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Thesis

Title: Pune's Information Technology (IT) Industry - a Boon or a Bane?

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UMD 7

Abbreviations

CO_2: Carbon Dioxide

CH_4: Methane

ESR: Environment Status Report

F.S.I: Floor Space Index

GHGs: Green House Gases

Gms: Grams

IT: Information Technology

INR: Indian Rupees

kWh: Kilo Watt Hour

MCCIA: Mahratta Chamber of Commerce, Industry and Agriculture

MSEB: Maharashtra State Electricity Board

MSEDCL: Maharashtra State Electricity Distribution Co Ltd.

mWh: Mega Watt Hour

NASSCOM: National Association of Software and Services Companies

Pcld: Per Capita Litres per Day

PMC: Pune Municipal Corporation

PSR: Pressure State Response

STPI: Software Technology Parks of India

SEAP: Software Exporters Association of Pune

USD: US Dollars

Abstract

Touted as one of the important IT hubs in India, Pune also has the dubious distinction of being one of the highly polluted cities in India.

The IT industry is considered as one of the biggest industries of Pune, and as the thesis tries to explore widespread spin-off effects. The IT industry was welcomed with open arms into the city as per the IT policy of the State government of Maharashtra. Many environmentalists have often stated that Pune has grown out of control because of the IT industry. That the various tax concessions and allowances have not been contributing enough, and the massive development that has taken place has affected the city's environment. Pune's IT industry – A Boon or A Bane? - is to explore the realism in this perception. The main objective of the thesis is to map the range of economic and environment effects of the IT industry.

Using the OECD Pressure State Response framework, various environment effects are identified and analysed. Where data has not been available, scenarios have been created to project the scale and level of possible effects of the IT industry in the city. In terms of environment the effects of IT industry have been explored two-fold - the industry level and the employee level. The reason to include the latter was to examine the entire gamut of environment effects due to the industry in the context of high migration and high consumption by employees. Various kinds of analysis have been used to process the data that was available, and draw conclusions. In terms of environment effects at the industry level, e-waste and transport congestion come out very strongly compared to electricity consumption. At the employee level, an overview of what the additional pressures on land (housing) and basic services, electricity and transport is created. Viewed within the lens of the effect of an industry, one can summarise that these are high pressures for the city.

Economic effects have been expressed through the taxes and revenues that the city receives from the IT industry; and the employment created. These have been classified as direct and indirect effects. From the data gathered and most importantly from the interviews, the economic effects for the city are considered to be high. Unfortunately, the city does not have a way to monitor these effects through a cost and benefit analysis. At some points, the thesis explores these connections such as by calculating carbon dioxide mitigation costs, or the cost to recycle one ton of PC e-waste.

The thesis also looks at the implementation of the IT policy in the city. Not all of the clauses are implemented by the city of Pune. This is mostly in terms of the collection of the octroi tax, which the IT policy essentially waives off; and the tax rates for property, which have recently been increased. In terms of effects of some of the clauses, the thesis tries to put into perspective the connection between traffic congestion and the allowance of double FSI for the IT industry. Based on the overall results of the thesis, interviews and the literature review a number of recommendations have been made.

Given the nature and scope of the thesis, it was not possible to dwell in deep on each aspect. Also given that wherever data was not available, scenarios have been created which project the possibilities but may not be absolute. In terms of the methodology used to analyse the environment effects, the PSR framework helps scientifically define various indicators and establish a cause and effect relationship. Improvisations can be made on the basic model, and can be used for other kinds of analysis as well

To finally conclude the thesis makes perspicuous the overall effects of an economic policy by mapping the economic and environment effects as a consequence of that activity.

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Foreword

The IT industry: A Boon or A Bane?, is a humble attempt to put into perspective the possible scale of the effect of the new economy or knowledge economy on cities like Pune. It is akin to building a weighing scale of looking at economic effects and environment effects.

The thesis topic selected was for varied reasons, but the most important one was my chance to experiment within an atmosphere that could lend the analytical, intellectual and creative support that I would need. This was coupled with the desire to come up with something simple to use in the near future for municipalities to assess the costs and benefits of the activities they promote. Being an environmentalist for many years in Pune, many occasions came up when the word passed on how the IT industry was a big reason for the city'. I initially shrugged the idea and that was also because the possible connections were not too clear. With IHS, the connections manifested more clearly and I was keen to solve this little riddle of what has been some of the impact of the IT industry on Pune.

The other trigger to take this topic on was my involvement in looking at the "economic vision" that was being proposed by a certain organisation. It was interesting to see how more and more economic niches (biotechnology, animation) were being proposed in total absence of a dovetailing process which integrated environment and social objectives. As usual, those were being built upon separately. For the moment and within the existing economic system, growth is inevitable. Urbanisation continues albeit at an accelerating speed. In this scenario, it would only make better sense in the given environment of better information, climate change and environment problems that the cities begin to track and connect the three pillars of sustainability – economics, environment and social.

Little is an understatement when it comes to comprehending the whole range of impacts that a large scale economic activity has on the city, and especially when the city does not have most of the data. When Pune talks about sustainability, it cannot be true to its word till it begins putting ways and means to measure and compare the different activities it pursues. It is a sincere hope that this thesis comes of good use!

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Chapter 1

1.1 Background

Pune lies on the western side of the Deccan Plateau on the banks of two rivers. It is 560m above the sea level and is characterized by hills on the west and the south. Earlier known as a hill station, Pune is now the eighth most populous cities of India and the thirteenth most polluted city (SIIB).

Figure 1: PMC (2006)

The Pune Municipal Cooperation (PMC), formed in 1950, covered an area of 138 km2 which held a population of 606,77,7. In 1991, the PMC area of 145.9 km2 held a population of 1,566,651. The recent population estimated is 3.5 million as per the latest Environment Status Report over an area of 243.84 sq km. In the last 50 years, the city's Population has grown by 50% (PMC 2010). It has further been estimated that 50% of population growth has been on account of migration (PMC 2006).

Census Year	**Population Total**	**Decadal Change**	**Growth Rate**
			(%)
1951	488,419		
1961	606,777	118,358	24.23
1971	856,105	249,328	41.09
1981	1,203,363	347,258	40.56
1991	1,691,430	488,067	40.56
2001	2,538,473	847,043	50.08

Table 1 : Pune's Population Growth Rate 1951-2001, PMC(2007)

The driving force for growth has been attributed to the development of the Information Technology (IT) industry in Pune. During the last five years, the national government has focussed on IT related infrastructure, and fiscal incentives to IT units.

These initiatives have enabled the IT industry in the state (province) of Maharashtra to establish a firm foundation in some cities like Pune for the IT sector growth to accelerate.

Exports of software and IT based services from Maharashtra account for about 20% share of the country's exports. During 2008- 09, software exports from Pune totalled $5,228 million, accounting for 60 per cent of the $8,786 million from Maharashtra (Kshirsagar 2010)

All this has been facilitated by the IT policy which was introduced in the year 1999 and reinforced in 2003 and further enhanced in 2009 by the State Government of Maharashtra to boost economic growth. The policy provided an array of benefits such as stamp duty and tax reductions, land permissions and concessions for development, subsidised rates for electricity etc.

1.1.1 Understanding the IT Policy:

The IT Policy of Maharashtra 2003 (IELD 2003) defines Information Technology Industry as a composite of IT Software, IT Hardware, IT Services and IT Enabled Services.

- **IT Software:**

  IT Software is defined as any representation of instruction, data, sound or image, including source code and object code, recorded in a machine readable form and capable of being manipulated or providing interactivity to a user, with the means of a computer.

- **IT Hardware:**

  IT Hardware covers approximately 150 IT products notified by Directorate of Industries

- **IT Services and IT Enabled Services (ITES):**

  IT Service including IT Enabled Service (ITES) is defined as any unit that provides services that result from the use of any IT Software over a computer system for realizing any value addition such as web based sale and marketing, customer service, and billing and accounting transactions

The main objective of the IT policy is to make Maharashtra the most favoured destination for investments in the IT industry referred to as IT and ITES units in the policy. Quite naturally, the policy assumed that the growth of the IT and ITES units in cities will benefit the cities themselves in many ways, therefore the policy categorically states that the city governments need to take the extra effort in promoting business and enterprise in the IT industry. Some of the crucial changes that the policy aims to achieve are outlined through some of the following means

- Levying of power charges on IT and ITES units at industrial rates
- As IT and ITES units do not cause any pollution they would be exempted from environment clearance.
- IT and ITES units would be exempted from paying octroi tax on all capital goods and raw materials purchased by them.
- Property tax on all establishments/properties/buildings/premises of IT and ITES units would be levied on par with residential premises.
- 100% additional Floor Space Index would be given to all IT and ITES units in public IT Parks.
- 100% additional Floor Space Index would be given to all IT and ITES units in private IT Parks of specified sizes subject to the payment of a premium of 25% of the present

day ready reckoner. Twenty five percent of which goes to the state government and 75% to the used by the municipal corporation, for the development and up-gradation of off-site infrastructure required for the IT and ITES units.

- Construction of IT and ITES units would henceforth be allowed in residential zones provided the plots are on roads having a width of more than 12 m.
- Construction of IT and ITES units with ancillary residential area would be allowed in No Development Zones (such as green belt areas) subject to certain conditions which includes the plantation of trees – 500 per ha.

1.2 Problem Statement

There is no doubt that the IT policy has worked for Pune, and the IT industry has grown by leaps and bounds spreading across the city. The industry has attracted a lot of migrants and increased incomes of many a households. Pune has a burgeoning software industry with over 1000 IT and ITES units employing around 220,000 people, 60% of which is migrant population (MCCIA 2009). During the last eight years, this sector has grown from Rs 25 million to Rs. 650 million (Kshirsagar 2010).Almost all of the major software players in the country have a base in Pune. This growth in itself has led to the growth in other complementary sectors, for example the rise in construction activity and educational institutions has been widely attributed to Pune's new face as the emerging IT hub of India (PMC 2010).

