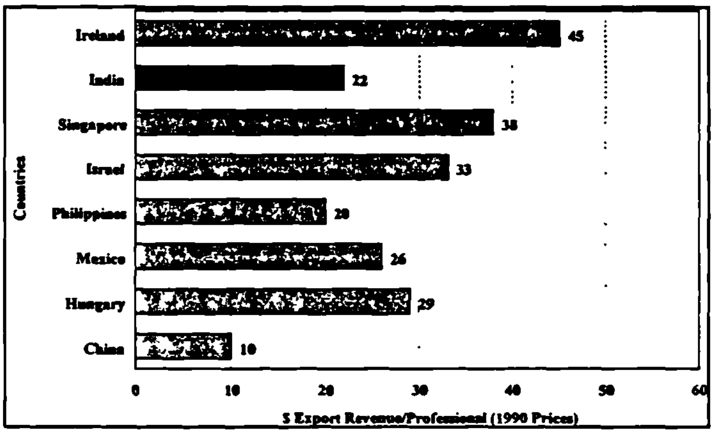


Source: World Bank, 1992

5.4.2 WEAKNESSES OF THE INDIAN SOFTWARE INDUSTRY

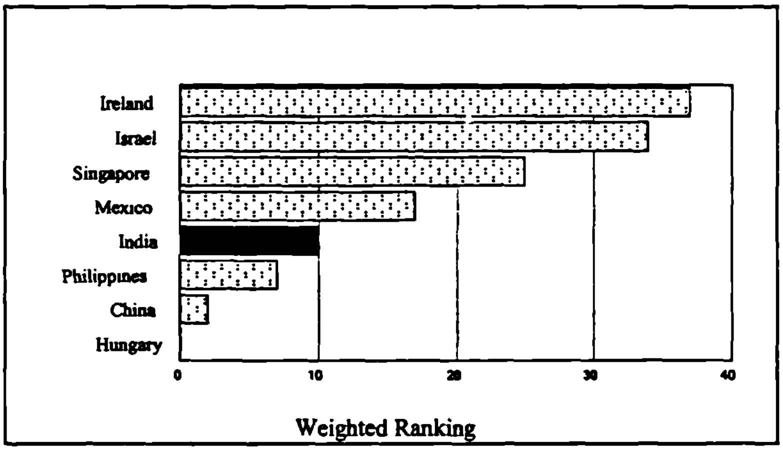
Although the annual growth rate of software industry exports has consistently surpassed the 30 percent mark over the last six years (1990-96), still the industry has some inherent weaknesses. First of all, its export productivity is still low compared to that of its competitors (Fig. 5.18).

Fig 5.18 India: Export productivity is still low compared to competitors



Source: World Bank, 1992

Fig. 5.19: India: One of the weakest in packaged software segment

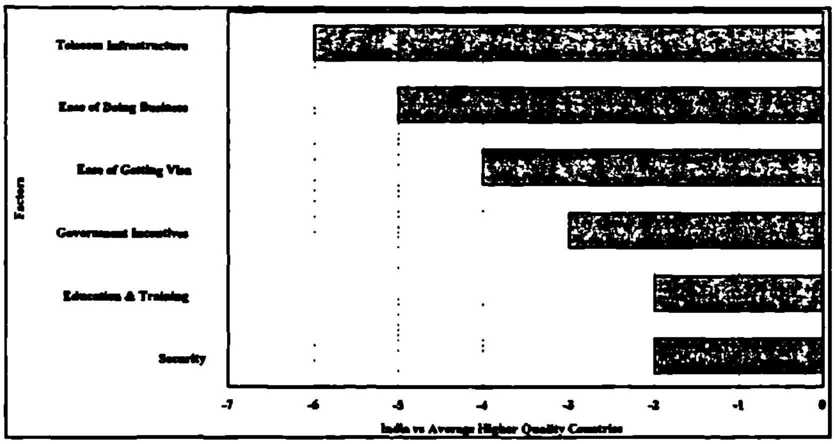


Source: World Bank, 1992

Secondly, India has one of the weakest packaged software segment among the competing nations (Fig. 5.19).The Indian software industry is so predominantly service oriented that it has not given importance to product and package development, with a few exceptions (like TCS, Vedika Software, Wipro, Infosys, Ramco, etc.). There are general factors for this lack of package orientation (NASSCOM, 1995; Dataquest, 1996). Predominant factors being- lack of availability of market intelligence, lack of experience to make packages including documentation, and lastly inadequate marketing funds. Not only have exports of software packages been weak, but even the creation of products and packages for use by the local market has been quite dismal. Among the surveyed vendors in the US by the IDC for the World Bank study, one-fourth of the companies mentioned software engineering techniques as a fundamental weakness of Indian companies, with one-fifth identifying project management skills as the next major problem of the Indian software industry (World Bank, 1992:75).

Telecommunications infrastructure is the backbone of a successful software industry in a company. India's performance is abysmally poor when compared to some of the developed countries, and is one of the lowest among the eight competing countries (Fig. 5.20). Huge investment in the telecommunications sector is the foremost task, if India wants to have a long-term command over the global software industry.

Fig. 5.20 India: Infrastructure is a major impediment in becoming leading producer of software products



Source: World Bank, 1992

The burgeoning domestic software market in India is still a matter of concern for long-term competitiveness of the industry. The total revenue generated by the domestic market in the year 1995-96 was US $ 411 million. Out of this, the total sales of products and packages (international and domestic) accounted for 44 percent, turnkey projects were worth 41 percent; consultancy services, 8 percent; and data processing was 7 percent. The figures clearly indicate that the gap between potential and reality is very high. No doubt, the growth in 1995-96 was 57 percent over the year 1994-95, but the domestic market continued to be ridden with two major obstacles-the most important being the slow rate of computer penetration in the country. The total installed base of PCs in the country, for example, is only 1.6

million units. In other words, one computer for every 1000 people. New York, alone has an installed base of 3.7 million PCs. New Zealand, with a total population of three million, has an installed base of one million PCs (Dataquest, 1996). Until and unless the penetration of the computers in the country is increased, it will not be generating economic viability to produce enough products and packages for the domestic market.

However, if a brief SWOT[92] analysis of the software industry in India is carried out, then the strengths and opportunities clearly outsmart weaknesses and threats. However, in the following paragraphs a summary of weaknesses of the software industry in India is provided.

- **Original Technology**: Indian software industry has the expertise to use the latest technology. However, with few exceptions, it has still not produced enough original technology in the country. In other words, the industry has not created original operating systems or many new computer languages.
- **Mission-Critical Real-Time Operations:** Some of the leading companies in India have handled software development for real-time operations. However, the industry as a whole does not have much experience in this field.
- **Venture Capital**: The US software industry owes a lot to the venture capitalists for its current status. There is a lack of adequate venture capital finance for the IT business and software industry in India (NASSCOM, 1995).
- **Infrastructure**: As the software industry is growing at a rapid rate, many other sectors in India have not yet been able to keep pace with it. Lack of power, highways, and international airports in some cities are major impediments.
- **Protectionism**: Many countries in North America and in the European Union, are imposing protective and non-tariff trade barriers regarding the movement of skilled workers. Such visa and immigration issues may prove to be a threat. Such restrictions delays the deployment of project staff at off-shore project sites, that can result in project lags. Since three-fourth of the Indian software exports are to these continents, such protectionist measures can act as a deterrent.

[92] Strengths, Weaknesses, Opportunities, Threats. These aspects of a business are examined to assess its past and present performance and prospects.

International connectivity apart, the general development of the telecommunications infrastructure in the country is of highest importance, particularly with regard to intra-country networks. The role of domestic high-speed connectivity in providing a low cost training ground for telecommunications-based software development methodologies and in leveraging the hardware base are some of the essential pre requisites, if India wants to consolidate its position as a leading player in the software industry. The real benefits from computerisation are realised fully only when computers get networked. This is the international experience. Therefore, if intra-country connectivity of reasonable cost and quality is made available, the spread of information technology is bound to go up in India (Sen, 1995). This will create a domestic demand base for software, and enable Indian software companies to establish their credibility and track-record for addressing the international markets.

The importance of enabling Indian software companies to establish track records needs to be re-emphasised. This, according to Sen (1995), is one of the major stumbling-blocks in entering the international markets. He further stresses the fact that Government has an important role to play in this. At the moment, 'the government is the single largest consumer of software in the country' (Sen, 1995, M-23), but it actually takes very little from the commercial software sector. This may make short-run financial sense, but the country loses out on the positive externalities. One suggestion, by Sen (1995) is that the government should start contracting out its software requirements to commercial developers, rather than trying to do it all in-house.

5.5 TESTING OF RESEARCH HYPOTHESIS

Section B of the dissertation provided an analysis of the IT industry, which discussed the software industry in the global context, and India's position as one of the emerging countries in the IT industry, especially in the software segment. Earlier in the chapter, a comparative analysis of India's IT industry with some of its competitors highlighted the strengths of the IT industry, especially the software segment of it. Before proceeding to the next chapter, which discusses the regional distribution of the IT industry in India, the first hypothesis of the current research will be put to test in the light of discussions and analysis already carried out in this and the previous chapter.

Reiterating the Research Hypothesis

> *The global IT industry is interested in India as it offers a large pool of high quality IT professionals at competitive wages. The IT industry is a highly skill based industry and would not shift on the basis of cost alone.*

This section attempts to test the above mentioned hypothesis

The strength of India in attracting investment in the IT industry lies in its large base of professional skills available in the country. India has the second largest number of English speaking scientific professionals in the world, after the USA (it is claimed to be the largest English speaking country in the world!). It was well demonstrated earlier in this chapter that the relative wages of IT professionals compared to their counterparts in the US and Europe are much lower, and in fact, India offers a good mix of quality and cost for the IT industry (cf. Fig. 5.9).

It was noted in Chapter 4 that, consequent to the fall in the hardware prices, leading to an increase in the user base, there has been a rise in the demand for software also. Evidence was provided to show that although the demand for software is increasing at an annual rate of approximately 12 percent (in the last ten years), yet the number of software professionals grew at only about 4 percent annually (in the same period) (Schware, 1992 :8). At the same time, productivity in developing software has increased slowly, which has left a significant annual shortfall of software developers. This has been significant to the development of the global software industry and to its geographic spread in the last ten years as companies (especially in the developed world) kept in mind the backlogs in the turnover of the professionals, and planned their investments in locations that offered increased availability of good quality software professionals.

The consequence is a huge backlog of software projects postponed or taking longer to complete because of a lack of personnel to work on them, and a great desire of organisations in these countries to find all possible sources of available skills. Thus, an understanding of wages of software professionals in the developing countries, and continued backlog of software professionals in the developed countries is very crucial to the understanding of the changing geography of world software industry, and to the present research on Bangalore.

The backlog of IT professionals in general and software professionals in particular in the developed world has resulted in a software productivity bottleneck and has forced software companies to look for world-wide hiring of software professionals. Chapter 4 also noted that software and software related activities such as training, documentation, and maintenance now account for a far greater percentage of total system costs than in earlier years. It is here that countries like India can offer very competitive location for software and support activities. The increasing demand for software, and an ever increasing shortfall of trained professionals in many parts of the developed countries (cf. Table 4.7) have led the firms to look for suitably trained professionals overseas, or to start off-shore activities. Evidence was drawn from differences in wage rates for similar kind of work to show that international firms can save a great deal of money by starting operations in India. The process of liberalisation, which has been more evident since 1991, has increased opportunities in the IT sector in India, and many firms claim that India has one of the largest untapped domestic markets in the world. Thus the international IT firms not only benefit by starting their operations in India, it also opens up an opportunity to tap a burgeoning market in the IT sector. Hence, it is not merely the cheap labour cost that pulls the IT industries around the world, but the high skills of the IT professionals and a vast untapped domestic IT market that attracts global IT giants to invest in India.

Thus the first hypothesis in the context of global IT industry, i.e., *the global IT industry is interested in India as it offers a large pool of high quality IT professionals at competitive wages.* And that *the IT industry is a highly skill based industry and would not shift on the basis of cost alone* is supported.

5.6 CONCLUSION

Exports of the Indian software industry have grown from under US $ 5 million in 1980 to over US $ 700 million in 1996, which is no doubt phenomenal by international standards. India's software industry has been growing consistently at over 30 percent annually in the period 1990-96. The Indian expertise is one of the finest in the industry, and in terms of cost, it is one of the most competitive. But, the strength of the software industry in India has to be judged on the basis of various indicators rather than just export statistics alone. This chapter has demonstrated that Indian strength lies in not only providing competitive software products, but also a quality that is globally recognisable and acceptable.

India presents an extremely interesting case of an-export oriented policy in a country which for most part of the last 50 years (since independence) has been strongly inward-looking. The relative success of this is illustrative of the opportunities opened to developing countries in software industry. India's success in the software industry can also be attributed to favourable government policies. If a newly industrialising country such as India is able to recognise and take advantage of an economic opportunity arising from a fundamental shift in the field of IT, which both lowers entry costs for firms and increases windfall benefits from rapid innovation, other countries at a similar stage of economic development may be able to do the same.

The present analysis of the Indian software industry, its growth and characteristics brings to the fore the following conclusions:

- The driving force behind the rapid growth of Indian software industry has been the exports.
- The domestic market although growing, needs to be consolidated, for India to become a global software giant. The growing domestic market is one of the greatest advantages of India.
- India is definitely one of the global leaders in the customised software segment, and controls over 16 percent of the global customised software market.

- India's performance on the packaged software segment is very poor. World-wide, competitiveness is gauged on the basis of packaged software, as that brings most of the revenue in the software industry.
- Inadequate telecommunications and data communications infrastructure will impinge upon India's competitiveness in the software industry, and this issue needs to be addressed very seriously
- For most part the government has played a positive role in the development of the software industry. But there is enough scope for further liberalisation. Computer hardware in the country is still expensive due to differential duty structure. To boost the domestic market, further liberalisation of the computer hardware is required.

Having provided a detailed analysis of the software industry in India, the next chapter discusses the regional variation in the location of IT industry in India.

6 GEOGRAPHICAL ANALYSIS OF THE IT INDUSTRY IN INDIA

6.1 INTRODUCTION

The last two chapters of the current section, discussed the software industry at the global and the national level. As mentioned earlier, the IT industry comprises a number of segments, significant among them being the software[93]. However, while attempting a macro analysis at the global and national level of the IT industry in its entirety would broaden the scope of the discussion, weakening the analytical frame that is being provided. Chapter five, provided a detailed analysis of the growth and characteristics of the software industry in India, and critically examined the competitive position of the software industry in India. Nevertheless, to provide a geographical analysis at the national level, all the constituents of the IT industry has been considered. This is essential, as it will enable to identify regions/locations that seem to perform better than others in various constituents of the IT industry. It also needs to be borne in mind that the software professionals in India are not only in the software and services firms alone, they are also employed in a large scale by the firms which undertake system integration (which need not be a software firm), and

[93] Section 4.1 discussed the significance of software among all the segments that constitutes information technology.

also increasingly by many value added resellers. Studying the spatial aspects of the software firms only will mask a large section of firms that may be employing software professionals. Moreover, a study of the entire IT industry will also offer an understanding of the performance of different segments of the IT industry in India.

The chapter is structured in five major sections. After this introduction, the second section discusses the data source issues confronting the study of IT industry in India. This is followed by a brief spatial analysis of the electronics industry in general in India. The fourth section deals with a detailed spatial analysis of the IT industry in India, while the conclusions are presented in the last section.

6.2 DATA SOURCE ON THE IT INDUSTRY IN INDIA

The Indian IT industry has been the subject of research only recently (Lakha, 1990; Brunner, 1991 and 1995; Evans, 1992; World Bank, 1992; Hanna, 1994; Chaudhuri, 1995; Sen, 1995; Bagchi, 1995; Heeks, 1995 and 1996; Financial Times, 1995 and 1996). Most of these studies primarily focus their attention on the growth performance, exports, technological capability, and state policy related to software industry only. Spatial aspects[94] of the IT industry in India are most neglected of all. To understand the locational competitiveness of the industry, the spatial aspects of the industry need careful analysis.

There is no single source for the information on the IT industry in India. The official statistics in the Annual Survey of Industries does not provide disaggregated information about the IT industry and limits itself to the electronics industry alone. Even the National Industrial Classification (NIC) three-digit code is not much of help. The NIC code 367 specifies only *manufacture of computers and computer based systems*. It does not provide details on whether that includes peripherals, and software- which in any case should be part of the services sector-which is also not included in any of the NIC three-digit classification. Other government sources like the DoE have information only about the firms operating within the purview of its

[94] The Dataquest in its annual number (Dataquest Top 20), does provide a broad geographical break up of the industry revenue, by classifying the country into four regions, viz., north, south, east, and the west.

jurisdiction (for example units in the DoE's STP[95]). As a result, one has no idea of the exact number of IT firms that are currently functional in India. Then there are other industry sources like the NASSCOM[96] and MAIT[97] that provide information on the number of firms that are its members. Finally there are trade magazines like Computers Today, and Dataquest[98](DQ), which provide a comprehensive overview of the industry in their annual issue, published every summer. While Computers Today's CT Almanac provides information on the top 100 IT companies in India, its information is largely limited as these are mainly those companies, that are already listed with trade bodies or with the DoE. Perhaps the most comprehensive information on IT industries in India is published by Dataquest in its DQ Top 20 annual issue. It covers the IT firms by four geographical regions of the country, and is largely referred to as one of the most important source of information on IT industry in India.

While the methodology adopted by DQ in its annual number is largely based on postal surveys, it obviously means the number of firms listed in the annual number is based on the responses received every year. Therefore, one could question the annual list of firms included in the DQ top 20, and should not treat it as the actual total of IT firms operational in India. So as of 1997, there are only estimates rather than precise figures on the actual number of IT firms in India. Hence, in the absence of a more comprehensive source of information on IT industry in India than the one offered by DQ Top 20, the present analysis is based on the information recorded from various annual numbers of DQ Top 20, and the CD-ROM that was made available with its annual issue in 1996.

[95] Software Technology Park

[96] NASSCOM: National Association of Software and Service Companies, main trade association for Indian software companies.

[97] MAIT: Manufacturers' Association for Information Technology, main trade association for Indian hardware companies, and also has a software sub-committee.

[98] Published from India, and independent of Dataquest-USA, which is owned by Dun and Bradstreet

6.3 ELECTRONICS INDUSTRY IN INDIA: A BRIEF SPATIAL ANALYSIS

Government statistics subsume all the segments of the IT industry within the electronics sector. In this section, a brief spatial analysis of the electronics industry is provided before analysing the IT industry in detail. Till the 1970s, the electronics industry in India grew only in and around three major urban centres, Bangalore, Bombay, and Delhi. Among these, Bangalore had the most sophisticated of all the industry, specialising in the manufacturing of telecommunications system, and defence electronics. A significant proportion of the city's workforce was engaged in the two of many major public sector corporations, one producing electronic components, and another manufacturing telecommunications equipment. Bombay (and Pune) was a traditional location for private sector electronics company, and Delhi region became an important centre in consumer electronics sector[99], manufacturing radios, components for radios, and later TVs, VCRs and hi-fi systems.

To encourage the geographic spread of the electronics industry, in the 1970s, public sector new plants came up at various locations. A major step in this direction was the establishment of various electronics development corporations in many of the states[100]. As a result, secondary centres in the electronics industry in the country emerged, which included Hyderabad, Calcutta, Hosur, Trivandrum, Madras, Ahmedabad among others.

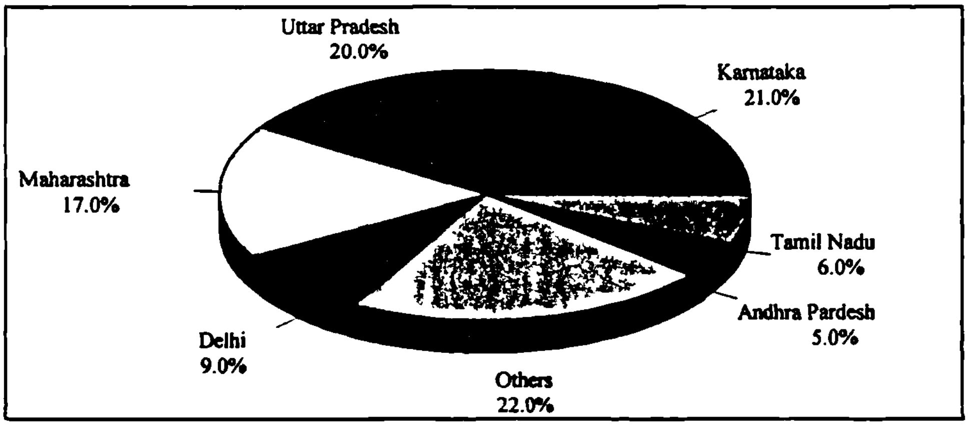
[99] Many in the electronics and the IT industry circles even today believe that the growth of consumer electronics happened in Delhi mainly because it is the country's capital. The consumer electronics industry was controlled by the licence and quota system that was so rampant in the 1970s and the 1980s *(to a large extent even today it is governed by excessive controls)*. These industries realised that it was essential to be in the "political and bureaucratic circle" to gain maximum leverage from such contacts. Thus to avoid unnecessary travel around the country, many chose to establish themselves in and around Delhi. Weston Electronics (which manufactures TVs, VCR, hi-fi Systems) and Onida-JVC, are two of the innumerable examples that can be cited to support this argument. According to the advocates of this "idea", computer and especially software industry enjoyed far more "freedom" than the consumer electronics companies, and thus were not required to be present too close to the political circles of Delhi. Therefore they argue that such freedom allowed investors and entrepreneurs to choose locations that made more business sense. Software industry has been particularly benefited by this "minimalist intervention" policy of the federal government. In fact during the discussions with the DoE officials in Delhi, the researcher was told by a very senior government executive that the most important policy that relates to software industry in the country is that it is out of the clutches of excessive government control!

[100] To name a few: Keonics of Karnataka, Uptron of Uttar Pradesh, Keltron of Kerala, Webel of West Bengal. Not all of these state electronics corporations have been a success. In the wake of the liberalisation in the country, many of these corporations are now being allowed to have private equity share, and are allowed to have joint ventures of their own.

Till the mid 1980s, Maharashtra state occupied the top position, followed by Karnataka state, and Delhi in the overall production and output of electronics industry in the country. In 1986, the Government of India launched the National Software Policy, and that brought a new dimension into the location of the computer related industries in the country. Bombay-Pune region, and Delhi continued to be important centres for electronics components, but Bangalore emerged as the major centre for the IT industry in the country. Various endogenous and exogenous factors have been responsible for Bangalore's emergence as an important centre for the IT industry[101]. The sophisticated defence and telecommunications industry, and a large number of engineering graduates, passing out of Bangalore's numerous engineering colleges offered a ready pool of technical work force for the IT industries wishing to set up in India. Between 1985 and 1991, many prominent names[102] in the computer and software industry established themselves in Bangalore.

When the Indian economy was further liberalised in 1991, and following subsequent changes in the import and customs regulations, importing electronics equipment became less difficult than before. Thus, the electronics industry spread to other parts of the country as well. However, even in 1993 Bangalore continued to lead the nation in the location of electronics industry in India. Karnataka state (whose capital is Bangalore) had 21 percent share of total value of electronics produced in the country (Fig 6.1).

Fig 6.1 India: Major electronics producing states (based on turnover)- 1993

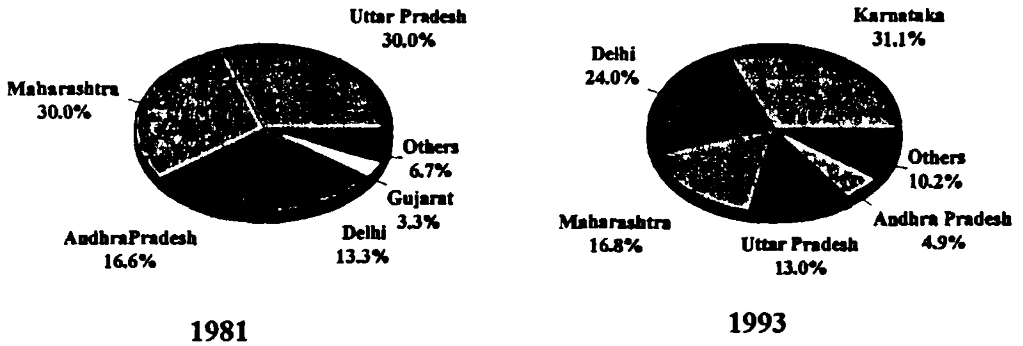


Source: Rastogi et al. (1994)

[101] That is the focus of the current research, and has been dealt with in great depth in part C of this dissertation.
[102] Texas Instruments (1985), Motorola (1988), IBM (as Tata-IBM in 1991)

In terms of employment in the electronics industry, Bangalore was second to Delhi in the country. Almost one-third of the country's production of computer systems (including software), came from Karnataka in 1993 (Rastogi et al. 1994). And since Bangalore has almost 90 percent of computer and software industry in Karnataka, it will be safe to assume that Bangalore produces almost one-third of the country's computer systems[103] and software (Fig. 6.2).

Fig. 6.2 India: Major states producing computer systems 1981 and 1993 (based on number of computer systems produced)



Source: Rastogi et al. (1994)

6.4 THE IT INDUSTRY IN INDIA: A SPATIAL ANALYSIS

This section is based on the analysis of information provided in the annual number of the Dataquest (DQ) magazine. Two points of time have been taken. An attempt has been made to include the latest possible data, and to offer a comparative analysis with an earlier point in time. The 1991 and 1992 DQ figures are not compatible with the later years. So for the present analysis the two points in time that have been considered are 1993 and 1996. DQ's annual number lists the firms by major geographical region, and all the firms within a particular region are arranged in an

[103] Official statistics do not provide further disaggregation of the industry, and software is bundled under computer systems. If separate figures for software were available, then Bangalore would have an even higher share of country's total software production..

alphabetical order. A typical example of the firm-wise information provided by DQ in its annual number is given in Appendix 9. Firm-wise information for all the IT firms listed in the Dataquest for both 1993 and 1996 was computerised, and SPSS 6.1 used for the analysis. All the firms were grouped under different categories for the purpose of analysis. Such a classification is purely to facilitate analysis and is specific only to the present research. Thus the IT industry in India has been classified into the following categories:

IT Firms, are those that have diversified interests in hardware, software and services (including system integration[104]), and even peripherals. The turnover of the firm is largely controlled by various segments of the IT industry, and hence been given that name. These employ a large number of software professionals not only for their software production, but also for system integration and system maintenance.

Hardware only firms, are those that are into manufacturing of hardware components, PCs, Network cards, motherboards, etc.

Software and Services only, are those that deal only with software and its related services. Firms producing customised or packaged software both have been included in these. Firms that provide software support and remote maintenance are also part of this group.

Values added resellers, are mainly dealers, but employ a large number of software and hardware engineers to tailor the systems as per their requirements. A large number of them do system integration as well.

Peripherals, are those firms that are into the manufacturing of peripherals and other equipment that are required by the IT industry. These include manufacturers of printers, scanners, and VDUs (or monitors).

Training firms, are those that provide software and hardware training.

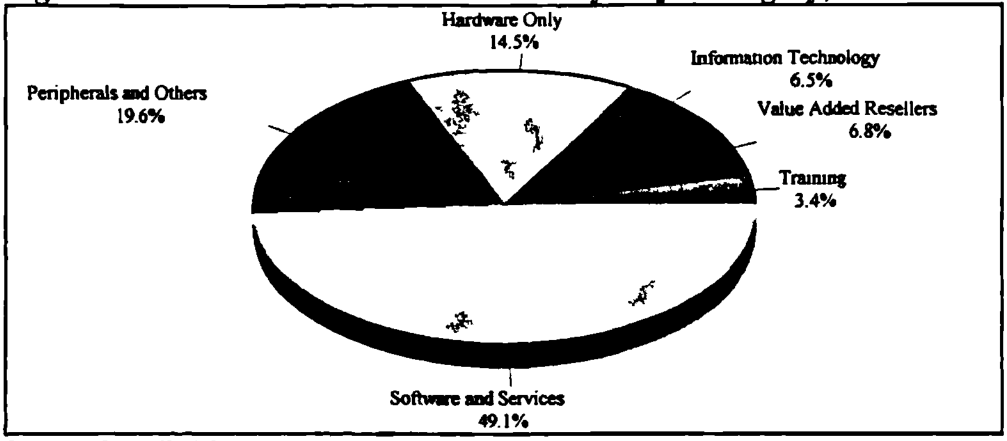
[104] For details on system integration see section Chapter 4 (Section 4.2)

Table 6.1 Growth of IT firms in major urban locations in India (1993-96)

Urban Area	Number of IT Firms (1993)	Percent	Number of IT Firms (1996)	Percent
Bangalore	124	36	205	22
Bombay	47	13	172	19
Calcutta	14	4	28	3
Delhi	68	19	187	20
Hyderabad-Secundrabad	37	10.5	75	8
Madras	37	10.5	169	18
Pune	6	2	28	3
Others	16	5	61	7
Total	**352**	**100**	**925**	**100**

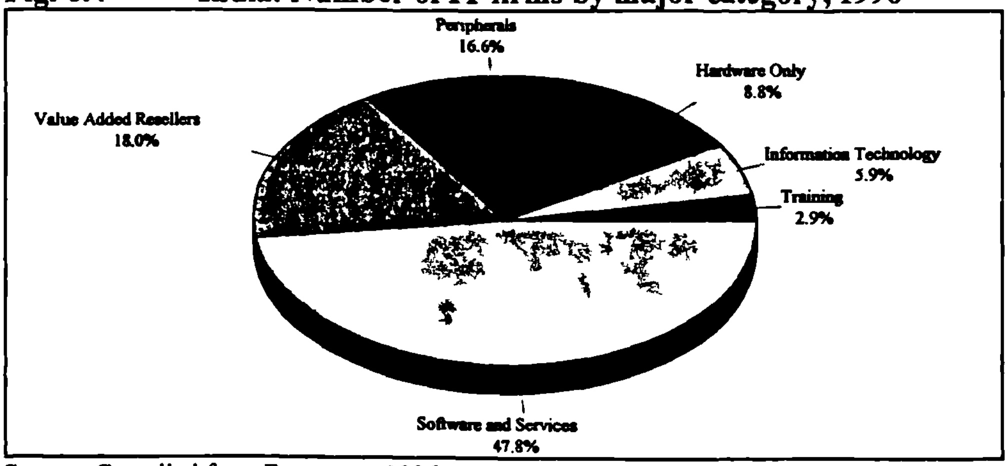
Source: Compiled from Dataquest, 1996

Fig. 6.3 India: Number of IT firms by major category, 1993



Source: Compiled from Dataquest, 1993

Fig. 6.4 India: Number of IT firms by major category, 1996

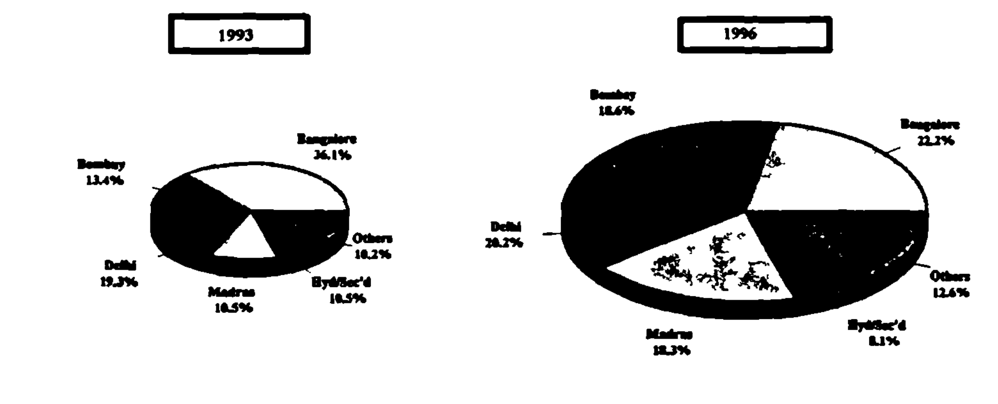


Source: Complied from Dataquest, 1996

Table 6.1 shows the distribution of all the IT companies in India in 1993 and 1996. There has been almost a three fold increase in the number of IT firms registered by DQ in India between 1993 and 1996. The table clearly shows that the industry has shown the tendency to concentrate in the large urban areas. The software and services segment contributes to almost half of all the IT firms in India during both these years. Between 1993 and 1996, the value added resellers have also grown about three times, accounting for 18 percent of all the IT firms in India in 1996 (Fig. 6.3 and Fig. 6.4).

Among the major urban locations where the IT industry seems to have concentrated, Bangalore has emerged as the most important centre for IT industry in India. Although its share of the country's total number of firms (as recorded by DQ) actually declined between 1993 and 1996, still, it has the largest concentration of IT industry in India (Fig. 6.5). Other major centres for the IT business in India include Delhi, Madras, Bombay, Hyderabad, Pune, and Calcutta (Fig. 6.6). However, Delhi, Madras and Bombay appear to be Bangalore's main competitors for attracting IT industries in India. Very recently, two more cities, Hyderabad and Pune, have grown in significance in the location of IT industries, and have been marketing themselves as alternatives to Bangalore for IT business in India.

Fig 6.5 India: Share of total IT firms by location (1993 & 1996)



Source: Dataquest 1993 & 1996

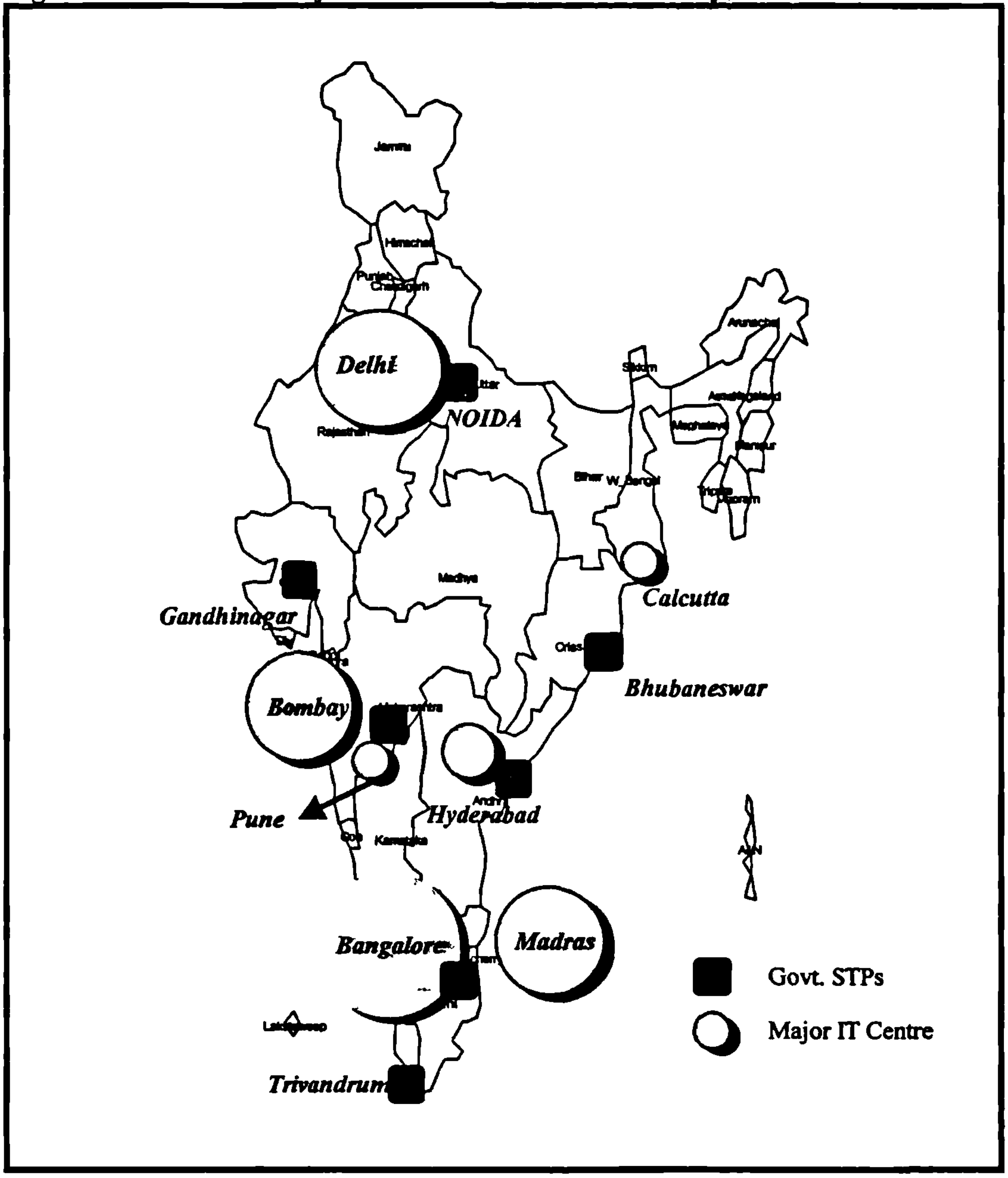
Note: Hyd/Sec'd- Hyderabad-Secundrabad

Table 6.2 India: Start up of IT firms by location

Year	Location								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
1950-59	-	1	-	-	-	-	-	-	1
1960-69	-	6	-	2	1	-	-	-	9
1970-80	10	18	1	9	3	2	5	3	51
1981-85	20	25	2	12	4	14	6	9	92
1986-90	71	64	10	82	26	60	8	26	347
1991-96	104	58	15	82	41	93	9	23	425
Total	205	172	28	187	75	169	28	61	925

Source: Compiled from Dataquest, 1996

Fig. 6.6 India: Major locations for the IT Industry, 1996



As per the 1996 DQ Top 20 volume, there are 925 IT firms in India. Of these, more than 83 percent have been founded since 1986, of which almost half were founded after 1991. Bangalore, Delhi, Madras and Bombay accounted for about 80 percent of all the IT firms started between 1986-90, and their share to the national total remained almost the same, with about 80 percent of all the IT firms that were formed between 1991 and 1996 were set up in these cities. Between 1986-90 and 1991-96, Bombay's share to the country's total fell by 5 percent (Table 6. 2). Table 6.2 also reveals that between 1986 and 1990, almost one-fifth of all the IT firms that started operations in India, based themselves in Bangalore. During the period 1991-96, Bangalore's share increased to include a quarter of all the new IT firms founded in India, demonstrating the importance of Bangalore as a location for IT industry in India.

The geographical analysis also reveals that areas having better telecommunications facilities have a higher concentration of IT industry (Table 6.3). That is one of the most important reasons for the concentration of the IT industry in the southern part of the country. Bangalore, Hyderabad and Trivandrum are also very important centres of space technology industries, which need state of the art telecommunications facilities, and that is probably another reason for the IT industry concentration more in the southern part of the country.

Table 6.3 India: Data communication facilities: City-wise comparison

City	**Availability of IT Professionals**	**Data Communication Links**	**Consumer Price Index for Industrial Workers (March 1992)***
Ahmedabad	2	2	236
Bangalore	**5**	**5**	**224**
Bhubaneswar	1	2	205
Bombay	5	4	242
Calcutta	3	2	229
Delhi	4	4	236
Hyderabad	3	3	223
Jaipur	1	2	221
Madras	4	3	231
Pune	3	2	241
Trivandrum	2	2	232

1= Low , 5 = Hign
Cities have been selected on the basis of demonstrated exports or presence of central / state run Software Technology Park. Delhi includes NOIDA, UP
* Is used to indicate the cost of living in these cities
Source: World Bank, 1992: IA-12

6.4.1 EMPLOYMENT CHARACTERISTICS OF IT FIRMS IN INDIA

Table 6.4 Firm size in India's IT industry, by city, 1993

Firm Size (in number of employees)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	5	4	1	2	9	4	-	1	26
0-10	36	5	1	9	1	4	1	-	57
11-25	35	5	3	18	10	12	-	6	89
26-50	24	2	4	10	5	7	4	3	59
51-75	4	3	1	11	4	4	-	1	28
76-250	17	12	3	13	6	2	1	3	57
251-500	3	7	1	1	1	1	-	-	14
501-999	2	6	-	1	-	2	-	2	13
1000-2000	1	2	-	2	1	-	-	-	4
2001-4000	-	1	-	2	1	-	-	-	4
4001-10000	-	-	-	-	-	1	-	-	1
Total	**127**	**47**	**14**	**68**	**37**	**37**	**6**	**16**	**352**
Percent of Total*	**36**	**13**	**4**	**19**	**10.5**	**10.5**	**2**	**5**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

In 1993, just over a quarter of all the IT firms in India, employed between 11-25 persons. Another 17 percent each employed less then ten people, and between 26 and 50 people. Thus almost 60 percent of the IT firms employed less than 50 persons in 1993, with only 23 firms employing more than 500 people (Table 6.4). While more than a quarter of Bombay's firms employed people in the 76-250 range, the figure was only 13 percent in the case of Bangalore. In 1993. 49 percent of all the IT firms in India belonged to the software and services segment. A third of these software firms employed 11-25 people. In all. 90 percent of all the software firms in India employed less than 250 people (Table 6.5).