On one hand as the industry has provided economic benefits, while on the other, directly and indirectly there have been ripple effects on the environment through the rapid economic growth. This is due to the surge in demand for land, energy, housing, transport, waste, water and sewage, for the industry itself and for its employees who live in the city. The latest Environment Status Report (ESR) 2010 of the PMC states that air and water pollution is on the rise. The former has become a serious problem and the Respiratory Suspended Particulate Matter in the air is more than the standard national level and is responsible for the rise in respiratory ailments. Of the total sewage generated in the city, the PMC treats only 55 per cent while 45 per cent sewage is released untreated into the river. For every 1000 people there are 473 private vehicles which implies that there are two vehicles in every family in the city. The Groundwater Survey and Development Agency, has pointed to the depleting levels of ground water. Again according to the ESR, the PMC body supplies just ten per cent of the total demand of water for commercial purposes from the reservoirs. The rest is met by drawing ground water (PMC 2010). As one reads this in the context with the provisions of the IT policy, few questions come to the mind

- Is it possible to assume that the IT industry is non-polluting as stated by the IT policy? The industry per se could be relatively non polluting compared to other industries, but for it to function it needs a whole set of infrastructure and services to complement it, which consequently have environment impacts such as land use change from green belts to paved commercial surfaces, sewage and waste generation, air pollution increase due to increase in number of vehicles and the increase in e-waste generation. Additionally the IT industry is energy intensive which can be responsible for carbon emissions and other emissions based on the source of electricity; and could be one of the major sources of e-waste generation.

- It seems that the role of the master plan in the IT policy has been overlooked when allowing for IT development in No Development Zones such as green belts, increasing the FSI, and allowing IT units in residential areas. Pune city's existing master plan (1987-2007) is the blueprint that guides the city's development in terms of spatial land use such as building new structures, building codes, roads, recreation areas, open spaces and infrastructure which includes transport, utilities, etc. To have the IT industry make a strong entry point without looking at the existing plans in place for that period, could mean that additional pressure is being put on the current resources and infrastructure of the city.

- Taxes are an important revenue source for cities, and if there are tax exemptions indeed, how is the city going to pay for the additional infrastructural demands of cities such as water, sewage, transport, waste disposal and energy as needed by the growing industry? The Octroi tax for example is a very important revenue source for the municipal corporations in Maharashtra. For the city of Pune it contributes around 40% to its revenue sources (PMC 2006).

So while Pune's environment is at a decline, it would be useful to assess what is the contribution of the IT industry to some of the environment woes of the city and, if indeed some of these problems can be directly attributed to the what the IT industry has grown.

Given these perspectives, it is possible that the clear understanding of the implications of rapid growth on account of economic policies like the IT policy on the city is not clearly laid out. Viewed within the lens of sustainable development, specially looking towards environment impacts this industry needs to be thoroughly and comprehensively analysed. In addition there is no existing framework of indicators to analyse the sustainability of such industries, and it would also be useful to select indicators and frameworks for the same.

1.3 Research objectives

1.3.1 Overall Objective

The aim of this research is to analyze what are the economic and environment effects of the IT industry in the city of Pune developing a framework of indicators.

1.3.2 Specific Objectives

- Identifying and mapping the economic benefits of the IT industry to the city

- Identifying and mapping the main environment effects of the IT industry on the city.
- Identifying possible areas of change in the IT policy such that environment effects are taken into account.

1.4 Main Research Question

What are the economic and environmental effects of the IT industry in the city of Pune?

1.4.1 Sub-Research questions

- What are the main economic benefits of the IT industry to the city?
- What are the main environmental effects of the IT industry on the city?
- What particular aspects of the IT policy that promotes IT industry expansion, can be improved and amended?

1.5 Significance of the Study

Economic growth remains priority for most governments including citizens, and policies such as the IT policy are pursued strongly. But economic growth cannot function in isolation as it is dependent on services and resources that the environment provides by virtue of its own activities; and to support the population who in turn need the services and resources that the environment provides. There is no doubt that economic policies such as the IT policy aim to improve city competitiveness through the benefits and the infrastructure set-ups that attract economic interests. Yet in the long run a city remains attractive and competitive when it is liveable for the industry and for the people who are employed by the industry. A good social and environmental index contributes strongly to this liveability of the city. This in turn improves competitiveness and any policy decision needs to therefore understand these linkages and plan more holistically for (Cities Alliance 2008). Policies to deal with environment issues specifically associated with land use change (developing open plots, green belt spaces, conversion of agricultural land) remains on the superficial level of e.g. planting some trees. In cities like Pune, the intricate connections between economy and environment are not embedded in decision making processes, so effective measures are not taken or accounted for when planning for the city's growth and development.

The thesis aims to delineate and map these connections to improve the understanding of environment related problems of the city, as a consequence of economic growth policy. The study could contribute in improving the understanding the interaction of economic growth like the IT industry and environment in the city; its dependence of the environment and its subsequent effects.

As Pune plans for further economic expansion, a study like this would perhaps be useful in mapping the effects, both at the economic and the environmental level. It would not only be useful for decision makers, but also for the civil society and the citizenship to understand the implications of any action on the area they inhabit.

1.6 Scope and Limitations

The study is currently limited to sourcing information on the city level which is defined as the area within the jurisdiction of the Pune Municipal Corporation. It also does not extend to analysing the links and flows outside the city such as the provincial and national levels such as the contribution to growth rates, financial benefits, inter-regional benefits etc. The study would have a more strong basis if the direct, indirect and trickle down economic benefits could have also been analysed in depth, for example benefits at the employee level; for landowners and builders who have profited from the real estate development; local economic growth as a result of the larger expansion of the city; and ancillary industries and services that have grown as a result of the IT industry. But this would not be possible to cover in this thesis.

The thesis will be a static study, as the aim of the thesis is not to make an analysis of the effects of the IT industry over time, but to explicitly break down the kinds of effects that this industry can have for the city. Still, the need to compare information based on previous years was considered in this study, but given that the focus of the study is to develop a set of indicators that would help analyse what are the effects of the current IT industry on the city, current information would also suffice. Such a mode of research is also carried out in other forms of research and studies that have been reviewed during this thesis. Also the relationship between the effects and the growth of the industry are directly proportional in terms of service needs and resource use, and such a comparison may not necessarily add value to the study.

The study would have benefitted by looking at the social aspect as well, more in terms of the change in working patterns, and lifestyles such as call centre jobs, late working nights for women, change of roles etc. Additionally, it has also been pointed out that the IT sector's fast growth has worked more to the advantage of the well educated section of society. That would also be important to put into perspective while looking at the beneficial aspects of the IT industry.

Chapter 2: Literature Review

2.1 Introduction

At India's national, state and city level, economic growth is pursued strongly at the policy level. The IT industry has been hailed as one of the sectors that would give India the edge towards achieving and maintaining its high economic growth rate. There is no doubt that economy wide reforms if well designed have the potential to contribute simultaneously to economic, social and environmental gains. Yet developed in isolation, such reforms have adverse side effects and some of the obvious trade-offs are with the environment, which is what is currently happening in the city of Pune and also for most of the regions in India. In the current context of thinking, this link immediately raises the issue of potential conflicts between two powerful current trends—the market oriented economic reform process now widely accepted worldwide, and protection of the environment (Pearce, Barbier 2000, Munasinghe 1999). There are both pro and cons of economic reforms. On the one hand , they could improve the efficiency of production means and methodologies, reduce waste and improve energy efficiency, while on the other their intensity has ripple environmental effects such as pollution on water and air, waste and energy (Brännlund, Ghalwash & Nordström 2007). The literature presented below attempts at drawing these links by initially understanding the overall concept of economic growth, economic and environment interactions , understanding the implications of the IT sector within this context and if this sector can be termed as beneficial at the level at which it operates (such as the city). It is certainly not exhaustive but presents the key principles, concepts and methodologies that would be a guide towards this research work.

2.2 Economic Growth and Environment

2.2.1 Economic Growth

Economic growth could be narrowly defined in general terms as real Gross National Product (GNP) per capita, or real consumption per capita. There are two aspects that need to be looked at here in the context of growth, one is that economic growth is a unilateral process driven solely by economic pursuits and targets, and the second is that that such processes affect and are affected by the environment. But can we say our economy is sustainable if we have a dwindling supply of natural resources or growing trends of health problems due to pollution? Many believe that economic growth inevitably leads to more emissions and hence a degradation of the natural environment (Meadows et al., 1972 and Meadows et al., 1992 as stated in Brännlund, Ghalwash & Nordström 2007.

2.2.2 Economic and Environmental interactions

It is widely known that growth induced by successful economy-wide reforms are associated with the excessive environmental damage that it causes—for example, external environmental effects of economic activities such as air or water pollution (Atkinson 1997). While such growth is an essential element of meeting the economic well being per se, it does increase the overall pressures on environmental resources (for e.g. underlying pressures- population change, economic growth, structural change, land use changes, water demands, waste emissions) and changes the state of the environment itself (Munasinghe 1999). So there lies a crucial interdependence as economy impacts the environment and vice versa. Unfortunately environment problems are treated in isolation, and on the side lines in the working of an economic system, and yet the most essential feature about environment is that their working is pervasive in the economic system (Pearce, Barbier 2000) .

The figure below helps demonstrate the environment relevant flows that take place related to changes in policy.