Table 6.5 Firm size in India's software and services only firms, by city, 1993

Firm Size (in number of employees)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	1	-	-	1	3	1	-	-	6
0-10	17	3	1	6	1	3	-	-	31
11-25	20	4	3	11	4	8	-	3	53
26-50	17	1	3	1	3	4	2	-	31
51-75	2	2	1	3	2	4	-	-	14
76-250	10	4	2	5	4	1	1	-	27
251-500	1	5	1	-	-	-	-	-	8
501-999	1	-	-	-	-	1	-	-	2
1000-2000	-	-	-	-	-	-	-	-	-
2001-4000	-	1	-	1	-	-	-	-	2
Total	**69**	**20**	**11**	**28**	**17**	**22**	**3**	**3**	**173**
Percent of Total*	**40**	**11**	**6**	**16**	**10**	**13**	**2**	**2**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

The 1996 DQ figures reveal that almost 20 percent of the IT firms did not report their employment figures, and that needs to be kept in mind while attempting any analysis of the 1996 DQ data. Almost half of all the IT firms in Delhi did not report employment figure for 1996. The 182 firms (in India) that did not report employment figures have been excluded from the current analysis. Over 70 percent of all the firms that reported employment figures employed less than 50 people, with more than 28 percent of these employing less than ten persons. Bombay continues to have the large IT firms, whereas Bangalore largely houses smaller firms. For example, Bombay has only 18 percent of firms employing less than ten persons, whereas in the case of Bangalore, it is as high as 30 percent. Firms employing up to 50 persons accounted for over 70 percent of all firms in Bangalore, compared to 55 percent in the same range in the case of Bombay (Table 6.6).

Table 6.6 Firm size in India's IT industry, by city, 1996

Firm Size (in number of employees)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	12	27	18	88	1	10	8	18	182
0-10	60	31	-	17	15	69	6	10	208
11-25	52	40	5	23	23	32	6	13	194
26-50	33	24	2	17	13	20	2	7	118
51-75	11	6	-	7	7	10	4	2	47
76-150	15	14	-	15	9	14	2	6	75
151-300	7	4	3	8	5	7	-	2	36
301-500	10	10	-	7	-	2	-	2	31
501-750	2	6	-	1	1	3	-	1	14
751-999	-	4	-	1	-	1	-	-	6
1000-2000	2	5	-	1	-	1	-	-	9
2001-3000	-	-	-	2	1	-	-	-	3
3001-4000	1	-	-	-	-	-	-	-	1
4000-5000	-	-	-	-	-	-	-	-	-
5001-10000	-	1	-	-	-	-	-	-	1
Total	**205**	**172**	**28**	**187**	**75**	**169**	**28**	**61**	**925**
Percent of Total*	**22**	**19**	**3**	**20**	**8**	**18**	**3**	**7**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

Table 6.7 Firm size in India's software and services only firms, by city, 1996

Firm Size (in number of employees)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	5	7	9	25	-	3	4	5	58
0-10	22	10	-	6	7	21	2	3	71
11-25	29	13	2	6	13	11	3	4	81
26-50	17	6	-	7	6	8	2	2	48
51-75	5	3	-	2	3	6	1	1	21
76-150	8	4	-	8	3	7	1	1	32
151-300	3	3	3	5	2	3	-	1	20
301-500	7	7	-	2	-	2	-	-	18
501-750	1	2	-	1	1	2	-	-	7
751-999	-	2	-	-	-	1	-	-	3
1000-2000	1	2	-	-	-	-	-	-	3
5001-10000	-	1	-	-	-	-	-	-	1
Total	**98**	**60**	**14**	**62**	**35**	**64**	**13**	**17**	**363**
Percent of Total*	**27**	**16.5**	**4**	**16.5**	**9.5**	**18**	**4**	**4.5**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

In 1996, 47 percent of all the IT firms in India belonged to the software and services segment. 16 percent of them did not report employment figures. 26.5 percent of the firms that reported employment figures belonged to the 11-25 employees range. 23 percent employed less than 10 persons. Firms' employing less than 50 people accounted for two-thirds of all the software only firms that reported employment figures. In all, more than 95 percent of all the software firms (that reported employment figures) in India employed less than 250 people in 1996 (Table 6.7).

6.4.2 ANNUAL TURNOVER OF IT FIRMS IN INDIA

In 1993, almost half of the IT firms in India had an annual turnover of less than Rs. 10 million (1993 prices). Only a little over two percent of the firms exceeded an annual turnover of over Rs. One billion. More than 88 percent of all the IT firms in 1993 had an annual turnover of less than Rs. 250 million (Table 6.8).

Table 6.8 also highlights that over 70 percent of Bangalore's IT firms had an annual turnover of less than Rs. 25 million. This figure was very low in the case of Bombay, which has only 38 percent firms in that turnover range. However, half of Bombay's IT firms had an annual turnover in the range of Rs. 50-500 million, whereas that figure for Bangalore was only 11 percent for the same turnover range. Thus it becomes evident that Bombay not only seems to have the larger IT firms in terms of employment, its firms have a far higher annual turnover than compared to Bangalore. The software and services only firms in India, followed a similar path to that of IT firms, with over 60 percent of the firms reporting an annual turnover of less than Rs. 10 million in 1993 (Table 6.9).

Table 6.8 **Annual turnover of IT firms in India, by city, 1993**

Turnover Range (Rs. Million)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	11	-	-	1	3	3	-	1	19
0-10	72	10	8	32	16	21	2	6	167
10-25	18	8	2	11	9	6	4	4	62
26-48	9	2	1	8	4	5	-	1	30
49-99	6	6	2	5	3	-	-	2	24
100-250	7	11	1	6	1	1	-	1	28
260-500	1	6	-	1	-	1	-	1	10
510-1000	1	2	-	1	-	-	-	-	4
1001-2000	1	1	-	2	1	-	-	-	5
2001-3000	1	1	-	1	-	-	-	-	3
Total	**127**	**47**	**14**	**68**	**37**	**37**	**6**	**16**	**352**
Percent of Total*	**36**	**13**	**4**	**19**	**10.5**	**10.5**	**2**	**5**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

Table 6. 9 **Annual turnover of India's software and services only firms, by city, 1993**

Turnover Range (Rs. Million)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	6	-	-	-	1	2	-	-	9
0-10	42	8	7	20	10	14	1	3	105
10-25	8	3	1	4	3	5	2	-	26
26-48	4	-	0	1	2	1	-	-	8
49-99	4	2	2	1	1	-	-	-	10
100-250	4	6	1	1	-	-	-	-	12
260-500	1	-	0	-	-	-	-	-	1
510-1000	-	-	0	-	-	-	-	-	-
1001-2000	-	-	0	1	-	-	-	-	1
2001-3000	-	1	0	-	-	-	-	-	1
Total	69	20	11	28	17	22	3	3	173
Percent of Total*	**40**	**11**	**6**	**16**	**10**	**13**	**2**	**2**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

Table 6.10 Annual turnover of IT firms in India, by city, 1996

Turnover Range (Rs. Million)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	11	2	1	7	8	15	-	12	56
0-9	104	61	10	77	29	92	11	20	404
10-20	28	29	6	26	8	17	7	11	132
21-30	14	8	2	14	10	7	2	5	62
31-40	10	6	-	12	7	7	2	2	46
41-50	2	4	-	6	3	4	1	4	24
51-99	9	19	5	15	4	15	4	2	73
100-250	14	15	3	13	4	5	1	4	59
260-500	6	11	1	7	-	3	-	-	28
510-750	-	5	-	2	1	1	-	1	10
760-1000	2	2	-	1	-	2	-	-	7
1001-2000	2	9	-	3	1	1	-	-	16
2001-3000	1	-	-	2	-	-	-	-	3
3001-4000	1	-	-	-	-	-	-	-	1
4001-5000	-	-	-	1	-	-	-	-	1
5001-7000	-	1	-	-	-	-	-	-	1
7001-9000	1	-	-	-	-	-	-	-	1
9001-10000	-	-	-	1	-	-	-	-	1
Total	**205**	**172**	**28**	**187**	**75**	**169**	**28**	**61**	**925**
Percent of Total*	**22**	**19**	**3**	**20**	**8**	**18**	**3**	**7**	**100**

Source: Compiled from Dataquest, 1993
* Horizontal percentage

In terms of share of annual turnover, there has not been much change in 1996 compared to 1993. The firms having an annual turnover of less than Rs. 10 million in 1996, accounted for 43 percent of all the IT firms in India. More than 80 percent of all the IT firms in 1996 had an annual turnover of less than Rs. 100 million. Only about 3 percent of all IT firms recorded an annual turnover of over Rs. One billion, and of these, almost half of it were to be found in Bombay alone. Bombay and Delhi together accounted for over 70 percent of all firms that recorded an annual turnover of over Rs. One billion in 1996 (Table 6.10).

Table 6.11 Annual turnover of software and services only firms in India, by city, 1996

Turnover Range (Rs. Million)	Number of Firms								
	Bangalore	Bombay	Calcutta	Delhi	Hyderabad	Madras	Pune	Others	Total
Not Available	6	-	1	3	6	8	-	2	26
0-9	51	22	5	24	16	36	5	11	170
10-20	13	8	2	10	5	5	5	1	49
21-30	5	2	1	5	2	3	1	1	20
31-40	2	-	-	4	3	1	-	-	10
41-50	1	-	-	3	-	2	-	-	6
51-99	4	8	1	4	-	4	2	-	23
100-250	11	8	3	4	2	1	-	2	31
260-500	3	5	1	3	-	2	-	-	14
510-750	-	4	-	1	1	1	-	-	7
760-1000	1	1	-	-	-	-	-	-	2
1001-2000	1	1	-	-	-	1	-	-	3
2001-3000	-	-	-	1	-	-	-	-	1
5001-7000	-	1	-	-	-	-	-	-	1
Total	98	60	14	62	35	64	13	17	363
Percent of Total*	27	16.5	4	16.5	9.5	18	4	4.5	100

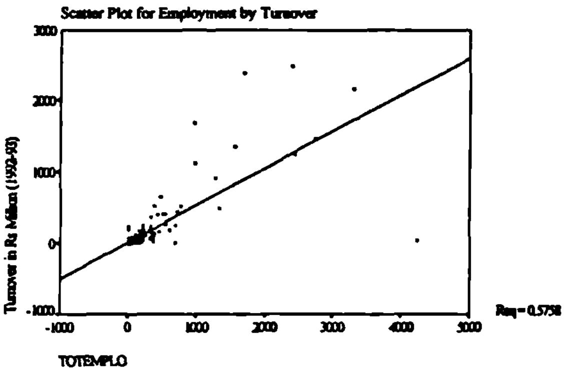
Source: Compiled from Dataquest, 1993
* Horizontal percentage

The software and services only firms in 1996, in general had a similar turnover pattern to that of all IT firms, with 47 percent firms recording an annual turnover of less than Rs. 10 million. More than 70 percent of the software only firms recorded a turnover of less than Rs. 50 million with almost 90 percent of them having an annual turnover of under Rs. 500 million (Table 6.11). When compared to all the IT firms, the software and services only firms appear to have a lower turnover than all IT firms.

6.4.3 Employee-Turnover Relationship in IT firms in India

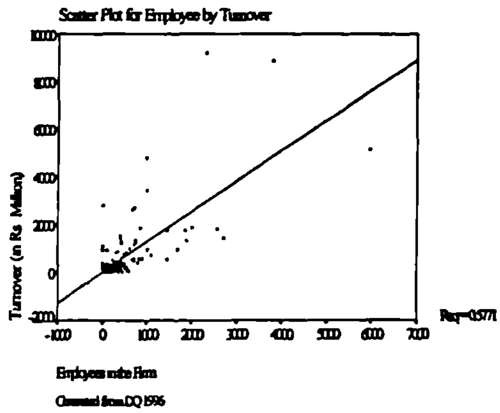
The analysis of firm size and annual turnover seems to indicate that perhaps the annual turnover in the IT industry is dependent on the number of employees engaged. Thus, the higher the number of employees a firm has, the higher will be its turnover. There are no studies to prove this, or to elucidate any inter-segment or inter-city variation that exists in the employee-turnover relationship. Hence an analysis was conducted for the two points in time (1993 and 1996) to understand the relationship between the number of employees in the IT firms and the annual turnover of these firms. An effort has also been made to comprehend if there are any differences in this relationship between major cities in India.

Fig. 6.7 : Employee-turnover relationship in the IT firms in India, 1993



Source: Generated from DQ 1993

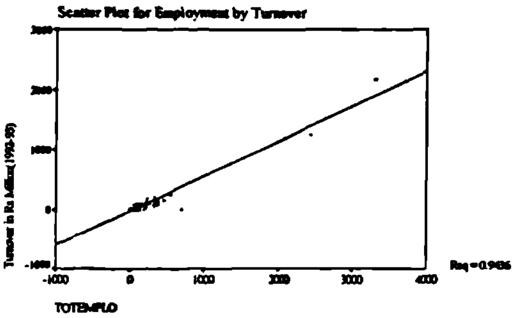
Fig. 6.8: Employee-turnover relationship in the IT firms in India, 1996



Source: Generated from DQ 1996

At the national level, the level of association between these two variables appear to be not very strong for all the IT firms. The R^2 results obtained from Pearson correlation statistics reveal that in 1993, the R^2 for all the IT firms at the national level was 0.575, which marginally changed to 0.577 in 1996. Thus it can be said that the relationship between number of employees and the annual turnover in India is not very strong, and has not changed in the 1993-96 period (Fig. 6.7 and 6.8). Analysis of the software and services only firms for 1993 and 1996 (Fig. 6.9 and 6.10) reveal that, the relationship was very strong in 1993 (R^2 = 0.943), but weakened in 1996 (R^2 = 0.798). The relationship between employees and annual turnover was weakest in all the firms that employed software professionals (these include not only the software and services only firms, but also the IT firms, value added resellers, and software training firms). The relationship expressed in terms of R^2 was 0.506 in 1993, which increased to 0.632 in 1996.

Fig. 6. 9: Employee-turnover relationship in the software and services only firms of India, 1993

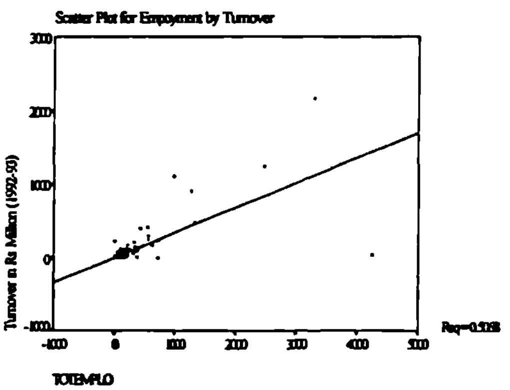


Source: Generated from DQ 1993

Fig. 6.10: Employee-turnover relationship in the software and services only firms of India, 1996

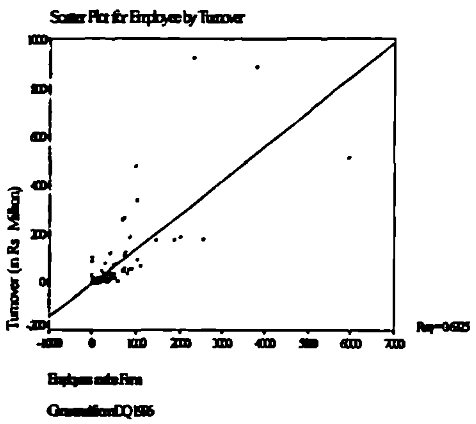
Source: Generated from DQ 1996

Fig. 6.11: Employee-turnover relationship in all the firms that employ software professionals in India, 1993



Source: Generated from DQ 1993

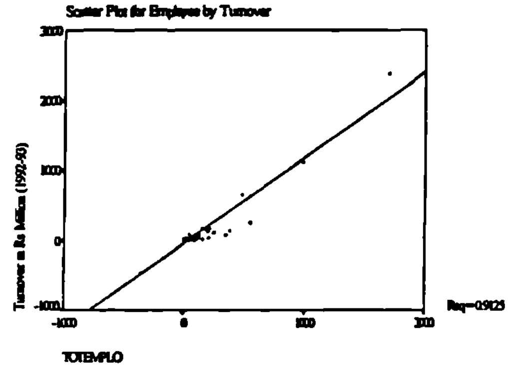
Fig. 6.12: Employee-turnover relationship in all the firms that employ software professionals in India, 1996



Source: Generated from DQ 1996

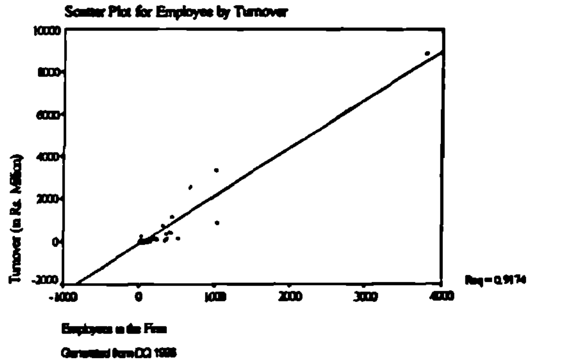
City-wise comparison of relationship between number of employees and annual turnover reveals that in most of the cases the relationship is a strong one, which remained largely consistent between 1993 and 1996. Bangalore and Bombay both seemed to have strongest employee-turnover relationship in 1993 and 1996. Bangalore's R^2 in 1993 was 0.912, and remained almost at the same level with a R^2 of 0.917 in 1996 (Fig. 6.13 and 6.14). In 1996, Bombay's employee turnover relationship weakened compared to 1993 (Fig. 6.15 and 6.16).

Fig. 6.13 : Employee-turnover relationship in all the IT firms in Bangalore, 1993



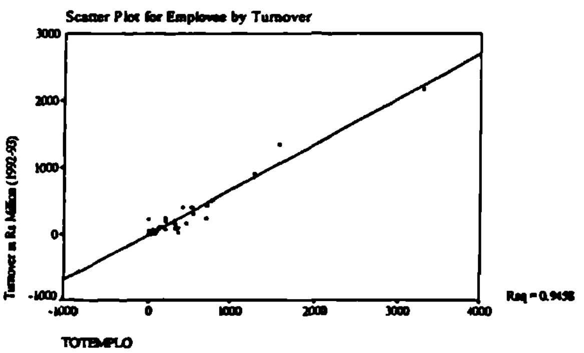
Source: Generated from DQ 1993

Fig. 6.14: Employee-turnover relationship in all the IT firms in Bangalore, 1996



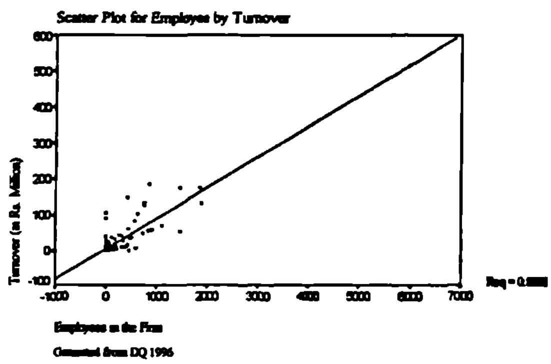
Source: Generated from DQ 1996

Fig. 6.15: Employee-turnover relationship in all the IT firms in Bombay, 1993



Source: Generated from DQ 1993

Fig. 6.16: Employee-turnover relationship in all the IT firms in Bombay, 1996



Source: Generated from DQ 1996

The preceding discussion made it clear that although at the national level the employee-annual turnover relationship appears to be weak for all the IT firms, there is however, a positive linear relationship between the number of employees in a firm to its annual turnover in software segment of the IT industry, and in some urban areas. Therefore for those cases it can be stated that higher the number of professionals in a firm, higher will be its annual turnover.

One important aspect of analysing the industrial growth is the issue of productivity. This is even more important in the case of IT industry, whose global competitiveness depends on apart from other things productivity of the professionals engaged in the industry. Such an analysis will also be useful in understanding spatial variation in the productivity of the industry in the country.

6.4.4 PRODUCTIVITY IN IT FIRMS IN INDIA

One of the best ways of understanding the productivity of an industry is by analysing the value addition or NVA[105,106](Net Value Added). However, despite its weaknesses NVA is still one of the best ways of determining per worker productivity in any manufacturing sector. Unfortunately due to the nature of data collection methods adopted by the Dataquest Magazine, the NVA per employee cannot be calculated. Instead, the Turnover per Employee (TOE) for each category and for each location has been computed for the years 1993 and 1996. Thus in the present analysis, TOE is used as a proxy variable to determine the productivity per employee in the different cities of India in the IT industry.

As reflected from Table 6.12, the average turnover per employee (TOE) for all IT firms in India almost doubled between 1993 and 1996. The rate of inflation measured by Wholesale Price Index (WPI), marginally increased by a percentage point between this time period[107]. Therefore, even by taking into account, the rate of inflation between 1993 and 1996, there has been an impressive increase in the average TOE in the IT industry in India. The increase in average TOE for all firms employing software engineers in India almost trebled from Rs. 0.42 million in 1993 to Rs. 1.17 in 1996.

[105] NVA is the increment to the value of goods and services that is contributed by a firm and is obtained by deducting the value of total inputs and depreciation from the value of output. The contribution to total production made by an industry, a firm or a worker. In the case of a firm, it is calculated by subtracting from its sales its purchases from other firms.

[106] According to Krugman (1996), one must treat NVA figures very carefully. In his analysis of various sectors of manufacturing in the USA, he finds that industries with really high value-added per worker are in sectors with very high-ratios of capital to labour, like petroleum refining. This according to him happens because capital intensive industries must earn a normal return on large investments, and so must charge prices that are a larger markup over labour costs than labour-intensive industries, which means that they have high value added per worker. Thus he concludes that among large industries, value added per worker tends to be high in traditional heavy manufacturing sectors like steel and autos. High technology sectors like aerospace and electronics turn out to be only roughly average. This is not surprising, as high value added per worker occurs in sectors that are highly capital intensive, that is, sectors in which an additional unit of currency of capital buys little extra value added.

[107] The rate of inflation measured by WPI stood at 7.3% in July 1993, and was 8.4 % in July 1996.

Table 6. 12 All India: Change in the growth, output and turnover per employee of IT firms, by major cities (1993-1996)

Year	Bangalore				Bombay			Delhi			All Locations	
1993	All Firms	SW Only Firms	All Firms Employing SW Engineers	All Firms	SW Only Firms	All Firms Employing SW Engineers	All Firms	SW Only Firms	All Firms Employing SW Engineers	All Firms	SW Only Firms	All Firms Employing S W Engineers
Total Firms	127	69	88	47	20	30	68	28	41	352	173	233
Total Employees	8,896	3,641	5,263	14,793	5,932	9,998	10,818	3,654	5,619	48,880	16,365	29,343
Total Turnover (Rs Billion)	6 698	1.466	2.926	9.752	3.269	5.951	8.199	1.573	2.300	28.999	7.013	12.32
Average Turnover Per Employee (Rs. Million)	0.753	0.427	0.555	0.659	0.551	0.595	0.757	0.430	0.409	0.593	0.428	.420
1996												
Total Firms	205	98	153	172	60	120	187[1]	62[2]	134[3]	925 (742)	363 *(305)*	694 *(560)*
Total Employees	16,924	7,277	14,114	29,900	16,826	22,664	16,214	3,990	13,252	84,924	36,999	62,691
Total Turnover (Rs Billion)	25.714	5.960	22.36	31.690	14.266	21.17	34.954 *29.718*	6.945 *5.451*	26.647 *24.901*	107.73 *96.019*	33.19 *29.05*	79.262 *73.938*
Average Turnover Per Employee (Rs. Million)	1.519	0.819	1.584	1.059	0.847	0.934	2.150 *1.771*	1.740 *1.366*	2.010 *1.879*	1.268 *1.130*	0.897 *0.785*	1.264 *1.170*

NOTE:

1 86 out of 187 Firms in Delhi did not disclose the number of employees which has skewed the Average Turnover per Employee in its favour

2 25 of the 62 have not given Employee figures

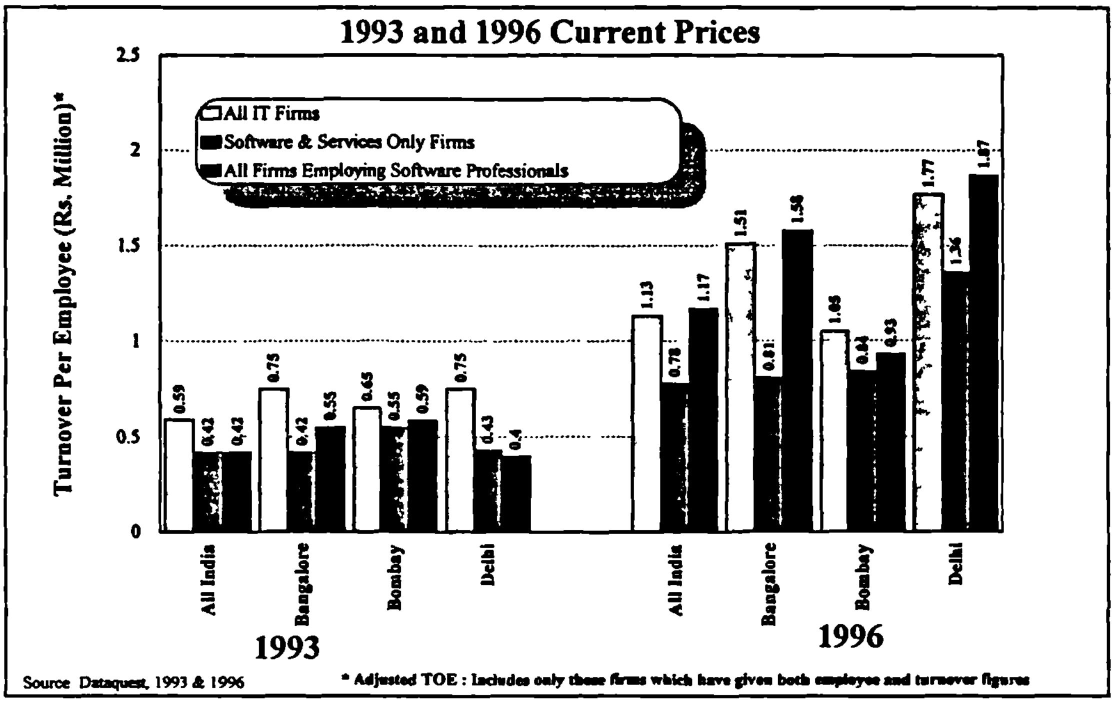
3 62 of these 134 have not divulged employee figures

SW: Software

The Figure in Italics for Delhi and All Locations excludes the firms without information about employees

Source: Author's own calculations based on the information from Dataquest 1993 and 1996

Fig. 6.17 Average annual turnover per employee in IT firms for major urban locations in India (1993 and 1996)



Among the major cities, Delhi and Bangalore have the highest TOE. Although Bombay has more number of large IT firms in India than any other city, still its average TOE is lower than Delhi or Bangalore. Delhi, with its mix of large and small IT firms (especially the hardware segment) had the highest TOE in 1996. It is interesting to note that Bangalore, which comprises mostly small IT firms (70% of the city's IT firms employ less than 50 people) has one of the highest TOE in the country. The city's TOE for all firms in 1996 was 30 percent more than that of Bombay, and 16 percent higher than the all- India aggregate. However, Delhi's TOE is 30 percent higher in all firms category than Bangalore (Fig. 6.17).

6.5 CONCLUSION

There were two main purposes of this chapter. One, to understand the geographic growth pattern of the IT industry in the country and secondly to explain the spatial variation in the growth of the IT industry in India. The detailed spatial analysis of the IT industry in India showed clearly the dominance of a few urban centres in the country. Out of this group, one city- Bangalore seems to have so far outpaced other cities in housing the IT industry in the country. Bangalore not only has the highest number of IT firms in the country as of 1996, but it also has one of the highest productivity of IT professionals (expressed in terms of TOE) among the major cities in the country.

How has Bangalore been able to emerge as the location to the largest number of IT firms in the country? Is it purely a matter of chance that such a phenomenon has occurred in Bangalore? For a size of country like India, is there any thing to be learnt from the experience of Bangalore? Most important of all, can Bangalore continue its pre-eminence in the location of IT industry in the country? These are some of the crucial issues that form the kernel of the present research, which will be analysed during the course of next section of the dissertation. that attempts to understand the competitiveness of Bangalore in the location of the IT industry in India.

PART C BANGALORE'S COMPETITIVENESS IN THE IT INDUSTRY IN INDIA

7 EMERGENCE OF BANGALORE AS A CENTRE FOR HIGH TECHNOLOGY PRODUCTION IN INDIA

7.1 INTRODUCTION

The chapter on the software industry in India established some of the causal links to the growth of the IT industry in the country. A detailed geographical analysis of the IT industry illustrated Bangalore as the leading centre for the industry in India. This third part of the current research aims to understand the competitiveness of Bangalore in attracting IT industry over a period of time in India. As an introduction to the current section of the dissertation, the present chapter discusses the history and growth of Bangalore as an industrial city to the present situation where it is the most important centre for IT industry in the country. This chapter probes how Bangalore has been able to transform itself from a "pensioner's paradise" to what the journalistic literature describes as the "Silicon Valley of India". The purpose of this chapter is to provide a context to the next set of chapters of this part of the dissertation. which analyses the national competitiveness of Bangalore in the IT industry.

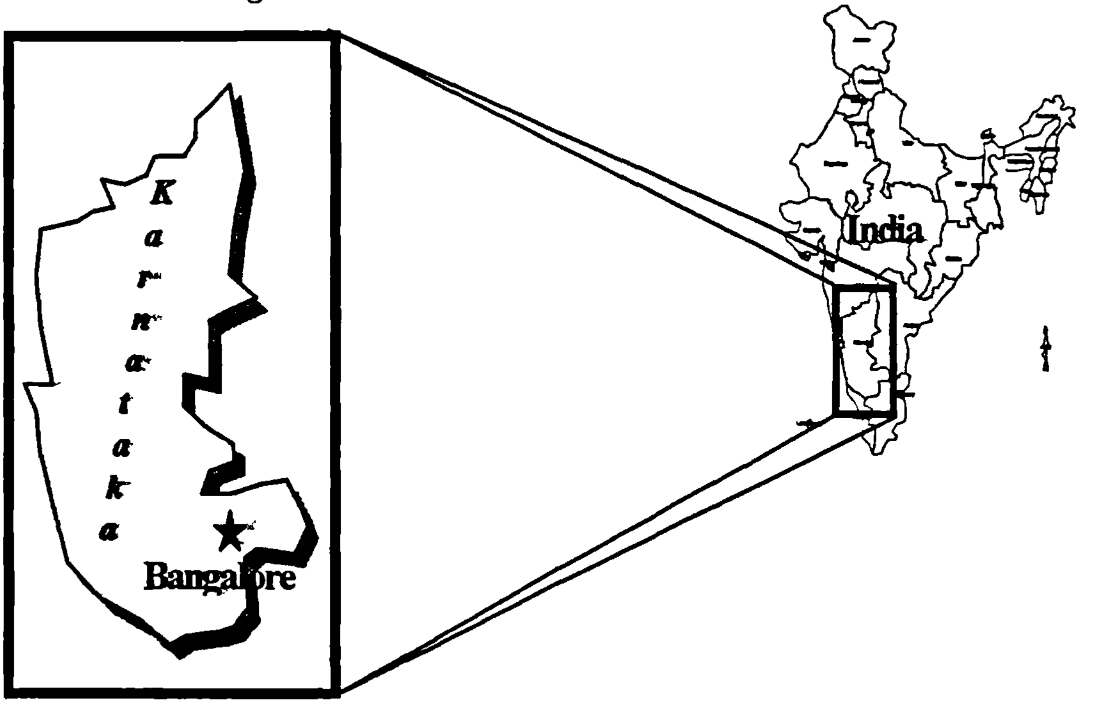
The chapter is structured in six major sections. After this introduction, the second section provides an overview of industrialisation in the state of Karnataka, where

Bangalore is located. This is followed by a discussion on the demographic and urban growth of Bangalore. The fourth section deals with the urban infrastructure in Bangalore, the fifth section discusses industrial development in Bangalore, and the sixth provides an analysis of the IT industry in Bangalore. The conclusions are summarised in the last section.

7.2 AN OVERVIEW OF INDUSTRIAL DEVELOPMENT IN KARNATAKA

Karnataka is the eighth largest state in India, both in terms of population and area (Fig. 7.1). The state occupies 192,000 Km^2 (5.8 % of the country's geographical

Fig 7.1 Karnataka in relation to the rest of India



area), and had a population of 45 million (5 % of the country's population) at the time of the 1991 Census. With nearly 31 percent of its total population living in urban areas in 1991, compared to 25.7 percent in India as a whole, Karnataka ranks fourth in the country in terms of percentage of urban population. Table 7.1 shows the growth of total population, and urban population from 1941 to 1991 in the state. During this period, the total population grew 2.7 times, whereas the urban population multiplied by five times.

Table 7.1 **Karnataka: Growth of urban population, 1941-91**

Census Year	Total Population (Millions)	Urban Population (Millions)	Percent of Urban to Total Population	Annual Growth rate of Urban Population in the Preceding decade	Number of Urban[1] Centres
1941	16.2	2.7	16.9	2.29	207
1951	19.4	4.4	22.9	6.17	283
1961	23.6	5.2	22.3	1.82	213
1971	29.3	7.1	24.2	3.52	227
1981	37.0	10.7	28.9	5.04	250
1991	44.9	13.9	30.9	2.91	254

Source: Government of Karnataka , Directorate of Census Operations, 1983:1993
[1] Urban Areas in India are defined on the basis of a number of criteria. See Section 1 (Chapter 1) for a full definition of an urban area in India.

Table 7.1 also demonstrates a massive spurt in urban growth in Karnataka during 1941-51 recording a growth of 61 percent. The major reason for this was due to a high inflow of migrants to major urban centres like Bangalore, Mysore, and Mangalore. As the National Institute of Urban Affairs (NIUA) study remarked, 'part of this was explained by the spurt in the industrial activities during the second world war period and part by the initiation of large scale economic and administrative activities after independence to the country' (NIUA, 1984-a:97), *most of which occurred in Bangalore.*

The process of industrial development has been an important factor in the growth of the state's economy, especially in recent years. On the basis of all-India average performance in industrial activity, 'Karnataka falls under the category of industrially advanced states in India' (Panneerselvam, 1996: 204). An attempt is made to present the dynamics of the industrial sector of the state in this section. The data on Annual Survey of Industries (ASI) by Central Statistical Organisation (CSO) is the basic source of information.

An analysis of the state's performance in the industrial sector vis-à-vis India reveals that Karnataka accounts for approximately five percent of the large-scale industrial sector[108] of the country in terms of number of factories, workers, value added, and value added per worker (Table 7.2). Karnataka's position in the all-India perspective has been relatively stable over time. Between 1990 and 1993, its share of factories and workers to that of nation was constant around 5 percent, but the NVA (Net Value Added) per worker increased from 5.0 to 5.7 percent during the same period.

It is quite distinctively noticeable that between 1981 and 1986, the total number of factories at the national level has increased very steeply (from 19,115 to 101,016). This appears more like a case of organised methods adopted in registering the factories, rather than a sudden growth of factories per se, which appears from Table 7.2

[108] The Industry in India is divided into the following segments:
Tiny Sector Units: Industrial units wherein investment in plant and machinery is Rs. 500,000 or below (irrespective of location of the unit).
Small Scale Industries (SSI): Units with an investment of Rs. 6 million and below in plant and machinery. In case of any SSI, that exports at least 30 percent of its annual production, by the end of third year from the date of its commencing production, the limit for investment in plant and machinery shall be Rs. 7.5 million.
Ancillary Industries: Units with an investment of Rs. 7.5 million and below in plant and machinery and engaged in manufacture of production of parts/sub-assemblies/components or rendering services of more than 50 % of production/services as the case may be to one or more industrial units.
Medium and Large Units: Industrial units that are none of the above and having investment more than Rs. 6 million in plant and machinery.
100 % Export Oriented Units (EOU): A unit which undertakes to export it entire production of goods. Such units may be set up under the EOU scheme or Export Processing Zones (EPZ), or Software Technology Park (STP) or Electronic Hardware Technology Park (EHTP). The units may be engaged in manufacturing, production of software, horticulture, agriculture and similar activity. Units engaged in services may also be considered under this scheme.

Table 7.2 Karnataka : Share in the all-India industrial aggregates (medium and large scale industries), 1961-1990

Year/Item	Selected Characteristics			
	No. of Factories*	**No. of Workers**	**Value Added (Rs. Billion)[1]**	**Valued added Per Worker (Rs.)[1]**
1961[2]				
All India Total	8,391	2,580,599	8.64	3,300
Karnataka	433	92,616	0.26	2,800
% Share of the State	5.2	3.6	3.0	
1971[2]				
All India Total	13,280	3,465,000	28.11	8,000
Karnataka	596	152,000	1.67	11,000
% Share of the State	4.5	4.4	5.9	
1981[2]				
All India Total	19,115	4,814,816	105.11	22,000
Karnataka	970	241,014	5.03	21,000
% Share of the State	5.1	5.0	4.8	
1986[3]				
All India Total	101,016	7,584,007	232.66	31,000
Karnataka	5,456	381,422	11.71	31,000
% Share of the State	5.4	5.0	5.0	
1990[4]				
All India Total	107,992	8,256,712	433.73	52,500
Karnataka	5724	420,869	21.84	52,000
% Share of the State	5.3	5.1	5.0	
1993[5]				
All India Total	119,494	8,835,952	712.48	80,000
Karnataka	6,165	442,737	41.21	93, 100
% Share of the State	5.1	5.0	5.7	

* Factories which are registered under the Factory Act, 1948. By definition it **does not include** factories that employ **less than ten workers, which uses electric power**, and factories that **employ less than twenty workers, and not using electric power.**

[1] All in Current Prices only

Source: [2] From Panneerselvam, 1996: 205
[3] Annual Survey of Industries, 1985-86 (GoI, 1989)
[4] Annual Survey of Industries, 1989-90 (GoI, 1993-a)
[5] Annual Survey of Industries, 1992-93 (GoI, 1995-a)

Any analysis derived from the foregoing table should bear in mind that it includes only the *registered* factories, and *excludes* factories that employ less than 20 workers (except those between 10 and 20 using electricity). Unfortunately the ASI is the only reliable source of information about the industrial sector, and has been considered in the present analysis. In terms of the growth rate of registered factories, Karnataka has been growing at a faster rate than the national average growth rate.

The focus of the research being the IT industry, it would be useful to carry out a similar kind of analysis at the industry level, for India and for the state of Karnataka. As mentioned in the previous chapter, NIC Code 367[109] (Manufacture of Computers and Computer based system), appears to be the closest that would fit the current description of the IT industry.

Table 7.3 describes the growth in the number of factories, total workers, net value added (NVA) for some of the NIC codes that relates to computer manufacturing (NIC code 367), and consumer electronics (NIC code 366-manufacture of consumer electronics products like video recorders, televisions, and audio systems). Since consumer electronics is another segment of the electronics sector that has been rapidly growing, a comparison with that segment would show how the computer manufacturing has performed vis-à-vis other segments of electronics sector.

[109]ASI presents the NIC (or the National Industrial Classification) code data at three digit level for the country, and two digit level for the states. Any analysis here would again be limited to the state (in case of two digit data), and to the country (in case of three digit data). However, there are information available for urban areas as a whole, and some analogies can be drawn upon from that data to the context of the present study.

Table 7.3 **India and Karnataka: Share of the computer manufacturing and consumer electronics, 1985-93 (at current prices)**

	NIC 366* NIC 367 India		NIC 36[4]			All Codes
1985-86[1]	**Computer Systems**	**Consumer Electronics**	**India**	**Share of Karnataka (%)**	**India Urban**	**India Urban**
Number of Factories	202	225	4066	306 (7.52%)	NA	NA
Total Employed	26,859	13,150	353,514	419,16 (11.8%)	NA	NA
Net Value Added Rs. Billion.	1.343	0.3	14.859	0.212 (14.1%)	NA	NA
NVA per Worker (Rs.)	50,000	22,813	42,032	50,000	NA	NA
	NIC 367 NIC 366 India		**NIC 36**			**All Codes**
1989-90[2]	**Computer Systems**	**Consumer Electronics**	**India**	**Share of Karnataka (%)**	**India Urban**	**India Urban**
Number of Factories	170	529	4790	396 (8.2%)	3881	78,157
Total Employed	20,710	42,675	385,811	46,775 (12.1%)	314,415	6,078,747
Net Value Added Rs. Billion.	2.67	3.37	32.84	3.92 (12%)	25.61	321
NVA per Worker (Rs.)	128,923	78,968	85,119	83,805	81,452	52,806
	NIC 367 NIC 366 India		**NIC 35-36[5]**			**All Codes**
1992-93[3]	**Computer Systems**	**Consumer Electronics**	**India**	**Share of Karnataka (%)**	**India Urban**	**India Urban**
Number of Factories	209	526	13434	1004 (7.4%)	11,641	84,931
Total Employed	31,942	38,582	898,656	89,349 (9.9%)	749,887	6,399,183
Net Value Added Rs. Billion.	6.39	5.14	98.53	11.4 (11.5%)	77.95	509.3
NVA per Worker (Rs.)	200,000	133,222	109,641	127,589	103,948	79,588

* In the Year 1985-86, Computer Systems was grouped under Code 366, which has moved to code 367, in the other two time period above.

NA: Not Available

[1] Government of India, 1989- Annual Survey of Industries

[2] Government of India, 1993- Annual Survey of Industries

[3] Government of India, 1995- Annual Survey of Industries

[4] This Classification is a more disaggregated than for the period 1992-93. The NIC code 36 stands for "Manufacture of electrical machinery, apparatus, appliances, supplies, and parts".