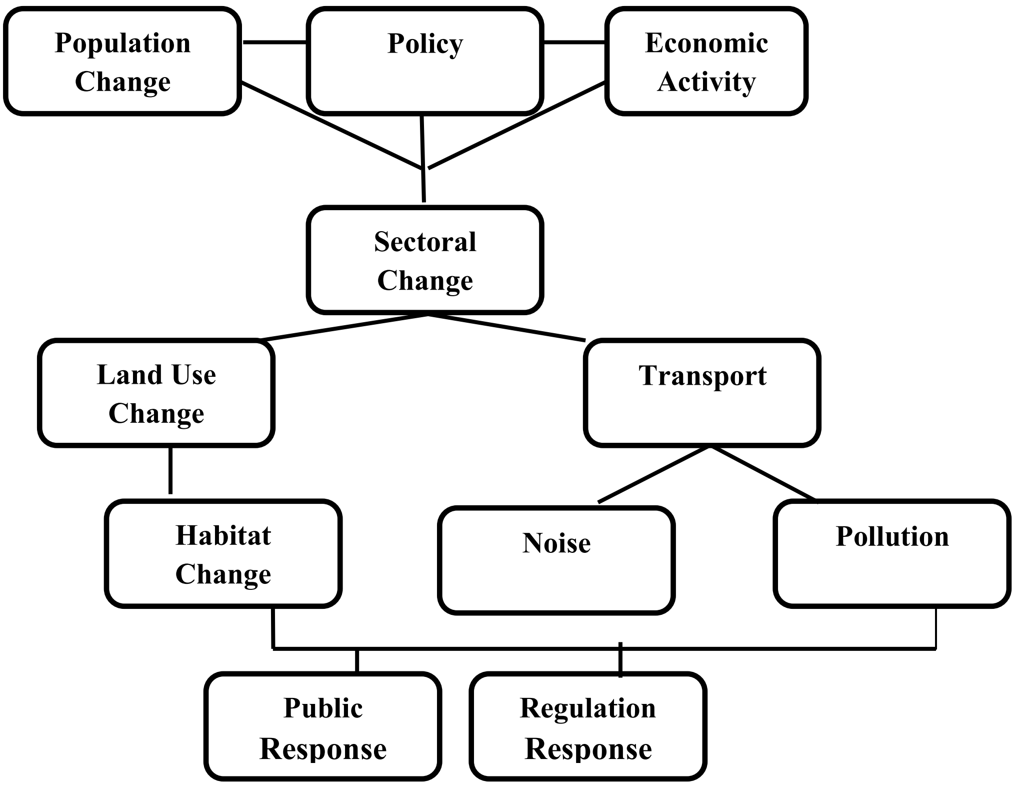


Figure 2: Policy changes and Environment, Atkinson (1997)

The interaction between the economic and the physical aspects of the environment is characterised by positive and negative externalities. Negative externalities i.e. negative external effects are those which are not paid for or compensated for by these activities themselves, and have unwanted effects. Cities are recognised to be the place where an intensive use of resources are detrimental to the environment through the production of greenhouse gas emissions such as of carbon dioxide, nitrous oxide or methane and wastes.

(Camagni, Capello & Nijkamp 1998) tabulate the interactions between economy and the physical environment aspects, and their positive and negative effects in table 2.

	Interactions between Economic and Physical Environments
Positive external effects	Efficient energy use
	Efficient use of non renewable natural resources
	Economies of scale in the use of urban environmental amenities
Negative external effects	Depletion of natural resources
	Intensive use of energy
	Water pollution
	Air pollution
	Depletion of green areas
	Traffic congestion
	Noise

Table 2: Positive and negative external effects in the interaction between the different environments in a city, Camagni, Capello and Nijkamp (1998)

Similar comparisons of externalities can also be drawn with the IT industry in Pune. Positive externalities would entail efficient technology and equipment, comparatively less paper offices, virtual modes of transactions altogether inducing better use of energy and other resources. Negative externalities would imply activities leading to changes in land use wherein farmlands, public (government owned) wastelands, hills, riverbanks, green belt areas in and around cities are converted into habitation, commercial or infrastructure (roads, bridges) uses. Other externalities would include energy use, air and water pollution, waste creation, and higher traffic volumes.

The natural environment provides cities with varied ecosystem services which may not be visible to urban managers and decision makers. For example, parks and greenbelts act as sinks for carbon dioxide (CO_2) and counteract the heat island effect of large built-up areas. They also provide essential open space for urban residents, flora and fauna, and counteract traffic noise. Reduced open spaces in turn can interrupt air circulation causing 2-3°C higher temperature than outside the city (Anonymous 2005).

2.2.2.1 Green Belt Development Effects

The IT industry is dependent on the availability of building infrastructure such as office space, parking, etc. The development of such infrastructure is often at the cost of urban green and open spaces which provide important services to the city and for the wellbeing of the citizens. These services are often referred to as ecosystem services. Bolund and Hunhammer (1999) analyze seven ecosystem services generated by ecosystems within an urban area. These are air filtration, micro climate regulation, noise reduction, rainwater drainage, sewage treatment, and recreational and cultural values. These locally generated ecosystem services have a substantial impact on the quality-of-life in urban areas (TEEB 2010).

In principle, Green belts zones are meant for preventing the urban sprawl and preserving natural areas in the precinct of the cities. In the case of Pune the effects of the IT industry on urban green spaces and its related ecosystem services are apparent. Though the urban master plan demarcates green belt zones in order to secure the above mentioned services to the city the IT policy is explicitly allowing the construction of IT infrastructure in this green belt area. This has resulted not only in the densification of built upon area but also the loss of important services. This is an important aspect to take into consideration while analysing the environmental effects of the IT industry

Cities can encourage good environmental practice and reduce these externalities provided they are able to understand such linkages by mapping such externalities and effects and using indicators that would help decision making, such as the ones mentioned above (Cities Alliance 2008).

2.3 The Information Technology (IT) Industry and its Implications

2.3.1 Information Technology

For the thesis, part of the literature review looks into the research on ICT (information and communications technology - or technologies) which is strongly applicable to the IT industry. A broad definition of the commonly used term for Information technology is ICT which is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning (Anonymous 2003).

In the context of the IT industry, promotion in the city of Pune is based on a strong assumption that it is a non-polluting industry. In part, the literature review attempts to look at the strength of this assumption. However, making a case on what is called relatively clean technology compared to other forms of industry such as manufacturing and processing is not straight forward. Some researchers even argue that the decline of energy intensity in the U.S. economy, for example, over the past ten years can be attributed in part to the growing e-commerce and IT sectors. Decreasing energy consumption would mean the reduction of the greenhouse gas (GHG) emissions and thus make the goals of Kyoto Protocol easier to achieve (Sui, Rejeski 2002). Obviously, the emerging digital economy in principle has great potentials for positive environmental impacts, which have been generally summarized as the three D’s for the new economy: dematerialization, decarbonization, and demobilization (Sui, Rejeski 2002). These concepts are explained in the next section. That rationale could also be why prima facie the IT policy acknowledges the industry as non-polluting but this of course remains debatable and dependent on different contexts and specifically that of the setting in which this is being discussed. So, the assumption in the IT policy that states the IT industry is not a polluting one is indeed worth looking at. By a certain rationale of thinking within the specific construct of effluents and waste, then one could categorise it as relatively non-polluting yet aspects of e-waste and energy consumption cannot be discounted

There is a long-standing discussion of how growth and technological progress affect the natural environment. Mumford (1934), Landes (1969), Headrick (1990), Rees (1992), Bowers (2000) reflect that historically, major technological innovations have not only brought fundamental change to the economic system but also far-reaching environmental impacts (Sui, Rejeski 2002). In fact, contemporary environmental problems can be traced to the sudden acceleration in the rate and power of technological innovations. While many business leaders and scholars contend that sustainable development hinges on the further development of knowledge-based industry and of innovative technologies, studies in areas such as the Silicon Valley, do show trends of environment degradation and concerns.

2.3.2 Understanding the environmental impacts of ICT

Berkhout and Hertin (2001) describe three kinds of impacts of ICT driven economy such as e-commerce based economies, on the environment

- **First Order impacts include** the direct environmental effects of the production and use of ICTs (resource use and pollution related to the production of ICT infrastructure and devices, electricity consumption of ICT hardware, electronic waste disposal)
- **Second-order impacts include** the indirect environmental impacts related to the effect of ICTs on the structure of the economy, production processes, products and distribution systems. The positive environmental effects would be that of dematerialisation which implies getting more output out of less input; virtualisation or decarbonisation which is the substitution of information goods for tangible goods; and demobilisation which is the substitution of communication for travel.
- **Third-order impacts include** the indirect effects on the environment through the rebound effect [1]of more consumption and higher economic growth.

[1]The term rebound effect is used to describe a number of, often counter-intuitive feedback effects that compensate or over-compensate increases in environmental efficiency

Figure 3 delineates the flow of these impacts related to E-commerce activity.