[5] This Classification is aggregated, and includes the Code 35, which is "Manufacture of machinery, machine tools, and parts except electrical machinery". **No separate information for Code 36 is available for 1992-93**

Some very important observations can be made from Table 7.3. At the national level, the NVA per worker is higher for the computer industries compared to the consumer electronics industries, which can be taken as an indication of the productivity level at the national level for the industry. The NVA per worker in computer manufacturing (based on current prices) has increased from Rs. 50,000 to Rs. 200,000 between 1985-86 and 1992-93. This is far higher than the consumer electronics sector, which increased from Rs. 23,813 in 1985-86 to Rs. 133,222 in 1992-93. A comparison with the city level TOE (Turnover per Employee) that was attempted in the last chapter reveals that, the TOE in the IT industry for the large cities is far higher than the national level NVA per worker in the NIC category for computer manufacturing.

It can also be observed that the share of Karnataka to that of country has fluctuated between 1986 and 1993. For example the share of workers in NIC 36 category to the country was 11.8 percent in 1986, which marginally increased to 12.1 percent in 1989, but reduced to 9.9 percent in 1993. It needs to be borne in mind that this includes more sectors than the computer industry, as the data presented here is aggregated at the two-digit level for the state.

For a long time the location of large and medium industries in Karnataka state was largely governed by the various industrial development policies, that have been enacted from time to time. However, with the liberalisation of the national economy since 1991, the industrial development policies have taken a facilitator's role rather than the earlier adopted regulatory role. Karnataka is no exception to it. The latest industrial policy came into effect from 1993, and will be in effect till 1998, unless modified. Appendix 10 provides an outline of the current industrial policy in the state. Only those aspects of the policy that have a direct relevance to the present research have been outlined in the Appendix 10. The policy is an illustration of the macro-economic reforms launched all over the country since 1991. It also outlines the thrust areas that have been identified within the state in line with the macro-economic policies. An important aspect which is of direct relevance to the present study is that, the policy explicitly states 'only non-polluting, high technology industries shall be encouraged within Bangalore South and North Taluk, including the Bangalore Urban Agglomeration Area' (Appendix 10). Thus high technology industry is the only type of industry that is encouraged in the urban region of Bangalore.

Karnataka also has a good and effective network of (state) government institutions that provide industrial infrastructure, and other supporting facilities. Many of these institutions have a direct relevance to the present study. For example, the Karnataka State Electronics Development Corporation (KEONICS)- a Government of Karnataka body, established the country's first Electronics City in 1980. This city was conceived to provide an exclusive manufacturing facility for all types of electronics firms. More recently, the Karnataka State Industrial Investment Development Corporation (KSIIDC)- a Government of Karnataka body that co-ordinates industrial development in the state, joined hands with the Singapore Consortium and the Tata group to construct an Information Technology (IT) park in Bangalore. The First phase of the park is already commissioned, and industries have moved into the park. The Electronic City and the IT park are both discussed further in Section 7.6 of this chapter. A brief note on other important state level institutions that have contributed to industrial development in Karnataka is provided in Appendix 11.

Apart from the government support institutions that have been mentioned in Appendix 11, Karnataka also has a large share of the R&D organisations in the country. It houses over 30 national laboratories and R&D institutions, most of them located in Bangalore. Apart from these institutions, there are a large number of industrial units in the state, which *inter-alia*, pursue R&D regularly.

Universities and Engineering Colleges in Karnataka as of 1992-93, have about 19,000 degree place for engineering, offering a degree in engineering. Apart from that, an additional 21,500 seats for the diploma level, are offered by the numerous polytechnics (Government of Karnataka, 1994:36). Telecommunications and Electronics together accounted for over 35 percent of the outturn[110] at the degree level in Engineering in Karnataka (Government of Karnataka, 1994:40). This

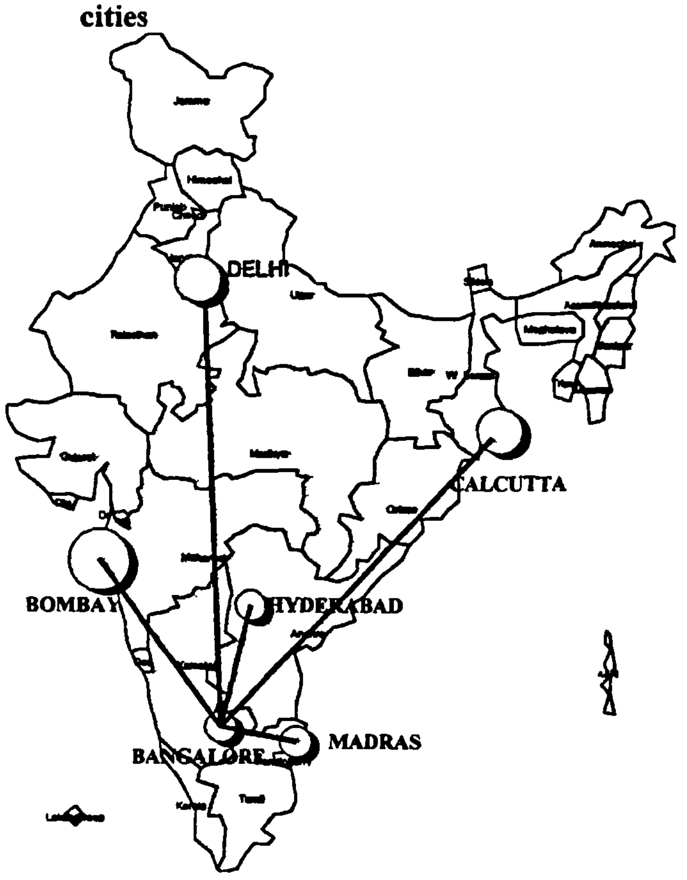
[110] Number of students actually completing the degree

indicates that electronics and telecommunications engineering are the two most popular[111] engineering degrees in Karnataka.

7.3 DEMOGRAPHIC AND URBAN GROWTH IN BANGALORE

Bangalore is the industrial, commercial, administrative, transportation, educational and telecommunications centre of Karnataka, and occupies an important position on the map of India (Fig 7.2). Demographically, Bangalore is the sixth largest city in India (1991), after Bombay, Calcutta, Delhi. Madras, and Hyderabad.

Fig 7.2 Bangalore in relation to other main Indian cities



It is also one of the most important node for highway, railway and air networks in the southern peninsula. Its location provides access to every part of the country. The only million plus city of India to be located at a height of over 3000 feet (921 metres), it is also known[112] as the "garden city", "air-conditioned city", "pensioner's paradise" and so forth.

[111] One could draw an indirect inference from this. One of the reasons for the popularity of these two courses could be due to the high demand for these engineers in the high technology industries in Karnataka, most of which are concentrated in and around Bangalore.

[112] These terms may have described Bangalore very well in the past. One may question if these terms can still be associated with the city now.

The origin of Bangalore dates back to the sixteenth century, with the setting up of the fort in 1537 by King Kempe Gowda II. 'The city quickly became a rich weaving and trading centre' (Holmström, 1994:17). To this the Britishers added a cantonment area as late as 1807. 'The two centres of growth developed independently until 1949, when the amalgamation took place and the city corporation was formed, under the Bangalore municipal corporation Act of 1949.'(Srinivas, 1992: 36).

In the twentieth century two *Dewans* (Prime Ministers) of the Princely State, Viswesvarayya and Mirza Ismail, 'launched a remarkable programme of agricultural, industrial and social development. Viswesvarayya established a polytechnic in Bangalore, and government-owned factories there and elsewhere in the state' (Holmström, 1994: 16). India's leading industrial firm Tata endowed what is now the Indian Institute of Science, 'to be followed by a host of publicly and privately funded research institutes' (Holmström, 1976: 8). During the Second World War, India's first aircraft factory Hindustan Aircraft (now Hindustan Aeronautics) was founded in Bangalore. Thus at the threshold of India's Independence (in 1947), Bangalore had one of the most technologically advanced industries and work force of the time in India.

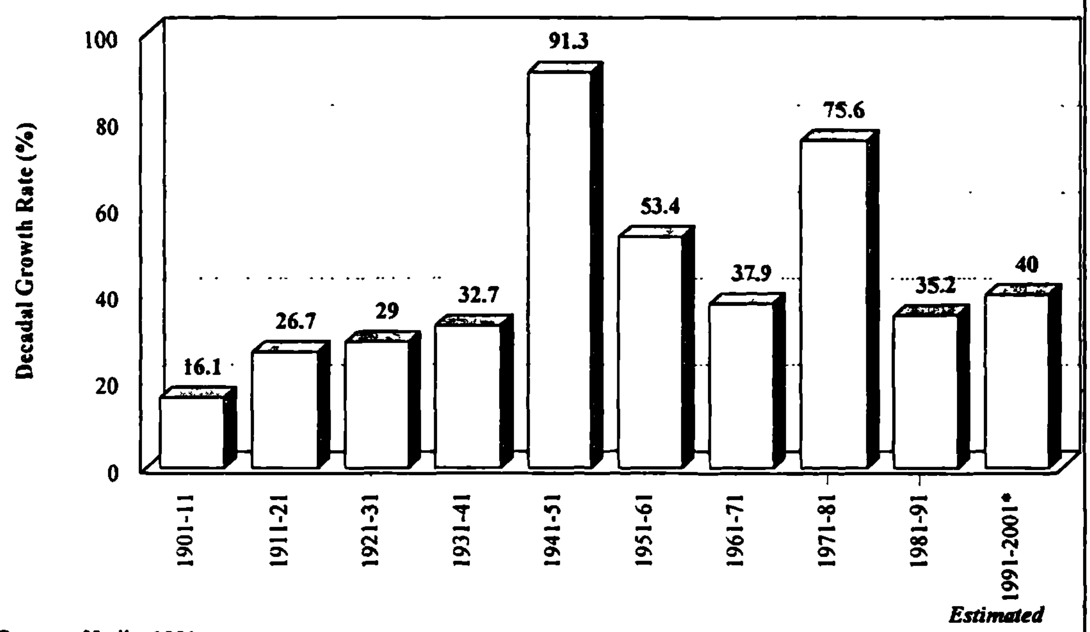
In the years after the Independence, the national government established some of the country's biggest public sector factories, notably Indian Telephone Industries, Hindustan[113] Machine Tools (making machine tools and watches for export and the domestic market), Bharat[114] Electronics (mainly supplying the defence forces), and Bharat Earth movers. The private sector, according to Holmström, 'followed, taking advantage of the large number of engineers and skilled workers trained in the vast public sector factories' (Holmström, 1994:18).

The first spurt of growth was between 1941 and 1951 when the city grew by over 91 percent (Fig 7.3). This was also the period when a number of important public sectors industries were established in Bangalore.

[113] The word is Persian in origin, which means the land of the Hindus.
[114] Bharat is a Sanskrit word for India, when historically the entire geographical area was described as *Bharat-varsha*

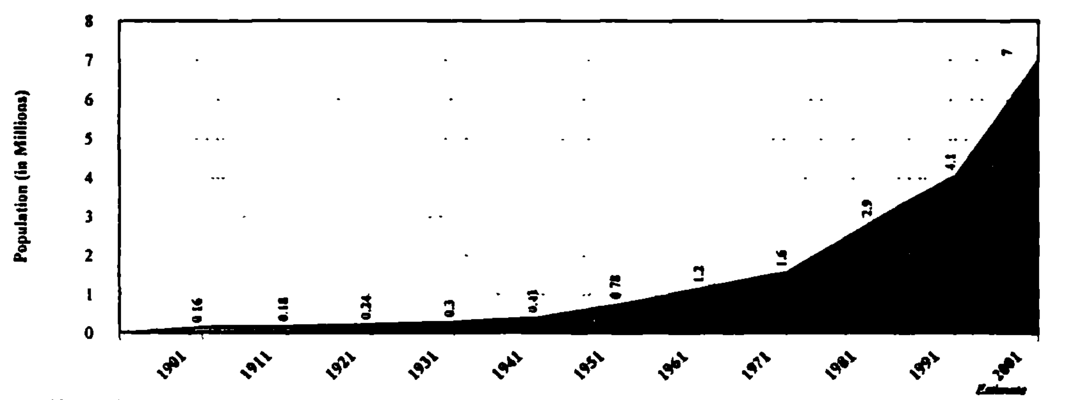
The city continued to grow, and during the decade 1971-81, Bangalore was the fastest growing million city in India (Holmström, 1994:20). By 1991, Bangalore had more than four million inhabitants (Fig. 7.3), and it is estimated that city's population in the mid-1990s is approximately five million (*ibid.*). The city's Outline Development Plan, formulated by the Bangalore Development Authority (BDA) for the year 2001, estimates a population of seven million for the year 2001(Fig. 7.4), although some authors suggest 'a more cautious estimate of 6-6.3 million'(*ibid.*) for the year 2001.

Fig. 7.3 Bangalore: Decadal growth rate of population (1911-2001)



Census of India, 1991

Fig. 7.4 Bangalore : Population growth (1901-2001)



Census of India, 1991

Bangalore is no exception to the numerous problems (like housing shortage, inadequate infrastructure, traffic problems, etc.) faced by large cities in India. Madon states that 'at least three characteristics have to be added to portray the city in its true light- gross inequality between groups of different socio-economic status, extreme poverty amongst many citizens, and civic deficiency'(Madon, n.d.:16). Madon further argues that contrary to the international reputation earned by Bangalore, the advent of the information age has yet to make a dent in the overall economic picture for the state which remains primarily an agricultural state. '95 percent of the rural poor population in Karnataka have an annual family income of less than £ 65... by contrast, the new IT-related service industries in Bangalore offer remuneration of about £ 250 a month growing to triple the salary over 3-4 years' (*op cit.*, p. 17).

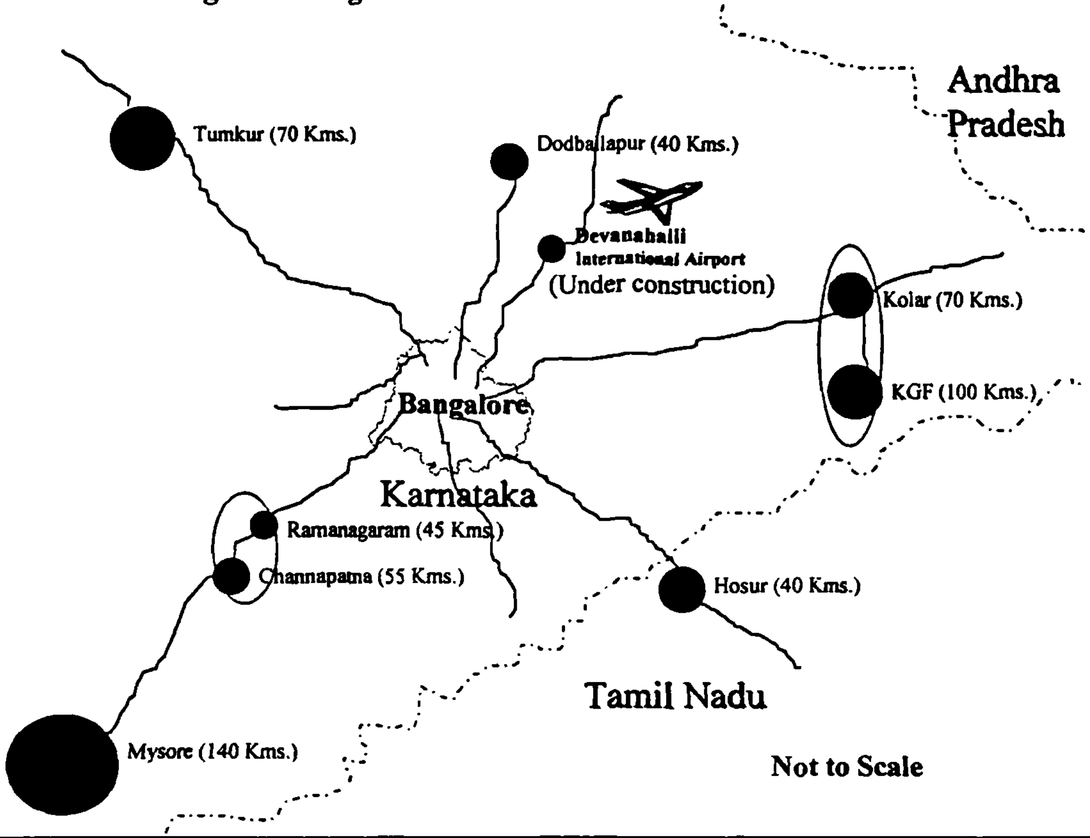
The affluent in the city constitutes only a minor fraction, and in absolute numbers, the poor easily predominate over middle and upper middle income groups. While Bangalore seems to be performing better than many other big cities of India in terms of urban inhabitants living in huts without access to infrastructure facilities, this is a growing area of concern, especially since 1985. In 1985, a study estimated that there are a minimum of 1000 slums in Bangalore (Ramachandran cf. Madon *op cit.*). The study further notes that the discrepancies in habitat conditions between the well-to-do and the poor inhabitants are more extreme and dramatically visible in Bangalore than in other cities.

Bangalore's one time prominent sign of spacious *bungalows* have given way to high rise structure especially in the centre of the city like MG Road and Brigade Road area. Since the mid 1980s, this part of the city has attracted both commercial and residential developers. Unplanned growth elsewhere in the city has encroached upon the green space in the city. To regulate the physical growth of the city, the BDA (which has its jurisdiction over the urban area of Bangalore), and the later constituted Bangalore Metropolitan Regional Development Authority (BMRDA)[115] in 1985 primarily function to govern and guide the growth in the Bangalore Metropolitan Region (BMR). The BMR constitutes the entire Bangalore urban and rural districts, and an administrative unit (*Taluka*) of the Kolar district. Fig. 7.5 illustrates the zone

[115] Not to be confused with BMRDA of Bombay.

of immediate influence of Bangalore.

Fig. 7.5 Bangalore and its immediate area of influence



Due to its geographic location, Bangalore exerts its influence on all the four south Indian states viz. Karnataka, Tamil Nadu, Andhra Pradesh and Kerala. Tamil Nadu's border is only 40 Kms south east of Bangalore, and Andhra Pradesh is only 100 Kms. to the north, and Kerala, is about 200 Kms to the south west.

Within Karnataka, Bangalore dominates the urban settlement system. Almost ten percent of the state's population lives in the city[116]. The city's primacy at the state is well illustrated by the fact that 30 percent of the state's urban population resides in Bangalore and the second largest system of cities in the state (Mysore and Hubli-Dharwad) have a population of only around 650,000 each (Government of Karnataka, 1993).

The occupational structure of workers in Bangalore (1991) shows that the city has the highest proportion of main workers employed in the manufacturing sector among the

[116] Bangalore's population (1991) 4.1 million and Karnataka's total population (1991) 44.9 million.

largest six metropolitan cities in India, closely followed by Greater Bombay (Table 7.4).

Table 7. 4: India: Population, sectoral distribution (%) of main workers * and functional categories of the big six urban agglomerations **, 1991

		Share of Workers by Sector (%)					
Name	**Population (in Million)**	**1**	**2**	**3**	**4**	**5**	**Function**
Greater Bombay	12.5	1	42	24	11	22	Mfg.
Calcutta	11.0	2	39	25	10	23	Mfg. + Trading
Delhi	8.4	1	33	25	8	33	Services + Mfg.
Madras	5.4	3	34	23	10	30	Mfg. + Services
Hyderabad	4.3	4	32	24	11	29	Mfg. + Services
Bangalore	4.1	3	**43**	22	8	24	Mfg.

Note: 1-Primary Activities; 2-Manufacturing (Mfg.); 3-Trade &Commerce (Trading); 4-Transport & Communication; 5- Services

* The Census of India classifies economically active population into three main categories.
(1) **main** (those who had worked for the major part of the year preceding the date of enumeration, i.e., those who were engaged in any economically productive activity for 183 days or six months or more during the year). (2) **marginal** (those who worked any time at all in the year preceding the enumeration but did not work for a major part of the year, i.e., those who worked less than 183 days or six months). (3) **non-workers** (those who had not worked any time at all in the year preceding the date of enumeration).

** **Urban Agglomerations** according to the Indian Census is a "continuous urban spread and normally consists of a town and its adjoining urban outgrowths (OGs), or two or more physically contiguous towns together with contiguous well recognised outgrowths if any, of such towns". The Census defines the **Outgrowths** as a "fairly large well recognised areas like a railway colony, university campus, port area, cantonment, which might have come up around a core city or a town" (Census, 1993)

Source: Government of India, 1993- Functional Classification of Urban Agglomerations and Towns

A comparison of the above data with the 1981 and 1971 figures (Table 7.5) reveal that the share of the sectoral distribution of main workers has remained largely consistent, with marginal change in the proportion of work force under trade and commerce, which increased by four percent, and services, which declined by three percent points during 1971-91 period. Manufacturing workforce has grown by two percentage points between 1971 and 1991 (Table 7.5). The increase in the share of primary activities between 1971 and 1981 is largely due the incorporation of peripheral villages into the urban agglomeration, which was also one of reasons for such a high growth rate of the city between 1971 and 1981 (when it grew by over 75 % during the decade).

Table 7.5 Bangalore urban agglomeration : Shift in sectoral distribution (%) of main workers (1971-1991)

		Share of Workers by Sector (%)				
Year/ Sector	Population (Million)	Primary Activities	Manufact uring	Trade & Commerce	Transport & Communica tion	Services
1971	1.65	2	41	18	12	27
1981	2.92	3	43	19	9	26
1991	4.13	3	43	22	8	24

Source: Mahadev, P. D., 1978: 254 (For 1971)
Government of India, 1986 (c)- General Economic Tables, Series 9 Karnataka, Part III A & B (i) (For 1981)
Government of India, 1993 (c)- Functional Classification of Urban Agglomerations and Towns (For 1991)

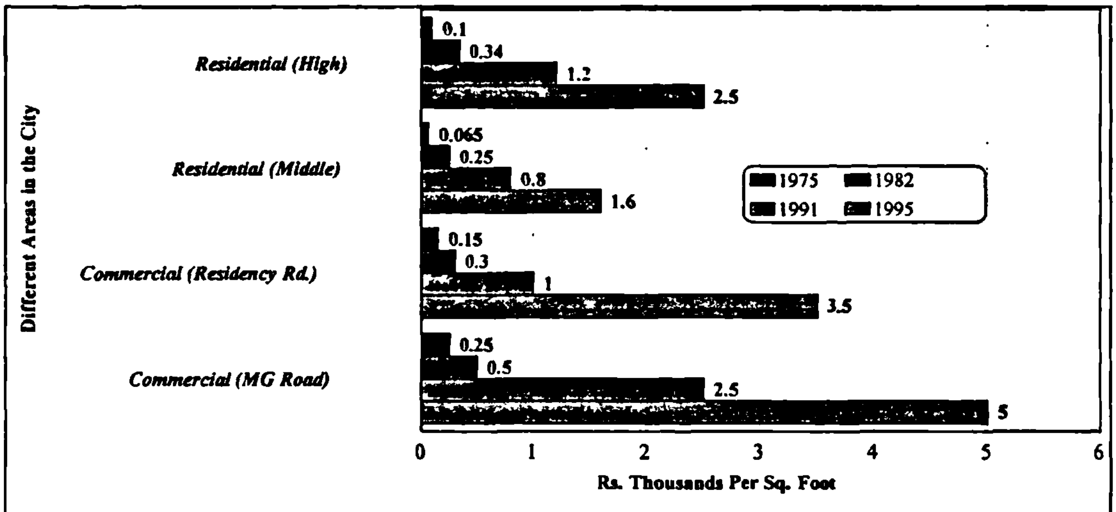
7.4 URBAN INFRASTRUCTURE IN BANGALORE

The review of the literature (in Chapter two) highlighted the importance of urban infrastructure in making cities competitive. This assumes greater significance, especially if foreign capital needs to be attracted into a particular city or a region. Urban infrastructure can be broadly divided into physical (for example, water supply, sanitation, electricity transportation, communication, etc.) and social (for example, health care, education, recreation etc.). Not all of these are discussed here. Only the most relevant ones to the research have been discussed. The literature review also highlighted that places with better levels of recreational facilities, lower cost of living and property rates, better standard of living, and efficient telecommunications links attracts high technology professionals. The aspects of urban infrastructure included in the present analysis are: availability of land, and land prices; power supply in Bangalore; and telecommunications infrastructure. Unreliable power supply, inadequate water supply, poor roads, heavy traffic, poor road safety and a lack of an international airport are all cited as major problems by the entrepreneurs in Bangalore, when contacted by the researcher.

7.4.1 URBAN LAND IN BANGALORE

The availability of land especially at very cheap rates (initially) has been one of the most dominating factors behind Bangalore's ability to attract a number of business activities and industries. The land prices have increased (Fig 7.6) tremendously since the 1980s, but continue to be much lower than the big cities like Delhi or Bombay (Fig. 7.7), both of which, as noted in chapter six are the toughest competitors to Bangalore as far as the IT industry is concerned.

Fig. 7.6 Bangalore: Current land prices: 1975, 1982, 1991, 1995

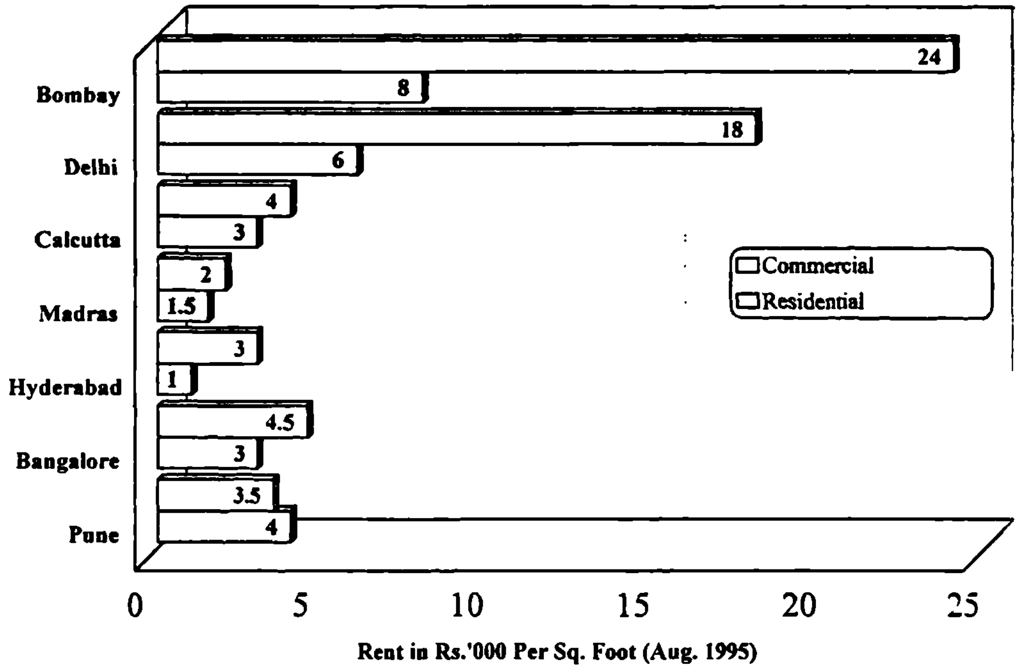


NIUA (1984), Srinivas (1992), Business Standard (1995)

The city's cheap land costs also caught the attention of real-estate agents and corporate houses, which were finding Delhi and Bombay too congested and expensive. For these people Bangalore became an obvious choice. According to a report in the Times of India (1995), there appears to be primarily three types of buyers of property in Bangalore. The Bombay and Delhi-based buyer; the multinational; and the corporate buyer. The report claims that the later two are gaining predominance over the former. According to its estimates, corporate buying of real estate makes up about 30 percent of the total purchases in the country, and Bangalore seems to be taking much of that share (Times of India, July, 1995).

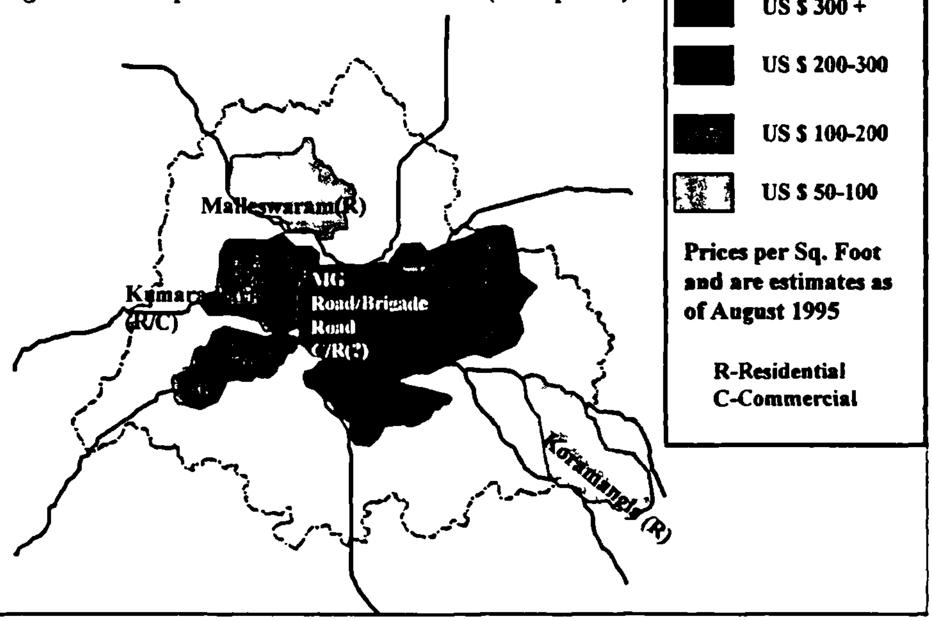
The prime area in Bangalore is the Mahatma Gandhi Road and Brigade Road (Fig. 7.8), where some land commands a price of even over Rs. 10,000 per ft.^{2} (US$ 300) which is hankered after for residential as well as commercial premises. Koramangla (in the south) is one of the recently developed residential areas with rates between Rs. 1500-1800 per ft.^{2}. The residential property in Koramangla is growing at the rate of an annual 40 percent.

Fig. 7.7 Rents for different properties in some cities, 1995



Business Standard, Sept. 1995

Fig. 7.8 Bangalore: Land prices in different locations (1995 prices)



The other famous locales in Bangalore include Frazer Town (Rs. 1700-2500 per ft.^{2}), Palace Orchards (Rs. 2500-3000 per ft.^{2}), Benson Town (Rs. 1600-2400 per ft.^{2}), Malleshwaram (Rs. 1200-1500 per ft.^{2}), and Lavelle Road (higher at Rs. 300-4000 per ft.^{2}). Kumara Park's properties were last reported in the range of Rs. 2000-2500 per ft.^{2}, while on Whitefield Main Road, next to ITP (Information Technology Park), prices are reported to have increased from Rs. 800,000, a few years ago to Rs. 7.5 Million per acre (Times of India, July, 1995). Figure 7.8 provides an illustration of prices in different location in Bangalore. As evidence from Fig 7.7, all these prices are still about one-third of the price for an equivalent area in Bombay or Delhi. What goes in Bangalore's favour is that there is still enough prime land (which is the commercial land) available-for those who are willing to pay the market price.

The real-estate boom has led big industrial houses also to venture into property development. The United Breweries (UB) Ltd. is planning a major foray into real estate sector. The group owns prime real estate in the heart of Bangalore, valued at Rs. five Billion. Among the proposal under consideration is the construction of a UB City- a multi-purpose complex with commercial space, residential area, and possibly even a hotel (Economic Times, September, 1995).

Lloyds Realty, a subsidiary of the Lloyds Steel Industries Ltd. is planning to build a township just outside Bangalore. To be spread over 300 acres it is by far the largest private sector housing project planned in the city. The company plans to construct 40,000 apartments in the township which would also provide facilities such as a shopping mall, auditorium, swimming pools etc. The apartments are targeted at the middle and upper middle class segment. With Bangalore emerging as a favourite destination for multinational companies and the city's information technology and banking industries growing rapidly, it is expected that these townships would ease the pressure on housing in the city. However, potable water, sewage and power supply may pose a major problem despite the Cauvery fourth stage coming up in the next few years. (Economic Times, August, 1995).

The speculation in land prices have spread even to areas outside Bangalore in the metropolitan region, which has forced the BMRDA to regulate unplanned development in areas falling outside the local planning area of Bangalore, keeping in view the future growth potential of these areas. The BMRDA has made it mandatory to have its prior approval for undertaking construction activities, formation of layouts, and for starting certain types of commercial and industrial activities in these areas. BMRDA would also concentrate on the development of areas in the periphery of the city, including White Field, Hosur Road, and Tumkur regions falling within its limits. These areas have been identified as "pressure points" considering the influence of the city's growth on them. BMRDA is also working on developing a "software district" and a "financial district" around Bangalore (Deccan Herald, July, 1995). It might be premature to take any of these seriously, as these are only at the proposal stage.

7.4.2 Power Supply in Bangalore

Power supply in the state of Karnataka is perhaps the most serious infrastructure bottleneck which could undermine the industrial development in the state. While the researcher was conducting the field work between July and October 1995, power cuts that ranged from three to nine hours were experienced in different parts of Bangalore city on a very regular basis. It was only after the monsoon rains that the power situation improved slightly. Such is Karnataka's dependence on hydro-electric power fed by reservoirs filled by the annual monsoon. Every Saturday, the entire Electronics City in Bangalore experiences a "power holiday", and there is no power supply on that day. This is in addition to the power cuts that are experienced on a daily basis.

Of the state's installed capacity of 3,377 MW, 71 percent comes from hydro-electric stations (Financial Times, 1995). The remaining power is generated by state's only thermal power, and or *increasingly*, by captive power units built by industrialists themselves. The danger with such a high rate of dependency on the hydro power is that it is dependent on monsoon, and so a bad rainfall means lower generation. This skewed hydro-thermal balance is a result of the great distances between sources of coal needed for thermal power generation. The three major sources of coal for the entire country are at least a thousand kilometers (625 miles) away.

To assess the electric power situation in the state, a survey was conducted by the Karnataka Power Corporation (quoted in Business Standard, 1995). The 1995-96 power situation suggests that there is a total requirement of 22,884 million units of energy at peak time. Against this the total energy (including the share that comes from the national grid) generated is 19,958 million units. Thus the overall deficit is 13 percent (Business Standard, 1995). The state's main hope at the moment is the on-going Cogentrix Power project, which when commissioned can provide some respite from the chronic power shortage affecting the state. Until then the weekly "power holidays" that happen on every Saturday in Bangalore's Electronic City will have to continue.

7.4.3 TELECOMMUNICATIONS INFRASTRUCTURE IN BANGALORE

Unlike the case of electric power, telecommunications facility in Karnataka, in general and Bangalore in particular is much better. Bangalore in particular is well placed in terms of telephone density vis-à-vis the other major cities of the country. Bangalore has 6.5 telephone lines per 100[117] inhabitants. Karnataka has about 800,000 telephone lines, and a waiting list of another 150,000. Projected demand by the year 2005 is at 2.15 million lines (Business Standard, 1995). The waiting time for telephones has been drastically reduced in Karnataka. In the category where one can own a telephone on demand (and where payments are higher), there was no backlog in the entire Karnataka, as of April 1995 (Business Standard, 1995).

Table 7.6 Data communication facilities: City-wise comparison

City	Availability of IT Professionals	Data Communication Links	Consumer Price Index* for Industrial Workers (March' 1992)
Ahmedabad	2	2	236
Bangalore	**5**	**5**	**224**
Bhubaneswar	1	2	205
Bombay	5	4	242
Calcutta	3	2	229
Delhi	4	4	236
Hyderabad	3	3	223
Jaipur	1	2	221
Madras	4	3	231
Pune	3	2	241
Trivandrum	2	2	232

1= Low , 5 = High
Source: World Bank, 1992: IA-12
Cities have been selected on the basis of demonstrated exports or presence of central / state run Software Technology Park. Delhi includes NOIDA, UP
* Is used to indicate the cost of living in these cities

A cross comparison of the data communications infrastructure (fundamental to the IT

[117] This figure is too far below the developed country standards. Considering that India has one telephone for every 100 people, Bangalore seems to be doing better than Bombay, or Delhi.

industry), with the cost of living, and availability of IT professionals in some of the major Indian cities puts Bangalore at the top (Table 7.6). This was presented as Table 6.3 in the previous chapter, however it is worth to be placed here again given the context of the present discussion.

Table 7.6 clearly demonstrates the dominant position commanded by Bangalore in the provision of data communications links. This combined with high rate of availability of IT professionals and lower cost of living[118] reflected in the generally lower consumer price index for industrial workers, makes it the most attractive location to IT industry.

Karnataka is also an important centre for telecommunications in the country. In real terms, Karnataka attracted the highest bids for basic telephone services[119] after Maharashtra when the central government invited quotes for 19 telecommunications circles[120] in 1995. At the national level, the state comes second in the bid rankings (Business Standard, 1995). Karnataka is thus considered a lucrative option because of Bangalore. Revenue per line is high, as Bangalore is a main centre for the IT industry, which is a heavy user of telecommunication lines.

7.4.4 Social Infrastructure and Investment climate in Bangalore

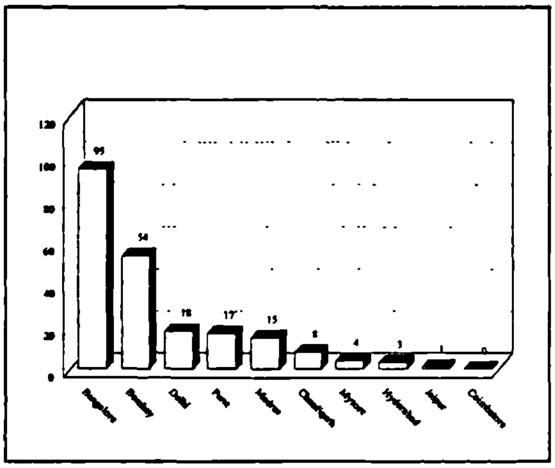
In a study conducted by Business Today among Chief Executive Officers (CEOs), senior and middle managers, spouses of executives belonging to these two categories, and business management students (Business Today, December 1994), Bangalore ranked as the best city to work in India. The survey was conducted by the Indian associate of Gallup Organisation (USA), and covered twenty six major cities in India. The detailed methodology adopted for the study is outlined in Appendix 12.

It is very clear from Figure 7.9 that Bangalore is well ahead of all other cities as the best city. The next city, Bombay scores only 54 compared to Bangalore which has the highest score of 95. Together, Bangalore and Bombay are way ahead of other cities.

[118] Which is also reflected in the lower land and rent prices (discussed in Section 7.4.1)
[119] A regulatory telecommunications term which means providing basic telephony (excluding value added services like E mail, etc.).
[120] Telecommunications circles in India largely correspond to state boundaries. Therefore, Karnataka telecommunications circle would imply the whole of Karnataka state.

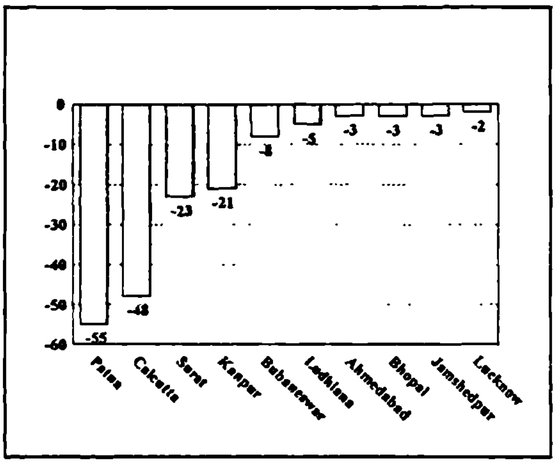
The state of Karnataka, Maharashtra and Tamil Nadu have two cities each in the Top Ten, proving that they are well ahead of other states to attract business.

Fig. 7.9 The "best cities" to work



Source: Business Today, (Dec. 1994)

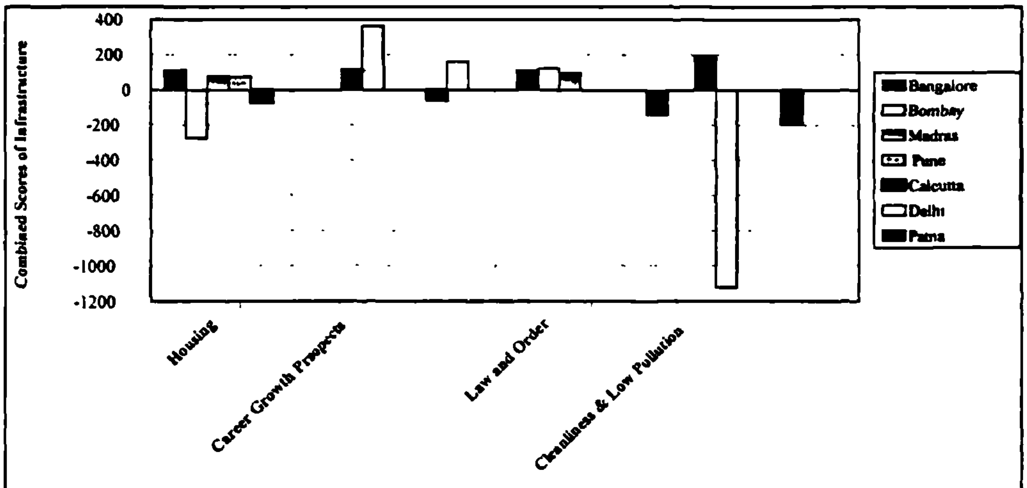
Fig. 7.10 The "worst cities" to work



Source: Business Today, (Dec. 1994)

Fig 7.11 illustrates the combined scores of the main cities by each of the respondent categories, which also demonstrates Bangalore as a clear winner among all the cities on most of the parameters. The infrastructure levels are more mixed than the overall figures. Bangalore emerges as top choice to live among all the cities. Bombay and Calcutta perform the worst (Fig 7.11).

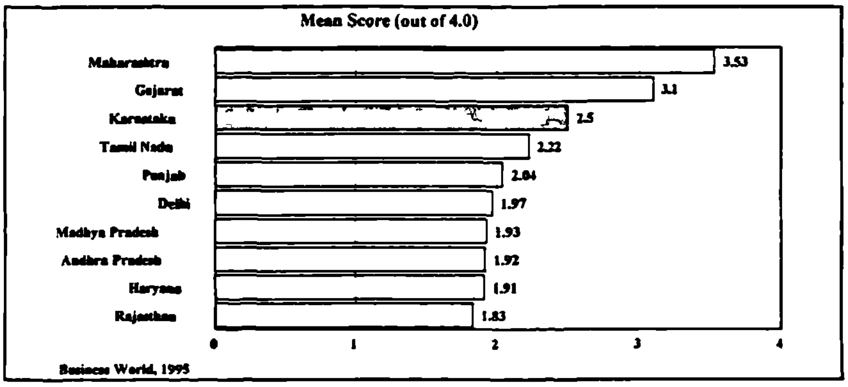
Fig. 7. 11 Bangalore's strength lies in housing, law & order, and low levels of pollution



Source: Business Today (Dec. 1994)

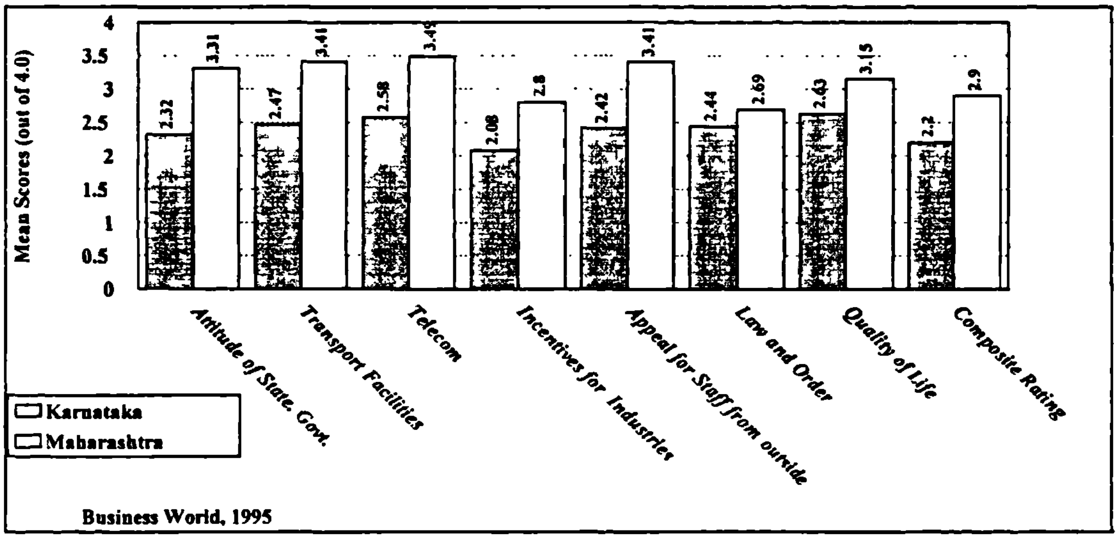
Business World in 1995 commissioned a study to explore the best states for investment in India. The methodology of this study can be found in Appendix 13. This study was conducted in 16 cities across the country and had a total respondent sample of 252 people. This study put Karnataka in the third place in the country for investment after Maharashtra and Gujarat (Fig. 7.12).

Fig. 7.12 Overall rating of the top ten states voted best for investment



A comparison with Maharashtra (where Bombay is located) on some of the important issues shows that Karnataka is behind in all of them (Fig. 7.13).

Fig. 7.13 Karnataka and Maharashtra: Mean scores of various indicators



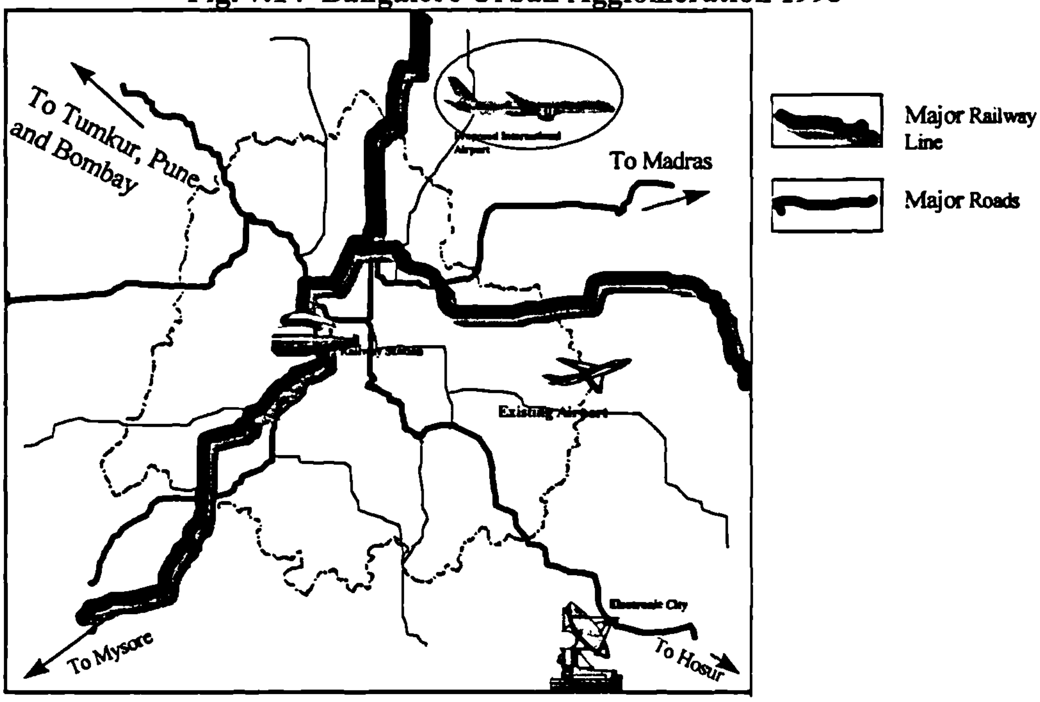
What do these opinion and research survey mean to the present study? One needs to approach all of these figures with a note of caution, since these are perceptions of people who are involved in the industry, and business in general. These perceptions would change from time to time. In the present study, which is based on understanding the competitiveness of a city in a particular industry, one cannot risk to base the entire analysis on the basis of opinions alone, and treat them as important indicators. However, these perceptions are very important, and extremely valuable in providing a good understanding of the situation.

7.5 INDUSTRIAL DEVELOPMENT IN BANGALORE

The focus of the present research is to understand the emergence of Bangalore as an international centre for IT industry and to explain its competitiveness in attracting information technology industries. For most of the analysis, city level information is difficult to obtain for Bangalore. State level data has been used for comparative purposes, wherever city level information is not available.

It has already been mentioned (in Section 7.4) that at the time of Indian Independence, Bangalore had one of the most modern and skilled workforce in the country. The city's present position as a centre for high technology can also be attributed to the decisions of the federal government in New Delhi. shortly after India's independence in 1947. Faced with potentially hostile neighbours to the north in Pakistan and China, the government sought to locate strategically sensitive industries well away from the borders, and away from the coast.

Fig. 7.14 Bangalore Urban Agglomeration 1995



That geopolitical decision led to location of strategic industries in Bangalore. Among the prominent industries that were established include the Indian Telephone Industries (ITI), the Bharat Electronics Limited (BEL)[121], which manufactures highly sophisticated electronic products for defence purposes and for export markets), and the Hindustan Machine Tools (HMT, making machine tools for domestic and foreign markets, and also watches and other precision equipment). Even till date, the city remains an important base for these and many more public sector giants such as Hindustan Aeronautics, Bharat Earth Movers, and the Indian Space Research Organisation, which develops and launches satellites for civilian purposes.

Although some of the public sector companies are now hardly at the cutting edge of the technology, they did spawn the establishment of a number of universities, institutes and colleges providing engineering and scientific training in Bangalore. The presence of such companies and educational establishments helped the computer industry to set up around Bangalore in the early 1980s. When the Indian computer software and services industry began to grow[122] in the early 1980s, Bangalore's public sector employers, among the few Indian organisations with extensive software and hardware installations provided a ready source of expertise.

Holmström states that, as industrial development continued, 'both private and public sector industries subcontracted the manufacture of electronic and engineering components to small ancillary workshops, often set up by engineers or skilled workers with experience of working in larger factories, who took advantage of the wide range of incentives offered to the Small Scale Industries (SSIs): cheap loans, advice, and assistance from number of institutions. Other government institutions like the Small Industries Services Institute, and Industrial Training Institute also provided assistance in industrial development in the city'(Holmström, 1994:18).

Since the 1950s, 'Bangalore has had a basically capital goods industrial base- the large industrial undertakings manufacturing capital goods; serviced by a large number of medium and small scale, ancillary and subcontracted industries for various components and services' (Matthai, P 1987: 4). Yet, the city is unusual because of

[121] Since its inception, BEL has always been at the forefront of the technological development, especially in the area of defence research.

the wide spectrum of industrial and consumer products, compared to other industrial cities like Ludhiana or Coimbatore.

By 1993, Karnataka state, which has about five percent of the country's population, was producing over 20 percent of the country's electronic output. In 1993, measured in terms of the total value of goods, Bangalore was contributing about one-third of all the computer system, and software developed in the country (Rastogi, et al., 1994)[123].

Table 7.7 Bangalore: Investment and employment in registered industries, 1994 *(Figures in parentheses indicate percent to the state total)*

Area	Sector	Units	Investment (US $ Million)	Employment
Bangalore	Small Scale	35,032 (23 %)	160.82 (30 %)	292,161 (29 %)
Karnataka	Small Scale	150,021	532.33	1,002,513
Bangalore	Medium and Large	337 (45 %)	411.46 (20 %)	124,192 (44 %)
Karnataka	Medium and Large	746	2005	280,205

Source: TECSOK, 1994

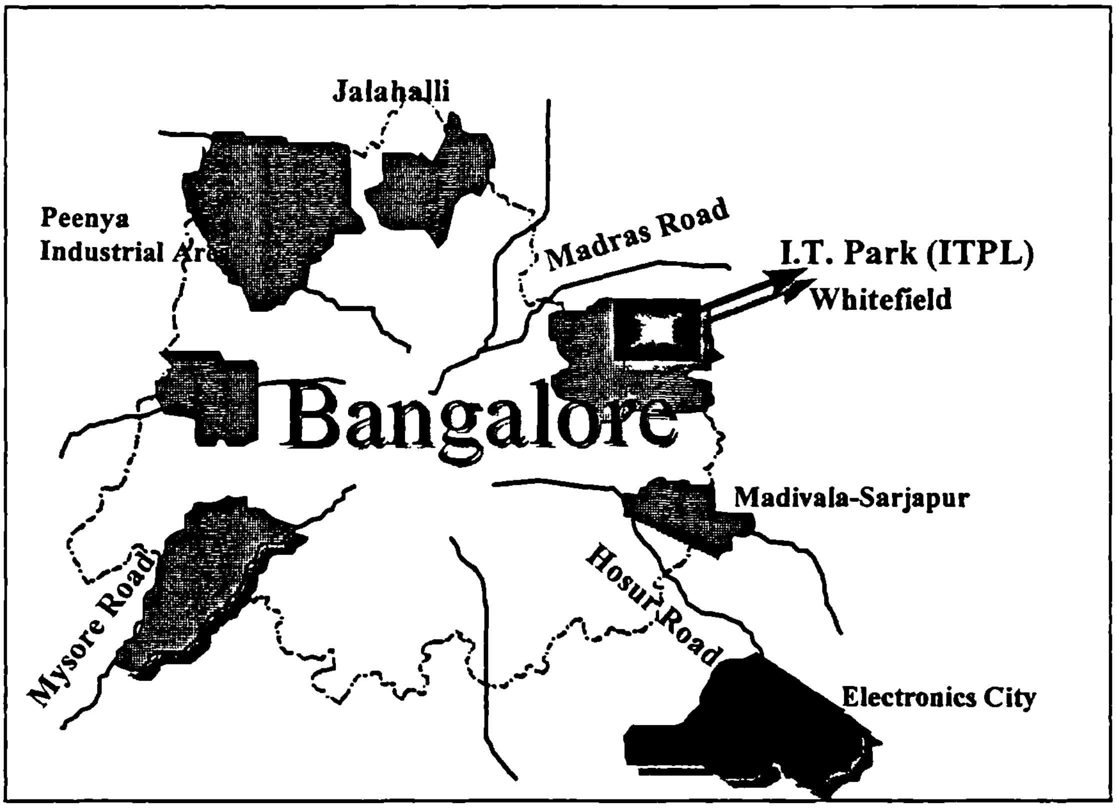
Bangalore is the most important industrial centre of the state of Karnataka. It has almost one-third of total investment in the small scale sector, and employs an equal proportion of the state's small scale sector workers. Bangalore has almost half of all the medium and large industries in the state, and employs 44 percent of state's total work force engaged in the medium and large industries (Table 7.7).

There are a number of industrial areas in Bangalore. The KSSIDC has industrial areas for the Small Scale Industries (SSIs) in the city. Apart from that, the state Government has established the Peenya Industrial Area (on Tumkur Road), which houses a mixture of large and medium sized firms, mainly in engineering and electronics sector (Fig. 7.14). The Electronics City is an exclusive industrial area developed by KEONICS for electronics industries and is located on the Hosur Road, which is about 20 Kms from the city. The Whitefield area on the eastern side of the city is another important area for the concentration of electronics industry. To the north of the city is the Jalahalli industrial area, which houses the big public sector factories of BEL and HMT. The Information Technology Park- a joint venture

[122] As discussed in Chapter 5, TCS was the first Indian Software Firm to be started in Bombay in 1968
[123] Last Chapter (Chapter 6), discussed in detail the regional variation of the IT industry in India.

between India and Singapore, is near Whitefield. This IT Park, has just completed its first phase of construction, and firms have already moved into the Park (Fig. 7.15). The city's growth in the electronics and software sector, has stimulated industrial development of similar nature in the nearby towns, most notable among them are Hosur (in the state of Tamil Nadu, but only 40 Kms. away), Mysore, and Tumkur (70 Kms.).

Fig. 7.15 Bangalore: Major industrial areas



Employment figures in the industrial units in Bangalore are unreliable, especially the "unorganised sector"-firms employing (officially) less than ten workers, not covered by the Indian Factories Act, and Employees State Insurance Act (Holmström, 1994: 19). The "organised sector" in Bangalore district (urban and rural) according to the 1991 Census, employed 468,819 persons; 63 percent of these "organised sector" jobs were in the public sector. Bangalore urban district during the same time had 3,437 registered factories, employing 365,000 people (an average of 106 per factory), and had 13 government-designated industrial estates. The 20,400 small scale units employed 194,800 persons (an average of 9.7 per unit). But there are certainly many more unregistered factories (Holmström, 1994 :19).

By the early 1990s, the kind of engineering firms which were Bangalore's mainstay, grew more slowly than before, and were overtaken by firms using newer technologies: electronic component factories, computer hardware manufacturing firms, software industries, and a more specialised high quality firms using CNC (Computer Numerically Controlled) machines, and CAD/CAM process (*ibid.*).

Having discussed about the urban, demographic and industrial development in Bangalore, the discussion will now concentrate on the core of this research- the IT industry in Bangalore.

7.6 THE INFORMATION TECHNOLOGY INDUSTRIES IN BANGALORE

As mentioned in the last chapter, there are very limited official statistics to show the spatial spread of the IT industry in India. Data from the Annual Survey of Industries (analysed in Section 7.2), primarily provided a brief state level analysis of a set of industries, of which the IT industry was merely a component. Hence, as described in the methodology chapter of the dissertation (Chapter 3), and in the chapter on geographical analysis of the IT Industry in India (Chapter 6) year-wise information of the IT industry for all the locations in India was collated from the various volumes of the IT Magazine -Dataquest [124](published from India), for two time points of time (1993 and 1996) to offer a temporal analysis.

Table 7.8 Bangalore: Start up year of IT firms (1996)

Year of Start-up	Number of IT Firms	%
1970-1980	10	4.9
1981-1985	20	9.8
1986-1990	71	34.6
1991-1996	104	50.7
Total	**205**	**100**

Source: Dataquest, 1996

[124] As explained in the previous chapter, Dataquest's information is collected through its own method of writing to individual firms, to seek information of the firm. A typical example of the firm level information provided by DQ is given in Appendix 9. Since, the information that is given in the DQ Top 20 is based on the response rate of the firms, one needs to fully understand the limitations of the information provided by DQ Top 20. Nevertheless, in the absence of any other exhaustive list of firms, and information characteristics, the information obtained through various DQ annual numbers have been analysed in the current research.

The majority of the IT firms in Bangalore have started their operation between 1991 and 1996 (Table 7.8). The combined share of firms starting their operation between 1986 and 1996 (the focus of the present research) is over 80 percent. One-fifth of all the firms started in India during the 1986-90 period and a quarter of the firms that started operation in India during 1991-96 period established themselves in Bangalore.

Table 7.9 Bangalore: Annual turnover of IT firms (1996)

Turnover Range (Rs. Million) 1995-96		%
Not Available	11	5.4
0-9	104	50.7
10-20	28	13.7
21-30	14	6.8
31-40	10	4.9
41-50	2	1.0
51-99	9	4.4
100-250	14	6.8
260-500	6	2.9
510-750	0	0
760-1000	2	1.0
1001-2000	2	1.0
2001-3000	1	0.5
3001-4000	1	0.5
7001-9000	1	0.5
TOTAL	**205**	**100**

Source: Dataquest, 1996

Half of the IT firms in Bangalore had a turnover of under Rs. 10 Million (US $ 32,000), and another 14 percent, a turnover between Rs. 10- 20 Million (Table 7.9). Bangalore has largely the smaller firms, unlike Bombay, which has all the large IT firms (i.e. more than 500 employee). One-third of Bangalore's IT firms employ 10 or less number of employees, and another quarter between 11 and 25. In fact over 70 Percent of Bangalore's IT firms employ 50 or less of people (Table 7.10).

In Bangalore, software only firms are the most predominant among all the IT firms (Table 7.11). The combined strength of all the firms employing software engineers in Bangalore is over 75 percent, that is unlike Delhi, which has a heavy hardware base, combined with software (as explained in the previous chapter). Hence it is very well established from Table 7.11 that software segment dominates the IT industry in

Bangalore. It is also pertinent to note that the Dataquest listed firms are only some of the firms that might actually exist in Bangalore.

Table 7.10 Bangalore : Employees in IT firms (1996)

Employee Range (1995-96)	Count	%	Cumulative %
Not Available	12	5.9	5.9
0-10	60	29.3	35.1
11-25	52	25.4	60.5
26-50	33	16.1	76.6
51-75	11	5.4	82.0
76-150	15	7.3	89.3
151-300	7	3.4	92.7
301-500	10	4.9	97.6
501-750	2	1.0	98.5
1000-2000	2	1.0	99.5
3001-4000	1	0.5	100.0
Total	**205**	**100**	**100**

Source: Dataquest, 1996

Table 7.11 Bangalore: Growth of the IT industry and employment 1993-96

Category	1993		1996	
	No. of Firms	**Employees**	**No. of Firms**	**Employees**
Information Technology [1]	7 (5.5%)	1354(15.2%)	12 (5.9%)	5908 (34.9%)
Hardware Only	20 (15.8%)	2247 (25.2%)	18 (8.8%)	623 (3.7%)
Software and Services Only	69 (54.4%)	3641(41%)	98 (47.8%)	7277 (43%)
Value Added Resellers	10 (7.8%)	255(2.9%)	37 (18%)	792 (4.7%)
Peripherals	19 (15.0%)	1386(15.6%)	34 (16.6%)	2187 (12.9%)
Training	2 (1.5%)	13 (0.1%)	6 (2.9%)	137 (0.8%)
Total	**127 (100%)**	**8896 (100%)**	**205 (100%)**	**16924 (100%)**

Source: Dataquest, 1993 and 1996

[1] Includes firms doing business in Hardware, Software, and System Integration

Source: Dataquest, 1996

The analysis of data for all type of IT firms and those that are specialising in software and services (cf. Chapter 6) only show that Bangalore has the largest concentration of IT firms in India. The comparative figures for 1993 and 1996 (Fig. 7.12) show that while the total number of IT firms in Bangalore increased by 17 percent between 1993 and 1996, their cumulative turnover increased by over 56 percent during the same period, while the actual number of employees in these firms increased only by about 24 percent. Among all the firms that employ software engineers, the total number of firms increased by over 20 percent between 1993 and 1996. While the employment in these firms increased by about 39 percent, their annual turnover increased by a massive 97 percent between 1993 and 1996.

Table 7.12 : Bangalore: Comparative performance of IT firms - 1993-1996

Year/Characteristics	Type of IT Firm		
1993	**All Firms**	**Software only Firms**	**All Firms Employing Software Professionals***
Total Firms	127	69	88
Total Employees	8896	3641	5263
Total Turnover (Rs.) Billion	6.698	1.466	2.926
Average Turnover per Employee (Rs.) Million	0.753	0.427	0.555
1996			
Total Firms	205	98	153
Total Employees	16,924	7,277	14,114
Total Turnover (Rs.) Billion	25.714	5.960	22.367
Average Turnover per Employee (Rs.) Million	1.519	0.819	1.584

Source: Own Calculations based on information from Dataquest, 1993 and 1996 (Computation based on SPSS).

* This includes all those firms that employ software engineers, viz. Software and services only firms, IT (as defined in Table 7.11) firms, Valued added resellers, and Software Training firms

Given the growth trend of Bangalore's IT industry over the past decade, many of the business journals/magazines even outside India have started referring to it as the "India's Silicon Valley/Plateau[125]". However, there are concerns over whether that growth can be sustained in the face of growing domestic and international competition, inadequate infrastructure and escalating costs. 85 percent of new software companies chose Bangalore as their headquarters, mainly because of the availability of 'a large pool of low cost professionals' (Arthur Andersen Study quoted in Business Standard, 1995, New Delhi). According to this report in the Business Standard, Arthur Andersen has advised a number of multinationals on siting for their new Indian operations. Based on a range of factors including transport, power, telecommunications, labour availability and "livability", Arthur Andersen rated Bangalore as the first preference for locating software development. Bombay was ruled out because of its extremely high property prices, while Andersen says, 'Delhi and Madras could be considered as alternative, backup locations' (Business

[125] There is a geographical connotation that needs to be clarified here. Bangalore is on a plateau, and it is what many (Economist, 1994; Financial Times, 1995) believe as India's answer to Silicon Valley in the US. So should it be called the Silicon Valley of India or Silicon Plateau of India?!

Standard, 1995). The capital of Karnataka, thus owes its success in attracting new IT investments to a combination of political, industrial and geographical factors (Financial Times, 1995).

INDUSTRIAL INFRASTRUCTURE FOR THE IT INDUSTRY

One of the important reasons for the attraction of IT industry in Bangalore has been the availability of infrastructure, that specifically caters to the needs of the IT industry. Earlier in this chapter, a brief analysis of the telecommunications infrastructure in Bangalore highlighted that the city enjoys one of the best telecommunications facilities in the country. Here, a brief analysis of the other physical infrastructure that supports the IT industry in the city will be provided.

- KEONICS Electronics City

Realising the potential that Bangalore offers to electronics industry in general, the Government of Karnataka's Electronic Development Corporation (KEONICS), launched the country's first Electronics city 22 Kms. south east of Bangalore on the National Highway 7 towards Hosur. The Electronics City has been constructed in two phases and the first phase is fully occupied. Stretching over an area of more than 300 hectares, the first phase of the Electronics City is home to some of the big names in the IT industry in India. The infrastructure for the Electronics city was developed by the Karnataka Industrial Investment Development Corporation (KSIIDC). The most fundamental problem faced by the Electronics City (which is so rampant all over the state) is chronic power failures. Power outages are very common, and fluctuations are very frequently reported. The severity of the problem could be well understood by the fact that the entire Electronics City has to undergo a weekly "power holiday". Most of the software and other IT firms use their own captive power generating system to run the sensitive computer systems, and use the state provided electricity for general lighting purposes. Combined with the electric power problem, getting to the Electronics City from Bangalore can vary from half an hour to a gruelling three hours depending on traffic conditions. That stretch of the Highway, to Hosur is any motorist's worst nightmare. Widening work of the National Highway into four lanes between Bangalore and Hosur, by a private construction company is almost completed. This will considerably reduce the travel time between Bangalore and the

Electronics City, and since the phase two of the Electronics city is also under operationalisation, it is hoped that, Electronics City would be able to offer more sites for IT companies in Bangalore.

- DoE's Software Technology Park (STP) - Bangalore

The STP scheme initiated by the DoE is a 100 percent export oriented scheme for the development and export of computer software using data communication links or in the form of physical media including export of professional services. The STP Bangalore, has been set up as a part of Government of India (DoE)'s objective of promoting export of computer software from the country through different STPs all over India. Bangalore STP was the first of its kind, and came into inception in 1991. In Bangalore, the STP is located within the Electronics City (which is 22 Kms. away from Bangalore),

The STP-B, offers high speed data communication facility, and provides the IBM AS-400[126] and ES-9000 Platforms to its clients in the form of computing facilities. The STP-B, also extends its facilities to firms that are actually located in Bangalore city itself. It offers them dial-up facilities to use the STP networked facilities. For the software firms operating inside STP-B, access has been provided through a LAN (local area network) system. STP-B, is the only centre at present which offers video conferencing facilities among all the STPs established in India. In 1993, due to the increased demand for use of high speed communications lines in Bangalore, a satellite earth station was set up in Bangalore. With this, the companies in Bangalore are able to lease their own 64-KBPS (Kilobytes per second) circuits, through the satellites. This has enabled many of the software companies to take on remote-user facility[127], and combined with the time difference between India. and the US and Western Europe, firms in Bangalore are able to offer, 24 hours backup services to its clients all over the world.

[126] IBM Application System -400

[127] Which basically means that, a company in Bangalore can log into the computer network of its clients even as far as USA, and provide its client instantaneous solutions to any difficulties faced by them or work jointly in resolving any bugs in the software.

- The Information Technology Park Ltd. (ITPL)

The government's efforts to provide a suitable infrastructure for the infotech industry are now being reinforced by the private sector. The Information Technology Park Limited (ITPL) is a step in that direction (Fig. 7.15). The park is a joint venture between the Singapore Consortium, The Tata Group, and the KSIIDC (the share is 40:40:20 respectively). The park hopes to provide far more facilities than the KEONICS' Electronics City. While the Electronics City confined itself to providing land and better telecommunications facilities, this Rs. 14 Billion Park aims at being self contained township which will integrate office, production and commercial space with residential and recreational facilities.

The park has been very recently commissioned, and IT companies have started to move into the complex. A global satellite links the park with locations around the world, and communications lines are already available for voice and data transmission[128]. A modern sewerage system and a dedicated water supply pipe are some other features. A business and an executive centre complete with conference and exhibition rooms, and a commercial centre is also being provided within the park.

There are plans for setting up a software village by Information Management Resources, India, a subsidiary of US$ 20 million IMR, USA. However, projects like these when they materialise, would enable Bangalore to retain its competitive edge over other cities in India's IT industry. For the fact to be noted is that, many cities in India have STP, and many more have proposed Electronics City, but none of them have a fully functional STP, Electronics City, and a functioning private IT Park, except for Bangalore. But it still leaves one crucial issue uncovered. How infotech companies will cope with their biggest problem yet-the manpower crunch and growing infrastructure deficit? Chronic power shortages, lack of international airport, and overcrowding at Bangalore has discouraged many IT investors, according to Business Standard (1995).

[128] An estimated 400 lines will be offered for voice and data transmission.

Does this signal an end to Bangalore's infotech boom? Not necessarily. Bangalore still has the largest share of IT as well as software firms in the country. It is not that the IT firms are moving out of Bangalore; it is more a question of some new companies who would have otherwise come in, not doing so while some of the existing companies are locating future expansion elsewhere. Infosys (a highly acclaimed domestic software company) is a good example of both the advantages and disadvantages of being in Bangalore. When it moved in, it was the first software company to be set up in Bangalore, and this happened due to very high property rates and congestion in Bombay. Infosys' 125,000 ft^2 campus at the Electronics City is the biggest single location of a software company in India. Now like all other companies in the Electronics City, Infosys has its own power supplies. It operates completely independently of the state power supply. This is important, according to its Chief Executive Officer (CEO) Narayana Murthy (one of the very respected figures in the Indian IT industry) as its competitors and clients both are from that part of the world, where uninterrupted good quality power supply is taken for granted. So Infosys also needs a similar kind of an environment to compete and prosper.

State electric power is not only in short supply but also faces incessant voltage fluctuation which makes it virtually impossible to use even on those rare occasions when it is available. *The only reason the IT industry in Bangalore has continued to grow in spite of this problem, is that its power requirement is not large, and the cost of captive generation*[129] *is comparatively lower.*

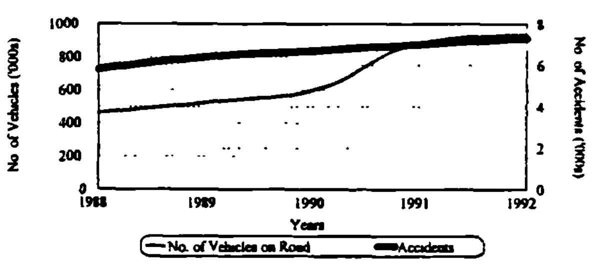
So while the power problem can at some cost be overcome, other problems are less easy to tackle, especially the shortage of professionals. The attrition rate among software professionals in Bangalore is very high. This demand-supply gap has inevitably forced salary levels up. Escalation of salaries by 25-30 percent per year have become the norm (Business Standard, 1995). This rapid growth in salaries means that soon India, and in particular Bangalore which is seeing the swiftest salary rise, will lose its cost competitiveness vis-à-vis rest of the world. Thus the future growth of the software development industry depends on its ability to move up the value chain.

[129] Power generated by the industries themselves independently off the state electricity board.

Most observers like to associate the present infrastructure deterioration in the city with the pressures that corporate investment have imposed on the city (Business Standard, 1995). But that is only part of the story. It is equally true that enforcement of city planning regulations has been lax. This realisation is slowly beginning to filter the pockets of the municipal authorities. High on the priority list is the 92 km long MRTS[130]. The MRTS project, with an estimated cost of Rs. 45 billion, will be executed on a BOOT[131] principle, by a private consortium or an entrepreneur. The project is expected to be completed by 2006. The government is also seriously considering the construction of small flyovers and subways.

Meanwhile, staff turnover is high and employers in the software industry report that wages are rising by an average of 20 to 25 percent a year. From a multinational's point of view this is not a critical issue yet. However, if the salaries continue to spiral, there is a danger that some of the software MNCs may move the operations out of India altogether. Most industry leaders warn that unless the city's infrastructure is improved urgently, new IT investments may go elsewhere[132].

Fig. 7. 16: Traffic growth in Bangalore (1988-92)



Source: Business Today, 1994

Another serious problem is coping with the increasing vehicular traffic in the roads of Bangalore. With increased number of firms and commercial activities basing themselves in Bangalore, traffic levels in the city have grown at astonishing levels since the 1970s (Fig. 7.16).

The problem of urban congestion needs immediate attention. The state government is hoping to alleviate the situation partly by developing satellite towns around the city. Tumkur, Mysore, and Mangalore are some of these. Plans have also been laid out to

[130] MRTS: Mass Rapid Transit System

[131] Build-Own-Operate-Transfer

[132] The capital city of Andhra Pradesh- Hyderabad has over the recent times been making a claim of presenting itself as a better alternative to Bangalore. Spearheaded by a technologically driven Chief Minister of the state (*who is always spotted with his laptop PC*), it will be interesting to watch, how the city plans to compete against Bangalore in attracting IT industries.

provide infrastructure for developing satellite towns along the Bangalore-Mysore Express Highway.

Many of these proposals will take time to realise. The question is whether the IT industry is willing to wait till that time, or move to other locations. That's easier said than done, Bombay and Delhi do not appear to be favourites among IT companies; Hyderabad, Madras and Pune do not seem to have many of the advantage enjoyed by Bangalore. The growth (if any) of the IT industry in Bangalore in the future, it appears would be more due to lack of other alternative locations within India, rather than (hitherto existed) advantages offered by Bangalore.

7.7 CONCLUSION

Bangalore has come a long way from the time of Kempe Gowda II, to being a "pensioners paradise", to a situation, where it is the main centre for the IT companies to customers in India and abroad, to make up what is perhaps the most globally competitive industry in the country. IT companies, seeking to capitalise on India's growing markets and its large pool of young talent, have made Bangalore, their main centre. Though their number remains quite small and the range of activities is still limited, the industry is acquiring depth as new companies spring up to produce software or provide other services for the computer companies which are already established. If this process of consolidation continues, Bangalore will be able to justify being called "India's Silicon Valley"(Financial Times, 1995).

Bangalore has had a number of advantages when it comes to attracting new foreign investment in the IT industry. First, and foremost is the supply of well-educated engineers. Bangalore is home to a large number of research laboratories and higher educational establishments, including the Indian Institute of Sciences, and one of the best management schools in the country- The Indian Institute of Management.

The state of Karnataka as a whole has 18,000 college places for degree course in engineering and a similar number for diploma in engineering. Despite rampant wage inflation-particularly for experienced software engineers- a first-class graduate can still be recruited for about Rs. 12,000 a month (about US $ 4,000 a year), although a new recruit can expect his/her salary to triple over three to four years.

But most of the start-ups IT firms say that relatively low labour costs are only one reason for setting up in Bangalore. Other factors include the state's relatively good record of labour relations, better telecommunications infrastructure, the state government's positive attitude towards foreign investment, and the city's pleasant climate.

But Bangalore's success in attracting new business ventures and its rapid population growth is taking its toll on the city's infrastructure, which needs immediate attention. Bangalore has no effective public transport system. Most crucially, power cuts and voltage reductions are a daily occurrence. Although IT companies are not big power users, they must install voltage regulators, uninterrupted power supplies, and generators to run their computers. The local telecommunications including the telephone network has improved dramatically, and is probably one of the strongest reason for Bangalore to be still attractive to the IT industries.

It is with this background that the analysis of the 52 IT firms exclusively surveyed for the current research is presented in the following chapters.

8 UNDERSTANDING THE COMPETITIVENESS OF BANGALORE IN INDIA: EVIDENCE FROM DOMESTIC IT FIRMS

8.1 INTRODUCTION

The chapter on the geographical analysis of the IT industry in India, and the preceding chapter brought to the fore emergence of Bangalore as the dominant centre for the IT industry in the country. Some general causal effects behind Bangalore's dominance were established in the last chapter, which discussed the industrial and urban development of Bangalore. This and the next two chapters will attempt, an in-depth examination of Bangalore's competitive position in the IT industry.

As outlined in the methodology chapter, as part of this research, a detailed study of 52 IT firms was carried out between July and October, 1995 in Bangalore. The analysis was done among three different types of firms, based on their ownership status, viz. domestic, foreign owned, and joint venture firms. This was essentially done to get a segment wise understanding of the IT firms in India, and to understand if there were any differences in the perceptions of the IT firm, depending on their ownership. Apart from providing an overview of the surveyed firms, the focus of the present chapter is to provide an in-depth understanding of the domestic IT firms that have been surveyed in Bangalore.

8.2 OVERVIEW OF THE SURVEYED IT FIRMS IN BANGALORE

Before proceeding with the analysis of the surveyed domestic IT firms in Bangalore, it may be worthwhile to recapitulate certain definitions that were put forward in the methodology chapter regarding the terms used in this research

Domestic Firms, are those firms whose shares are largely owned by an Indian parent group. Some may or may not have financial collaboration with an overseas firm. In any case, the Indian group will control 51 or more percent share of these companies. Examples are Infosys Technologies and BFL Software. ***Joint Ventures***, are those firms that are equally owned by a foreign and a domestic company. In the most typical case the ownership would be divided into equal parts in the case of two partners. This would be 50 percent each in such a case. Examples of these include TATA-IBM (TISL) and Cranes Software. ***Foreign Owned***, are those firms that are fully owned or a fully owned subsidiary of a foreign firm. These types of firms were allowed in the IT sector in India only from 1985, when Texas Instruments (TI) of USA started its fully owned subsidiary in Bangalore. Other examples include Motorola, and Digital Equipment (India) Limited (both from USA based parent companies).

Apart from the ownership status of the firms, reference is also made to the category of firms, based on the nature of their products. These have been grouped as Information Technology, Software and Services only, Hardware only, and Peripherals. As explained in the methodology chapter, this nomenclature is study specific, and are working definitions adopted by the researcher to distinguish various firms.

IT Firms, are those that have diversified interests in hardware, software and services (including system integration), and even peripherals. The turnover of the firm is largely controlled by various segments of the IT industry, and hence been given that name. These employ a large number of software professionals not only for their software production, but also for system integration and system maintenance. Examples of such firms are Wipro, and TATA-Elxsi. ***Hardware only firms***, are those that manufacture hardware components, PCs, network cards etc. Advanced Micronic Devices, and Analog and Systems are two good examples of the hardware only firms, from the surveyed firms. ***Software and Services only firms***, are those that deal only with software and its related services. Firms producing customised and packaged software have both been included in these as well as firms that provide software support. Examples of this include Hewlett-Packard's International Software Operations, and Netquest. ***Peripherals firms***, are those firms that manufacture peripherals and other equipment required by the IT industry. These include manufacturers of printers, scanners, and VDUs (or monitors). Examples of these are TVSE, and VXL Instruments.

The problems of not getting the actual number of IT firms operating in India, and Bangalore were demonstrated in Chapter 6 and 7. In the light of that, only the figures presented by the Dataquest Top 20 appear to have a larger coverage of IT firms in India, than any other source. Table 8.1 outlines the number of IT firms in Bangalore by product category, as generated from the Dataquest Magazine. This data is used as a reference point for being the total number of IT firms in Bangalore.

Table 8.1 Bangalore: Number of IT firms, 1993 and 1996

Category	1993	1996
	No. of Firms	**No. of Firms**
Information Technology [1]	7 (5.5%)	12 (5.9%)
Hardware Only	20 (15.8%)	18 (8.8%)
Software and Services Only	69 (54.4%)	98 (47.8%)
Value Added Resellers	10 (7.8%)	37 (18%)
Peripherals	19 (15.0%)	34 (16.6%)
Training	2 (1.5%)	6 (2.9%)
Total	127 (100%)	205 (100%)

Source: Dataquest, 1993 and 1996

[1] Includes firms doing business in hardware, software, and system integration

The process by which the firms were selected for study has been described in the study methodology (Chapter 3). Nevertheless, it is worthwhile to recapitulate the fundamental problems that beleaguered the researcher: first and foremost, an absence of a definitive official source on the number of IT firms in Bangalore; second heavy reliance on the estimates about the number of IT firms in Bangalore by different sources (as opposed to a reliable census); and thirdly, very low response rates from the firms that were approached. The idea was to contact as many IT firms as possible within the very limited available time, and yet try and strike a balance as far as the ownership of the firm was concerned. Ownership, as mentioned earlier was a crucial element of analysis, as it was perceived that responses to the question would vary on the basis of the ownership of the firm. Table 8.2 outlines the ownership status and product category of the surveyed IT firms in Bangalore. Although over 70 IT firms were contacted in Bangalore, only in 52 cases, could comparable information be collected. These 52 firms are the sample of the current research.

Table 8.2 Case study firms : Ownership status and product category

Category of Firm	**Ownership Status**			
	Domestic	Joint Venture	Foreign Owned	Total
Information Technology [1]	-	3	1	4
Software & Services only	15	13	14	42
Hardware only	3	-	-	3
Peripherals	2	-	1	3
Total	20	16	16	52

Source: Field Survey, 1995

[1] Includes firms doing business in hardware, software, and system Integration

Although every effort was made to keep the ratio of category of IT firm, and the ownership status equal in the sample, in practice this proved impossible because of the high number of interview rejections. As can be seen from Table 8.2, over 80 percent of the sampled firms were software only firms, although as per the Dataquest figures, software only firms accounted for roughly half of all the IT firms in Bangalore. Any generalisations drawn during the course of the analysis should take this into account. The sample is more uniformly distributed on the basis of ownership. While foreign and joint venture firms each accounted for just under one third of the total sample, domestic IT firms accounted for a slightly larger share-of 38 percent-of the total number of the case study firms.

The last chapter on Bangalore's industrial development highlighted that most of the IT firms recorded in the city began their operations since the mid-1980s. The sampled IT firms also reflect a similar behaviour, and the firms established after 1986 account for over 80 percent of the total, of which 42 percent were established between 1991 and 1995 (Table 8.3). Fig. 8.1 shows that 1992 and 1990 recorded the highest number of start ups among the case study firms with 8 and 7 firms respectively.