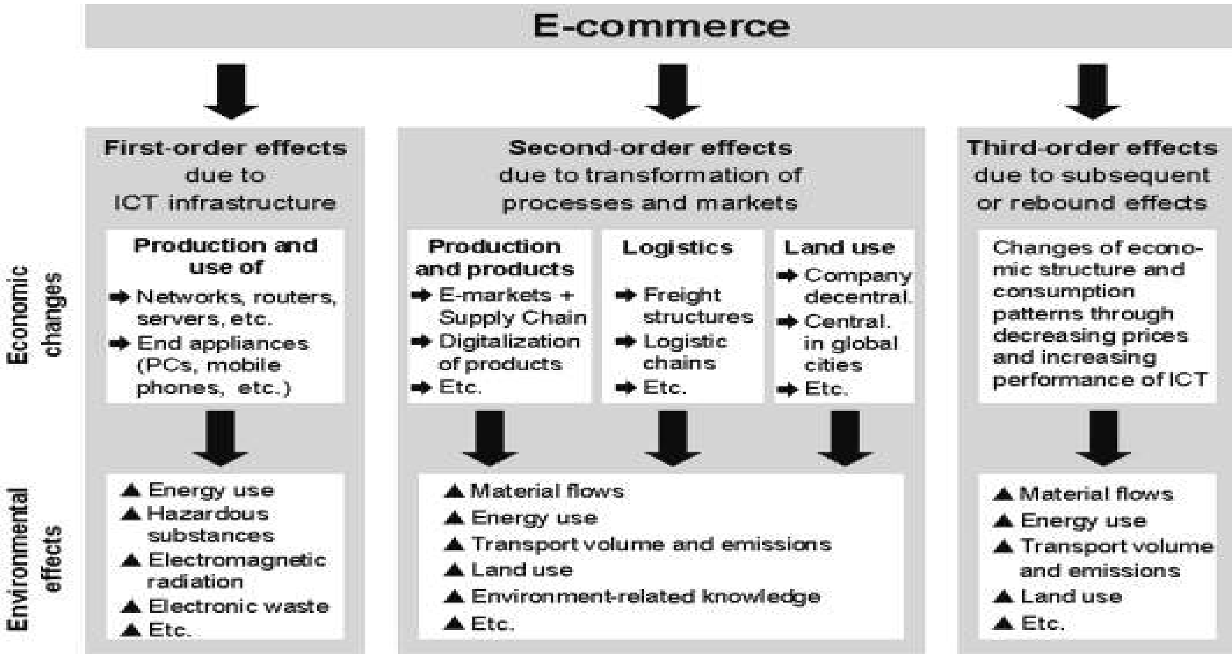
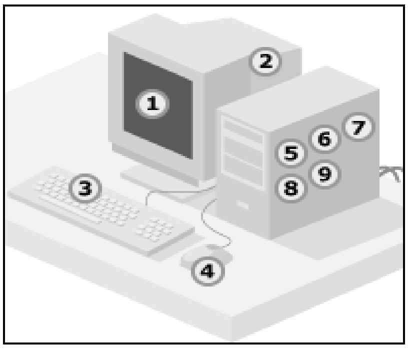


Figure 3: E-commerce Impacts, Fichter (2002)

While it would be interesting to model the environment effects of Pune's IT industry using this but a more thorough and detailed research would be needed to incorporate the second and third level impacts. The impacts at these levels deal with structural changes of the economy, changes in production and distribution systems; and consequences on consumption levels. All this would be difficult to assimilate in this amount of time, but the thesis could benefit by including some of the indicators based on the first order impacts such as E-waste and energy.

2.3.2.1 E-waste

Electronic waste (E-waste) or waste electrical and electronic equipment (WEEE) is now being recognised as an emerging global environmental issue. E-waste and its constituents are highly complex and toxic. Products like computers and printers are a composite of many toxic materials, and require highly advanced set of technological interventions for disposal and recycling. The electronic and electrical goods are largely classified under three major heads of: "White goods" comprising household appliances like air conditioners, dishwashers, refrigerators and washing machines; "Brown goods" comprising Televisions, Camcorders, Cameras etc and "Grey goods" like Computers, Printers, Fax machines, Scanners. These grey goods are comparatively more complex to recycle due to their toxic composition (Sinha 2007). Figure 4 shows the location of contaminants in a standard home computer.



1. **Lead** In cathode ray tubes (CRT) and solder
2. **Arsenic** in older cathode ray tubes
3. **Selenium** circuit boards as power supply
4. **Polybrominated flame retardants** in plastic castings, cables and circuit boards.
5. **Antimony trioxide** as flame retardant.
6. **Cadmium** in circuit boards and semi-conductors.
7. **Chrommium** in steel as corrosion protection.
8. **Cobalt** in steel for structure and magnetivity.
9. **Mercury** in switches and housing.

Figure 4: Toxics in Computers, Texas Senate Research Centre as stated in New Earth (2007)

UNEP (2005) estimates that 20-50 million tonnes of e-waste is generated around the world every year, which is more than 5% of the total municipal solid waste stream, and nearly the same amount as all the plastic packaging (UNEP 2005 as stated in SEPA 2011). When e-waste is disposed of in landfills, toxins can leach into groundwater or nearby water bodies. The material of most concern in e-waste is lead. Studies indicate that lead may constitute up to 6.3% of a typical PC. Every computer, including the monitor, on average contains between 1 and 2 kg of lead (Milojkovic & Litovski 2005 as stated in Osibanjo, Nnorom 2007). When these components are disposed and crushed in landfills, the lead is released into the environment, posing a huge hazard for current and future generations (SVTC 2004, Sinha 2006, Binns et al. 2006). Lead can cause damage to the central and peripheral nervous systems, blood system and kidneys in humans. Heavy metals such chromium may contaminate the environment through landfill leachate, and air contamination can occur when materials containing chromium are incinerated causing contamination of groundwater and posing other environmental and public health risks. Children suffer developmental effects and loss of mental ability, even at low levels of exposure. The presence of these chemicals also makes computer recycling particularly hazardous to workers, as well as the environment (SVTC 2004). Benefits of avoiding possible negative health effects associated with CRT disposal, for example, far outweighed its cost (Sui, Rejeski 2002).

2.3.2.2 Energy

Adequate supply of energy is of vital importance to the IT industry for economic prosperity but at the same time efficient use of energy in IT industry is of equal importance to pollution control. Energy in this case is specifically referred to electricity. Energy production is largely dependent on fossil fuels, which in turn contributes to global climate change. If we look at India's energy production, then the increased level of energy consumption accelerates the use of non-renewable sources of energy production, primarily coal, causing atmospheric pollution in form of increased levels of carbon dioxide and other pollutants released by thermal power plants. Therefore, there is an intimate connection between energy and, the environment (Sen et al. 2006).

ICT per se is stated to be responsible for 2% of global emissions of CO2 (OECD 2009). This is said to be at par with the emission from the aviation industry (Global Action Plan 2009). According to (Ramamoorthy et al. 2010), energy consumption by India's enterprise ICT infrastructure stood at close to 4% of the country's overall energy consumption in 2009 and accounted for about 2% of the country's overall carbon emissions. It is forecasted to grow at a compound annual rate of 5.4% and 4.9% respectively through 2014. An annual production of 1000 MW of electricity requires about 8 million tonnes of coal and 13 million gallons of water; in addition to producing emissions (Sen et al. 2006).

On an average, a desktop consumes 200 watt of energy, which implies a minimum of 1000 MW increase in energy consumption per day (Sen et al. 2006). One of the most energy intense ICT infrastructures is the Data Centre. Data centres account for about a quarter of the ICT sector's emissions. A data centre with 1000 servers will use enough electricity in a single month to power 16,800 homes for a year (Global Action Plan 2009). In a typical data centre, every watt of power directly consumed by information technology (IT) equipments requires another watt of power for indirect power needs including power transmission, appliance cooling and lighting (Sen et al. 2006).

In the context of Pune, the concern of e-waste and energy are both very relevant to look at, as first order impacts. Taking the case of e-waste alone, according to the Pune Municipal Corporation, around 40 per cent of the waste dumped at the landfill site consists of e-waste, and the IT sector is recognised as one of the main sources for e-waste generation (Sabnis 2008).

2.4 The Growth of IT cities: International experiences

IT industrial growth is focussed in cities for reasons of infrastructure and human resource availability. This section will look at some of the experiences of the IT cities across the world. These cases have been selected as they reflect similar patterns of their history of rapid growth policy intervention, but leading to problems faced by the cities.

2.4.1 Santa Clara County, US

By 1970, Santa Clara County in the U. S was known as Silicon Valley – the hub for Information Technology. In the case of San Jose, one of the cities within the county, the city's administration supported by a coalition of landowners, realtors, speculators, road builders, and bankers, promoted rapid urban expansion and residential and commercial development to build upon the IT economic activity (Saxenian 1983). The city government rezoned large tracts of land, and aggressively annexed nearby territory. It extended sewers, storm drains and roads to peripheral areas. San Jose metamorphosed from an agricultural processing and distribution centre of 17 miles in 1950 to a sprawling 147 square mile metropolis in 1975. Very soon, Silicon Valley was plagued with skyrocketing housing prices, overly congested freeways, and unhealthy levels of air pollution – all of which were rooted in the region's distorted pattern of urban development. The region's housing supply failed to grow in pace with its accelerated job growth, resulting in price rises which far outpaced national and state wide increases. The impacts of rezoning residential areas to industrial usage reduced the housing capacity of the county by 43%, a loss of 417000 potential units (Bernstein et al, 1971 as stated in (Saxenian 1983)). Also job opportunities automatically attracted more high paid employees who had the capacity to pay more. More than 30 years of sustained population growth have exacerbated the congestion of the county's roadways. With no viable mass transit alternatives, local residents were dependent on private automobiles for transportation further leading to emissions. Severe shortage of tax revenues failed to improve infrastructural services and needs such as sewers, roads, parks and other public works. The overall infrastructure was ill equipped to handle the fast pace of growth, and what could possibly be planning oversights. Repeated breakdowns of San Jose's sewage treatment plants damaged the aquatic life and water quality. The fruit orchards and agricultural fields disappeared completely (Saxenian 1983). In the Bay area around San Francisco, traffic jams and environmental burdens are no less than in other areas. Energy consumption in Silicon Valley is by no means more efficient than in other regions in the U.S. Environmental concerns also are associated with disposal of the lead embodied in cathode ray tubes (CRTs) that are used in most monitors (SVTC 2003).