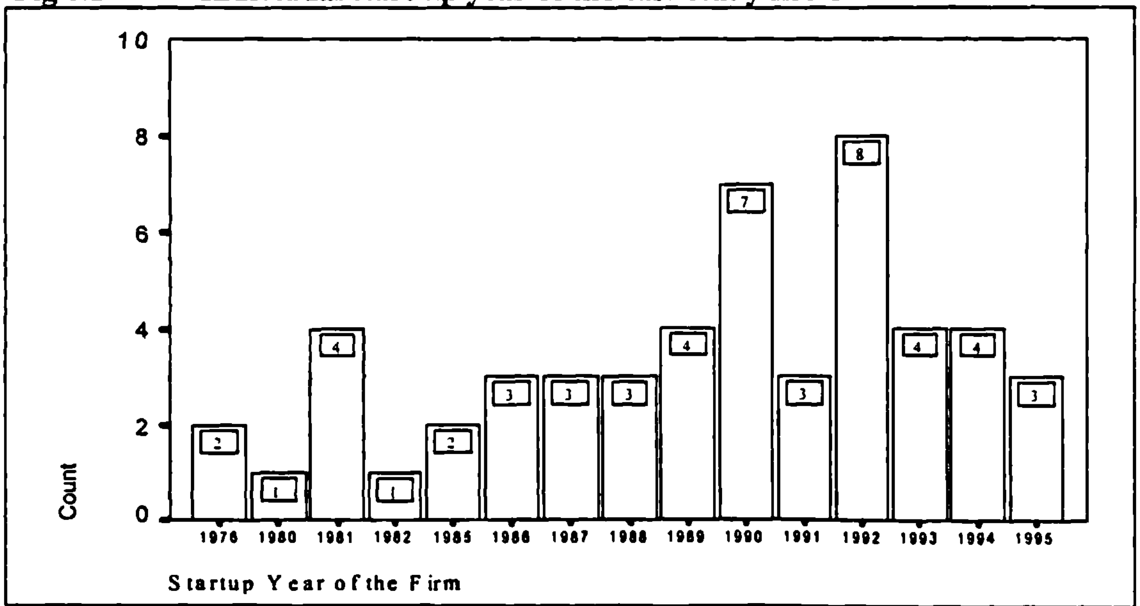
As already mentioned in earlier chapters, Bangalore's IT firms tend to be smaller than those in Bombay or Delhi. Almost half of the case study firms have less than 50 employees in 1995. Another fifth of the firms had 201 and 500 employees in 1995 (Table 8.4). The macro economic reforms started in 1991, and that year has been taken as one point of reference for the number of employees in the firm, apart from 1995 (the year of survey). The years mentioned are fiscal years.

Table 8.3 Bangalore: Start-up year of the surveyed firms, 1995

Year of Commencement of Production	Number	%
1970-1980	3	5.8
1981-85	7	13.5
1986-90	20	38.5
1991-95	22	42.3
Total	52	100

Source: Field Survey, 1995

Fig 8.1 Individual start up year of the case study firms



Source: Field Survey, 1995

Table 8.4 Bangalore: Firm size of the surveyed firms

	Total Employment in 1990-91		Total Employment in 1994-95	
	Number	%	Number	%
Did not Exist	18	34.6	-	-
0-50	18	34.6	25	48.1
51-100	4	7.7	5	9.6
101-200	7	13.5	7	13
201-500	3	5.8	11.	21.2
501-1000	1	1.9	3	5.8
1001-2000	1	1.9	-	-
2001-3000	-	-	1	1.9
Total	52	100	52	100

Source: Field Survey, 1995

Table 8.5 Bangalore: Annual turnover of the surveyed firms, 1995

Turnover Range (Rs. Million) 1995 Prices	Number	%
0-50	24	46.2
51-100	3	5.8
101-250	9	17.3
251-500	2	3.8
501-750	3	5.8
1501-2000	3	5.8
More than 2000	1	1.9
Not available	7	13.5
Total	52	100

Source: Field Survey, 1995

Almost half of the firms have an annual turnover of under Rs. 50 Million (1995 prices). 17 percent of the studied firms recorded an annual turnover of Rs. 101-250 Million (Table 8.5).

Only 45 of the 52 firms reported both employment and turnover figures. These 45 firms between them had total employment of 10,073, with an arithmetic mean of 223 employees per firm, and a median value of 68. The cumulative turnover of these firms amounted to Rs. 150.03 Billion (1995 prices), with an arithmetic mean of Rs. 334.22 million per firm, and a median value of 37.35. The arithmetic mean of turnover per employee among these 45 firms stood at Rs. 900,000 (1995 prices).

Having provided an overview of the surveyed firms, and a description of some of their salient characteristics, now the analysis will be focused on each of the segment as described in the introduction. Since there are large number of both multinational and domestic IT firms in Bangalore, the issue of ownership is also of paramount importance. It needs to be assessed if firms based on their ownership have behaved differently in selecting Bangalore as the production base. Thus in the primary analysis of this research, the firms will be grouped on the basis of ownership. The rest of the chapter will provide an analysis of the domestic IT companies in Bangalore.

8.3 DOMESTIC IT COMPANIES

The domestic IT companies which are the largest group when classified according to the ownership status among the surveyed firms account for 38.5 percent of all the surveyed firms.

8.3.1 GENERAL CHARACTERISTICS

Among the surveyed domestic IT firms, software and services firms account for three-fourths of the total (Table 8.6), which is less than the figure for all the surveyed firms (which is 80.8%).

Table 8.6 Domestic firms: By product category, 1995

Category of the Firm	Count	%
Hardware Only	3	15.0%
Software & Services Only	15	75.0%
Peripherals	2	10.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.7 Domestic firms: Start-up year

Year of Commencement of Production	Count	%
1970-1980	2	10.0%
1981-85	4	20.0%
1986-90	8	40.0%
1991-95	6	30.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.8 Domestic firms: Employment size 1991, 1995

	Total Employment in 1990-91		Total Employment in 1994-95	
	Count	%	Count	%
0-50	9	50.0%	7	35.0%
51-100	3	16.6%	1	5.0%
101-200	4	22.2%	5	25.0%
201 -500	2	11.1%	6	30.0%
501-1000			1	5.0%
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

The majority of the domestic firms were established between 1986 and 1995 (Table 8.7). In 1995, the domestic firms were dominant in two sizes. One which has up to 50 employees (accounting for 35 %), and another in the range of 201-500 employees, which accounted for 30 percent of the surveyed domestic IT firms in Bangalore (Table 8.8).

Two-thirds of the surveyed domestic firms had a annual turnover of less than Rs. 500 million. In fact, 45 percent of the firms have a turnover of less than Rs. 50 million, which is analogous to the turnover of all firms surveyed in Bangalore (Table 8.9).

Table 8.9 Domestic firms: Annual turnover (Rs. Million), 1995

Turnover Range (Rs. Million) 1995	Count	%
0-50	9	45.0%
101-250	5	25.0%
251-500	1	5.0%
501-750	2	10.0%
1501-2000	1	5.0%
Not Available	2	10.0%
Total	20	100.0%

Source : Field Survey, 1995

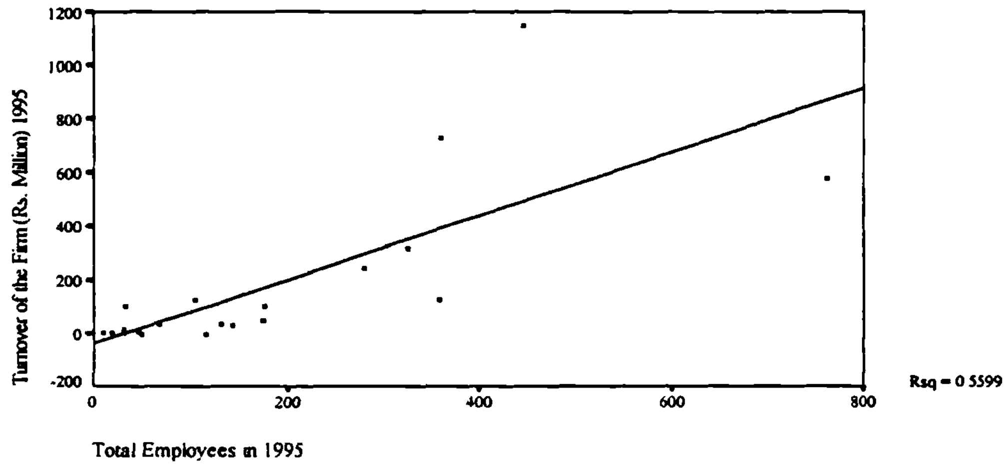
An attempt has been made to measure the strength of association between the employment size of the surveyed firms and their annual turnover through a correlation analysis. The correlation test between the independent variable (*employ95*), and dependent variable (*turnover*) reveals that there is a positive relationship between employment and turnover, proving the fact that the higher the number of employees the higher the turnover is. The relationship which is expressed by the statistical term R^2, is .56 for all the domestic firms, whereas for all the surveyed firms in Bangalore R^2 is .92, which signifies that relationship between employees and turnover, although a positive one for the surveyed domestic firms is weaker than that of all the surveyed firms (Table 8.10).

Table 8.10 Domestic firms: Relationship between total number of employees and annual turnover, 1995

- - Pearson Correlation Coefficients - -

	EMPLOY95	TURNOVER
EMPLOY95	1.0000 (20) P= .	.7483 (20) P= .000
TURNOVER	.7483 (20) P= .000	1.0000 (20) P=

Bangalore: Relationship between Employment and the Turnover (1995)
Surveyed Domestic IT Firms Only



These 20 surveyed domestic firms between them employed 3673 persons in 1995, which had increased from 2110 persons (an arithmetic mean of 105 persons per firm) in 1991. In 1995, the arithmetic mean of employees per surveyed domestic firm stood at 184 persons, with a median value of 123 persons. The cumulative turnover of these firms was Rs. 3662 million (1995 prices), with an arithmetic mean of Rs. 183 million per firm, and a median value of Rs. 43.83 million. The arithmetic mean of turnover per employee of the surveyed domestic firm was Rs. 735,000, and the median value was Rs. 418,000.

As outlined in the research methodology (Chapter 3), this study used an "opinion questionnaire". The questionnaire attempted to gather the firms' opinion on various issues. The aim of the firm level survey was to obtain information about the origin, growth and problems faced by firms at different locations in the city. More specifically, the questionnaire sought information on the following issues: (1) General information of the firm, (2) Product profile, (3) The main factors influencing the firm's decision to settle in Bangalore, (4) The industry-research lab interaction on R&D and new product development, (5) Issues related to government support, (6) Infrastructure support for the IT industry in Bangalore, and (7) Major problems faced by the IT companies in Bangalore. This formed the crucial aspect of the study based on which Bangalore's competitive position has been appreciated in the research.

8.3.2 PRODUCTION PROFILE

All the 20 surveyed domestic firms have their own R&D set up. With this R&D base, the firms carried out their routine research activities, and also testing and development of new products. In fact, all the surveyed firms in Bangalore reported to have an R&D set up, which indicates the importance attached to R&D by these IT firms. Almost 25 percent of the surveyed domestic firms in software and services only category did not refer to use of foreign technology as a great advantage. All the surveyed firms in Bangalore acknowledged the importance of the technology or support received from research institutes and laboratories. All the surveyed firms agreed that being closer to their customers was an added advantage, although many agree that in the present day of good telecommunication links, not being nearer to the customers will not hamper their competitiveness. All the domestic firms agree that the service provided to their customers (this is especially true for all the surveyed software firms) is of utmost importance in providing competitive edge over their rivals.

Further to the above questions, the firms were also asked to indicate the significance of certain characteristics that may act as a potential source of competitiveness. These include R&D, production capacity, investment capacity to make new products, selling in domestic and overseas market (Table 8.11).

Table 8.11 Competitiveness of domestic firms: Significance of factors related to operation (Figures in parentheses show share of the total domestic firms surveyed)

Factors	Very Important	Fairly Important	Not Important
Research & Development	18 (90%)	2 (10%)	-
Selling in the Domestic Market	14 (70%)	3 (15%)	3 (15%)
Selling in the Overseas Market	8 (40%)	4 (20%)	8 (40%)
Production Capacity	4 (20%)	13 (65%)	3 (15%)
Investment Capacity	3 (15%)	7 (35%)	10 (50%)

Source: Field Survey, 1995

Perhaps the most significant aspect of the above table is the issue of selling in the domestic market. 70 percent of the firms treat that as a very important (and another 15% fairly important) aspect of competitiveness, which is also a reflection of the importance attached by all the surveyed firms in penetrating the Indian market. Half of the surveyed firms opine that investment capacity is not important as a source of potential competitiveness to their firms. This is an interesting finding, as many of the interviewed firms suggested lack of venture capital as a major impediment for future expansion, or to start new operations.

8.3.3 Locational Aspects

This examines the reasons why firms chose Bangalore rather than any other city for their operations. Chapter 6 made it clear that Bombay and Delhi seem to be competing closely with Bangalore to attract investment in the IT sector, and in the recent time, cities like Madras, Pune and Hyderabad also seems to be vying to attract large investment in the IT sector.

Table 8.12 provides an overview of the cities that were considered by the domestic IT companies as probable locations before Bangalore was selected as the production base. Three-fourth of the surveyed domestic firms considered locational alternatives. The other quarter did not consider any other location, as their first choice was Bangalore.

Bombay appears as the first choice that was considered for location, followed by both Delhi and Madras. This supports the earlier argument put forward in chapter 6 that Bombay and Delhi appear to the toughest competitors to Bangalore in attracting IT industries in India. Among the second alternatives Hyderabad was considered by a quarter of the domestic firms that were surveyed.

Table 8.12 Domestic firms: Alternative locations to Bangalore that were considered

	Which other cities were considered as possible First location?		Which other city was considered as Second possible location?	
	Count	%	Count	%
Bombay	6	30.0%	2	10.0%
Delhi	4	20.0%	3	15.0%
Madras	4	20.0%	2	10.0%
Hyderabad			5	25.0%
Pune	1	5.0%		
Calcutta	1	5.0%		
not applicable	5	25.0%	7	35.0%
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

Perhaps one of the most significant aspects of the study is explained by the following sets of tables. It seeks to explain why the IT firms choose Bangalore, and thus is one of the very important findings of the study. The firms were asked to list out all the factors that they considered in choosing Bangalore. Then they were asked to rank each of those parameters, in order of importance to them.

A little over one-third of the surveyed domestic firms consider supportive government policies (of Karnataka state) as a very important factor in choosing Bangalore as a base. Only 10 percent of firms consider government support as less important in choosing Bangalore (Table 8.13).

Table 8.13 Domestic firms: Importance of locational factors- government support

	Government Support	
	Count	%
Very Important	7	35.0%
Important	11	55.0%
Less Important	2	10.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.14 Domestic firms: Importance of locational factors-availability of high technology professionals

	Availability of High Technology Professionals	
	Count	%
Very Important	15	75.0%
Important	3	15.0%
Less Important	2	10.0%
Total	20	100.0%

Source: Field Survey, 1995

Forty percent of the domestic IT firms state availability of high technology professionals as the first reason for choosing Bangalore. Three-fourth of the domestic firms agree that the availability of high technology professionals in the city was a very important reason for setting up the firm in Bangalore (Rank 1-3). Ninety percent of domestic firms have opined availability of professionals as either very important or important (Rank 1-6) (Table 8.14). Haug's study (quoted in Heeks, 1996:91) in the US showed that five main factors play a part in the locational decisions of new software companies: (a) proximity to previous employer and residence; (b) labour availability; (c) quality of life; (d) infrastructure; and (e) proximity to customers. Similar to that study, the present research also found that the surveyed domestic IT firms attached a high level of importance to the availability of high technology professionals in Bangalore as one of the most fundamental locational decision.

Table 8.15 Domestic firms : Importance of locational decisions-availability of research institutes in Bangalore

	Availability of Research Labs/Institutes?	
	Count	%
Very Important	13	65.0%
Important	7	35.0%
Less Important		
Total	20	100.0%

Source: Field Survey, 1995

Two-third of the surveyed domestic firms consider the availability of research institutes and laboratories as a very important reason for choosing Bangalore (Table 8.15). This is also true for all the surveyed firms in Bangalore, which ranked the availability of research laboratories as very important (82.7 %).

By the (*mid*) 1980s, Bangalore had become one of the country's major high technology centre. Table 8.16 illustrates the choice expressed by the entrepreneurs once Bangalore had become an important centre for high technology production. Thirteen of the 14 surveyed domestic firms that started operating in the city between 1986 and 1995 list Bangalore's existing base of high technology industry to be an important reason for choosing the city.

Table 8.16 Domestic firms: Importance of locational factors-Bangalore as an established high technology centre

	Bangalore already a centre for High Technology production	
	Count	%
Very Important	7	35.0%
Important	10	50.0%
Less Important	3	15.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.17 Domestic firms: Importance of locational factors- cheaper living costs in Bangalore

	Cheaper Living Costs[1] in Bangalore	
	Count	%
Very Important	7	35.0%
Important	10	50.0%
Less Important	3	15.0%
Total	20	100.0%

Source: Field Survey, 1995

[1] Chapter 7 attempted to demonstrate that Bangalore was relatively inexpensive compared to Delhi or Bombay, and three indicators, land prices, rents and wholesale price index (WPI) were used to demonstrate that.

Half of the surveyed domestic IT firms consider cheaper living costs in Bangalore (than for example Bombay or Delhi) as an important reason in choosing the city. Further analysis based on the year of inception of firms reveals that only the firms that were established before 1991 consider cheaper living costs in the city as an important locational consideration. Half the firms that came up between 1991 and 1995 opine cheaper living costs in Bangalore as less important reason for choosing the city (Table 8.17). This is a clear indication that firms were realising that the city was loosing its edge as a relatively inexpensive city.

The above factors do highlight the importance of various locational factors that facilitated the growth of the IT industry in Bangalore. However, it is also important to note that a quarter of the surveyed domestic firms chose Bangalore as a *first choice* (Table 8.18). This is particularly important when one or many of the directors of the firm are themselves natives of the city, and most of them started their own independent firms after a stint with the IT industry in the city. This again seems to confirm Haug's findings in USA. A good example of this type of firm is NCore, whose three directors are all natives of Bangalore and joined together to form the company, after working in the industry for a long time in the city.

Bangalore has been a referred to as an "air conditioned city" because it offers a temperate climate in a largely tropical plateau, and even today it offers a less harsh climate compared to Delhi, Hyderabad or Madras. A temporal analysis of climate as a critical factor in choosing Bangalore as a production base highlights that none of the firms that came up till 1990 mentioned climate as a less important factor (Table 8.19). There could be two interpretations of why firms that came up after 1990 listed climate as less important factor. One, initially it was important for the firms to attract the best of the talents to work in Bangalore, and by projecting the city that enjoys salubrious climate it was able to attract a large number of professionals. Once that threshold was reached, the executives were not required to be wooed to come to Bangalore. Secondly, since Bangalore has experienced rapid growth as a centre for high technology firms, firms will not have to resort to climate as an important pulling factor. Moreover, many in Bangalore claim that the city's *(unorganised)* growth has had a detrimental effect on its climate, and that rapid expansion, inadequate infrastructure and increasing congestion on the roads of Bangalore has considerably reduced the overall appeal that a favourable physical climate had to offer earlier. According to these people (whom the researcher had spoken to), the city cannot lure world class professionals on the basis of hitherto existing favourable physical climate alone.

Table 8. 18 Domestic firms: Importance of locational factors- Personal decision

	Sheer Convenience	
	Count	%
Very Important	6	30.0%
Important	3	15.0%
Less Important	11	55.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.19 Domestic firms: Importance of locational factors- Climate

	Climate	
	Count	%
Very Important	6	30.0%
Important	10	50.0%
Less Important	4	20.0%
Total	20	100.0%

Source: Field Survey, 1995

The state government provided infrastructure like the Electronics City has not been an important factor in choosing Bangalore for domestic firms itself, let alone the foreign ones. Only 10 percent of the surveyed domestic firms ranked the Electronic City in Bangalore as an important locational factor (Table 8.20). It is interesting to note that there are no variations in the responses of the firms based on year of inception. It may be noted that in the last chapter it was mentioned that the Electronics City is plagued with a number of problems, and so it is no surprise that very little of the surveyed firms have actually accorded it any importance. Table 8.21 illustrates the low level of importance attached to the Government established Software Technology Park (STP) in Bangalore. The overwhelming majority of the surveyed domestic firms feel STP as a less important locational factor in choosing Bangalore.

Table 8.20 Domestic firms: Importance of locational factors- The Electronic city

	Electronic City	
	Count	%
Important	2	10.0%
Less Important	18	90.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8.21 Domestic firms: Importance of locational factors- STP, Bangalore

	STP Bangalore	
	Count	%
Important	4	20.0%
Less Important	16	80.0%
Total	20	100.0%

Source: Field Survey, 1995

Table 8. 22 : Domestic firms: Ranking of all locational factors in Bangalore

Locational Factors →	Already	Cheaper	Climate	Convenience	Elect.City	Govt Supp.	Hitec.Pro	Res.Inst	STP-B	Total
Rank 1	1	2	0	4	0	2	8	3	0	20
Rank 2	1	3	3	0	0	2	6	5	0	20
Rank 3	5	2	3	2	0	3	0	5	0	20
Rank 4	7	1	1	2	0	6	1	1	1	20
Rank 5	1	7	1	0	1	2	1	5	2	20
Rank 6	2	2	8	1	1	3	1	1	1	20
Rank 7	3	1	1	0	6	2	3	0	4	20
Rank 8	0	2	2	0	6	0	0	0	10	20
Rank 9	0	0	1	11	6	0	0	0	2	20
Total	20	20	20	20	20	20	20	20	20	

Note for Abbreviations used in the Table:

Already: Bangalore as an established centre for high technology production
Cheaper: Cheaper cost of living in Bangalore than some other big cities in India
Climate: Favourable physical climate in Bangalore
Convenience: Sheer Convenience as a locational factor
Elect. City: Availability of Electronics City
Govt Supp.: Government Support
Hitec. Pro: Availability of high technology professionals
Res. Inst.: Availability of research institutes in Bangalore
STP-B: Software Technology Park, Bangalore

Source: Field Survey, 1995

Table 8.22 provides an overview of the ranking of various locational factors as mentioned by all the 20 surveyed domestic firms in Bangalore. As appears very clear from the table, 40 percent of the firms have ranked availability of high technology professionals as the first choice, followed by sheer convenience (20%), and availability of research laboratories (15%). Firms accorded second rank to cheaper land prices and living costs, high technology professionals, and availability of research institutes in Bangalore. The factors that were given rank three mainly include, Bangalore already being a centre for high technology production, availability of research laboratories and institutes (Table 8.22).

Having described the locational reasons attributed to by the domestic IT firms, the study further probed on the aspects related to the current situation in the city and about the future of Bangalore.

Table 8.23 Domestic firms : Opinion on current status of Bangalore

	Is Bangalore still attractive for IT Industries?	
	Count	%
No	5	25.0%
Yes	15	75.0%
Total	20	100.0%

Source : Field Survey, 1995

Table 8.23 illustrates that, only three fourths of the surveyed domestic firms (in 1995) think that Bangalore is still attractive to the IT industry. Interestingly, the quarter that thinks Bangalore is not attractive are all firms that were founded before 1990. However, when a similar question was asked on whether Bangalore would continue to be the desired location for the IT industry, 90 percent of the surveyed domestic firms concurred with the idea.

Reasons in support of answer to the question posed in Table 8.23 highlight a very interesting mix of strength and weakness of Bangalore as perceived by the surveyed domestic IT firms. Among the firms that disagreed with the idea that Bangalore is still attractive to the IT industry made reference to severe power supply problems as a major constraint. Those firms that agreed to the view regard the availability of good infrastructure for the IT industry in the city as the most important reason which continues to make Bangalore attractive for IT firms. Other reasons against the viewpoint that Bangalore is still the desirable location include availability of other alternative locations, and limited scope for further expansion in Bangalore combined with severe congestion/pollution. Further reasons in support of the view point that Bangalore is still the desirable location emphasise the fact that the city offers the best opportunities for the growth of IT industry in India, and better telecommunications infrastructure than other big cities in the country.

The opinion questionnaire also covered aspects related to India, and probed the reason why IT firms choose India in the first instance. This will provide a marker to the discussion on the software industry in India (Chapter 5), where these were examined in detail. Table 8.24 outlines the perceptions of domestic firms regarding the main reason why foreign IT companies choose India for business. That particular question was addressed to the domestic firms only and firms were asked to give one important reason to support their answer. Almost half of the surveyed domestic firms feel that it is the English speaking scientific professionals that act as a major attraction for the foreign firms in choosing India. This is followed by availability of skilled labour at low wages which is supported by a quarter of the respondents in the domestic firms category.

Table 8.24 Domestic firms: Why are international IT firms interested in India?

	Why should Foreign IT Firms be interested in India	
	Count	%
Scientific Professionals speak English	9	45.0%
Cheap Labour and High Skills	5	25.0%
Cheap Labour Main Reason	4	20.0%
Reliability of Indian Professionals	2	10.0%
Total	20	100.0%

Source: Field Survey, 1995

A similar question was addressed to all the surveyed firms, as to what they thought as a main reason for any IT firm to be interested in India. Lower wage rates in India, and use of English together accounted for 60 percent of the responses given by domestic firms (Table 8.25).

Table 8.25 Domestic firms: Why are IT Firms Interested in India?

	Why Should any IT company be interested in India? Count	%
Best of value and quality	4	20.0%
Lower wages compared to competitors	7	35.0%
English speaking SW Engineers	5	25.0%
Hardworking and Reliable	2	10.0%
Large untapped Domestic Market for IT services	2	10.0%
Total	20	100.0%

Source : Field Survey, 1995

8.3.4 CONTACT WITH RESEARCH LABORATORIES AND INSTITUTES

This constitutes yet another important aspect of the current analysis. It was noted in the preceding section that the availability of research laboratories and institutes was considered as a very important factor in choosing Bangalore by the surveyed firms. This subsection of the chapter explores the nature of relationship that exist between the surveyed domestic IT firms and the research laboratories and institutes in Bangalore. Almost all the surveyed domestic firms (except one), have had some form of professional contact with the research laboratories or institutes in Bangalore in the last five years preceding the field survey in 1995, or since their inception, whichever was earlier.

Table 8.26 Domestic firms: Nature of relationship with research laboratories in Bangalore

Parentheses are percent of the total answers

Professional Issue	No	Yes
Provided R&D advice	2 (10 %)	18 (90 %)
Provided new ideas	12 (60 %)	8(40 %)
Provided advice on resolving production problem	17 (85 %)	3 (15 %)
Provided advice on marketing	18 (90 %)	2 (10 %)

Source: Field Survey, 1995

It is well illustrated from table 8.26 that most of the surveyed domestic firms were provided some form of professional advice by the research institutes and laboratories in Bangalore in the recent past. Appendix 11 notes that there are over 30 national laboratories and R&D institutions in Bangalore. These institutions offer indigenous technologies, collaborative research for products/process modification and development, design and testing of prototypes and testing and certification. Among these, only the Indian Institute of Management (IIM-B) seems to be providing any marketing advice to the surveyed domestic IT firms. Over one-third (40 %) of the firms agree that these institutes provided new ideas that help improve their existing products or design and produce new products. Some of the firms worked in collaboration with the research institutes in Bangalore to design new products, and redesign an existing product. It needs to be noted that, it is in providing R&D advice and contributing to new ideas, that the relationship between the research laboratories and the surveyed domestic IT firms strongly emerge. On the issue of resolving production problem and marketing advice the relationship does not appear very strong, as only 15 percent of the surveyed domestic firms note that the research institutes provided advice on resolving production problem, and only 10 percent of the surveyed domestic firms were provided with any marketing advice of any kind.

The computer hardware manufacturers among the surveyed domestic IT firms seem to have had the maximum leverage of the availability of the research institutes and laboratories in Bangalore. Two of three surveyed domestic hardware manufacturers point that these laboratories and institutes provided ideas for new products. Among the surveyed domestic software firms, only 6 out of 15 think that professional association with laboratories led to a new product. Small firms (under 50 employees) seem to have received most of the advice on new products from the research laboratories and institutes. Four out of seven firms employing less than 50 employees have stated that they received ideas on developing new products from the research laboratories in Bangalore. Compared to this in firms with employees range of between 51 and 500, only two of the eleven surveyed firms received any new ideas for product development from the research laboratories in Bangalore. Therefore it appears that the interaction with the research laboratories is strong among the smaller surveyed domestic IT firms.

8.3.5 GOVERNMENTAL ASSISTANCE

While discussing the locational aspects of the firm, the firms were asked the importance of the government support in attracting the firms to Bangalore. This section will assess the overall importance of the government policies (both federal and state) as perceived by the surveyed domestic firms in Bangalore. The first question was addressed towards the overall liberalisation policy that has been shaping the Indian economy since 1991. Almost all the surveyed domestic firms (except one), agreed that there has been a positive change in government policies towards the IT industry in general, and more specifically towards the software industry (Table 8.27).

Table 8.27 Domestic firms: Reactions about government policies towards IT industry

	Has there been a positive change[1] in Govt. policies since 1991?	
	Count	%
No	1	5.0%
Yes	19	95.0%
Total	20	100.0%

[1] This is a loaded question, rather than a neutral one. Instead of asking "has there been a change in government policies", it seeks to ask if there have been any positive change.

Source: Field Survey, 1995

Table 8.28 Domestic firms : Importance of various government policies-special concessions and ease of doing business

	A		B	
	Importance of Special Concessions		Ease of Doing Business[1]	
	Count	%	Count	%
Important	17	85.0%	20	100.0%
fairly Important	2	10.0%		
Not Important	1	5.0%		
Total	20	100.0%	20	100.0%

[1] Although this is not a direct government policy, yet the ease of doing business is largely a product of government policies, that enables firms to conduct their business with ease

Source: Field Survey, 1995

Following the general opinion on government policies, the firms were asked to specifically highlight the importance of various aspects of government policies. These were mainly grouped under: special concession, and ease of doing business, tax incentives, backward area scheme, creation of special location for the IT industry, and industrial support schemes for the IT industry. All these are directed towards the state government, as the state government is vested with powers to decide on all these issues.

Most (85%) of the surveyed domestic firms agree that special concessions that are provided to the industry by the government are important. All but one of the surveyed domestic firm agree that special concessions are important or fairly important (Table 8.28A). All the surveyed domestic firms agree that, with liberalisation of the economy and doing away with many of the earlier rules and regulations[133], the government has incredibly eased the way business can be held. They consider that as a very important aspect of the government policy (Table 8.28B). Many of the surveyed domestic firms refer to the single window clearance system[134] adopted by the Government of Karnataka to provide a one stop need for all the formalities as a highly effective one. Karnataka is by far the only state in India at the moment which has its own independent Foreign Investment Promotion Board (FIPB)[135], which is directly headed by the Chief Minister of the state. Such measures have definitely found appreciation not only from the surveyed domestic firms, but even the foreign firms that have been surveyed.

Table 8.29 Domestic firms : Importance of various government policies-tax relief and backward area scheme

	A		B	
	Importance of Tax Incentive		Importance of Backward area scheme	
	Count	%	Count	%
Important	16	80.0%	4	20.0%
fairly Important	4	20.0%	7	35.0%
Not Important			9	45.0%
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

[133] These were referred to as *Licence Raj*, as any industry that wanted to produce something had to go through a plethora of rules and regulations, and permissions and clearances.

[134] This is one of the popular government jargon that has caught state governments all over India since the 1991 macro economic reforms started. Simply put, it means a one stop location for all the "shopping" needs of an entrepreneur who wants to set up a manufacturing facility in any area. This primarily includes issuing licences, providing water, electricity, and telephone connection, among other things. Among the recent steps taken by the Government of Karnataka to speed up industrial activity is the decentralisation of the single-window agency from state to the lower administrative units (districts) and enhanced powers at the district level to clear small investments, through the District Industries Centre (DIC).

[135] The FIPB exists at the national level, and co-ordinates all the foreign investment proposals that intend to come to the country.

Very high proportions (80%) of the surveyed domestic firms feel that the various tax incentive measures of the government are important (Table 8.29A). Only one fifth of all the surveyed domestic firms feel that the backward areas scheme (of the state government in attracting economic activities to the designated backward areas) in the state (Table 8.29B) as an effective government policy to attract investment. Almost half of the surveyed domestic firms find this scheme less important. Interestingly, half of the surveyed domestic firms that set up between 1986-90, viewed the backward area scheme to be important. It may be noted that it was around the same time that trend of investment into the IT sector began, and the state government had launched this scheme to attract investment into these areas.

Table 8.30 Domestic firms : Importance of various government policies-special locations and industrial support schemes

	A		B	
	Creation of Special Location		Industrial Support Schemes	
	Count	%	Count	%
Important	16	80.0%	12	60.0%
fairly Important	4	20.0%	8	40.0%
Not Important				
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

The surveyed domestic firms do consider creation of special locations (like the Electronics City) as an important aspect, for promoting a particular industry (Table 8.30A). However, the problems confronting the Electronics City were well described in the last chapter. While the firms in general are appreciative of these efforts in special locations, they do not consider that as an important locational determinant (see Table 8.20). The surveyed domestic firms also find the industrial support scheme in general as important (Table 8.30B).

8.3.6 INFRASTRUCTURE FOR THE IT INDUSTRY

The review of literature (Chapter 2) made it clear that one of the governing principles of urban competitiveness is a strong infrastructure base in the city. This assumes even greater significance, when the infrastructure for the IT industry is in question, as the requirements of IT industry are quite distinct to the requirements of general industries. Keeping that in mind, the research proceeded to ask the IT firms in Bangalore certain aspects of infrastructure that have direct relevance and applicability to the IT industry. The firms were not only asked to rank the importance of various infrastructure services relevant to the industry, but they were also asked to rank each one of them.

- **Importance of urban infrastructure to the domestic IT industry in Bangalore**

Table 8.31 Domestic firms: Importance of urban infrastructure in Bangalore-power supply and data communication link

	A		B	
	Uninterrupted Power Supply		High Speed Communication Link	
	Count	%	Count	%
Important	19	95.0%	20	100.0%
fairly Important	1	5.0%		
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

Almost all the surveyed IT firms consider availability of uninterrupted power supply (*ups*) and high speed data communication (*hsd*) link as a very important aspect of urban infrastructure. These IT firms need uninterrupted power and data communication links. As pointed out Chapter 4 and 5, many of the IT firms in Bangalore work for their off-shore clients be it a routine "remote" maintenance or more advanced product development work. For this they have to be in constant touch with their overseas clients. Therefore, it is not surprising that the firms attach significance importance to these two factors of infrastructure (Table 8.31 A and B).

Even in 1995 (when the survey was conducted), land cost in Bangalore was considered fairly important by the surveyed domestic firms notwithstanding the fact that land and property prices have increased many folds in recent years (as illustrated in the last chapter) in the city. With the rapid urbanisation and industrial development, availability of space for further expansion is considered crucial by the surveyed domestic firms (Table 8.32 A & B).

Table 8.32 Domestic firms : Other important aspects of urban infrastructure in Bangalore-land cost and space availability

	A		B	
	Land Cost		Space Availability	
	Count	%	Count	%
Important	2	10.0%	11	55.0%
fairly Important	14	70.0%	4	20.0%
not Important	4	20.0%	5	25.0%
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

Many of the surveyed domestic IT firms depend on a network of firms to carry out tests of various levels for different products (Table 8.33). A particular software company may send its *Beta* Version[136] on test to some firms, and in another case, a hardware manufacturer may want to test its product independent of its R&D department. Most of the firms agree that having such firms within Bangalore has been indeed extremely useful, as it provides for an interaction with these firms on a regular basis, and the relationship is more personal, rather than purely a commercial one[137]. Such networks (as described in chapter 2) in the regional economy help the firms to adopt and change more quickly based on the needs and the requirements of the market, than those that operate in a less interactive region (Saxenian, 1996; The Economist, 1997-a).

Table 8.33 Domestic firms: Importance of test facilities and availability of network of firms

	Test Facility and network of firms	
	Count	%
Important	19	95.0%
fairly Important	1	5.0%
Total	20	100.0%

Source: Field Survey, 1995

[136] Usually the software companies put their product in two versions. The *alpha* version is largely to obtain feedback from in-house, after which it is put on a *beta* version and send out to potential clients, partners, or test centres to obtain their feedback. Many companies are now using the Internet to put up the *beta* version.

[137] The IT industry all over the world thrives on such regular interactions and exchange of ideas, which are often very beneficial to the firms engaged in such a relationship. Various studies have highlighted the benefits of such interaction. For examples from Silicon Valley see Saxenian (1996),and on engineering firms in Bangalore see Holmström (1994).

- **Ranking of urban infrastructure important to the domestic IT industry in Bangalore**

Having established the importance of various infrastructure facilities in Bangalore, all the surveyed firms were asked to rank each of the elements of infrastructure. Firstly, they were asked about the overall infrastructure level in the city, following which questions specific to each of the infrastructure elements were addressed.

Table 8.34: Domestic firms: Response on infrastructure adequacy[1] in Bangalore

	Is Bangalore's existing infrastructure adequate to support further growth of the IT Industry?	
	Count	%
no	11	55.0%
Yes	9	45.0%
Total	20	100.0%

Source: Field Survey, 1995

[1] While executing this question, the order in which the question was asked was rotated to avoid any kind of "order bias" that could distort the results. Many more questions were subjected to such rotation, as explained in the methodology chapter.

Table 8.34 clearly highlights the level of satisfaction expressed by the surveyed domestic firms on the existing level of overall infrastructure services provided in the city. More than half (55%) of the surveyed domestic IT firms feel that Bangalore's current level of infrastructure availability cannot support further growth of the IT industry, unless immediate steps are taken to improve the infrastructure provision in the city.

Table 8.35 Domestic firms: Ranking of infrastructure crucial to the IT Industry in Bangalore

	High Speed data link		Uninterrupted Power Supply	
	Count	%	Count	%
good	19	95.0%		
fair	1	5.0%	3	15.0%
poor			17	85.0%
Total	20	100.0%	20	100.0%

Source: Field Survey, 1995

Since the focus of the research is the IT industry, further satisfaction level of certain crucial infrastructure elements were also gathered. Firms were asked to rank the availability of the crucial infrastructure segments into good, fair, and poor.

High speed data (*hsd*) link, and uninterrupted power supply reflect the two contrasting images of Bangalore[138], one which reflects Bangalore as a premier centre for high technology industry, and another which threatens to undermine that very status. The surveyed firms are not the only ones that acknowledge the fact that Bangalore (and Karnataka in general) has better telecommunications infrastructure compared to other Indian states. Even other international studies have reflected similar views[139] on Bangalore.

Obviously when almost all the surveyed domestic firms agree that the city has good telecommunications infrastructure, they are not referring some thing that is unique. It is something that their developed country counterparts would take for granted and will not even question. This assumes greater significance when seen in the context of international competitiveness of Bangalore in the IT industry. It also means that an enormous amount work needs to be done on consolidating the existing telecommunications infrastructure in the city. Unfortunately not many things are in the city or state government's hands. The issue of Internet will make it simpler to explain. India still has a monopoly organisation[140] that provides Internet services.

[138] *The Economist* (1994) while writing on Bangalore stated that the software firms in the city work on 21st Century things in an environment that's not even 20th Century, and the above table makes it very clear that the article was not exaggerating.

[139] For Example see World Bank (1992)

[140] Videsh Sanchar Nigam Limited (VSNL)-a government firm has the monopoly on providing Internet services in the country. Despite strong protests and criticisms by the industry and by the very strong and highly critical media in India, things have not changed. Between February and July 1997, the VSNL had stopped issuing any new connections, as it was unable to cope up with the increasing demand. It is understandable that system problems, and delays are something that has been common all over the world, and even the largest software company in the world has not escaped from it. The Microsoft Network (or the MSN), had to shut off its entire global e mail facility for four days (from April, 17th to 20th, 1997), as its network could not cope up with load. While there is a debate that even the Internet links should become a completely reliable system like the power, telephone (again only in the developed world!) system, such problems can be tolerated to an extent. Definitely the services offered by VSNL, and its reliability are far from being of global standard, and unless impediments to further growth of the Internet are removed in India, it may loose out on many foreign investment. With the global financial interactions being dependent on electronic medium so strongly (and with buzz words like E-commerce, and E-banking and E-trading becoming common terms world-wide), any country that does not meet up sufficiently to the needs of the global investor in terms of connectivity will surely fall out of potential investment in any sector. However, on September 16, 1997 the Indian federal government announced the "Internet Policy", which would allow private Internet service

Being a government monopoly it is not very efficiently run (as many of the services that are usually provided by different agencies in the US for example, are often bundled together in India), and that is hindering the further growth of not only the Internet service in India, but also has implications for other sectors of the economy.

The importance of working with a network of firms in the context of the IT industry has been well referred to in Chapter 2, and reference has been made to it earlier in this chapter as well. The responses of the surveyed domestic IT companies reflect that they are satisfied by the test facilities being offered in Bangalore, be it by private firms or government organisations/ institutes (Table 8.36). It is certainly clear that given the better level of telecommunications infrastructure in the state, combined with the availability of high technology professionals, research institutes and test facilities, Bangalore does offer a very competitive location to house the IT industry.