2.4.2 Hschichu Science based industrial park, Taiwan

Shenglin, Hua-mei & Wenling (2004) describe the situation in the Hschichu Science based industrial park (HSIP) in Taiwan. The HSIP also called the Eastern Silicon Valley, provided entrepreneurs with low cost physical infrastructure, cheap labour and poor environmental regulatory standards that led to profitable production. But while investors, managers and researchers profited from the enormous growth, the labour force and local residents suffered. In the case of HSIP, massive clusters of land development further led to resource use conflicts, because site selection of the industry was not based on sustainable land use or regional environmental objectives. The environmental agencies had little or no power in stopping inappropriate land development in watershed protection area or the hillside land. The EIA was setback as the state relaxed land use control (e.g. hillside land use control), released nation owned land for large pieces of high-tech park development. The application process was simplified and rents lowered to encourage industrial development in Taiwan. In HSIP, the area faced water shortage every winter and spring since 1995. The situation began to get worse in 2002 and the Ministry of Economic Affairs (MOEA) implemented emergency measure that diverted water from farms to HSIP. Around 15,000 ha of farmland were left fallow. Neighbours of the park continue to endure traffic jams, air pollution, toxic water discharge and ground water pollution.

2.4.3 Bangalore, India

Back home in India, the same set of patterns and trends emerge. Bangalore has been incapable of dealing with the rapid economic growth due to the IT industry. This is supported by The State of Environment Report 2003 and 2008 for Bangalore. The 2003 report highlights some of the trends of the environmental consequences that have occurred as a result of the rapid economic growth. Some of them being inadequate sewage systems to deal with the increase in the sewage load resulting in sewage water being released in freshwater tanks and lakes; housing deficits resulting in the conversion of agricultural land to residential development, further impinging on the infrastructure needs and services that have to be provided (EMPRI 2003). The Environment Status Report of Bangalore 2009 states that Bangalore has grown from 1.2 million in 1970 to 6.5 million in 2008 (EMPRI 2009). The report acknowledges that Bangalore being the "Silicon Valley of India" has made it attractive to migrants and business alike. But such a rapid growth has caused serious environment threats such as health, sanitation, water management, waste etc basically dealing with the incapacity of the city to meet the needs of basic services as a result of increase in population, caused by rapid economic growth.

Srinivasaraju (2007) writes about the disenchantment of Bangalore which is the first city in India that pioneered the IT industry set-up. The article states how the class of people that just the other day was being congratulated for putting the city and the state on the international map, is now increasingly being accused of turning the garden city into a garbage city, a pensioner's paradise into the suicide capital. One of the major charges against the IT class is that it is responsible for the increase in land prices and rents in and around Bangalore. Other bone of contentions include the land acquisitions made to improve transport systems and other roads for which tree-lined avenues were brought down much to the anger of the local people

In the case of Santa Clara and Bangalore, again one sees how rapid growth caused by IT based economies, has direct and indirect effects on cities. In a report by the Santa Clara County Industry and Housing Management Task Force (1979) titled "Living within our limits: a framework of action for the 1980's", the uncontrolled job growth was stated as the primary cause of the county's urban and environmental problems (Saxenian 1983).

Urban growth is the rate of increase of urban population, it grows in two ways – natural increase (more births and less death); and immigration (rural-urban, urban-urban). People are pushed and pulled to cities by government policies that favour urban areas. Developing countries spend most of their budget on economic development and job creation in urban areas (Miller 2004). By concentrating people and production, cities concentrate demands for fresh water and other natural resources – and inevitably concentrate waste generation. As populations grow, this can, and often does, have strong local ecological impacts (Newman 2006).

In that sense, urban growth in turn is attributed to the creation of new job opportunities, that attracts labour causing an increase in population into the cities and consequently leading to an increased demand for basic infrastructure and services (water, housing, electricity) that the city simply has to provide. This has in turn its own consequent set of environment effects such as sewage, pollution, emissions, and congestion (Haughton, Hunter 2003). Failure to provide services to cope with demand, leads to another set of spill over effects, like the case in Bangalore where the lack of sewage treatment facilities have degraded the lakes. This aspect is even more relevant for Pune as sixty percent of the population employed in the IT industry is said to be migrant population (MCCIA 2009). It is for this reason, to analyse the environment effects of the IT industry as a whole, it is pertinent to **include the environment effects of the population that is employed by the industry.** Therefore, it would be useful to look at the IT industry as a composite of the IT units and companies and the employees of the industry, and to look at the environment effects of both.

2. 5 Environmental Assessment Indicator Methodologies

The best approach to avoid environmental damage that may arise from economy wide policies would be to identify, prioritise and analyse the most serious economic and environmental linkages and devise complementary measures (Atkinson 1997). Various methodologies and frameworks exist to identify, assess and measure environment effects, a few of which have been described below.

2.5.1 Ecological Footprint

Ecological Footprint (EF) has often been suggested as a way to assess the human impact on earth. EFs are expressed as area, sum up the total productive area of land and water ecosystems required to sustain the resources, wastes, and emissions of a population wherever that land may be located. They can be established on a global or other geographic level (Atkinson 1997, Newman 2006). EF has become a matter of interest because the impacts it measures, and may help define targets for remedial actions. It is therefore being widely used as a tool that helps to set up an agenda for local policies. Consider, as an example, the impact due to electricity consumptions. EF quantifies the use of electricity by citizens by taking into account the carbon dioxide emitted by the power plants and consequently the amount of forested land required to absorb these emissions. In principle, this land requirement is shared among all the citizens who use electricity, and contributes to build up their EF (Scotti, Bondavalli & Bodini 2009). The EF can also be used at the individual company level as demonstrated by the authors (Barrett, Scott 2001)**.**

	Consumption	Total EF (hectares)	EF/per Employee (hectares)	EF/net income (m2)
Electricity (GWh)	8442	1267777	67	137
Gas (GWh)	1770	114764	6	12
Oil (GWh)	976	86641	5	9
Waste (recycled: tonnes)	2,26,540	178601	9	19
Waste (disposed: tonnes)	54,928	86908	5	9
Total EF		**1734691**		**188**

Table 3: An example of the Sony group (global impact), Barrett and Scott (2001)

Table 3 does quantify all of Sony's activities, yet the impact of energy consumption and waste generation provides an insight into the impact of the company. The table shows that the highest impact by far is that of electricity consumption. The reason waste generation has a subsequently lower ecological footprint is due to the very high percentage of recycled waste (80% recycled) but recycling also has an impact associated with it. EF also considers the ecological impact of recycling. The table also compares the ecological footprint with the net income of Sony (total of 188 m2) (Sony Environmental Report, 2001 as stated in (Barrett, Scott 2001)).

There is the danger of assuming that lower the EF the more sustainable is the community, which may not be true for all cases. Considering two scenarios: (a) a steelworks, located within municipal boundaries and having a requisite filter for dusts and water purification systems in place; against (b) a municipality with a similar steelworks plant but without any cleaning or mitigation technology and with an inefficient water system. Within the parameters given above, the EF in the first scenario would be larger than in the second because electricity consumptions, required by dust abatement system and water purification procedure, increase CO_2 emissions. Therefore, the simple value of EF may not tell the entire story about the environmental performance of a settlement or community (Scotti, Bondavalli & Bodini 2009). But coming back to the case of Sony in this context, if it had not recycled any of its waste, it's EF for waste would be 445,000 hectares, nearly double the present for waste production.

The EF would enable the thesis to analyse the footprint of the IT industry but it ultimately translates to a single value of land required, which would be difficult to put in context. One of the objectives of the thesis is to have a relook at the IT policy, based on the assessment and analysis that comes out in the research. A singular value of land required may not help with providing a concrete understanding of how policy can be improvised, as it does not give a relevant "value" of effect which corresponds to the indicator that is being looked at, for e.g. transport leading to air pollution. It does not in essence establish the cause and effect relationship which would be important in this thesis.

2.5.2 Carrying Capacity

Another methodology used to measure sustainability is that of Carrying Capacity (CC). CC lays emphasis on sustainability constraints in the form of assimilative capacity of the environment. This notion is drawn from biology and states that a given area can only support a given population of a particular species and at this upper limit the population will have reached its maximum sustainable level. Ecologically speaking, any level of development or economic activity that does not exceed the carrying-capacity of the planning region is sustainable. In the article the authors Khanna, Ram Babu & Suju George (1999) explain the operational framework of CC. This includes:

Estimation of supportive capacity - which involves the understanding of regeneration, resilience and critical points, e.g. extraction of groundwater in keeping with its recharge, use of biological resources without harming rejuvenation, controlled use of non-renewable resources in keeping with the perceived demand for future generations, use of water resources in a river without impairing life-support systems of riparian populations.

Estimation of assimilative capacity entails the maximum pollution load that can be discharged in the environment without affecting its designated use.

For cities, assessment of CC with respect to their basic infrastructure provisions like water supply, transportation and sanitation helps to determine the relative potentials of individual urban centres across regions growth reforms. It also enables the provision of a framework for decision making with regards to sectoral and spatial allocations of resources for infrastructure development. Both resource consumption and waste generation depend on population size where the application of per capita norms, such as for water supply, solid waste collection based on per capita generation, sewage or wastewater treatment plant, are common (Khanna, Ram Babu & Suju George 1999).

Carrying capacity would be a relevant methodology to use in its entirety provided there is scientific data to assess the assimilative and regenerative capacities of the city. For example, to understand if the city is able to sustain the water supply to its population, one needs to estimate the capacity of the natural resources of the city to retain enough water (soil strata for water infiltration, self purification capacity, etc). This would be out of the scope of this thesis. Additionally, it does not directly assess environment effects, which is what the objective of this thesis is.