Table 8.36 Domestic firms: Ranking of test facilities and availability of network of firms in Bangalore

	Test facility & availability of network of firms	
	Count	%
good	19	95.0%
fair	1	5.0%
Total	20	100.0%

Source: Field Survey, 1995

It may be the earnest hope of many IT firms that IT firms would continue to make a beeline to Bangalore given the city's certain distinct advantages. Unless there is further scope for expansion and land price makes it a sound business proposition, Bangalore may already be turning away investment into the IT sector, for it needs to be noted that when excessively high land prices can actually *drive* business out[141] of Delhi and Bombay, it can do the same thing to Bangalore as well.

providers (ISPs) to operate in the country, ending the monopoly of VSNL. More details are awaited as to when that policy will *actually* come into force.

[141] The research study referred to in Appendix 12 notes that one of strongest reasons for firms wishing to establish themselves in Bangalore, is due to excessively high prices of property and rents both in Bombay and Delhi.

Table 8.37 Domestic firms: Ranking of space availability in Bangalore

	Space Availability in Bangalore for further expansion	
	Count	%
good	7	35.0%
fair	9	45.0%
poor	4	20.0%
Total	20	100.0%

Source: Field Survey, 1995

Over one-third of the surveyed domestic IT firms ranked space availability for further expansion in Bangalore as good (Table 8.37). Another 45 percent ranked it as fair. So overall, it can be concluded that 80 percent of the surveyed domestic firms do think that the city can still offer space for further expansion. Obviously there is a cost associated in acquiring more land, and it will be worthwhile to note how many of the surveyed domestic IT firms would be willing to spend more on that. As a proxy to that question, the firms were asked to rank the land prices (as of 1995) in Bangalore (Table 8.38).

Table 8.38 Domestic firms : Ranking of land prices in Bangalore

	Land Prices in Bangalore 1995	
	Count	%
low	6	30.0%
affordable	7	35.0%
very high	7	35.0%
Total	20	100.0%

Source: Field Survey, 1995

The surveyed domestic firms were largely divided on the issue of land prices in Bangalore. While just one-third of the surveyed domestic firms perceive land prices in Bangalore as low, another one-third feel it is affordable, and yet another one-third note that it is very high. None of the firms that started operations prior to 1986 view land prices in Bangalore as low. There are no apparent differences on issue of land prices among the surveyed domestic IT firms on the basis of employment, year of startup or product category.

8.3.7 PROBLEMS

In the final part of the investigation, the firms were asked to comment on the current problems faced by them, and on the future of the city as a premier centre for IT industry in the country. The firms were also asked to support their answers with reasons.

Table 8.39 Domestic firms: Will Bangalore be attractive to the IT industry in future?

	Will Bangalore still be the most favourable location for IT Industry in India in the Future[1]	
	Count	%
No	2	10.0%
Yes	18	90.0%
Total	20	100.0%

[1] This was a difficult issue to tackle. Given so much uncertainty in the Indian politics, and rapidly changing IT industry, this question was asked to the firms with a perspective of 2-3 years, and certainly not beyond 5 years. **While Table 8.23 probed the current (1995) condition of Bangalore, this table is different in that, it seeks to probe the future attractiveness of Bangalore to the IT industry in India.**

Source: Field Survey, 1995

Almost all the surveyed domestic firms (90%) agree that Bangalore would continue to be the most favourable location for the IT industry in India. It is almost similar to the responses of all the surveyed firms, 85 percent of whom feel that the city would continue to excel in the industry in the near future than other cities in India.

Table 8.39 needs to be carefully interpreted in the light of discussions that have been held in this and the previous chapter, as responses like these will play a pivotal role in actually determining the competitiveness of the city. If seen in isolation Table 8.39 does speak a lot in favour of Bangalore. A bivariate analysis (using SPSS Crosstabs) of infrastructure adequacy (*infadequ*) with future of Bangalore (*bangfutr*) reveals that, nine out of eleven firms that rate city's infrastructure as poor, also state that the city will continue to be the dominant centre for IT industry in the country. The infrastructure problems confronting the city have been well demonstrated earlier, hence, responses that emerge from Table 8.39 needs careful interpretation. It is obvious that the city's infrastructure is under severe stress, and so it certainly cannot maintain its pre eminent role for a long time. It also needs to be noted that Table 8.39

is constructed out of opinion (albeit extremely vital), and opinions do change from time to time. Hence one needs to take an objective stand on these responses on the issue of Bangalore's future as a premier centre for high technology industry in the country.

The surveyed domestic firms were further asked to qualify their answer, by providing supportive ideas to their answer on the future of Bangalore being a premier centre for IT industry in India. Table 8.40 lists the **foremost** reasons put forth by surveyed domestic firms to support their answer on the future of Bangalore. The reasons in favour include *Bangalore is a traditionally strong centre for high technology* (40%); *Despite all problems Bangalore is more attractive than other cities in India* (30%); and *Better telecommunications infrastructure* (15%). One of the entrepreneurs suggested that similar to the dominance of Silicon Valley (in the US), despite the existence of many other centres like Route 128, and Austin in Texas, Bangalore would also continue to excel despite competition from other cities in India (especially Madras, Hyderabad and Pune). The entrepreneur however does not realise that in the US, the IT firms are not compelled to go to Silicon Valley due to absence of other options. It is the advantage of being in the Silicon Valley that attracts them to that part of the US, rather than a choice of best among the worst, as in the case of India, and Bangalore. However, 10 percent firms opine that Bangalore's future is uncertain as a pre eminent centre for IT industry, as IT firms are moving out[142] of Bangalore.

[142] BPL Electronics and Infosys Technologies, both have decided to start their new expansions away from Bangalore in Pune.

Table 8.40 **Domestic firms: Statements in support of answer on the future of Bangalore (most important reason)**

	Positive		Negative	
Reasons	**Number**	**% to the total surveyed domestic firms**	**Number**	**% to the total surveyed domestic firms**
• Some IT firms already moving out of Bangalore			2	10
• It is a traditional stronghold, & would continue	8	40		
• Despite all problems it still attracts more IT firms than any other Indian city	6	30		
• Telecommunications infrastructure best in the country-& is essential	3	15		
• Government projecting it as the "Silicon Valley" & IT industry is supported	1	5		

Source: Field Survey, 1995

Table 8.41 **Domestic firms: Statements in support of answer on the future of Bangalore (other important reasons)**

	Positive		Negative	
Reasons	**Number**	**% to the total surveyed domestic firms**	**Number**	**% to the total surveyed domestic firms**
• Bangalore faces severe power supply shortage			1	5
• Limited scope for future expansion			1	
• It is a traditional stronghold, & would continue	3	15		
• Telecommunications infrastructure best in the country-& is essential	8	40		
• Government projecting it as the "Silicon Valley" & IT industry is supported	5	25		
• Despite all problems it still attracts more IT firms than any other Indian city	2	10		

Source: Field Survey, 1995

Other important reasons (second best reason), *include better telecommunications infrastructure in the city* (40%), *support offered to the IT industry by the state government* (25%) (Table 8.41). Among the third important reason in support of the answer to the question on Bangalore's future, state government's supportive role finds a dominant place (40%), followed by better telecommunications facilities in the city (35%).

The question on Bangalore's future leads to the last important issue to understand any hindrance to Bangalore's competitive position in the IT industry in India. The firms were asked to list the major problems that confront them as result of being in Bangalore. The answers provided by the firms do not come as a surprise, as it is more or less reflection of the problems already discussed earlier in the analysis.

Table 8.42 Domestic firms: Problems confronting the IT industry in Bangalore

Factors	Problems of being in Bangalore (% of responding firms)		
	Most Serious →		Less Serious
Severe Power Crisis	**60**	*25*	10
Very high turnover of IT Professionals	*25*	10	**35**
Absence of International Airport	15	10	5
Congestion & Pollution	-	**45**	20
Limited Scope for further expansion	-	10	*30*
Total	100 %	100 %	100 %

Source: Field Survey, 1995

Power supply appears as any entrepreneur's worst nightmare in Bangalore. This is despite the fact that the IT industry is not a big consumer of power, still most of the surveyed domestic firms agree that they cannot expect their professionals or their families to lead a *dark life* outside the firm. Almost all the firms agree that IT professionals all over the world are very mobile, and only the finest infrastructure in the firm and high quality of life outside the firm can lure professionals to a particular location. That is probably the reason that a quarter of the surveyed domestic firms are very concerned with a very high turnover of IT professionals in Bangalore. Among other problems cited by the surveyed domestic firms include: increasing pollution level and congestion, limited scope for further expansion, and an absence of an international airport[143].

Having discussed the response of the surveyed domestic firms in detail, the next chapter discusses in detail the responses of the foreign firms and the joint ventures firms to understand the difference of perceptions expressed by these firms on various aspects of the IT industry and on Bangalore's competitiveness. That will be followed by a chapter on comparative analysis of responses between the domestic and foreign and joint venture firms.

[143] The International Airport is under construction (at Devanahalli near Bangalore), and knowing well how these kind of projects are executed in India, the Airport has to be made operational as quickly as possible. As of 1997, the Airport is scheduled to be operational by 1999, but only time will tell when the International Airport in Bangalore becomes a reality!

9 UNDERSTANDING THE COMPETITIVENESS OF BANGALORE IN INDIA: EVIDENCE FROM NON-DOMESTIC FIRMS

9.1 INTRODUCTION

The previous chapter discussed in detail the views expressed by the surveyed domestic IT firms in Bangalore. The purpose of this chapter is to provide a detailed analysis of the views expressed by the non-domestic case study firms in Bangalore. The foreign and joint venture (henceforth referred to as F-JV firms) firms together account for over 60 percent of the total surveyed firms in Bangalore, with both segments accounting for 16 firms each of the total of 52 firms surveyed.

9.2 GENERAL CHARACTERISTICS

Over 80 percent of the surveyed F-JV are from the software and services only category[144], with foreign firms accounting for 14 and joint venture ones for 13 firms. Most of the IT segment (3 out of 4) belong to the joint venture category. The three collaborating joint ventures in the IT segment are Wipro-Acer, Tata-IBM, and Tata-Elxsi (Table 9.1).

[144] For the different categories used in the study, and their definitions see section 8.2 and the methodology chapter

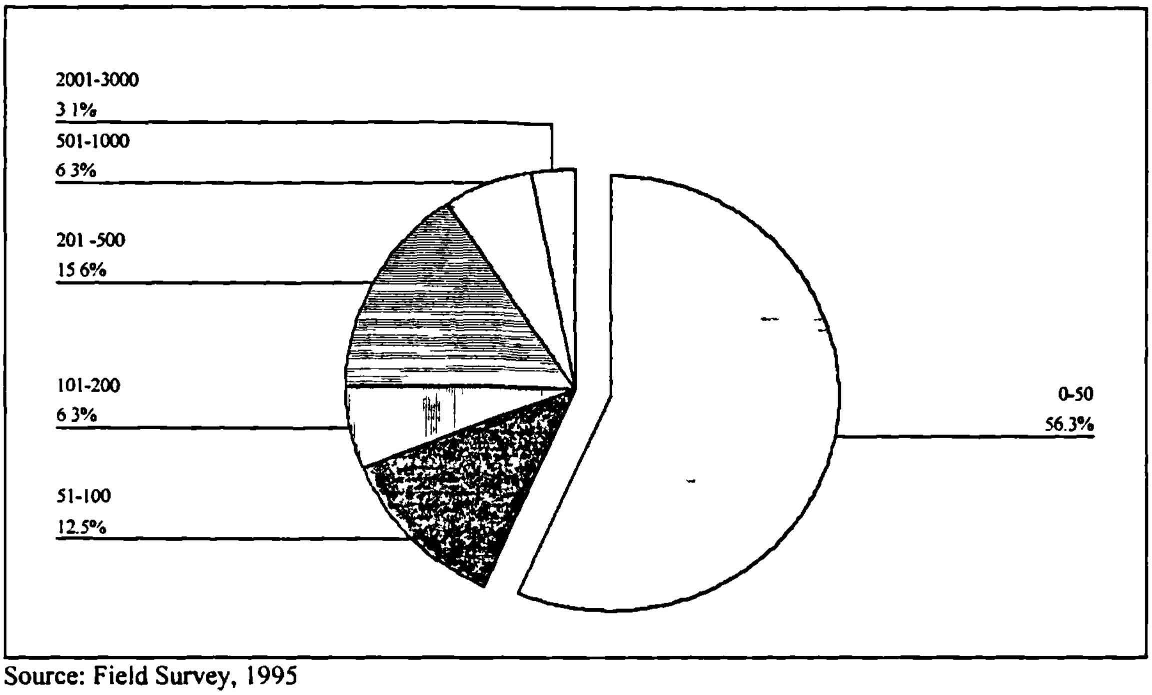
Table 9.1 F- JV firms: Ownership and category

Category of Firm	Ownership Status		
	Joint Venture	Foreign Owned	Total
Information Technology [1]	3	1	1
Software & Services only	13	14	14
Peripherals	-	1	1
Total	16	16	16

Source: Field Survey, 1995
[1] Includes firms doing business in hardware, software, and system integration

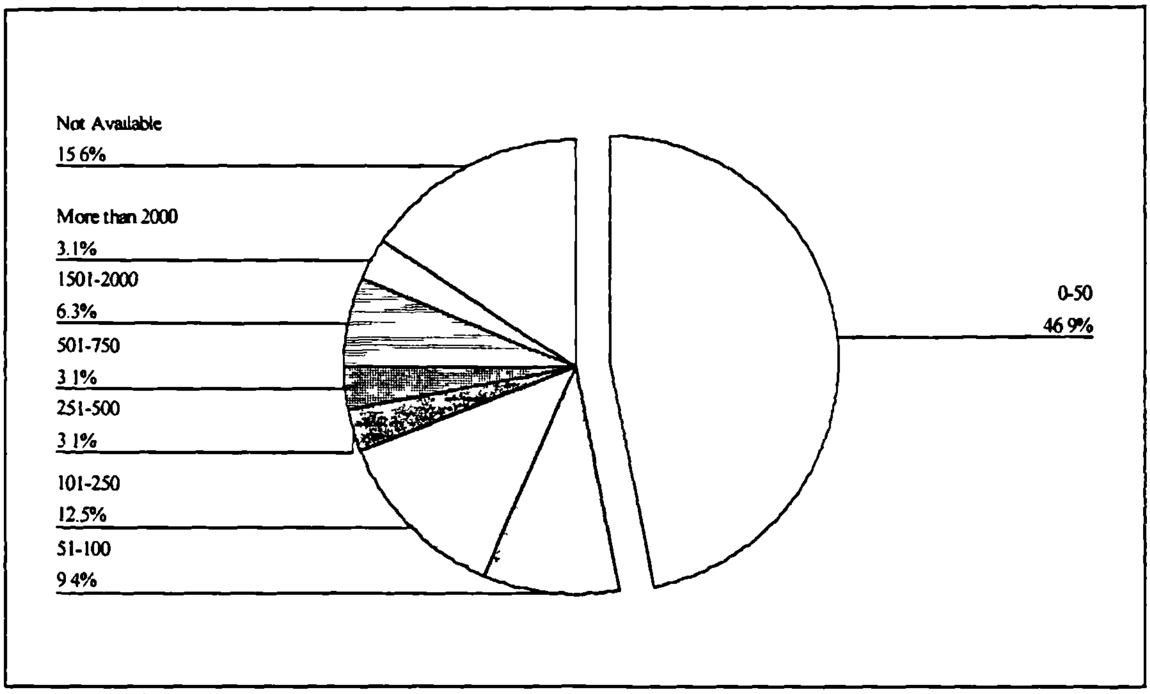
An analysis of the surveyed F-JV Firms by the year of start-up reflects that over 80 percent of the firms began their operations after 1985. Texas Instruments was the first fully foreign owned IT Firm to begin operations in Bangalore in 1985, and soon other firms followed suit. More than half of the surveyed F-JV firms have less than 50 professionals. The next big group is 200-500 employees (15.6%), followed by 51-100 range (12. 5%), as seen from Figure 9.1.

Fig. 9.1 F-JV firms: Employment size, 1995



Source: Field Survey, 1995

Fig. 9.2 F-JV firms : Turnover range (Rs. Million), 1995 Prices



Source: Field Survey

Almost half of the surveyed F-JV firms have an annual turnover of under Rs. 50 million, and another 12.5 percent firms reported a turnover of between Rs. 101-250 Million (Fig. 9.2).

The Pearson's correlation test (Table 9.2) for relationship between the employment size of the firms to that of annual turnover reveals that, among the F-JV firms, the significance is highest among all the surveyed firms (be it the total number of surveyed firms, or the domestic ones only). The R^2 (.95) for the F-JV firms is slightly higher than the R^2 of all the surveyed firms (.92), and significantly higher than the R^2 for the surveyed domestic firms (.56). The R^2 of the joint venture only firms is even higher than the F-JV firms at .97. Thus it is clearly established that the F-JV firms have the highest likelihood that higher the employment, higher will be the turnover of the firms, when compared to the surveyed domestic firms.

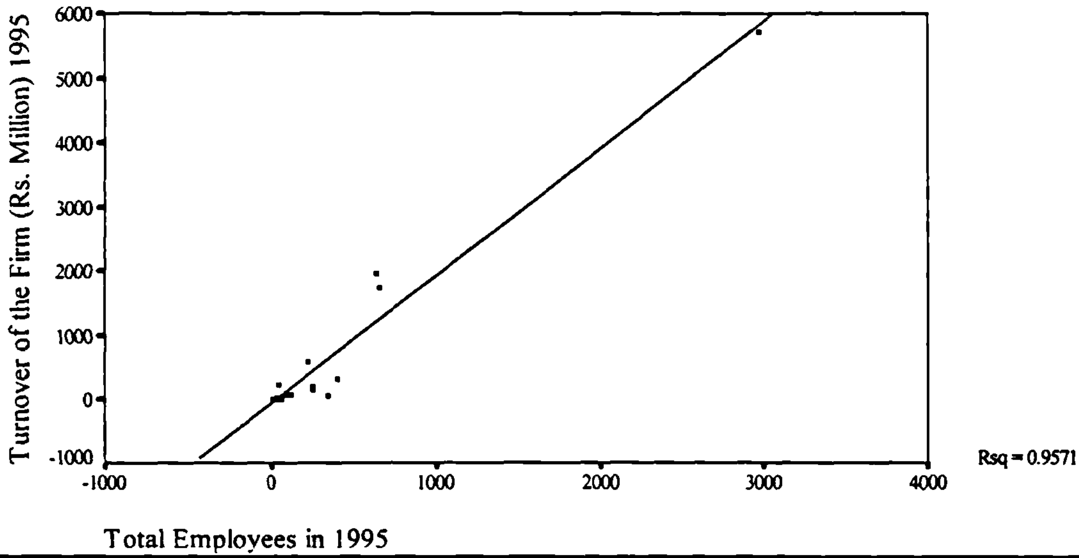
Table 9.2 F-JV firms: Relationship between total number of employees and annual turnover, 1995

- - Pearson Correlation Coefficients - -

	EMPLOY95	TURNOVER
EMPLOY95	1.0000	.9783
	(32)	(32)
	P= .	P= .000
TURNOVER	.9783	1.0000
	(32)	(32)
	P= .000	P= .

Bangalore: Relationship between Employment and Turnover (1995)

Surveyed F-JV Firms only



Only 16 of the surveyed 32 F-JV firms existed in 1991. In 1991, they cumulatively employed 3815 persons, with an arithmetic mean of 238 persons per firm, and a median value of 45 persons. In 1995, the surveyed 32 F-JV firms employed 6656 persons, with an arithmetic mean of 208 persons per firm, and a median value of 40 persons per firm. The combined turnover of these surveyed 32 F-JV firms was Rs. 113.78 Billion (1995 prices), with an arithmetic mean average of Rs. 421.4 million per firm, and a median value of Rs. 20.86 million. The arithmetic mean of average turnover per employee (TOE) for these firms by 1995 prices was Rs. 968,000 with a median value of Rs. 469,000. Thus the F-JV firms have a higher TOE than compared to the surveyed domestic IT firms (whose arithmetic mean TOE is Rs. 735,000 and a median value of Rs. 418,000).

9.3 PRODUCTION PROFILE

All the F-JV firms have their own R&D set up. They do consider that technology received from research institutes and laboratories is important. However, it may be that they may be referring to the laboratories and institutes in their parent country rather than exclusively to Bangalore. Only few of the surveyed F-JV firms actually acknowledged that technology received from institutes and laboratories *in Bangalore* is of importance to them.

Almost all the firms perceive that R&D is a potential source of competitiveness (Table 9.3A). It is necessary to note that many of the surveyed firms in this category are leaders in the global IT industry, and have proprietary system architecture or software, which is why all of them feel R&D is such an important source of competitiveness. One-third of the surveyed F-JV firms feel production capacity (*in their Bangalore base*) is a source of competitiveness. Again it needs to be borne in mind that they are referring to the Indian market, and specifically to Bangalore, when answering these questions, and this is not purported to reflect their view on global operations (Table 9.3 B).

Table 9.3 F-JV firms: Various factors of competitiveness-R&D and production capacity

	A		B	
	R&D as a source of competitiveness		Production Capacity as a potential source of competitiveness to your firm	
	Count	%	Count	%
Important	31	96.9%	10	31.3%
fairly Important	1	3.1%	14	43.8%
Not Important			8	25.0%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

A little over quarter of the surveyed F-JV firms feel that investment capacity is an important source of competitiveness (Table 9.4). Most of these are very big firms and have operations in many more countries, and as such mobilising finance (unlike many of the surveyed domestic firms) is not a big problem for them.

Table 9.4 F-JV firms: Various factors of competitiveness-Investment capacity

	Investment Capacity	
	Count	%
Important	9	28.1%
Fairly Important	10	31.3%
Not Important	13	40.6%
Total	32	100.0%

Source: Field Survey, 1995

More than two-third of the surveyed F-JV firms feel that selling in the domestic market in India is an important aspect of their operation. Many of these firms contend that the domestic market in India is fragmented, and as these firms have had experience of global operations, they argue, they will be able to capture sizeable share of the market. In fact, the proportion of the surveyed F-JV firms who consider selling in domestic market as a source of competitiveness is greater than the ones that feel selling in overseas market as an important aspect of their operations (Table 9.5 A&B).

Table 9.5 F-JV firms: Selling in domestic and overseas market

	A		B	
	Selling in Domestic market		Selling in Overseas market	
	Count	%	Count	%
Important	22	68.8%	20	62.5%
fairly important	7	21.9%	6	18.8%
Not Important	3	9.4%	6	18.8%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

9.4 FIRMS WITH JOINT - VENTURE (JV) ONLY

As already mentioned, 16 of the total of 52 surveyed firms have foreign collaboration. These firms are in only two category, the IT category, and the software and services only group, with 3 and 13 firms respectively. In this subsection, the details of collaboration, and the perceived advantages of the joint venture expressed by the firms will be discussed.

The research also has tried to understand the reasons for global interest in the Indian computing skills in general, and particularly the software skills, and that spirit of inquiry led to ascertain certain basic facts about the kind of joint ventures found in Bangalore. Almost two-third of the collaboration materialised due to joint effort by the local as well as the efforts of the foreign firm, and in under one-third of the cases, it was initiated by the foreign firm, which was looking for a partner to operate in India (Table 9.6)

Table 9.6 Joint-Venture firms: Source of collaborative ideas

	Who came up with the idea of establishing this collaboration?	
	Count	%
foreign firm	5	31.3%
your firm	1	6.3%
jointly	10	62.5%
Total	16	100.0%

Source: Field Survey, 1995

In more than half the case of the surveyed joint venture firms, it was experienced that the foreign partner, had negotiated the collaborative arrangement with another firm (not necessarily in Bangalore), before finalising the existing arrangement (Table 9.7).

Table 9.7 Joint-Venture firms: Collaborative negotiations

	Did the collaborator negotiated with anyone else before selecting you	
	Count	%
no	7	43.8%
yes	9	56.3%
Total	16	100.0%

Source: Field Survey, 1995

Work on similar applications (37.5%), and mutual agreement (31.5%) are the two most strongest reasons for explaining the successful formulation of the joint venture among the surveyed firms. Strong professional skills in the domestic partner (37.5%) was cited as the second most important reason, and apart from already mentioned reasons, brand name/market image of the foreign firm was also one of the considerations (18.5%). Two firms state that since they were already in Bangalore, it was a crucial factor for the successful initiation of the joint venture (Table 9.8).

Table 9.8 Joint-Venture firms : Reasons for collaboration

Factors	Reasons cited for Joint Ventures (% to total Surveyed JV Firms)		
	Most Important →		Least Important
Work on Similar applications	**37.5**	31.3	6.3
Mutual Agreement	31.3	18.8	**37.5**
We are in Bangalore	12.5	0	6.3
Brand Name / Image	12.5	12.5	18.8
Strong Professional skills	6.3	**37.5**	31.3

Source: Field Survey, 1995

The surveyed joint venture firms were also asked to rank the aspect of competitiveness on various aspects in relation to the domestic firms in Bangalore, and to identify their strengths and weaknesses (Table 9.9).

Table 9.9 Joint-Venture firms: Aspects of comparative advantage over domestic firms

Aspect of Comparative Advantage over Domestic Firms	% of Surveyed Firms Stating		
	Yes	No	Not Applicable
• Product Design	100	0	0
• R&D	100	0	0
• After Sales Services	100	0	0
• Target Group	75	25	0
• Image	62.5	37.5	0
• Cost of the Product	50	50	0
• Market Testing	6.3	62.5	31.3

Source: Field Survey, 1995

All the joint venture firms are very confident that they enjoy absolute comparative advantage over the domestic firms on the issue of product design and R&D. This is not surprising, as many of the parent companies of these joint ventures in Bangalore have many years of experience in product design, and R&D. For example, Novell, a major global software company, is investing into its Bangalore facility 5 percent of its entire global R&D expenditure on the UNIX operating system. With such high scale of operations. and R&D budget, these joint venture firms do definitely enjoy comparative advantage over domestic firms on issues related to product design and R&D. The surveyed joint venture firms contend that many of the domestic firms have lower operating costs, and are able to tap the smaller network of IT firms operating in Bangalore quite successfully. They also emphasise that in most of the cases they outsource the testing to other (domestic) firms in Bangalore, as that (according to them) is more economical than doing it themselves.

More than two-third surveyed JV firms feel that using parent company's brand name/image helps them in attracting more clients than the domestic IT companies in Bangalore. However, another one-third do not think that is a very competitive aspect for them. They argue that some very respected IT companies (not only in India, but overseas as well), have an equally competitive edge on using brand name and image. Many of the surveyed JV firms own patents and have proprietary system and higher overheads, and that results in higher market price of the product, which according to the surveyed JV firms, can be avoided by the domestic IT firms. They contest that by keeping the overheads low, many of the domestic firms are able to have a competitive edge over foreign and collaborative brands as far as the price of the product is concerned. Nevertheless, that handicap according to the surveyed JV firms is overcome by the target group of clients. Three-fourths of the surveyed JV firms opine that they have a clear advantage over the domestic firms in attracting a distinctive clientele that cannot be achieved easily by the domestic firms or those based on low prices of the product alone (Table 9.9).

The advantages of being in a joint collaboration has been well expressed by the surveyed firms, yet, the researcher wanted to establish the single most advantage of being in the joint venture. Half of the surveyed JV firms agree that JV arrangement has improved their image in the domestic market- which according to them is very significant. They state that the IT industry's domestic segment in India is burgeoning and by improving their brand image as a result of the joint venture, they will have distinct *first mover* advantage[145]. More than a third of the surveyed JV firms also note that the JV arrangement has helped them to penetrate into the overseas market.

[145] An economist's conception of the first-mover advantage held by incumbent firms is usually contained within the micro-economic theory of strategic behaviour and market structure. Of particular interest is how first mover advantages can be used by incumbents to deter entry by potential market entrants. Typically, incumbent firms resort to particular pricing (or output) strategies, capital investment strategies, or strategic timing of lumpy investments in order to deter entry by potential competitors.

9.5 LOCATIONAL ASPECTS

This subsection of the chapter on F-JV firms will seek to determine the reasons for these firms to be in India in the first place, and the reasons for choosing Bangalore.

Table 9.10 F-JV firms: Most important reason for choosing India

Most Important reason for Choosing India	Count	%
Reliability and Quality	13	40.6%
Reliability + High Skills + English Speaking	9	28.1%
High Quality skills	4	12.5%
Cheap Labour + High Skills	4	12.5%
Cheap Labour + English Speaking + High Skills	1	3.1%
Cheap Labour alone	1	3.1%
Total	32	100.0%

Source: Field Survey, 1995

High quality skills, and reliability combined with English speaking ability of the Indian IT professionals appears to be the underlying factor for all the surveyed F-JV firms in choosing India. Reliability and quality of Indian professionals itself account for 40 percent of the reasons given by the surveyed F-JV firms in choosing India. When English speaking ability is added to that, it explains 68 percent of all the reasons for choosing India (Table 9.10).

The issue of why any global IT firm should be interested in India, throws open two interesting issues. One reason has to do with the cost and quality of the Indian IT professionals (43.8% respondents), and the second one is to do with the large untapped domestic market for IT services (43.8% respondents) (Table 9.11).

Table 9.11 F-JV firms: Why should any global IT company be interested in India?

	Why Should be any IT company be interested in India? Count	%
Best of value and quality	14	43.8%
Lower wages compared to competitors	3	9.4%
Hardworking and Reliable	1	3.1%
Large untapped Domestic Market for IT services	14	43.8%
Total	32	100.0%

Source: Field Survey, 1995

It is even more interesting, if the analysis in the above table is further divided on the basis of ownership between the foreign owned firms and joint venture firms. While 62.5 percent of the surveyed foreign owned firms opine that it is *best value and quality of the IT professionals in India*, which attracts IT companies all over the world to look to India. On the other hand, same percentage (62.5%) of the joint venture firms feel the major reason for attraction in India is *the large untapped domestic market for the IT services.* It is very interesting to see how different owners of the same kind of firms react so differently on the issue of why they are at a particular location (Table 9.12).

Table 9.12 F-JV firms: Reasons for being in India based on ownership status

Ownership Status	Reasons Why IT Companies Should be Interested in India				
	Best of value and quality	**Lower wages compared to competitors**	**Hardworking and Reliable**	**Large untapped Domestic Market for IT**	**Total**
Foreign Owned	10 *(62.5%)*	1 *(6.3%)*	1 *(6.3%)*	4 *(25.0%)*	16 *(100.0%)*
Joint Ventures	4 *(25.0%)*	2 *(12.5%)*	0	10 *(62.5%)*	16 *(100.0%)*

Source: Field Survey, 1995

Almost all the foreign and joint venture firms did consider other cities before finalising Bangalore. Almost half of the surveyed foreign and joint venture firms considered Madras as the first option. This is different from the choice expressed by the surveyed domestic firms, which held Bombay and Delhi as their first choices. Delhi and Bombay were the next largest first preference cities, each accounting for

18.8 percent of the responding F-JV firms. Among the second choice, Pune appeared as the most favourite, accounting for 34.4 percent of all second choices followed by Hyderabad, which got 25 % of all the second centre choice. It is interesting to note that, at the present moment, when Bangalore is facing myriad of problems, many of the IT firms are contemplating locating future expansions in Madras, Pune or Hyderabad.

Table 9.13 F-JV firms: Ranking of all Locational Factors in Bangalore

	Already	Cheaper	Climate	Convenience	Elect.City	Govt Supp.	Hitec.Pro	Res.Inst	STP-B	Total
Rank 1	2	2	0	0	0	2	**22**	4	0	32
Rank 2	5	0	1	0	0	7	6	**13**	0	32
Rank 3	5	2	0	1	0	10	1	**13**	0	32
Rank 4	**11**	10	3	0	1	5	0	1	1	32
Rank 5	3	**14**	3	2	0	5	1	1	3	32
Rank 6	3	1	**18**	1	1	2	2	0	4	32
Rank 7	2	1	4	3	10	0	0	0	**12**	32
Rank 8	1	2	2	6	8	1	0	0	**12**	32
Rank 9	0	0	1	**19**	12	0	0	0	0	32
Total	32	32	32	32	32	32	32	32	32	

Note for Abbreviations used in the Table:
Already: Bangalore as an established centre for high technology production
Cheaper: Cheaper cost of living in Bangalore than some other big cities in India
Climate: Favourable physical climate in Bangalore
Convenience: Sheer Convenience as a locational factor
Elect. City: Availability of Electronics City
Govt Supp.: Government Support
Hitec. Pro: Availability of high technology professionals
Res. Inst.: Availability of research institutes in Bangalore
STP-B: Software Technology Park, Bangalore

Source: Field Survey, 1995

As with the surveyed domestic firms in Bangalore, the surveyed F-JV firms in Bangalore opine the availability of high technology professionals in Bangalore as the most important reason for choosing the city. More than two-thirds of the surveyed F-JV firms have given availability of high technology professionals as Rank 1, among all variables. Eighteen percent respondents have given Rank 1 to the availability of research institutes and laboratories in Bangalore (Table 9.13).

The responses given by the firms as ranks were converted into three scales viz., very important, important, and less important. The following tables are based on those scales to illustrate how firms have rated other locational factors in Bangalore. A overwhelming majority of the surveyed F-JV firms feel that availability of high technology professionals and research laboratories and institutes are two very important locational considerations (Table 9.14). 87.5 percent of the surveyed F-JV firms feel availability of high technology professionals as very important. The availability of research laboratories and institutes (93.8% of the responses) appears as an even more crucial determinant in choosing Bangalore (Table 9.15).

Table 9.14 F-JV firms: Importance of locational factors-availability of high technology professionals

	Availability of High Technology Professionals	
	Count	%
Very Important	28	87.5%
Important	3	9.4%
Less Important	1	3.1%
Total	32	100.0%

Source: Field Survey, 1995

Table 9.15 F-JV firms : Importance of locational decisions-availability of research institutes in Bangalore

	Availability of Research Labs/Institutes?	
	Count	%
Very Important	30	93.8%
Important	2	6.3%
Less Important		
Total	32	100.0%

Source: Field Survey, 1995

Over a third of the surveyed F-JV firms opine that since Bangalore was already an important centre for high technology firms, that became a very important locational consideration, and another 53 percent quoted that as an important indicator (Table 9.16). Among the other important factors, 60 percent of the surveyed F-JV find supportive state government policies as a very important locational consideration, and another 37 percent state that as an important consideration (Table 9.17).

Table 9.16 F-JV firms: Importance of locational factors-Bangalore as an established high technology centre

	Bangalore already a centre for High Technology production	
	Count	%
Very Important	12	37.5%
Important	17	53.1%
Less Important	3	9.4%
Total	32	100.0%

Source: Field Survey, 1995

Table 9.17 F-JV firms: Importance of locational factors- government support

	Government Support	
	Count	%
Very Important	19	59.4%
Important	12	37.5%
Less Important	1	3.1%
Total	32	100.0%

Source: Field Survey, 1995

Among the other locational considerations by the F-JV firms, more than three-quarters of the surveyed firms feel cheaper living and property prices in Bangalore compared to other big cities (like Delhi and Bombay) was an important locational consideration (Table 9.18). Another three quarter of the surveyed F-JV firms consider favourable physical climate (at least when they started operations) as an important locational consideration (Table 9.19).

Table 9.18 F-JV firms: Importance of locational factors- cheaper living costs in Bangalore

	Cheaper Living Costs in Bangalore	
	Count	%
Very Important	4	12.5%
Important	25	78.1%
Less Important	3	9.4%
Total	32	100.0%

Source: Field Survey, 1995

Table 9.19 F-JV firms: Importance of locational factors- Climate

	Climate	
	Count	%
Very Important	1	3.1%
Important	24	75.0%
Less Important	7	21.9%
Total	32	100.0%

Source: Field Survey, 1995

Government established infrastructure has literally very little takers among the surveyed F-JV firms in Bangalore. Almost all these surveyed firms find the Electronic City and the Government of India's Software Technology Park (STP) as a less important locational consideration (Table 9.20 and 9.21).

Table 9.20 F-JV firms: Importance of locational factors- The electronic city

	Electronic City	
	Count	%
Important	2	6.3%
Less Important	30	93.8%
Total	52	100.0%

Source: Field Survey, 1995

Table 9.21 F-JV firms: Importance of locational factors- STP, Bangalore

	STP Bangalore	
	Count	%
Important	8	25.0%
Less Important	24	75.0%
Total	32	100.0%

Source: Field Survey, 1995

The response given by F-JV firms to the locational factors reflects that the surveyed F-JV firms have a different kind of behaviour when compared to the domestic firms. However, they have expressed a similar reaction to that of the domestic firms on the issue of Bangalore's future as the premier centre for IT industry in India. More than 80 percent of the surveyed F-JV firms feel that Bangalore would continue its pre-eminence in the IT industry in India (Table 9.22).

Table 9.22 F-JV firms: Opinion on current status of Bangalore

	Do You Think Bangalore is still attractive for IT Industries?	
	Count	%
No	6	18.8%
Yes	26	81.3%
Total	32	100.0%

Source: Field Survey, 1995

Table 9.23 F-JV firms: Supporting statements on Bangalore's current position

Factors	% of Surveyed Foreign and Joint Venture Firms		
	Level of Importance High ⟶ Low		
• Good Infrastructure for the IT industry	34.4	34.4	9.4
• Best city for the IT industry in India	21.9	37.5	21.9
• More IT Firms are Choosing Bangalore than any other centre	21.9	9.4	50.0
• Severe Power Problem in the city	18.8	3.1	0
• Severe pollution, and congestion- limited scope for further expansion	3.1	3.1	12.5
• Other attractive centres exist	0	12.5	6.3

Source: Field Survey, 1995

Among the most important reason to support the fact that Bangalore is still attractive to the IT industry, over a third of the surveyed F-JV firms feel that the city has good infrastructure for the IT industry. More than a fifth of the surveyed F-JV firms state that it is the best city for the IT industry in India, and would continue to be like that. Another fifth argue that even at the present time, more IT firms are choosing Bangalore than any other city in India (Table 9.23).

9.6 CONTACT WITH RESEARCH LABORATORIES AND INSTITUTES

Almost all the surveyed F-JV firms (except one JV firm) have had some form of professional contact with research laboratories or institutes in Bangalore in the past five years preceding the field work or since the beginning of their operations. Most of the firms have acknowledged that the research laboratories and institutes based in Bangalore have advised on R&D related issues. Only 40 percent of the surveyed F-

JV firms note that these institutes provided some ideas that contributed to a new product or improvisation of an existing product (Table 9.24).

Table 9.24 F-JV firms: Contact with research institutes/laboratories in Bangalore

	A		B	
	They Provided R & D Advice		They Provided new Ideas	
	Count	%	Count	%
no	2	6.3%	19	59.4%
yes	30	93.8%	13	40.6%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

Table 9.25 F-JV firms: Contact with research institutes and laboratories in Bangalore- Help in resolving production problem

	They Provided advice on resolving production problem	
	Count	%
no	25	78.1%
yes	7	21.9%
Total	32	100.0%

Source: Field Survey, 1995

The research laboratories and institutes have not interacted much with the surveyed F-JV firms on aspects related to resolving production problems. Only little over a fifth of the surveyed F-JV firms note that the laboratories and institutes provided any advice on production problems (Table 9.25). On further probing, the surveyed F-JV firms state that most of the advice on resolving production problem is usually provided by a well defined staff within the firm in Bangalore or by the staff in the parent group outside India.

9.7 REACTIONS ON GOVERNMENT POLICIES

Almost all the surveyed F-JV firms agree that the policies of the Indian government, and that of the Karnataka government have changed positively to benefit the IT industry in general (Table 9.26).

Table 9.26 F-JV firms: Opinion on government policies-general

	Has there been a positive change in Govt. policies ?	
	Count	%
No	1	3.1%
Yes	31	96.9%
Total	32	100.0%

Source: Field Survey, 1995

Over 60 percent of the surveyed F-JV firms have availed of some form of industrial support scheme extended either by the Government of India or by the state government (Table 9.27). The surveyed joint venture firms have benefited more from government policies than the foreign firms. About 69 percent of the joint venture firms have availed the industrial support schemes compared to 56 percent by the foreign firms.

Table 9.27 F-JV firms: Opinion on government policies- industrial support

	Have you availed of any industrial support scheme	
	Count	%
no	12	37.5%
yes	20	62.5%
Total	32	100.0%

Source: Field Survey, 1995

Similar to the domestic firms, the F-JV firms were also asked to map out the importance of the various aspects of government policies (both the Central and State government). They were asked to rank each of the policies as important; fairly important; not important.

Table 9.28 F-JV firms: Importance of various government policies- ease of doing business and special concessions

	A		B	
	Ease of Doing Business		Special Concessions	
	Count	%	Count	%
Important	32	100.0%	25	78.1%
Fairly Important			6	18.8%
Not Important			1	3.1%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

All the surveyed F-JV firms consider the change in policies of government that has led to ease of doing business in the state as an important aspect (Table 9.28A). Most of the surveyed F-JV firms (78%) consider special concessions given to the IT industry as an important factor for conducting the business (Table 9.28B). Again more number of the joint venture firms (56%) find the special concessions to the IT industry as an important factor than the foreign firms (44%). Most (81.3%) of the surveyed F-JV consider the tax incentives given by the (state or central) government as an important aspect of the government support. The backward areas scheme of the government has very few takers with more than 60 percent of the surveyed F-JV firms considering it as not an important aspect of government support (Table 9.29 A&B). Joint venture firms find the tax incentives marginally more important than the foreign owned firms.

Table 9.29 F-JV firms: Ranking of government policies

	A		B	
	Importance of Tax Incentive		Importance of Backward area scheme	
	Count	%	Count	%
Important	26	81.3%	3	9.4%
fairly Important	6	18.8%	9	28.1%
Not Important			20	62.5%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

About 60 percent of the surveyed F-JV firms find the general industrial support scheme of the state government as an important feature of the government support structure.

9.8 INFRASTRUCTURE FOR THE IT INDUSTRY IN BANGALORE

One of the crucial determinants of urban competitiveness is the level of infrastructure supply in a given urban location. It is vital in a highly competitive industry like IT. It becomes even more significant, if one of the important aspect of competitiveness is to attract foreign investment and that too in the IT sector. Research (as discussed in Chapter 2) studies have demonstrated that an ability to attract FDI (Foreign Direct

Investment) is one of the significant aspect of competitiveness for an urban area. In a competitive environment involving global IT firms that can choose from a number of locations, if a particular location is able to attract a sizeable amount of foreign investment in the IT sector than other urban locations within a country, it is a positive indication for the urban area in question.

When asked the question of whether they think that Bangalore's infrastructure is adequate to support further growth of the IT industry, only about 60 percent of the F-JV firms answered in affirmative (Table 9.30).

Table 9.30 F-JV firms : Response on infrastructure adequacy in Bangalore

	Is Bangalore's infrastructure adequate to support further growth of the IT Industry?	
	Count	%
no	13	40.6%
Yes	19	59.4%
Total	32	100.0%

Source : Field Survey, 1995

However, there are certain elements of infrastructure in Bangalore that seem to have been better ranked by the surveyed F-JV firms than compared to the overall ranking of the infrastructure. The surveyed F-JV firms were first asked to mention the level of importance that they attach to the various segment of the infrastructure available in Bangalore, and later asked to rank all those segments of infrastructure.

Table 9.31 F-JV firms: Importance of urban infrastructure in Bangalore-power supply and data link

	A		B	
	Uninterrupted Power Supply		High Speed Data Link	
	Count	%	Count	%
Important	31	96.9%	30	93.8%
fairly Important	1	3.1%	2	6.3%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

Almost all the surveyed F-JV firms find both uninterrupted power supply (*ups*) and high speed data (*hsd*) link as very important element of urban infrastructure. The ranking of these two segment of infrastructure by the surveyed F-JV firms re-confirms the fact that has been reiterated at different points in the earlier two chapters. The electric power shortage in Bangalore is well illustrated by the fact that over 87 percent of the surveyed F-JV firms find *ups* in an appalling condition. On the other hand, almost a similar number (84.4%), find the *hsd* link very good in Bangalore (Table 9.32).

Table 9.32 F-JV firms: Ranking of infrastructure crucial to the IT Industry in Bangalore- power supply and data link

	A		B	
	Uninterrupted Power Supply		High Speed link	
	Count	%	Count	%
good			27	84.4%
fair	4	12.5%	5	15.6%
poor	28	87.5%		
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

Table 9.33 F-JV firms: Importance and ranking of test facilities and availability of network of firms

	Test Facility and network of firms	
	Count	%
Important	28	87.5%
fairly Important	4	12.5%
Total	32	100.0%

	Test facility & network	
	Count	%
good	30	93.8%
fair	2	6.3%
Total	32	100.0%

Source: Field Survey, 1995

A substantial proportion (87.5%) of the surveyed F-JV firms find that test facilities that exist in Bangalore (both public and private sector) are important, and over 90 percent of them agree that these are good (Table 9.33).

Table 9.34 F-JV firms: Other important aspects of urban infrastructure in Bangalore-land cost and space availability

	A		B	
	Space Availability		Land Cost	
	Count	%	Count	%
Important	16	50.0%	14	43.8%
Fairly Important	13	40.6%	17	53.1%
Not Important	3	9.4%	1	3.1%
Total	32	100.0%	32	100.0%

Source: Field Survey, 1995

On the issue of availability of land and land prices, two vital elements determine the future growth of Bangalore, half of the surveyed F-JV firms consider availability of land for future expansion in the city as vital. More than half of the surveyed F-JV firms find land cost an issue of fair importance (Table 9.34). This is primarily due to the enormous purchasing capacity of most of the foreign owned and joint venture firms that do not see escalating costs in Bangalore as a very serious issue. Only a third of the surveyed F-JV firms have reported Bangalore's land prices to be very high. Another one third finds it low, and a third finds it affordable (Table 9.35).

Table 9.35 F-JV firms: Ranking of land prices in Bangalore

	land Cost	
	Count	%
low	11	34.4%
affordable	10	31.3%
very high	11	34.4%
Total	32	100.0%

Source: Field Survey, 1995

9.9 PROBLEMS

When asked to comment on the problems faced as result of being in Bangalore, 60% of the surveyed F-JV firms point to electric power crisis in the city as the most serious problem confronting them. Absence of an international airport appears to be the second major concern among these firms, as about one-fifth of these consider it as the most serious problem. Among all the respondents that have cited lack of an international airport as a problem, 80 percent belong to the foreign firms (only) category. Congestion and pollution in the once garden city of India now seems to be bothering the F-JV firms, as 28 percent of the surveyed F-JV firms note that as the second serious problem. Among other matters of concern, limited scope for expansion of the city seems to be a concern, with over a third of the surveyed F-JV firms considering it as a matter of anxiety (Table 9.36). The surveyed joint venture firms seems to be confronted by a high turnover of the IT professionals in Bangalore, than compared to the foreign firms.

Table 9.36 F-JV firms : Problems of being in Bangalore

Reasons for Concern	Percentage of Responding Firms		
	Most Serious →		Less Serious
• Severe Power Crisis	59.4	18.8	15.6
• Absence of an International Airport	18.8	25.0	12.5
• High Turnover of IT Professionals	15.6	25.0	15.6
• Congestion and Pollution	6.3	28.1	21.9
• Limited Scope for Future Expansion	0	3.1	34.4

Source: Field Survey, 1995

Table 9.37: F-JV firms: Opinion on future of Bangalore

	Will Bangalore be still the most favourable location for the IT industry in India? Count	%
No	6	18.8%
Yes	26	81.3%
Total	32	100.0%

Source: Field Survey, 1995

Majority of the surveyed F-JV firms feel that Bangalore will continue to be the most favourable location at least for the next three to four years (Table 9.37) for the IT industry (as of 1995). They base their decision more due to lack of a viable alternative rather solely on virtues of Bangalore. Even among the firms that support the fact that Bangalore will continue to attract more IT firms than any other city in India, there is no clear consensus on which they are emphatic. All the surveyed F-JV firms that support the proposition are very divided on the their reasons, and it makes one wonder if how complacent these claims are (Table 9.38).

Table 9.38 F-JV firms: Reasons in support of answer on the future of Bangalore

Factors	Percentage of Foreign and Joint Venture Firms Degree of Importance High → Low		
	High		Low
• It Is A Traditional Stronghold And Has A Good Network of IT Firms Which Is Important	21.9	6.3	21.9
• Despite all the problems it still attracts more IT Firms than any other centre in India	21.9	15.6	9.4
• Telecommunications Infrastructure, which is vital for IT Industry is better than many other cities	18.8	15.6	40.6
• Government is projecting it as Silicon Valley of India, and the IT industry is encouraged	18.8	43.8	9.4
• Some IT Firms already moving out of Bangalore	15.6	0	3.1
• Bangalore faces severe power crisis	3.1	12.5	3.1
• Limited Scope for Future Expansion	0	6.3	12.5

Source: Field Survey, 1995

This chapter discussed the responses of the foreign and other joint venture case study IT firms in Bangalore. It outlined their perceptions on the strengths and weaknesses of Bangalore as a base for IT industry in India. As a brief conclusion to this section of the dissertation, the next chapter provides a comparative analysis of the responses given by the domestic and non-domestic case study firms in Bangalore.

10 UNDERSTANDING THE COMPETITIVENESS OF BANGALORE IN INDIA: COMPARATIVE ANALYSIS OF THE RESPONSES

10.1 INTRODUCTION

The previous two chapters analysed the responses of the case study IT firms in Bangalore. This analysis was presented in two categories: domestic firms; and non-domestic firms-which included the foreign owned and joint venture case study firms. The concluding chapter of this section of the dissertation provides a brief comparative analysis of the behaviour of the surveyed firms in the two categories viz., domestic and non-domestic firms.

This chapter is organised in seven sections. After the introduction, the second to the fifth sections of the chapter provide a comparative analysis of various features using ownership as a basis. The penultimate section of this chapter attempts to test the research hypotheses, followed by concluding remarks in the last section.

10.2 DOMESTIC AND NON-DOMESTIC FIRMS: BASIC FEATURES

Almost half of the surveyed IT firms employed less than 50 persons. Over 70 percent of the firms in the employee range of 0-50 belonged to the non-domestic category.

Over twenty percent of all the surveyed firms employed between 201 and 500 people. Of this, three-quarters belonged to the non-domestic category (Table 10.1).

Table 10.1 Firm size based on ownership status of the sampled firms

Ownership Status	Employee Range						
	0-50	51-100	101-200	201-500	501-1000	2001-3000	Total
Foreign Owned	11	1	1	2	1	0	16
Domestic Firms	7	1	5	6	1	0	20
Joint Ventures	7	3	1	3	1	1	16
Total	25	5	7	11	3	1	52

Source: Field Survey, 1995

Table 10.2 Annual turnover of the sampled firms according to ownership

Ownership	Annual Turnover Range (Rs. Million) 1995							
	Not Available	0-50	51-100	101-250	501-750	1501-2000	More than 2000	Total
Foreign Owned	5	6	2	2	0	1	0	16
Domestic Firms	2	9	0	5	2	1	0	20
Joint Ventures	0	9	1	2	1	1	1	16
Total	7	24	3	9	3	3	1	52

Source: Field Survey, 1995

Almost half of the surveyed firms had an annual turnover of less than Rs. 50 million as of 1995. Of the 24 firms that belonged to this turnover range, over 60 percent were non-domestic firms. Over half of all the surveyed IT firms in the turnover range of Rs. 101-250 million were domestically owned firms (Table 10.2).

10.3 LOCATIONAL FACTORS

The first comparative analysis is based on the reasons for choosing India. Table 10.3 is based on the answers given to the question on why any IT firm should be interested in India. As evident from Table 10.3, each type of firm seems to have their own vision of why any IT firm should be interested in India. While domestic firms seem to be basing their view largely on lower wages alone, the foreign firms seem to view the value and quality of the IT professionals as the crucial factor in choosing India. It is very pertinent to look back to Chapter 5, wherein a similar analysis revealed that India offers the best of value and quality of work, when compared to her competitors. Large untapped domestic market seems to catch the attention of the surveyed joint venture firms. Over 60 percent of the joint ventures see that as a main reason for firms to be interested in India, a *raison d' être* for their being in India?

Table 10.3 All firms: Single most reason for any IT firm to be interested in India

Characteristics	Category of Firm (% to the total responses)		
	Foreign Owned	Domestic	Joint Ventures
• Best of Value and Quality	**62.5**	20.0	*25*
• Lower Wages Compared to Competitors	6.3	**35.0**	12.5
• English Speaking IT Professionals	6.3	*25.0*	0
• Hardworking and Reliable	0	10.0	0
• Large Untapped Domestic Market	*25.0*	10.0	**62.5**

Source: Field Survey, 1995

Almost certainly, all the surveyed firms acknowledged the enormous amount of investment made by the Indian central government in the electronics and the telecommunications sector in Bangalore. This according to them was the foundation of the high technology industry in the city. Some of the surveyed firms, also made reference the "technology and industry culture" that originated in the region in the early part of this century. At the threshold of India's Independence (in 1947), Bangalore had one of the most technologically advanced industries and work force of the time in India. All these according to the surveyed firms put Bangalore well ahead of other Indian cities as far as technological development was concerned.

There are no significant differences expressed by the three types of surveyed firms on the basis of their ownership for reasons to choose Bangalore. The choice of the city as expressed by all the 52 surveyed IT firms is summarised in Table 10.4. The factors have been divided into three major category, viz., government related factors, city related factors, and others. Over 85 percent of the firms ranked city related factors as most important reason (Rank 1) in choosing Bangalore. Within the city related factors, the surveyed firms have accorded highest importance to the availability of high technology professionals in Bangalore. In the city based factors, availability of high technology professionals and research institutes together account for almost 50 percent of all responses.

To this, if the city's base as a high technology centre is added as an another locational factor, that accounts for 70 percent of all the city based factors as expressed by the all the surveyed IT firms in Bangalore. Thus three important city based factors (availability of skilled professionals, availability of research laboratories and institutes, and Bangalore being a centre for high technology production), account for almost three quarter of the city based factors (as expressed by Rank 1).

Government support, availability of high technology professionals, and research institutes and laboratories account for almost 50 percent of all the locational factors expressed by all the surveyed firms in Bangalore (Table 10.4). As evident from the Table 10.4, government support accounts for over 55 percent of the government related factors.

Table 10.4 Major reasons for choosing Bangalore (ranked scores)

Major Factors for Choosing Bangalore as a Production Base	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Total
Government Related Factors										
• Government Support	4	9	13	11	7	5	2	1	0	52
• Software Technology Park	0	0	0	2	5	5	16	22	2	52
• Electronic City	0	0	0	1	1	2	16	14	18	52
Sub Total	4	9	13	14	13	12	34	37	20	
Sub Total (% of col. Total)	**7.6**	**17.3**	**25.0**	**26.9**	**25.0**	**23.0**	**65.3**	**71.1**	**38.4**	
City Related Factors										
• Availability of High Technology Professionals	30	12	1	1	2	3	3	0	0	52
• Availability of Research Institutes and Laboratories	7	18	18	2	6	1	0	0	0	52
• Already a Major Centre for High Technology Production	3	6	10	18	4	5	5	1	0	52
• Cheaper Cost of Living than Bombay/Delhi	4	3	4	11	21	3	2	4	0	52
• Favourable Physical Climate throughout the year	0	4	3	4	4	26	5	4	2	52
Sub Total	44	43	36	36	37	48	15	9	2	
Sub Total (% of col. Total)	**84.6**	**82.6**	**69.2**	**69.2**	**71.1**	**92.3**	**28.8**	**17.3**	**3.8**	
Others										
• Sheer Convenience	4	0	3	2	2	2	3	6	30	52
Sub Total	4	0	3	2	2	2	3	6	30	
Sub Total (% of col. Total)	**7.6**	**0**	**5.7**	**3.8**	**3.8**	**3.8**	**5.7**	**11.5**	**57.6**	
Total	52	52	52	52	52	52	52	52	52	52
Total Percent	100	100	100	100	100	100	100	100	100	100

Source: Field Survey, 1995

Unfortunately the rankings themselves do not reveal much of qualitative information. For example a particular factor may have got only one rank 1, and may have scored many rank 2. This does not make it an extremely less important factor. To overcome that ranking problem, all the ranks have been grouped into three major choice groups (Table 10.5).

Table 10.5 Importance of locational decisions
(Horizontal percentages)

Major Factors for Choosing Bangalore as a Production Base	**Very Important Locational Decision** *(Rank 1,2,3)*	**Important Locational Decision** *(Rank 4,5,6)*	**Less Important Locational Decision** *(Rank 7,8,9)*	**Total (%)**
Government Related Factors				
• Government Support	50	44.2	5.8	100
• Software Technology Park	0	23.1	76.9	100
• Electronic City	0	7.7	92.3	100
City Related Factors				
• Availability of High Technology Professionals	82.7	11.5	5.8	100
• Availability of Research Institutes and Laboratories	82.7	17.3	0	100
• Already a Major Centre for High Technology Production	36.5	51.9	11.5	100
• Cheaper Cost of Living than Bombay/Delhi	21.2	67.3	11.5	100
• Favourable Physical Climate throughout the year	13.5	65.4	21.2	100
Others				
• Sheer Convenience	13.5	11.5	75.0	100

Source: Field Survey, 1995

Ranks 1, 2 and 3 constituted the very important choice; rank 4, 5 and 6 important choice; and 7, 8 and 9 less important locational decision (Table 10.5). Among the government related factors, more than 90 percent of the surveyed firms consider government support as an important or very important locational factor (50 % of these find it as a very important locational decision). Availability of research laboratories and institutes scores higher than the availability of professionals. All the 52 firms find the research laboratories and institutes as an important locational factor (with 82.7% stating it as the very important factor). Interestingly, 5.8 percent of these 52 firms find availability of skilled professionals as a less important locational factor. This clearly demonstrates the importance attached by the IT firms in Bangalore to the research institutes and laboratories in Bangalore. Bangalore's position as a high technology centre, cheaper cost of living than Delhi and Bombay, and favourable physical climate all are important locational decisions (but not the very important ones).

Table 10.6 Domestic and non-domestic firms: Importance of locational factors

Major Factors for Choosing Bangalore as a Production Base	Foreign Owned IT Firms			Joint Venture IT Firms			Domestic IT Firms			Total
	□	▣	■	□	▣	■	□	▣	■	
Government Related Factors										
• Government Support	1	4	11	0	8	8	2	11	7	52
• Software Technology Park	13	3	0	16	5	0	11	4	5	52
• Electronic City	15	1	0	15	1	0	18	2	0	52
City Related Factors										
• Availability of High Technology Professionals	0	1	15	1	2	13	2	3	15	52
• Availability of Research Institutes and Laboratories	0	0	16	0	2	14	0	7	13	52
• Already a Major Centre for High Technology Production	1	10	5	2	7	7	3	10	7	52
• Cheaper Cost of Living than Bombay/Delhi	1	15	0	2	10	14	3	10	7	52
• Favourable Physical Climate throughout the year	1	15	0	6	9	1	4	10	6	52
Others										
• Sheer Convenience	16	0	0	12	3	1	11	3	6	52

Key:

□ Less Important Locational Factor

▣ Important Locational Factor

■ Very Important Locational Factor

Source: Field Survey, 1995

10.4 GOVERNMENT ASSISTANCE

There is an interesting trend among the three types of surveyed firms in response to availing of government's industrial support scheme. Only 56 percent of the foreign owned firms have used any industrial support scheme offered by either the state or the central government. This is very high (70%), in the case of the surveyed domestic firms, and joint venture firms (68%) (Table 10.7).

Table 10.7 All firms: Responses to availing of any industrial support schemes

Ownership Category	Percentage of Firms Stating	
	No	Yes
Foreign Firms	43.7	56.3
Domestic Firms	30.0	70.0
Joint Ventures	31.2	68.8
Total	**34.6**	**65.4**

Source: Field Survey, 1995

10.5 INFRASTRUCTURE

The question on infrastructure adequacy in Bangalore has produced a very interesting pattern of result. A high proportion (68.8%) of surveyed foreign owned firms seem to agree that Bangalore's present level of infrastructure is adequate to support the IT industry. The response of the domestic firms is the lowest with only 45 percent of the surveyed domestic firms feel that Bangalore's present level of infrastructure can support further growth of the IT industry. This figure for the surveyed joint venture firms is 50 percent (Table 10.8). Combined, it can be interpreted that while 40 percent (13 out of 32) of the *non-domestic* firms find Bangalore's infrastructure inadequate to support further growth of IT industry, 55 percent (11 out of 20) of *domestic* firms feel that Bangalore's infrastructure is inadequate to cater to future growth of IT industry in the city.

Table 10.8 All firms: Response on infrastructure adequacy in Bangalore

Firm Category	Is Bangalore's Infrastructure Adequate to Support Further Growth of the IT Industry?	
	No	Yes
All Domestic Firms	11	9
• Foreign Firms	5	11
• Joint Venture Firms	8	8
All Non-Domestic Firms	13	19
Total	24	28

Source: Field Survey, 1995

The responses summarised in the above table should not be interpreted as the non-domestic firms being more satisfied with the infrastructure provision than the domestic firms in Bangalore. The non-domestic firms can afford to easily bye pass the government provided infrastructure by having their own infrastructure than many domestic firms. This has been largely done by having their own dedicated services, either having their own power generating source, or dedicated satellite link for high speed data, voice and video transfer. One multinational firm based in the Electronics City has its own diesel power generating plant within the factory, so that it does not have to depend on the erratic power supply of the state electricity board. Therefore, the responses listed on the table needs to be seen in the light of discussion that has been carried out in the last three chapters, and should not be interpreted in isolation.

10.6 TESTING OF RESEARCH HYPOTHESES

REITERATING THE RESEARCH HYPOTHESES

- *The dominant position of Bangalore in the Indian IT industry is a result of a combination (synergy) of various factors viz., availability of skilled professionals, a favourable government policy and a network of research laboratories and research institutes.*
- *The vitality of the IT industry in Bangalore is further consolidated by a strong IT industry-Research Laboratories link, which takes the form of joint R & D activities, and informal networks among them.*

This section attempts to test the above mentioned hypotheses

- ***Hypothesis on competitiveness of Bangalore***

The chapter on the software industry in India, and the chapter on the geographical distribution of IT industry in India revealed that Bangalore is the most important centre for IT industry in the country. The causal factors behind the city's dominance have also been well illustrated. Chapter seven explored how that dominance evolved over a period of time. Bangalore does enjoy the dominant position in the IT industry among major Indian cities. It was also revealed that the city's dominance is not limited to aspects of having the largest number of IT firms in India, it has a higher rates of output per employee as well. It is quite pertinent to reiterate some of the aspects of Bangalore's dominance and the causal reasons behind the growth of the IT industry in India.

Table 10.9 India: Geographical distribution of IT firms by major urban location, 1996

	Location of the Firm (City)	
	Count	%
Bangalore	205	22.2%
Bombay	172	18.6%
Calcutta	28	3.0%
Delhi	187	20.2%
Hyderabad-Secundrabad	75	8.1%
Madras	169	18.3%
Pune	28	3.0%
Others	61	6.6%
Total	925	100.0%

Source: Generated from Dataquest, 1996

It was also noted that over the years other important cities have recorded very high growth rates in establishing the IT industry, but despite that Bangalore still has the largest share of the IT industry in India (Table 10.8).

The causal factors for choosing Bangalore as expressed by all the 52 surveyed IT firms was summarised in Table 10.4. The factors have been divided into three major category, viz., government related factors, city related factors, and others. Government support accounts for over 55 percent of the government related factors. In the city based factors, availability of high technology professionals and research institutes together account for almost 50 percent of all responses in city based factors.

To this, if the city's base as a high technology centre is added as an another locational factor, that accounts for 70 percent of all the city based factors as expressed by the all the surveyed IT firms in Bangalore. Government support, availability of high technology professionals, and research institutes and laboratories account for almost 50 percent of all the locational factors expressed by all the surveyed firms in Bangalore (c.f. Table 10.4).

Thus the second hypothesis of the research which is related to reasons for the growth of the IT industry in Bangalore, i.e., *the dominant position of Bangalore in the Indian IT industry is a result of a combination (synergy) of various factors viz., availability of skilled professionals, a favourable government policy and a network of research laboratories and research institutes* is supported.

However, one needs to note that apart from the synergy of factors mentioned above (availability of skilled professionals, favourable government policy and network of research laboratories), there could been other factors too that might have contributed to Bangalore's dominant position in the IT industry in India. These factors, if analysed in detail, may well falsify the hypothesis put forward above. However, given the focus of the research these factors could not possibly be examined in the depth that is required for such an analysis.

- ***Hypothesis on IT Industry-Research Laboratories Link***

In the earlier part of this section of the dissertation, detailed analysis of the three types of surveyed firms, viz., foreign, domestic and joint venture firms were discussed, and their interaction with the various research laboratories and institutes in Bangalore was provided. Here a summary of the nature of that link will be provided. Almost all the surveyed firms (96%) have had some form of professional contact with the research laboratories or institutes in Bangalore.

Table 10.10 All firms: Responses on interaction with research laboratories

	Did you have any contacts with Research Institutes, Labs, Universities, or Professional Institutions in the last 5 yrs or since your inception?	
	Count	%
no	2	3.8%
yes	50	96.2%
Total	52	100.0%

Source: Field Survey, 1995

Table 10.11 All firms: Nature of contact with research laboratories in Bangalore- R&D advice and advice on new ideas

	They Provided R & D Advice		They Provided new Ideas	
	Count	%	Count	%
no	4	7.7%	31	59.6%
yes	48	92.3%	21	40.4%
Total	52	100.0%	52	100.0%

Source: Field Survey, 1995

Most of the contribution of the research laboratories and institutes in Bangalore came in the form of providing R&D advice to the surveyed IT firms in Bangalore. The surveyed firm state that in about 40 percent cases the research laboratories provided contribution towards formulation of new ideas or improvisation of an exiting product or a software. Together these two features are strongest among all the factors cited on the IT industry-research laboratories interaction among the surveyed firms in Bangalore (Table 10.10).

As regards providing advice related to solving production problem in the IT firms, only a fifth of the surveyed firms regard any effective contribution by the research laboratories. Under half of the surveyed firms agree that these research laboratories and institutes provided other advice, which included training of its professionals, and testing of its facilities (Table 10.12). Only a very small proportion (7.7%) of the surveyed firm state that these institutes provided any marketing advice to them.

Table 10.12 All firms: Nature of contact with research laboratories in Bangalore- resolving production problem and other advice

	They Provided advice on resolving production problem		Did research labs provide other advice	
	Count	%	Count	%
no	42	80.8%	29	55.8%
yes	10	19.2%	23	44.2%
Total	52	100.0%	52	100.0%

Source: Field Survey, 1995

Although one anticipates a large variation in the level of interaction between a typical IT firm in Bangalore, and the research institutes in Bangalore, one fact emerges very clearly from the current research that there is a wide spectrum of interaction between IT firms and research laboratories in Bangalore. Sometimes this has taken the shape of informal discussion forums[146] or more serious collaborative projects[147]. Yet many more are one-off interactions in the form of a consultancy or training. Whatever the

[146] An example of this is the semi-serious BAIT (Beer-drinkers Association of Information Technology), which regularly brings together senior IT industry managers, and often scientists from various research institutes and laboratories to informally discuss various aspects of the industry, including informal talk on possible collaboration. The only condition of a BAIT evening... "Drink a minimum of six mugs of beer during the evening!"

[147] Tata-IBM (TISL), and the IISc's Super Computer Centre have been discussing on a joint project (whose details both the parties have declined so far to divulge).

case may be, one cannot deny the fact that there is a strong industry-lab link in Bangalore, (although it could be argued that there is a very high scope for further improvement in such linkages).

Thus, the third research hypothesis-on IT industry-research laboratories link, i.e., *The vitality of the IT industry in Bangalore is further consolidated by a strong IT industry-Research Laboratories link, which takes the form of joint R & D activities, and informal networks among them,* is supported.

10.7 CONCLUSION

The earlier two chapters analysed the 52 IT case study firms that were surveyed as a part of the research. This chapter attempted to provide a comparative analysis of responses of firms based on their ownership. Additionally it also tested the research hypotheses, that were stated in Chapter two. Based on the analysis of these surveyed firms, some of the important conclusions that emerge are:

- ❑ While the different types (based on ownership) of firms have expressed their own priorities for being in India, the most important reasons are: availability of highly skilled professionals at internationally competitive prices, liberalisation of the Indian economy, and large untapped domestic market for IT products and services.
- ❑ The major reason behind the growth of IT industry in Bangalore has been the availability of a vast pool of scientific professionals, and existence of a large number of research institutes and laboratories. Favourable state government policies to attract the IT industry has also borne fruit over time.
- ❑ There is a high degree of interaction between the surveyed IT firms and the research laboratories and institutes in Bangalore. This is largely dominant in R&D related activities. There is a vast potential for strengthening this tie, especially in the direction of collaborating towards the production of innovative products.
- ❑ Surveyed firms attach a lot of importance to the network of firms that exist not only in the IT sector, but those also extend to the electronics and the engineering

sector. This network, according to a number of firms is unique to Bangalore and that, they contend, will provide further growth impetus for IT industry in future as well.

- Surveyed firms in general are not at all happy with the status of infrastructure supply in Bangalore. While the electric power has come under severe criticism, the surveyed firms note that the telecommunications facility, and the high speed data link for communications- two vital aspects for the sustenance of the IT industry, are relatively far better than power supply, and that of other cities in India. The surveyed firms opine that but for a relatively higher level of telecommunications and related facilities, the IT industry growth would have been retarded in Bangalore.

- Bangalore is better placed when compared to many of the competing cities in India. It has a solid base of professional skills which is so vital to the IT industry. If the industry, and the public sector, come together and if venture capital commit resources to finance new projects, then Bangalore and the IT industry could look to a bright future.

- Even if the vital aspect of infrastructure for IT industry is relatively better off, given the fact that most of the industry is not a big consumer of power, still the power supply situation in the state and in Bangalore is of immediate concern. The professionals who work in the IT industry in Bangalore have been drawn from one of the finest available pool of professionals not only from India, but even elsewhere too. This group of professionals is highly conscious of the comparatively high quality of life where they work, and the infrastructure and other facilities available to them. Obviously even if firms provide these professionals power supply inside the firm (and isolate them from the vagaries of the state power supply department), they cannot do the same thing once the professionals reach home. Moreover, many of the surveyed firms have expressed alarm over the rapidly increasing pollution levels and traffic congestion in the city.

- To put it in a nut shell, if the level of infrastructure in Bangalore is not improved immediately, the pre-eminence of Bangalore in the IT industry will be considerably reduced in the near future.

PART D CONCLUSION

- **Chapter 11: Conclusions**

11 CONCLUSIONS

11.1 INTRODUCTION

This research has been primarily undertaken to examine how a particular urban region is able to attract certain type of industries or economic activities. It examined the growth of the information technology (IT) industry in Bangalore between the mid-1980s and the mid-1990s. Another significant aspect of the inquiry aimed at understanding the global spatial dynamics of the IT industry, and what some of the developing countries could offer to IT firms world-wide. The case of India was put forward, as one of the rapidly growing nations in the field of global information technology industry. Further, by using the IT industry as an illustration, the research explored the extent to which Bangalore is competitive in the IT industry in India.

Since the focus of the research was on the IT industry, the initial analysis concentrated on understanding the industry at the global level, and providing a national level analysis for India. This assumed greater significance, as noted in the earlier chapters, as one of the reasons for Bangalore's growth as a major centre for high technology industries can be partly explained by the changes and the recent developments that are taking place in the IT industry world-wide, and the opportunities offered by India to the IT industry around the world.

In the first part of the dissertation, chapter two discussed the theoretical framework surrounding the research, which was followed by the chapter on the study methodology. In the second part, which focused on the IT industry, the geography of the software industry at the global level was discussed in chapter four, followed by an in-depth discussion of the software industry in India in chapter five. The following chapter provided a detailed geographical and statistical analysis of the IT industry in India, by using secondary information for two points in time (1993 and 1996), and covering over 1,250 IT firms all over India. The third part concentrated on Bangalore, in which chapter seven discussed the emergence of Bangalore as the most important centre for the high technology industry in India. Chapters eight, nine and ten provided a detailed analysis and understanding of the competitiveness of Bangalore in the IT industry in India. Fundamental to that analysis was a survey of 52 IT companies in Bangalore, devised specifically for this research.

There is ample evidence of a long history of scientific excellence of various engineering colleges and research institutes in Bangalore that have led to the development of particular sectors of local industry. Nevertheless, in its present form and scale as well as pace of change of what is happening in Bangalore must be understood as still essentially very young. How will it mature and grow, what influences will bear critically on this development, and what the implications will be of continuing development, are matters of great interest from many different points of view. They are national not just local issues, given the scale and significance of what is happening in Bangalore, and the significance of the economic and technological changes currently helping to shape the world economy and the location of economic activities world-wide, as discussed in chapter one, two and four.

This chapter sets out to explore these issues. To help understand the purpose of the chapter, it is important to appreciate what it is not. The chapter's contents are not about predictions, quantitative or otherwise; they are not to do with setting different scenarios for the future; and nor do they seek to make any recommendations, though there are policy implications in some of the observations and conclusions. It is beyond the scope of the present study to treat these topics, important as they are, in the depth they necessarily require.

This chapter is thus put forward in order to help identify, and encourage discussion about some of the key issues that arise that will shape the future evolution of IT industries not only in Bangalore but elsewhere too, whether as a cause or as a consequence of it.

Thus the prime objective of this final chapter is to outline some of the conclusions from this research exercise. It also presents a summary of the major findings of the research. The chapter is organised into five sections. After this introduction, the second section provides an overview of the dissertation design. This is followed by a discussion of the principal findings of the study in section three and four. Potential areas for future research are identified in the last section of this chapter.

11.2 SUMMARY OF THE DISSERTATION DESIGN

Theoretically, the study attempted to explain how an urban region in a developing country can attract an industry which is rapidly growing and requires highly skilled labour and high technology inputs for its success. These factors have not traditionally been associated with the so-called developing countries. Further, the study also records the salient factors underpinning spatial change in the IT industry, and more specifically the software industry. Empirically, the study attempts to record the view points of IT industries in Bangalore with regard to government policies, available infrastructure, interaction with the universities, and other support services.

11.2.1 ON THEORETICAL GROUNDS

The internationalisation of economic activities enable business operations to be conducted in an increasingly borderless environment, thus allowing movement of technology, production, capital and other specialised services more easily than ever before. The globalisation of manufacturing and services has been spurred by a number of interrelated factors that include the changing character of international investment and changes in the forms of corporate activity, organisation and relationships; improvements in transport and communications which have reduced the economic distance between countries; technological advances in production and processing methods; and the adoption of market liberalisation and deregulation policies. The combination of these factors has made the global integration of production, technology and marketing an increasingly dominant feature of the world economy since the 1980s. These factors have also contributed to the locational shift of economic activities. Thus new investments are able to move to locations that are considered most profitable. Largely these investments (especially the ones that come from overseas), tend to concentrate in those locations that have certain levels of infrastructure, favourable government policies, and a skilled labour force. This is more so in the case of the new high technology industries that tend to concentrate in cities and urban regions, thus making the best use of the urbanisation and localisation economies offered by a city.

New technologies have led to the introduction of flexible production systems in the context of mass customisation, a new form of industrial organisation which provides for large scale production while at the same time meeting consumer demand for quality and diversity. Mass customisation is further characterised by the use of flexible machinery, often applying microelectronics based technologies, and by production in small customised batches in response to specific customer requirements. Thus firms often tend to concentrate on their core competencies, and outsource other functions to firms within the urban region. In many cases this has led to the development of networks of firms, and the "industrial district model" is one such representation of this kind of a network. Thus once industries and economic activities become concentrated in certain urban regions, there is "competition" among these regions to vie for future investment into a particular industrial sector or an economic activity.

Studies related to urban competitiveness and territorial competition have been largely conducted in Western Europe and North America. In these regions the recent emphasis on studying urban competitiveness emanates from the importance associated to the major urban areas as a result of territorial integration of markets (EU in the case of Europe, and NAFTA in the case of North America). In such a situation, urban areas have gained significance as economic actors and are more aware of the greater burden on them to strategically plan and manage their economic futures. In an environment that is largely being subjected to challenges to the existing activities that urban areas have been hitherto engaged, and the opportunities to grow into new areas as a result of the new global economic order, the study of urban competition assumes great significance.

The study of urban competitiveness in the developing part of the world has its own purpose. Whereas in the richer industrialised world it assumes greater significance as a result of blurring of national boundaries, it becomes important in the developing world as a result of economic dominance of some of the large cities in these countries. Equally important is the large and growing share of a country's urban population that lives in these cities of the developing world. The economic liberalisation that is now taking place in many countries, not excluding India, has increased the importance of urban areas as recipients of foreign direct investment (FDI), and as a result, the study of urban competitiveness in the developing world acquires special significance.

A large amount of FDI is channelled into the cities and urban regions through the new high technology industries. Thus, there is a distinctive role for the new high technology firms in urban development. A number of studies have shown that urban economic development strategies have become increasingly focused on high technology development. There are significant economic gains attributable to new high technology firms in the urban development process. Prominent among them are the positive spillovers caused by these firms, which usually rest within the local area. Thus these help in the skill upgrading of the local work force. Moreover, as these new firms are dependent on constant source of innovations, the local educational institutions that can offer research facilities are also likely to benefit from technology transfer. The graduates passing out of these institutions also have a good chance to get employed in these firms.

11.2.2 On Empirical Grounds

The concept of competitiveness as extended to the urban areas or to an urban economy is envisaged to stretch beyond the urban region, and sometimes even beyond the national economy. Recent economic literature in Europe argues that in an increasingly integrated economic world, the issue of competition between producers is viewed more and more often in terms of territorial competition, particularly inter-urban competition. These studies reveal that European cities are competing with one another to attract activities and to gain international influence. Some of them, like London, Paris and. Frankfurt must already compete on a global scale in areas like international finance, higher education and so on. Others need a careful redefinition of their position, their image, their role, using the European continent as their minimum reference point instead of perceiving activities in terms of their own country, as they have in the past.

Several factors reinforce such trends. The internationalisation of the world economy and reductions in transport and communications costs favour investment flows and greatly improved production mobility. In Europe, progress towards the Single Market has gradually worn down barriers to trade and to the spreading or obtaining of services, and favours factor mobility. Quite a number of traditional economic activities (for example, car making, educational services, garment manufacturing) are much more footloose now than in the past along with several new activities (like IT, consulting services, etc.) which are footloose and mobile. At the same time these processes are exposing big cities and regional capitals to tougher competition. In fact, quite a few centres and economies that used to hold a near-monopolistic position in their own country (for instance London, Paris, and Madrid) are coming under tough outside fire from nearby countries and farther away as well. This has also been contributed by the behaviour of multinational companies and other formerly domestic firms (now restructuring to serve broader markets), and by a general globalisation process. Then there is the fact that activities such as R&D, high-level services and financial services, communications media and other services are increasingly exposed to stiffer competition beyond their national borders.

How far any of these are relevant to the Indian context? Limited literature available on the IT industry world-wide suggests that IT and other high technology firms concentrate in regions that offer high quality work force, interaction with research laboratories, availability of state of the art infrastructure, and favourable state or federal laws to promote such industries. Does Bangalore offer any of these to IT firms? The evidence is summarised in the next section.

11.3 SUMMARY OF THE RESEARCH FINDINGS

11.3.1 THE CHANGING GEOGRAPHY OF THE WORLD SOFTWARE INDUSTRY

A spatial analysis of the software industry at the global level highlighted that the geography of the industry is shifting (albeit slowly), from traditional strongholds like the United States and Western Europe to Asia. An analysis of the software industry world-wide provides the reasons for the emergence of certain countries as leaders. A shortage of software and other IT professionals, and their high wages in the western world, are altering the manner in which software is produced and the types of hardware, telecommunications, and non-software firms that are entering the market. This has contributed to its shift to locations that offer high quality professionals in the IT industry or high technology industries, and whose wages are lower than those in developed countries. The IT industry is largely both cost and quality sensitive, and would not move to locations that offer lower wages, unless it is matched by highly skilled technical work force. This has been well complemented by favourable policies to attract software industries in some developing countries like Taiwan, India, Brazil etc.

Thus it is very likely that the software industry, and many aspects of software production, and IT industry in general will continue to shift to locations that offer high quality professionals at competitive wage rates, have the necessary infrastructure, and where there is continuous government support in terms of policies to attract software and IT industries from all over the world.

11.3.2 THE SOFTWARE INDUSTRY IN INDIA

The software industry exports from India have grown from under US$ 5 million in 1980 to over US$ 700 million in 1996. Measured in output terms, the industry has been growing steadily at over 30 percent annually since 1990. Internationally, India's strength lies not only in providing competitive software products, but also a quality that is globally recognisable and acceptable.

Despite an impressive performance, particularly in terms of export, the industry still has some inherent weaknesses. First of all, its export productivity is still low compared to its competitors. Secondly, India has one of the weakest packaged software segment among the competing nations. There have been only a few attempts to develop software packages, and as such the Indian software industry remains predominantly service oriented.

The availability of telecommunications infrastructure is still very poor in India, even in comparison to many developing countries. Huge investment in the telecommunications sector is the foremost task, if India wants to have a long-term presence in the global software industry. The domestic market in India for software is still largely under-developed, although it has been growing rapidly in the past. The country still has a very slow rate of computer penetration, and the installed base of PCs is also low.

So what attracts the global IT firms to India? The present study reveals that over 60 percent of the foreign owned firms stated *best value and quality* of IT professionals in India as the most important reason for choosing India. On the other hand, over 60 percent of joint venture firms emphasise a *large untapped domestic market for IT services and* products as the most important cause for basing their operations in India. The surveyed domestic firms feel that the foreign firms are interested in India, mainly because of the lower wages of IT professionals compared to India's competitors. This largely summarises the reasons why IT firms choose India as a production base.

Certain urban locations have been able to excel themselves as most important centres for software production and IT industry in India. In the mid 1990s Bangalore had the highest concentration of software and IT industries among all the cities in the country. Not only in terms of numbers, Bangalore also has one of the highest level of productivity, measured in terms of turnover per worker in the IT industry among all the major cities in India.