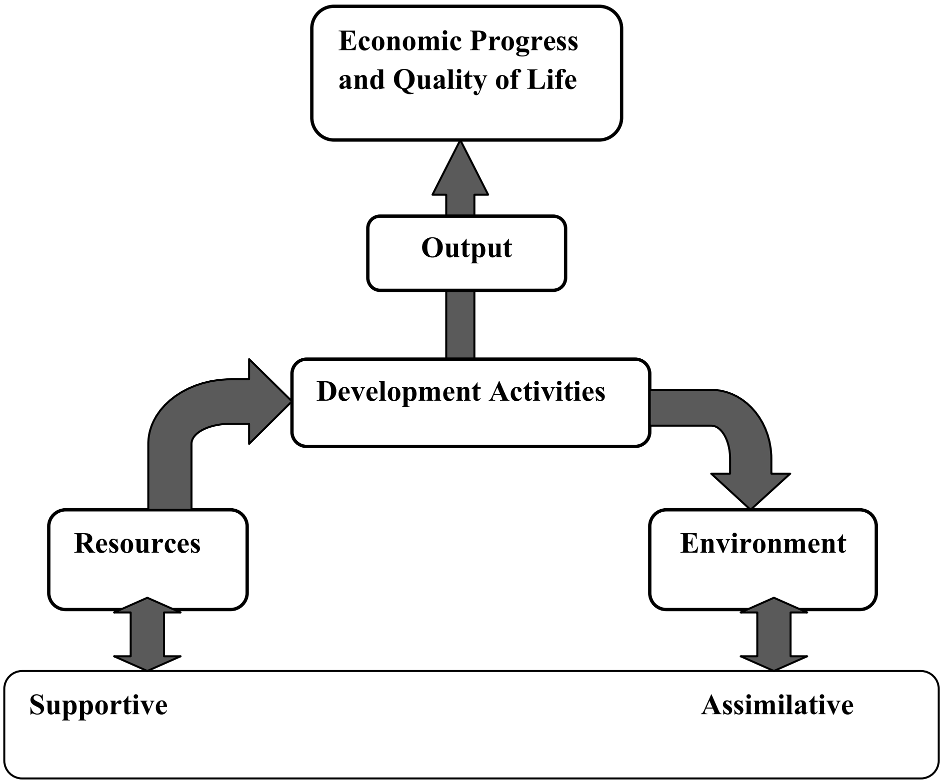


Figure 5: Elements of Carrying Capacity, Khanna, Ram Babu & Suju George (1999)

2.5.3 Pressure State Response (PSR) Framework

Frameworks aid the understanding of how different issues are interrelated. Sustainability assessment frameworks for example help to focus and clarify what to measure, what to expect from measurement and what kind of indicators to use (Segnestam 2002).

Waheed et al (2009) categorise some frameworks that are available such as the follows:

Objective-based (e.g., strategic environmental assessment (SEA))

- Impact-based (e.g., environmental impact assessment (EIA))
- Linkages-based (e.g., pressure-state-response (PSR), driving force-pressure-state-impact-response (DPSIR))
- Process-based or stakeholder-based
- Material flow accounting and Life cycle assessment

OECD has developed a framework to facilitate sustainability assessments at the national, regional and international level. The first version of this framework is called the Pressure-State-Response (PSR) framework, but has since other variations to it the second variation adds a category of impact indicators, transforming it into a Pressure State-Impact-Response (PSIR) framework, and, finally, the last version includes all five indicator categories which includes Drivers creating a DPSIR framework (Segnestam 2002).

At a less detailed level, where inputs and outputs are either not relevant or not easily identified, the PSR framework is more useful. The PSR framework distinguishes between three different angles of environmental issues. The PSR framework (as depicted in figure 6 below) is based on the concept of causality wherein human activities exert pressures on the environment leading to the change in the quality and the quantity of natural resources (the "state" box). Information about these changes reaches the decision-making instances in society which respond through environmental, general economic and sectoral policies (OECD 1991).

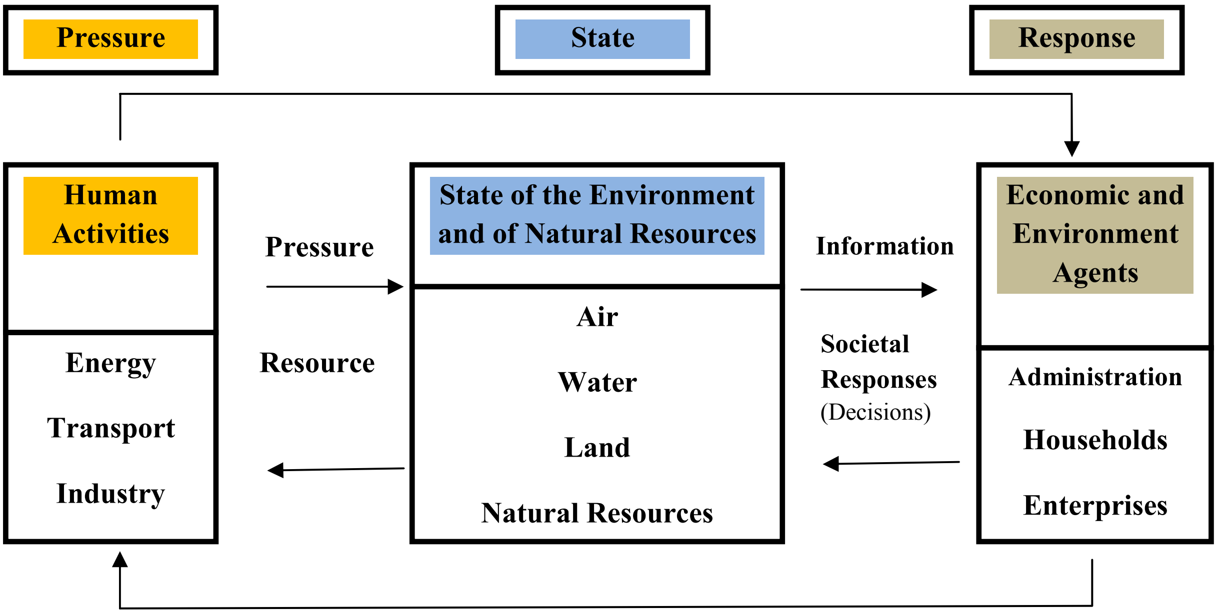


Figure 6: Pressure State Response Framework, Segnestam (2002)

• ***Pressure*** describes human activities which exert pressures and are the cause of a problem. Examples of potential pressures include income growth, trade patterns, fuel and energy use, and population growth.

• ***State*** usually describes some physical measurable characteristic of the environment that results from the pressure. Examples include indicators that monitor aspects such as water quality, water availability, deforestation, soil erosion, and existence and quality of habitats.

• ***Response*** measures to what degree society is responding to environmental changes and concerns, for example those policies, actions or investments that are introduced to solve the problem. As responses to environmental problems they can affect the state either directly or indirectly. In the latter case they aim to influence the pressures at work. Examples of indicators of societal responses are environmental expenditure, environment-related taxes and subsidies, price structures, market shares of environmentally friendly goods and services, pollution abatement rates, waste recycling rates etc

In particular, the PSR model provides a means for selecting and organising data and indicators (as further illustrated in figure 7) in a manner useful for decision makers and the public, and ensuring that important considerations are not overlooked (Boothroyd, Drury 2007).

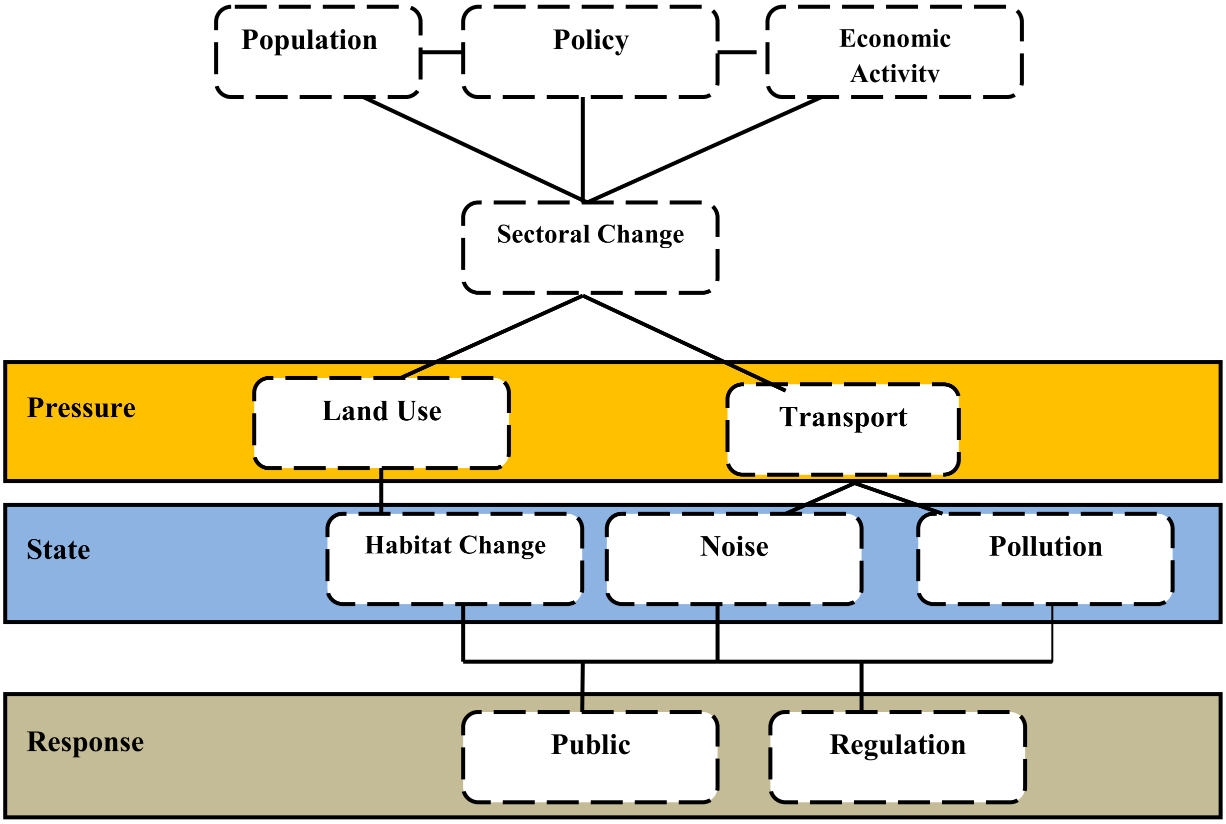


Figure 7: Policy changes and Environment within the Pressure State Response Framework, Atkinson (1997)

The PSR frameworks has other versions as mentioned earlier, one of which includes the addition of a fourth indicator category to be able to capture the change in the state, thereby creating a PSIR framework. In the PSIR framework, the impact indicator is added in order to capture the effects the pressures may have on that state.