11.3.3 UNDERSTANDING THE COMPETITIVENESS OF BANGALORE IN THE IT INDUSTRY IN INDIA

Bangalore is a relatively a new urban centre compared to many older cities in India. At the turn of the twentieth century it had a population of 160,000 and this is projected to grow to 7 million by the beginning of the next millennium. The initial industrial development in the city can be attributed to the princely rulers of the then Mysore state. The early part of the century also witnessed the establishment of a number of research institutes and professional colleges (or polytechnics), which have become a hallmark of Bangalore's supremacy in high technology education in India. After independence, the central government's conscious move to locate strategically important industries, gave a growth impetus to high technology industries and to professionals working in high technology industries. Thus, it became an important base to attract the IT industry, when the Indian economy started opening up partially from the mid-1980s.

Since 1991, the macro-economic changes that are occurring in India has put the major cities in a competitive position to one another. Traditionally the economic activities and industries concentrated around the big cities especially Bombay, Delhi, and Madras. But since the government has done away with many of the earlier existing regulations about location of economic activities, firms are now able to choose locations which make most business sense to them. Parallel to this process, the opening up of the economy has also uncovered vast potential that exists for investment opportunities, that hitherto were not open to competition. This has given cities like Bangalore a fillip to vie for not only foreign direct investment (FDI), but also pull domestic investors from other exiting major cities (like Bombay and Delhi), which in the last decade have been confronted with a myriad of problems as a result of poorly managed growth. Combined with the recent development in telecommunications and information technology infrastructure, the availability of high technology professionals and research institutes and some support from the state government have all contributed to the rapid growth of the IT industry in Bangalore.

Bangalore has had a number of advantages when it comes to attracting new foreign investment in the IT industry. First and foremost is the supply of well educated IT professionals and engineers. Bangalore is also home to a large number of research laboratories and higher educational establishments, including the Indian Institute of Sciences, and one of the best management school in the country- The Indian Institute of Management. Perhaps unique to Bangalore is the fine network of firms that are interdependent with one another, which is not only limited to the IT industries, but extend to the general electronics and the engineering sector as well. Almost all the surveyed firm in the present research have professional links with the research institutes and laboratories. These links are more pronounced in collaborative R&D activities. The surveyed firms also find the network of other smaller firms in IT, electronics and engineering sector very useful. According to them, this network of firms that exist in the city is unique to Bangalore.

Bangalore also enjoys some good recreational spaces, in terms of green spaces and water bodies, and hills (just outside the city). The city's pubs are quite popular attractions. The city's population is very cosmopolitan (unlike Madras or Hyderabad), and that is a strong point in attracting professionals from not only all over India, but even elsewhere too. The city seems to be forging ahead of Bombay in the fashion industry as well, with many of the famous designers and international brand names starting their operations in the city. The organisation of Miss World Contest in 1996 in Bangalore is an indication of the city's position in the fashion industry in India.

The review of literature highlighted the importance of government policies and support in encouraging high technology firms all around the world. Government support (in whatever form), has found appreciation among the surveyed firms. Two-thirds of the surveyed firms have availed of some form of industrial support scheme or the other offered by (both central and state) government. Among the locational factors to choose Bangalore, almost half of the surveyed IT firms put government support, availability of high technology professionals, and research institutes and laboratories as the most important reason for choosing Bangalore.

However, Bangalore's success in attracting new business ventures in the IT sector and its rapid population growth are taking their toll on the city's infrastructure, which is under severe stress. Bangalore has no mass rapid transit system. Most crucially, power cuts and voltage reductions are a daily occurrence. Although the IT companies are not big power users, they must install voltage regulators, uninterrupted power supplies, and generators to run their computers. The local telecommunications including the telephone network has improved dramatically since the mid 1980s, and this research has shown that it is one of the strongest reasons for Bangalore to be still attractive to the IT industries.

Infrastructure is perceived as a major impediment to Bangalore's future growth as the dominant IT centres in India. Almost half of the surveyed IT firms in Bangalore do not find Bangalore's present infrastructure supply adequate to support further growth of IT industry in the city. Karnataka and Bangalore both face a very serious electric power crisis. This is compounded in the urban area of Bangalore, where poor availability and quality of other infrastructure like roads, could undermine the competitive position Bangalore has achieved in the IT industry. The surveyed firms also note the absence of an international airport in Bangalore as one of the important issues. If the urban infrastructure in Bangalore is not improved, and the increasing pollution levels in the city not checked, then some of the surveyed firms feel that cities like Hyderabad, and Pune will have a very high chance of siphoning-off the future IT investment from Bangalore.

11.3.4 CAN THE CASE OF BANGALORE BE PLACED WITHIN THE AVAILABLE THEORETICAL FRAMEWORK OF SPATIAL ANALYSIS OF HIGH TECHNOLOGY PRODUCTION?

As presented in chapter two, Castells and Hall provide a typology of high technology enclaves which they collectively describe as "technopoles". In this typology,

> 'The *first* type of technopole consists of industrial complexes of high technology firms that are built on the basis of innovative milieux. These complexes, linking R&D and manufacturing, are the true command centres of the new industrial space. These new techno-industrial complexes arise without deliberate planning, though even there governments and universities did play a crucial role in their development. The most prominent *among these types* is Silicon Valley' (Castells & Hall, 1994:10).

Even though the above analysis was primarily carried out in the context of industrially advanced countries, based on past research (especially Holmström, 1994) on Bangalore, and the major conclusions that emerge from this research, it is possible to consider Bangalore as the type of technopole that Castells and Hall describe above. Perhaps the most striking commonality between Silicon Valley in the US and Bangalore is in their genesis. Both of them received enormous amount of federal funding. While in the US, the defence funding was channelled to the various research laboratories, in the case of Bangalore, it went to the government owned defence research laboratories. As regards universities, both Silicon Valley and Bangalore have some of the finest research institutes of their countries. and of international standing.

The second important theoretical construct is to view Bangalore within the framework of the industrial district model. This study of IT firms in Bangalore suggests that Bangalore seems to have some of the characteristics of the "classical" industrial district model. Yet on certain parameters, it seems to fail the test. There appears to be a high level of interaction among firms that have developed into formal associations and informal networks. This network is not restricted to firms alone, and exists between industry and research laboratories, and other support organisations as well. The typical industrial district model operates within a very close social circle, and with entrepreneurs who come from more or less a similar social background. By contrast, the actors in the IT industry in Bangalore are from diverse cultures (even if they are from within India), and, as the detailed discussion with some of them revealed, some of the firms are linked more to firms outside India than within Bangalore. In such a situation, how does Bangalore fit in as an example of industrial district model? Holmström's study of the small engineering firms in Bangalore (1994) also seems to suggest that perhaps there is no clear cut message. On the parameters of associations, networks, flexibility, sub-contracting, the study of IT industry in Bangalore would seem to point it towards an industrial district. On the issue of social network, innovation, new products and design, there is not enough substantial evidence to support the industrial district model.

11.4 CONCLUDING REMARKS

India presents an extremely interesting case of an-export oriented policy in a country which for most part of the last 50 years (since independence) has been strongly inward-looking. The study of the IT industry and especially its software segment suggest major policy implication for the developing countries is that. The relative success of India is illustrative of the opportunities opened to developing countries in software industry. India's success in the software industry can also be attributed to favourable government policies (especially since the mid 1980s). If a newly industrialising country such as India is able to recognize and take advantage of an economic opportunity arising from a fundamental shift in the field of IT, which both lowers entry costs for firms and increases windfall benefits from rapid innovation, other countries at a similar stage of economic development may be able to do the same.

The study of the software industry in India is also unique in that it goes in contrary to the picture of Indian industry in general, which for most of its history was seen as inward-looking, protected, working within an environment of all-pervasive government controls, and using obsolescent technology. As information technology and information services assumes greater importance in the economic development process, the study of Indian software and IT industry can provide valuable lessons for the other developing countries, that want to establish themselves in a increasingly competitive global information services market.

At the micro level, the study highlights that a mere ability to attract knowledge based economic activities like the software industry is not enough for an urban area. The availability of infrastructure in the urban area, the quality of urban environment, and economic opportunities to the city's population are three of the many fundamental requirements that can sustain the growth of knowledge based industries. Thus cities that wish to embark on the path of achieving a pivotal role in the location of knowledge based high technology industry like IT and software can learn valuable lessons from the study of the IT industry in Bangalore.

One of the crucial lessons for other Indian cities to learn from the experience of Bangalore is that with little measure of government support, infrastructure, and the establishment of research laboratories and institutes the city has been able to attract world class IT firms. Other Indian cities that have a potential to offer these have also got a chance to attract such industries. Already, Pune and Hyderabad are heading in that direction.

It appears from the responses of the case studies of IT firms in Bangalore, that one can only be partially optimistic about the prospects for the IT and high technology industry in the Bangalore region. Of course there are many imponderables and many unpredictable factors that could damage even these partial prospects. But among measurable factors, a *crucial one is the lack of basic infrastructure to support future growth, or even sustain the present one.*

Thus the following can be summarised about the present and future outlook of Bangalore's information technology industry:

First, even though the concentration of IT firms is small in number there is still a good deal of diversity in terms of the particular products and markets and of the firms involved.

Second, there is no reason to doubt the ability of the educational institutions and associated research bodies to maintain their record of scientific excellence and to continue to make significant advances which have industrial applications.

Third, the position and outlook among the established companies is generally favourable. In some of them, Digital Equipment, for instance, major restructuring exercises have recently been gone through and there is a return to sound growth and profitability. Infosys technologies, has emerged as the most favourite (and admired) of all the domestic IT companies not only in Bangalore, but all over India, and even outside India as well.

Fourth, the sheer number of young companies is now such that the chances of at least a few of them growing to be large international businesses is greatly increased; several of them are already heading this way (like BFL, Microland, NCore, and BAeHAL), though one must recognise that it is early days yet and the international markets that they operate in are fiercely competitive and becoming so.

Fifth, the processes of spinning-out of new firms from existing firms will continue. Further to go on the American experience: even if some of the small firms get acquired by larger firms, it is quite likely that the individualism of founders of the former will reassert itself after a period and they will spin out again and this time with greatly increased business experience. The "recycling" of people, which has already started happening, will probably continue to contribute to the maturing and expansion of the IT industry in Bangalore.

Sixth, the increasing availability and sophistication of financial and business services is likely to contribute to strengthen the young company sector, by helping both to overcome problems and to take new market opportunities. Many of the international accountancy and management consultancy practices (for e.g. Coopers and Lybrand) that have set up in Bangalore or are in the offing, similarly add to the local business scene by contribution to the extension of the network of contacts and opportunities especially for the somewhat older and better established IT firms.

Seventh, in the same way as outside business financial interests have become active in Bangalore so has the property development industry been attracted. An unprecedented number of new, high technology or similar property schemes are committed or being planned; although they raise many difficult and controversial problems, their effect is also to provide the companies with an appropriate range of choice of property and to ensure that growth of the IT industry is not constrained by lack of sufficient and suitable accommodation.

11.5 PROSPECTS FOR FUTURE RESEARCH

This study has illustrated many interesting facts about not only the global and Indian IT industry, but also equally about a city's progressive growth as a major centre for an industry and support services. In this regard, the theme of urban competition or competitiveness assumes a great significance for countries like India. Whether it is attracting foreign investment or domestic capital, cities that are poised to offer best return on investment are likely to continue to exert influence on the international and national urban hierarchy.

As derived from this study, some of the potential areas which deserve more attention in future research include the following:

- This study demonstrated that the IT firms are engaged in formal and informal networks, which constantly enable transmission of information. However, not much is known about the people who are actually behind the Bangalore's IT industry. Who are they? What social groups do they come from? What educational levels do they have? How do they differ from the other group of workers in the city? In brief, one of the most pressing needs is to conduct research on the "sociology of IT professionals" in Bangalore. A better understanding of these issues is bound to help policy makers in charge of providing support to the industry, and those responsible for outlining and implementing social policies.

- Despite being hailed as a "success story", Bangalore remains a city of contrasts. And given the fact that the city's economy is getting more globalised, n ic disparities are likely to continue to grow among the different social grou n the city, and with the rest of Karnataka. Further research to examine the et f growing income disparities within the city as result of the growth of IT industry in the city, and economic liberalisation in the country needs to be carried out. This should also help policy makers at the national and city level.
- Given that many more urban areas in India, and elsewhere would attract investment in the IT sector in the future, it needs to be researched if Bangalore would be able carve out a niche in a particular segment that will make it a centre of not only national importance, but even of international standing. Software and services sector seems to have that potential. However, it warrants a detailed study to see if Bangalore can stand up to the emerging challenges.
- This study has also briefly highlighted the importance of IT and telecommunications for a country's economic development. Efforts need to be made to broaden the availability of Internet and data communications facilities in the country, which is the backbone for the sustenance of the IT and telecommunications industries. Studies to identify investment needs of these sectors are also another area of future research.

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APPENDICES

Appendix 1

DEVELOPMENT PLANNING UNIT
UNIVERSITY COLLEGE LONDON

A Study of IT Industries in Bangalore, India

Date of Interview:

SECTION ONE GENERAL INFORMATION

1.1 Name of the Firm/Establishment :

1.2 Category of the Firm :
1- Information Technology
2- Hardware only
3- Software & services only
4- Value added re-seller or dealer
5- Peripherals
6- Training

1.3 Ownership status :
Foreign owned-1, Domestic-2, Joint Venture-3

1.4 Whether this is the HQ or branch office? (Office status) :
0- Branch office
1- Headquarters

1.5 Start up year :

1.6 Total number of employees : 1991 1995

1.7 Turnover of the Firm (Rs. Million) 1995 :

SECTION TWO PRODUCT PROFILE

2.1 Do you have a R & D department Yes/No

2.2 Please rank the following sources of advantage in order of importance to your firm

		Is this a source of advantage to your firm
1.	Use of foreign technology/tie-up	Yes/No
2.	Technology received from research institutes/labs	Yes/No
3.	Proximity to local customers	Yes/No
4.	Proximity to local suppliers	Yes/No
5.	Quality of service provided to customers, including after sales service	Yes/No
6.	Selling price of the product	Yes/No
7.	Features available on the product	Yes/No
8.	Goodwill	Yes/No

2.3 Please indicate the significance of the following as the potential source of competitiveness to your firm:

1. Research & Development ---------
2. Production capacity ---------
3. Investment in capacity to make products ---------
4. Selling and marketing domestically ---------
5. Selling and marketing overseas ---------

Important: 1, Fairly Important: 2, Not Important: 3

2.4 Do you have any foreign collaboration Yes/No

If answered NO, please proceed to Section III

2.5 Who came up with the idea of establishing this collaboration?
1 Foreign Firm
2 Your Firm
3 Jointly
4 Not applicable

2.6 Did your collaborator contact anybody else for collaboration before the tie-up with you? Yes/No

2.7 Why did they finally select you? Please list the three most important reasons
1.
2.
3.

2.8 The following are asked to assess the competitive advantage that you enjoy of being a domestic collaborator

Do you enjoy comparative advantage over other domestic firms on the following:

1. On designing of products? Yes/No
2. Research and Development? Yes/No
3. Market testing, consumer choice, and preferences? Yes/No
4. Reputation/ market image/reliability? Yes/No
5. After sales service? Yes/No
6. Cost/pricing Yes/No
7. Target group of customers Yes/No

2.8 Please list the single most advantage of being with a foreign collaborator

SECTION THREE LOCATIONAL ASPECTS

3.1 Did you consider any other city before choosing Bangalore as the production base? Yes/No

3.2 If yes, please mention the names of the cities (or city regions), that you considered.
1.

2.

3.

3.3 Why Foreign IT Firms should be interested in India (**ask only the Domestic IT Firms**)
1.

2.

3.

3.4 What has been the most important reason for you to choose India as production base (**ask only the Foreign and Joint Venture Firms**)

1.

2.

3.

3.5 Why should any IT Company be interested in India? **Please give single most reason according to you.**

3.6 Why did you choose Bangalore as your production base? Please put a × on all the relevant ones (choose as many as relevant).

1 Government provided tax incentives ☐
2. Dedicated location like the Electronics City available ☐
3. The Software Technology Park (STP) exists in Bangalore ☐
4. There are more Research Labs/ Institutes, and Engineering Colleges exists in Bangalore than any other city ☐
5. Bangalore is already hub of high-technology industries in India ☐
6. Favourable physical climate than compared to many other cities ☐
7. Cheaper house rents to attract executives from all over ☐
8. Peaceful labour force ☐
9. Sheer convenience (for example, native of Bangalore) ☐
10. Bangalore is easily accessible from all parts of the country ☐
11. Work culture is better than rest of the country ☐
12. Cosmopolitan nature of the city ☐

3.7 Please rank the choices that you selected in order of preference to your firm

1.	7.
2.	8.
3.	9.
4.	10.
5.	11.
6.	12.

3.8 Do you think Bangalore is still an attractive location for IT industry in the country ? Yes/No

Please **state the reasons** for your answer

1.

2.

3.

4.

5.

SECTION FOUR TECHNICAL ASSISTANCE

4.1 Did you have any contacts with Research Institutes, Labs, Universities, or Professional Institutions in the last five years? Yes/No

4.2 **If Yes**, Please indicate the nature of these contacts

a. They provided ideas for new products Yes/No
b. They provide advice for R&D problems Yes/No

c. They provided advice for resolving production problems Yes/No
d. They provided advice on global or domestic marketing Yes/No
e. They provided other advice or assistance Yes/No

If Yes to (e), then please specify the type of advice or assistance

SECTION FIVE GOVERNMENTAL ASSISTANCE

5.1 Do you think there has been any positive change in government policies with respect to your industry since 1990? Yes/No

5.2 Has that acted in favour of your firm? Yes/No

5.3 Have you availed of any industrial support scheme, incentive etc., provided by the Government? Yes/No

5.4 From the list given below, please put a × next to the Government policies that have helped your firm

a. Tax incentives ☐
b. Backward area ☐
c. Special concessions to 100 % Export Oriented Units (EOUs) ☐
d. Ease of doing business (for example, Single Window system for all clearances) ☐
e. Creation of special locations for the promotion of software industry (for example, the STP, Electronics City complex) ☐
f. Industrial support schemes (both Central and State Government ones) ☐
g. Others Please Specify ________________ ☐

5.5 Please rank the above stated policies, in order of importance.

	Policy	Nature of Importance
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

Important = 1 Fairly Important = 2 Not Important = 3

SECTION SIX INFRASTRUCTURE FOR THE IT INDUSTRY

6.1 Do you find Bangalore's infrastructure to cater to the IT industry adequate as of today? Yes/No

6.2 Among the following aspects of infrastructure in Bangalore, please mention the level of importance attached, and your ranking as an IT Firm of the infrastructure provision and supply.

		Level of Importance Important = 1 Fairly Important = 2 Not Important = 3	**Rank** Good =1 Fair =2 Poor =3
1.	Uninterrupted power supply	☐	☐
2.	High speed/ multi-speed, voice, data, Video communication link	☐	☐
3.	Availability of space	☐	☐
4.	Land cost (acquisition, rent)	☐	☐
5.	Test facilities (for example to do dry run of the programme codes)	☐	☐

SECTION SEVEN PROBLEMS

7.1 Please outline, the three most serious problem that you have to confront as a an IT Firm

1.

2.

3.

7.2 Will Bangalore be still the most favourable location for the IT industry in India?

Yes/No

7.3 Please provide reasons to support your answer to the above statement

1.

2.

3.

7.3 Any suggestions...

Thank you very much for your co-operation. May I reiterate that all the information collected from you/your firm will be used only in the context of the present research, and shall not be passed on to any third party. If you consider that you have provided sensitive information, and wish to see the way it has been recorded, the researcher will be glad to provide you with the information concerning your firm, and shall be published only with your consent.

Appendix 2

How to manage IT outsourcing?

In a four year study on outsourcing, McFarlan and Nolan (1995), have explored in detail the reasons for outsourcing, and state the following as the major reasons:

a) *General Managers' concerns about costs and quality.* The same questions about IT costs and response times came up repeatedly. Can we get our existing services for a reduced price at acceptable quality standards? Can we get new systems developed faster?
b) *Breakdown in IT performance.* Failure to meet service standards can force general management to find other ways of achieving reliability. An additional driving factor is the need to rapidly retool a backward IT structure to maintain its competitiveness
c) *Intense Supplier Pressures.* The fear of not being able to complete an assignment forces the companies to choose outsourcing. For if they are unable to complete the project on time, the client will be able to give the next project to some other competitor.
d) *Simplified General Management Agenda.* A firm under intense cost or competitive pressure, may find that outsourcing is a way to delegate time-consuming, and low-end IT jobs. But firms do outsource even most sophisticated IT jobs, primarily due to lack of time, or due to better service offered by the outside agency.
e) *Financial Factors.* Severe financial issues can make outsourcing appealing. An important part of many of the arrangement struck in the past two years has been the significant up front capital paid for both the real value of the hardware/software assets and the intangible value of IT assets.

Source: McFarlan and Nolan, 1995

Appendix 3

The truth about IT outsourcing

One of the good things about outsourcing, according to Rothery and Robertson (1995:5) is that large corporations are outsourcing even R & D work in IT to small companies, and that according to them, puts a brake on fears that large fortress-like cartels may gobble up all of industry and put small to medium sized enterprises (SMEs) out of business. These have a versatility and ingenuity which the larger companies need. Outsourcing, combined with other techniques, is creating a whole new sophisticated environment for the customer-supplier activity, according to them.

Rothery and Robertson (1995:105-120), quote a PA Consulting Group, UK study on IT outsourcing in 1993, and the following is based on that. The study is based on the directors' experiences and views of IT outsourcing. The key findings are as follows:

- There is widespread and growing use of outsourcing in all aspects of IT, from strategy through delivery
- This use is chiefly tactical, with short-term contracts covering only a few aspects, rather than long-term, strategic contracts for substantial IT service provision
- The benefits of outsourcing are not just in cost cutting, but also in the delivery of business and IT service improvements.
- There are high levels of concern about IT outsourcing, with significant number of organisations reporting problems of cost escalation, over-independence and a lack of flexibility from their suppliers
- IT outsourcing is increasingly becoming popular, but both the purchasers and suppliers must work to establish mutual confidence.

Of those surveyed, 74 percent were already outsourcing some IT services, or were considering it. This is a big increase from 1990, when the US Yankee Group survey showed that two-thirds were opposed to outsourcing. Over 70 percent of contracts were for less than £ 1 million and 78 percent were for three years or less.

There is more caution being demonstrated, possibly what is known as 'smartsourcing', or fragmenting the operations into more manageable pieces so that they can be evaluated separately and independently as candidates for outsourcing. For example, it may be beneficial to outsource the help desk part of operations, rather than employ the wide range skills needed to support all the installed applications and Personal Computers (PCs).

IT organisations are moving from internally focused management information systems (MIS) to service-led MIS. This change means that they are focusing on the performance of the services they are delivering to users as opposed to the traditional data centre operations. This again is enabling them to pick off services that are delivering to users as opposed to the traditional data centre operations. This again is enabling them to pick off services that are more readily outsourced. For example, the traditional IT department used to measure things like the central processing unit (CPU) utilisation, disk storage, lines of code written and so on. The wise ones today are measuring things like number of outstanding user requests, availability of the computing service, mean time to fix problems and number of applications right first time- all of which are aspects of customer service.

The 11 services most actively considered as candidates for outsourcing, according to the survey, were:

1. systems and technical strategy
2. business analysis
3. system analysis and design
4. application development and implementation (*a growing area in outsourcing*)
5. network design and implementation (*survey identifies as a high growth area*)
6. data centre operations
7. network operations (*future high growth area*)
8. applications maintenance (*most frequently outsourced function*)
9. technical support (*another popular function for outsourcing*)

10. end user support and help desk

IT Managers no longer feel threatened.

'Turkeys do not vote for Christmas' was a criticism levelled at certain IT managers who resisted looking at the benefits of outsourcing for fear it might cost them their job. On the contrary, the survey found that IT directors led the way in outsourcing and staff were prepared to look outside to get the best service for their companies.

Difference between public and private sectors.

In the public sector, PA had expected the level of activity to be spurred on by market testing, or the obligation to compare value for money from internal service provision with that from private sector. According to the survey, the public sector is marginally more likely to outsource services such as systems and technical strategy and business analysis, ***but there is no clear cut distinction.***

Conclusions from the survey

For some organisations, the buying-in of IT services is regarded as a valuable tool in:
- gaining access to certain new skills
- smoothing peaks and troughs of demand
- providing a means of demonstrating the value for money being delivered in-house

For others, it is much more a question of securing the longer-term supply of up-to-the minute technology and IT skills and the rapid delivery of new applications, backed up by the formality and rigour of service legal agreements.

Source: Rothery and Robertson, 1995

Appendix 4

The YANKEE 100 survey

The US research company, The Yankee Group, carried out a survey of 100 companies most of whom, but not all, are US based. The findings were published in 1993 in a report entitled 'The Yankee 100'. The following is a summary of the survey.

The purpose of outsourcing

In order of importance the purpose of outsourcing by the companies surveyed was:

- to control IT costs
- to accomplish change
- to gain expertise
- to improve IT generally
- to make IT more responsive
- to off-load management
- to focus on core business
- to liquidate (get rid of function).

The benefits sought from outsourcing

In traditional outsourcing arrangements the "expertise" was in the area of efficient operation of a data centre running batch and on-line transaction processing (OLTP) applications. Today, there is much more variety and complexity at both the system level (from mainframes to networks, desktop, and client/server) and the applications level (from batch and OLTP application to office, work flow, decision support, and more). This increases the complexity and expense needed to master IT, and increases opportunities to make wise use of the outsourcing approach, according to the survey. In addition to cost containment, the benefits sought from outsourcing by 107 companies are shown below (in order of importance).

Benefit sought	***Percentage of companies***
expertise	36
quality/improvement/excellence	25
timeliness (better lead times)	18
reliability, stability	13
track record (to improve image)	10
improved business	9
temporary*	8
cost	8
fit	7
new technology	6
transfer**	3
none	3

* where an opportunity to concentrate on other things was obtained

** the survey report is not clear about what this particular benefit is, but probably it means to move the function within the company

Companies opposed to outsourcing

The following table shows the percentage of companies opposed to outsourcing:

Year	*IT Companies opposed to outsourcing*
1989	66%
1990	51%
1991*	34.5%

* This figure shows how rapidly outsourcing came to be an accepted strategy in the IT managers' armoury; from outright resistance in 1989 to a complete reversal in 1991. Yankee Group ceased asking this question at this time. Today they believe that there is no organisation that would oppose outsourcing as a strategy.

The percentage of Yankee 100 respondents who were signing outsourcing contracts had risen from 2 percent in 1989 to 19 percent in 1993. Total expenditures on outsourcing world-wide of these companies rose from $26 billion in 1989 to $50 billion in 1994 (Rothery and Robertson, 1995: 115).

The current state of IT outsourcing

IT vendor companies such as Digital and IBM, together with research organisations, such as Input, Yankee, all concur that outsourcing is the fastest growing sector in the IT market, growing at 20-30 percent a year. As IT is a mature function, this is an indication of the general growth of outsourcing and of great potential for other functions.

Source: Rothery and Robinson, 1995

Appendix 5

Major IT companies in the US (1995 sales in $ billion)

Name of the Company	Sales Figure
Companies Posting Sales between 100 -10 ($ billions)	
IBM	72
Hewlett Packard	32
Motorola	27
Xerox	19
Intel	16
Compaq	15
Digital Equipment	14
Texas Instruments	13
EDS	12
Apple	11
Companies Posting Sales between 10 -1 ($ billions)	
Microsoft	7.4
Unisys	6.5
Sun Microsystems	6.4
Seagate	5.5
AMP	5.2
Dell	5.0
Packard Bell	4.6
Computer Sciences	4.1
Gateway 2000	3.7
Micron Technology	3.6
Oracle	3.5
Quantum	3.4
Computer Associates	3.2
Cisco Systems	2.7
Silicon Graphics	2.5
AST Research	2.5
National Semiconductor	2.4
Advanced Micro Devices	2.4
Tandem	2.3
Novell	2.0
Storage Tek	1.9
Bay Networks	1.7
Amdhal	1.5
Entex	1.5
3 Com	1.3
LSI Logic	1.3
Data General	1.2
Intergraph	1.1
Sybase	1.0
Wang Laboratories	1.0
Cabletron System	1.0

Note: Hard Disk Drive (HDD) companies, and Modem manufacturers have been excluded from the above table

Source: Business Week 1000 (March 25, 1996), Fortune 500 (April 29, 1996)

Appendix 6

The Top 10 Japanese IT vendors

Vendor	Sales in 1994 (US $ billion)
Matushita	70.0
Toshiba	47.0
NEC	37.0
Fujitsu	34.0
Mitsubishi	32.0
Canon	19.0
Hitachi America	14.0
Ricoh	10.2
Oki	6.4
Seiko Epson	4.0

Source : Business Week 1000 (March 25, 1996), Fortune 500 (April 29, 1996)

Appendix 7

Currency conversion rates

US $ to Indian Rupee

1980--Rs.7.75;	1980/81--Rs.7.90;	1981--Rs.8.70;	1981 82--Rs.9.00 ;
1982--Rs.9.50;	1982/83--Rs.9.70;	1983--Rs.10.20;	1983 84--Rs.10.30;
1984--Rs.11.50;	1984/85--Rs.11.90;	1985--Rs.12.15;	1985 86--Rs.12.20;
1986--Rs.12.60;	1986/87--Rs.12.80;	1987--Rs.12.90;	1987 88--Rs.13.00;
1988--Rs.14.00;	1988/89--Rs.14.50;	1989--Rs.16.00;	1989-90--Rs.16.60;
1990--Rs.17.50;	1990/91--Rs.17.90;	1991--Rs.22.20;	1991 92--Rs.24.50;
1992--Rs.29.60;	1992/93--Rs.30.50;	1993--Rs.31.40;	1993 94--Rs.31.40;
1994--Rs.31.40;	1994/95--Rs.31.40;	1995--Rs.31.40;	1995 96--Rs.32.10;
1996--Rs.35.60;	12/1996--Rs.35.92;		

Source: Heeks (1996); Financial Times (1996)

Appendix 8

The Software Engineering Index (SEI) : Various levels

Level 1: Initial Processes

- SEI: 'Unpredictable and poorly controlled'
- Includes nearly all 'unprepared' organisations.
- No entry requirements, so skills may greatly vary

Level 2: Repeatable Processes

- SEI: 'Can repeat previously mastered tasks'
- Focus on management and tight project control.
- Focus on collecting various types of 'trend' data.

Level 3: Defined Processes

- SEI: 'Process characterised, fairly well understood'
- Focus on software design skills, design tracking
- Focus on various types of traceability

Level 4: Managed Processes

- SEI: 'Process measured and controlled'
- Focus on technology management
- Focus on estimates/actuals, error-cause analysis

Level 5: 'Optimising' processes

- SEI: 'Focus on process improvement'
- Focus on rapid technology updating, replacement
- Focus on optimisation to reduce errors.

Source: World Bank, 1992

Appendix 9

Typical case of firm level information provided by Dataquest, 1996

112

Comptech Electronics Private Limited

Comptech Electronics Private Limited grew by a moderate 27 percent in the last fiscal at a total revenue of Rs. 11.72 Crores. Despite a substantial drop in peripherals prices, the company managed to maintain its rapid growth in the last fiscal. Comptech has reported to have sold about 24,000 pieces of its range of monitors (VDUs) which accounted for its entire revenue. While the manufacturing sector accounted for 60 percent of the company's revenue, 15 percent came in from banking, finance, and telecommunications.

Year of Star-up: 1989
Products/Services: Monitors, VGA Cards, Motherboards
Technical Collaboration: Chuntex Electronics Co. Ltd.
Turnover: Rs. 11.72 Crores
CEO: Vikash Chandra
Employees: 90
Head Office: HSGW Campus, Athipet, Ambattur, Madras 600 058
Tel: 6258429, 6257982
Fax: 6257980
Branch Offices: 6

Source: Dataquest, Vol. 2, July 31, 1996: 211

Appendix 10

Government of Karnataka New Industrial Policy 1993

Having regard to the available natural and human resources in the state, and in line with the liberalised economic, industrial and trade policies enunciated by the Government of India since 1991, Government of Karnataka resolved to adopt the following policy initiatives:

A.

- Package of Incentives and concessions will be restructured to promote development of industries in all sizes (tiny, small-scale, medium, and large scale).
- Non-polluting, high technology industries shall only be encouraged within Bangalore South and North Taluk, including the Bangalore Urban Agglomeration area.
- In order to attract entrepreneurs and to enable regional development in the state (since licensing has been removed for most industrial products), most of the talukas in Karnataka have been identified as 'developing areas' and eligible for incentives and concessions.
- A special thrust will be given for promotion of mega projects which have scope for development of ancillaries. Projects of Rs. One billion and above will be given tax concessions and facilities on the merits of each case.
- Capital investment subsidy shall be offered to tiny and SSIs. Sales Tax exemption/sales tax deferral shall be offered for tiny/small/medium and large scale industries

B.

Special emphasis will be laid for improving and strengthening infrastructural facilities for the industrial sector. To achieve this a Nodal Authority will be created to manage and maintain industrial areas and estates in important locations and this authority will take care of improving and strengthening power, water supply and telecommunications facilities in these industrial areas/industrial estates.

C.

Infrastructural development agencies of the state (KSSIDC, KIADB, KEONICS) will develop specialised industrial estates/areas, with full complement of infrastructural facilities, in important Growth Centres of the state. In particular, the following projects will be completed in the next three years time.

- Growth Centres at Hassan, Raichur and Dharwad
- Electronics Cities in Mysore and Dharwad
- Export Promotion Industrial Park

D.

Conversion of agricultural land to industrial land in identified 'industrial zones' of the respective municipal/Town Planning authorities will henceforth need no prior approval of the Government.

- Bangalore has grown to be an important centre particularly for high technology industries. At the same time it is necessary to preserve and maintain the ecology and environment in Bangalore Urban Agglomeration area. To achieve this, only non-polluting industries in the electronics, telecommunications, IT, ready made garments, including leather garments (but excluding tanneries) precision tooling industries will be encouraged in BUA, Bangalore South and North Talukas. All other categories of industries will be encouraged outside the above areas mentioned therein.

- In order to utilise the industrial and infrastructural base of Bangalore and to derive spin off benefits of these developments, industrial townships will be developed around Bangalore region in Kanakapura, Ramanagaram, Tumkur, Doddaballapur, and Malur-Kolar.

Government of Karnataka: Package of incentives and concessions- 1993-98

Salient features of the New Incentives Package 1993 are as under:

- Reclassification of developed and developing areas

Zone I:	**Developed areas-** Bangalore South and North talukas and Bangalore Urban agglomeration as per 1991 Census
Zone II	**Developing areas-** All the remaining parts of the state- 173 talukas
Zone III	**Growth Centres-** Dharwad, Hassan and Raichur, and any other area as notified at a later stage.

- Electronics, telecommunications, computer software, ready-made garments are some of the sectors that have been identified as the thrust sector in the state. and their development would be given highest priority

- Electronics, telecommunications, computer software, precision tooling, ready-made garments are the only industries which will be allowed to be set up in the developed areas (see above).

Appendix 11

Institutions providing industrial infrastructure and supporting facilities in Karnataka

Like most states in India, Karnataka also has number of "development corporations". In the following some of the corporations that have long standing contribution towards attracting industrial investment in the state. Some of these institutions might appear to have overlapping functions also. Almost all these corporations have their headquarters in Bangalore.

Karnataka State Financial Corporation (KSFC)

The KSFC is a state level development financing institution. The main objective of KFSC is to finance and promote small and medium industries in the state for achieving balanced regional growth, catalyse investments, generate employment and widen the ownership base of industry.

The KSFC was established in 1959 under the State Financial Corporation Act, 1951. Financial assistance provided by the KSFC to the industrial units is in the form of term loans, direct subscriptions to equity/debentures, guarantees, discounting of bills of exchange and seed/special capital. The KSFC operates a number of schemes of refinance and equity-type assistance on behalf of the national level- Industrial Development Bank of India (IDBI) and Small Industries Development Bank of India (SIDBI).

Karnataka State Industrial Investment and Development Corporation (KSIIDC)

The KSIIDC was set up under the Companies Act of 1956, as a wholly-owned state government undertaking for promotion and development of medium and large industries. The KSIIDC acts as a catalyst for industrial development and provides impetus to investment in the state. The assistance provided by the KSIIDC is in the form of term loans, underwriting/direct subscription to shares/debentures and guarantees. It undertakes a range of promotional activities such as preparation of feasibility reports, conducting industrial potential surveys etc. The organisation is also involved in setting up medium and large industrial projects in the joint sector/assisted sector in collaboration with the private entrepreneurs. The KSIIDC also offers a package of developmental services which include technical guidance, assistance in plant location, and coordination with other agencies. Recently, the organisation has also ventured into equipment leasing and merchant banking.

Karnataka Industrial Area Development Board (KIADB)

The KIADB develops industrial areas in various parts of the state, with the requisite facilities such as roads, power, water, telecommunications etc. The KIADB is also the nodal agency responsible for the development of the growth centres in the state.

Karnataka State Small Industries Development Corporation (KSSIDC)

The KSSIDC provides inputs such as shed in industrial estates and raw materials. It targeted at the small scale industries in the state. It provides assistance to SSIs by disseminating information on SSIs development, and marketing advise through its subsidiary, the Karnataka Small Industries Marketing Corporation.

Karnataka State Electronics Development Corporation (KEONICS)

The KEONICS has been working for the promotion of electronics industries in the state, by participating in the joint ventures in the state (most of those joint ventures have become defunct). The organisation is also responsible for the provision of infrastructural facilities for the electronics industry in the state. KEONICS has established the Electronics City outside Bangalore, and has proposals to set up such Cities in Mysore and Dharwad in association with the KIADB.

Industrial Finance

Credit facilities for industries are channelised through a number of all-India and state level financial institutions besides scheduled, commercial and rural banks. These institutions apart from extending financial assistance in the form of term loans and working capital also provide developmental support in various forms such as venture capital, seed capital/soft loan, subscription to equity, providing guarantees and discounting facilities, financial services etc.

Research and Development Organisations

Karnataka has a large share of the R&D organisations in the country. It houses over 30 national laboratories and R&D institutions, most of it located in Bangalore. These institutions offer indigenous technologies, collaborative research for product/process modification and development, design and testing of prototypes and testing and certification. Apart from these institutions, there are a large number of industrial units in the state, which *inter-alia*, pursue R&D regularly. Most of these units are recognised by the Department of Scientific and Industrial Research (DISR), Government of India.

Source: TECSOK, 1994

Appendix 12

Methodology adopted by Gallup Organisation in conducting the study

The sample comprised of 820 respondents, across four categories: Chief Executive Officers (CEOs) of leading private and public sector companies (82); senior and middle managers (322); spouses of executives belonging to these two categories (308); and business management students (110). Thirteen parameters for judging a city were presented to the respondents, which were: cost of living; housing; traffic and commuting; law and order; health care; adequate air and surface connections; climate; cosmopolitan nature; recreation and entertainment facilities; career growth prospects; cleanliness and pollution levels; and life.

Each respondent was also invited to suggest other parameters, and then pick the eight parameters most important to them, and identify the best city, other good cities, the worst city, and other bad cities under each of the parameter. Next the respondent were also asked to name the best overall city, the second best overall city, and worst and second worst overall city, taking all these parameters into consideration.

The scoring was done in the following manner: Under each parameter, a net score was derived for every city. The scoring formula was: two points for every mention as the best city. One point for every mention as the second best city, minus two points for every mention as the worst city, and minus one point for every mention as a bad city.

Evaluation: To identify the best cities overall, only the net scores computed under the best overall city parameter were used. Net scores computed under the best overall city parameter were used. Net scores from the four different categories of respondents were combined to derive a summated net score, using the following weightages: CEOs :0.4; Managers: 0.3; Spouses: 0.2; MBA Students: 0.1.

The four results thus calculated were added to compute the summated net score for each city, and the 20 cities ranked accordingly. Also net scores under each category and parameter were used to rank the 20 cities under each category and category of respondents. These parameters- or issues of concern- were also ranked for each respondent category in order to establish its priority. Each respondent was asked to the eight parameters from one to eight. A parameter was given eight points every time it scored first, and it was given one point, every time it scored eighth position.

Source: Business Today, Dec. 1994

Annexure 13

Methodology adopted by the Business World study, 1995

This Survey was conducted in 16 cities across the country and had a total respondent base of 252 people. The sample was drawn from three categories: owners/industrialists who have made investments of Rs. 1 Billion during the past five years (sample size 1991); general managers in the manufacturing, finance or corporate planning areas in large companies with a turnover of Rs. 1 Billion or more (73); and senior managers from the project appraisal departments of banks and financial institutions (88). The zone wise distribution of the sample was north (36), west (85), south (70), east (30), and central (31).

The respondents were first asked to rate three states and the worst three states for setting up an industry. They were then asked to enumerate what they felt were the critical factors that qualified a state as an attractive investment site. Then, the respondents were asked to read-out a re-decided set of attributes on each of which they had to rank the 19 chosen sates as very good, good, fair, and poor.

Both the order of the states and that of the attributes were rotated from respondent to respondent in order to avoid any kind of order bias that could distort the results. The responses were then translated into a four-point scale and the mean score for each state was worked out for each parameter. The states included in the survey were Andhra Pradesh, Bihar, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, the North eastern states, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

After the states were rated on each parameter, a composite ranking was worked out averaging the scores obtained earlier. Finally, the respondents were asked to list the states that made the major promotional efforts to boost investment.

Source: Business World, 1995