The third, and final, development of the PSR framework is the presentation of all five indicator categories (driving force, pressure, state, impact, and response indicators) in one and the same framework, providing an overall mechanism for analyzing environmental problems. In this DPSIR framework, the different indicator categories cover the following aspects of an environmental issue (Virtual Research and Development Centre, 2001 as stated in (Segnestam 2002))

- Driving forces, such as industry and transport produce a pressure...
- Pressures on the environment, such as polluting emissions, which then degrade the environment...
- State of the environment, which have an impact...

- Impact on human health and eco-systems, causing society to respond....
- Respond with various policy measures, such as regulations, information and taxes, which can be directed at any other part of the system...

To be able to understand the environment effects of the IT industry, the PSR framework would be most appropriate for this thesis as it can help link the cause and effect relationships. It is evident that we are analysing the environment effects of the IT industry, so there is only one driver that we are looking at and we do not need to emphasize on that aspect further. Due to constraints of time, the thesis will also not look in detail at all the specific impacts resulting from the state of environment such as health impacts due to air pollution or that of biodiversity loss due to green belt development.

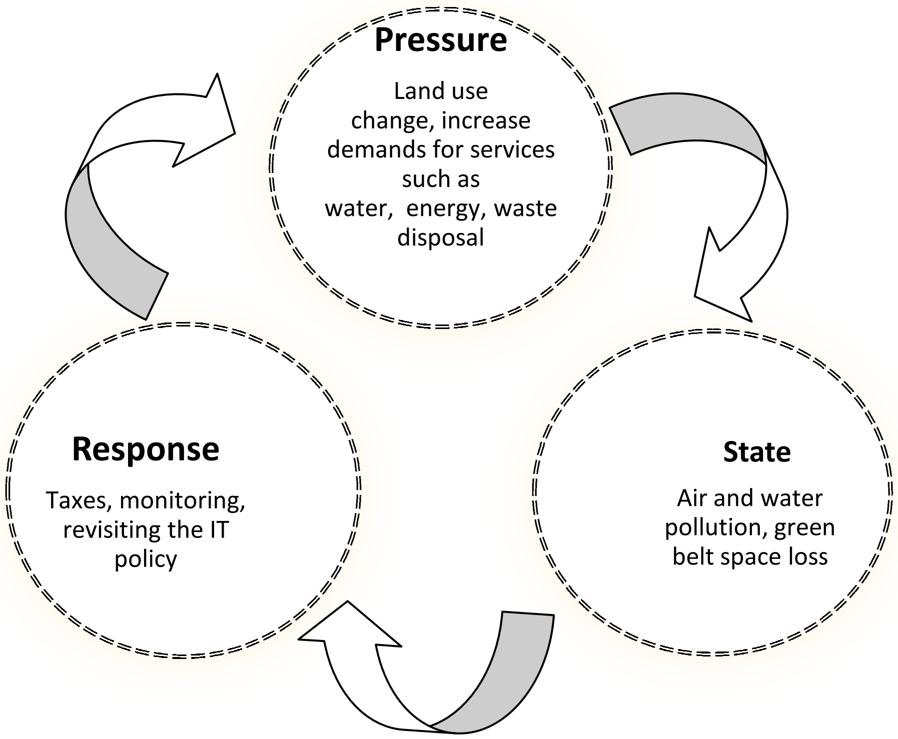


Figure 8: IT Industry and Pressure State Response. Source Author, Adapted from OECD (1991)

Figure 8 depicts the operational cycle of the IT industry using the PSR framework. The IT industry being the driver for change inducing pressures such as land use change, and energy consumption increase. This consequently resulting in changes in the state of the environment such poor air quality, water pollution, emission, e-waste generation, congestion, more paved areas etc. To mitigate the pressure based on this information, the government would need to respond appropriately. For example by relooking at the IT policy design, or make certain stronger regulations or taxes, by setting technology standards and by encouraging energy pricing that accounts for environment costs, and for the retrieval and recycling of equipment.

2.5.4 Selection of Indicators

Having selecting the framework for assessment, the next step is to select the set of indicators that would be appropriate for the thesis research. The literature review above brings out the main indicators that could be used in the thesis research.

At the industry level – which is a composite of the total units or companies of the IT industry – section 2.3 describes some of the main environment effects of an ICT based industry such as e-waste and energy. The other indicator that would be relevant to include in the context of Pune is the loss of green belt land area, on which IT industries have been built upon. This aspect has also been touched upon in the earlier section.

At the employee level – which is the population employed by the IT industry – the indicators that would be used are the basic services that the city government has to provide. These services are water, sewage, housing, waste and transport. The literature review has touched upon this aspect in the previous section. Shortage or mismanagement of the provision of these basic services at the city level is cited as being one of the main environment problems faced by cities. Another reason to select the basic services as a set of indicators is to be able to demonstrate the effects of economic growth on the city's capacity and functioning to be able to provide these services. One minor limitation in using this set of indicators is that the per capita standards would be used in research. There exists literature that points to the fact that the employees of the IT industry have higher levels of income. And these high levels of income, could translate to higher levels of consumption including of the basic services that are provided. Due to time and scope limitation of the thesis, it is not possible to make a separate assessment on the consumption standards of the IT employees. But with the per capita standards the thesis would develop a baseline of the environment effects of the employees of the industry. Figure 9, depicts the map and flow of these the industry level and employee level indicators within the OECD PSR framework.

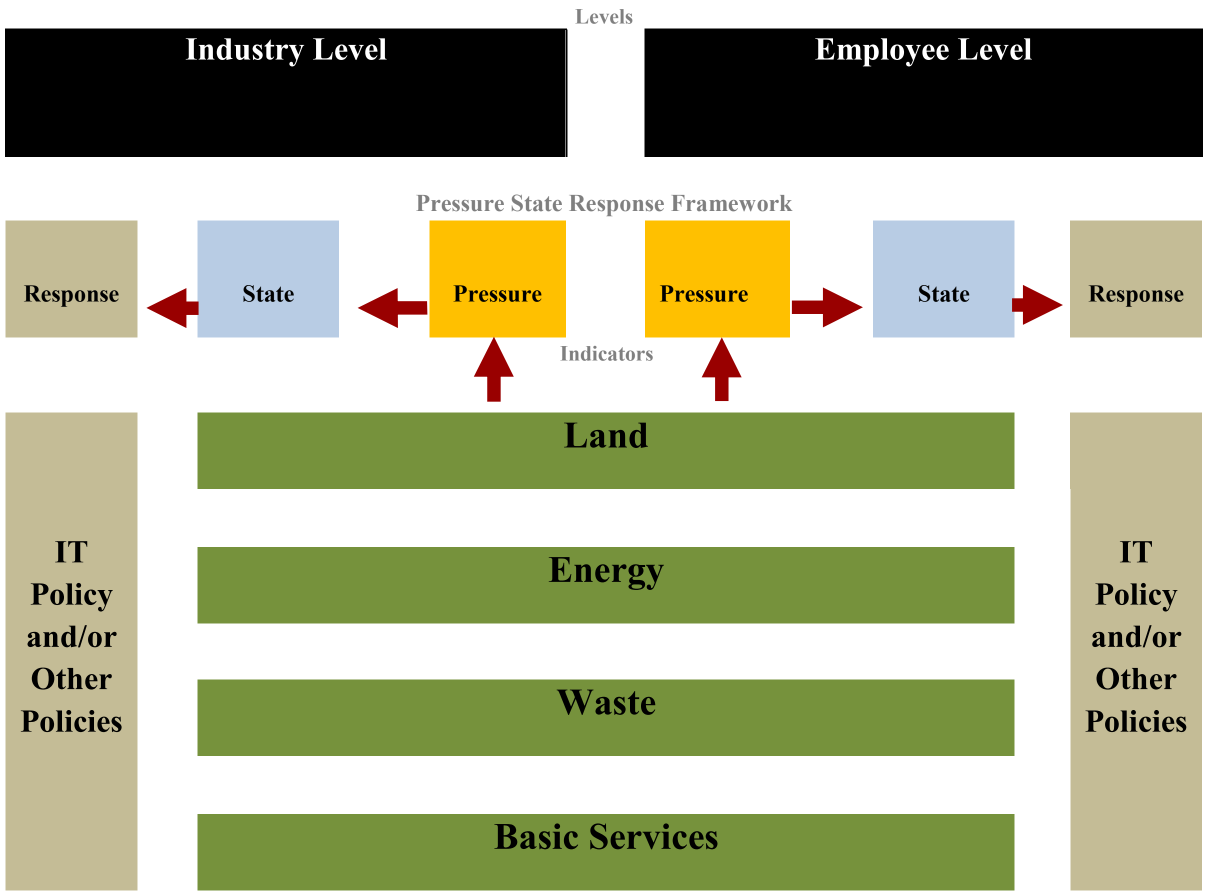


Figure 9: IT industry environment effects in the PSR framework, Source Author

2.6 Policy

The power of the IT industry is legitimised in the name of international competitiveness of national economy or high tech regions. The paper on Hschishu Science based industrial park articulates that in many IT developing regions, rational planning is dominated by IT's powerful influence on public policies that override the environment and social concerns addressed in the planning and policy making processes. Economic success and the soaring social image of IT industries is deemed as a stepping stone of a developing country leading to their domination over political economy and the general society (Shenglin, Hua-mei & Wenling 2004).

State economic agencies provide favourite treatments to the industry through national IT promotion plans and centrally regulated IT parks. Local authorities, on one hand have neither the capability nor political intention to confront the industrial sector for poor environmental outcomes. One the other hand the local authorities take the spill over effects of high tech growth to open us economic initiatives and land development as a strategy to leverage local economy. The power of global IT capitals leaves the state economic agencies and local authorities with few options, even allowing the override of environmental and community health concerns (Shenglin, Hua-mei & Wenling 2004, Huang, Wong & Chen 1998). Unfortunately at the global level, given the dynamics of market competition, global firms tend to relocate to those markets which may have more incentives, including lower environmental standards (Berkhout, Hertin 2001).

The remedy does not require reversal of the original reforms, but rather the implementation of additional complementary measures (both economic and non-economic) that remove such policy, market and institutional difficulties. Several studies confirm that economic changes often succeed in generating new economic opportunities and sources of livelihood. However, at the same time, properly valuing resources, increasing efficiency and reducing waste, will help to restructure economic growth and limit undesirable environmental impacts. Environmentally sustainable development is possible but it requires a shift in the balance of the way economic progress is pursued (van Pelt 1993). Social and environment concerns need to be integrated into economic policy from the highest macroeconomic level to the most detailed microeconomic level (Munasinghe 1999, Atkinson 1997, Pearce, Barbier 2000). The same would be true while planning environment and social policy. For example, in the city of Bourgas, Bulgaria, the Mayor and municipal staff have sought ways to alleviate the environmental impacts of the municipality's intensive industrialisation. The Municipal Development Strategy for 2007-2013 recognises the need for an integrated long-term approach to balance current development with resource protection and sustainability. The new strategy places greater emphasis on the inter-connections between environmental policies and other aspects of municipal life. The majority of municipal responsibilities are formally linked to environment (for example, procurement, public transport, urban planning, energy management), and policy-making attempts to address economic and social issues in synergy with environmental questions (Cities Alliance 2008).

Roberts (2004) talks about pre requisites for the development of Eco Industrial Parks which need to fully understand the macro-context of waste flows, markets, production and materials transport costs and requirements are fully understood, the prospects for development will be considerably weakened. While the author talks specifically on industrial parks, most of the principles would hold true for any intense economic growth policy that is being undertaken. These include:

- Assessment of total waste water, materials and energy volumes/flow patterns.
- Identification of actual and potential commercial waste volumes by industry segmentation and waste sinks;
- Identification of critical waste mass volumes for commercial utilisation
- Economic, environmental and physical risk assessment of waste and energy by product utilisation;
- Spatial concentrations and transportation or flows of waste by types;
- Environmental sensitivities of regional locations for waste materials, water and energy processing and reprocessing;

- Implications of the regional growth management strategy and planning schemes for sustainable development—especially future industry location;
- Assessment of local government consistency on the application of environmental policies, standards and performance criteria affecting waste management and reprocessing industries across the region;

These would all be applicable for consideration when a region is planning industrial based economic growth.

Button (2002) makes his point by describing the various phases of economic activity - once an urban economy has been encouraged to begin to grow, the initial danger is that the expansion will occur on land which, while financially cheap, may be environmentally sensitive. During the subsequent phase of rapid economic expansion the policy problem is one containing the overheating of the urban economy and to contain the local environmental damage associated with increased economic activity. Careful monitoring combined with more intensive use of flexible policy instruments, such as local emissions charges, are relevant (Button 2002). Within this operation, he states that there is a need for the public authorities to have sets of indicators which reflect each stage in the economic cycle and which highlight the extent to which policy portfolios should be adjusted to correspond to the evolving situation. But linked with this, the non-public sector actors in the urban situation also require appropriate information to adjust their stances. If they have appropriate indications of what is happening then there are intrinsic processes in the urban economy that will activate automatic feedback mechanisms.

2.7 Conclusive Remarks

The literature review above is an attempt to build a certain structure and logic for assessing what all could constitute environment effects of the IT industries. It builds on the understanding of the interactions between environment and economic growth, and the externalities. Sections of the literature review look at facts and principles that would be relevant to understand, if the IT industry, simply based on its basic mode of operation (energy, e-waste) can be called non-polluting indeed. Experience of the international case studies of IT cities, used in this literature review lend a logic to the idea that economic growth leads to rapid urban growth and growth in population, which in effect has its own suite of environment effects that occur in the cities that they operate. Therefore, one approach to assess environmental effects would be to look at the industry itself and the population employed by the industry. This probably has not been looked at before, as attempts to find research similar lines and thoughts were not available within themes of economic growth and cities. In the very end, what is most important is the ease of use as much as the ease of understanding. The PSR framework comes out as effective way of organising the structure, and demonstrating the causal relationships as compared to some other methods that were looked at. It also leads to the "response" aspect of the looking at the policy for recommendations and suitable changes based on the assessment. Figure 10 reflects the conceptual framework illustrating the connections and flows of the concepts and theories that have been looked at so far and which are relevant for the objective of this thesis.

2.8 Conceptual Framework

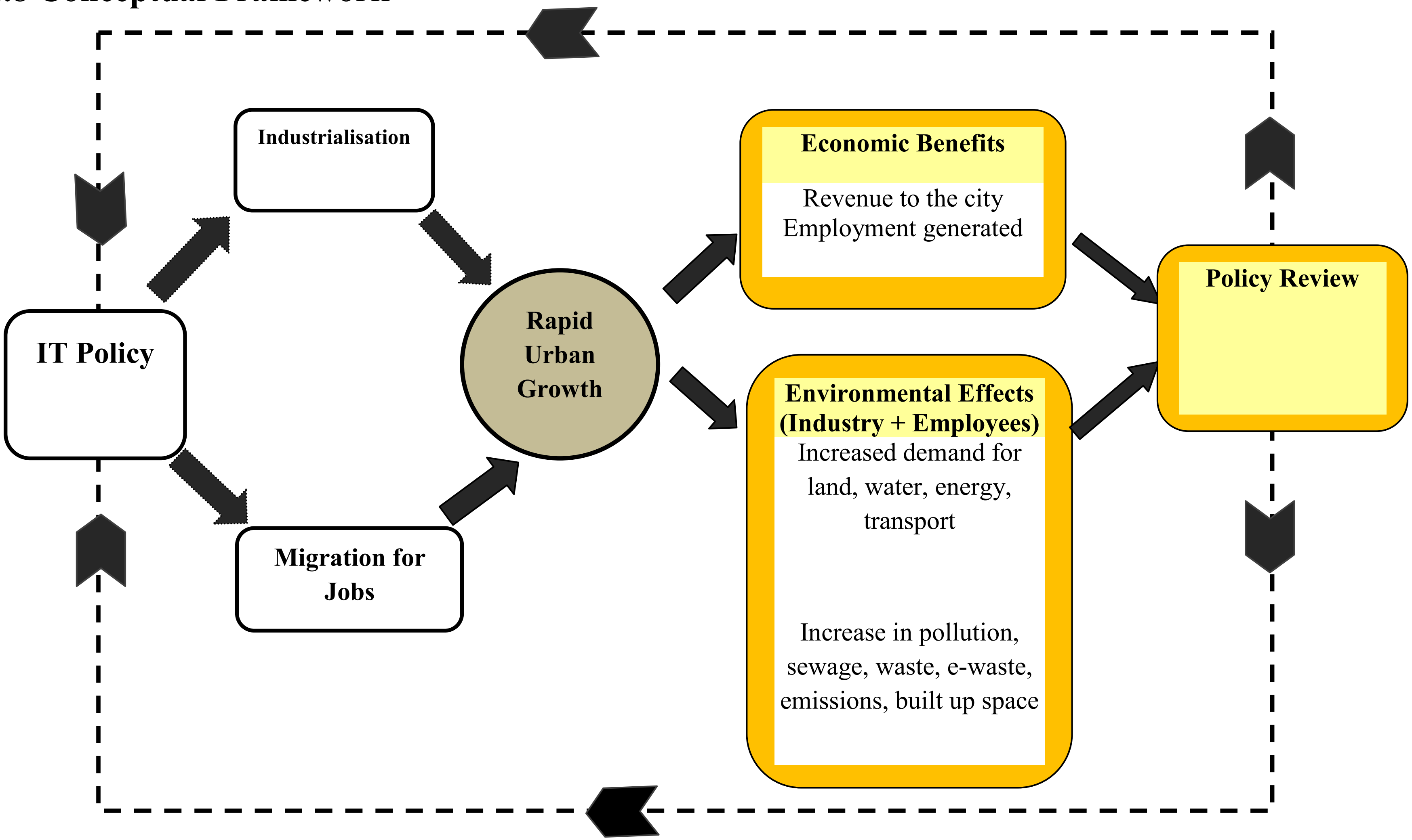


Figure 10: Conceptual Framework of the Literature Review for Pune's IT Industry – Boon or Bane?, Source Author

Chapter 3: Research Methodology

3.1 Research Type and Strategy

The research is analytical as it aims to analyse facts and information that is already available to evaluate the impacts of the IT industry on Pune. The research would be largely quantitative.

Within the context presented in chapter 1, the research can be defined as exploratory as it seeks to explore what are the relationships and the interactions between the IT industry and its environment impacts for the city of Pune, using a framework of indicators.

3.2 Unit of Analysis

The unit of analysis of the research is the area that falls under the jurisdiction of the Pune Municipal Corporation (PMC). Within the PMC, some departments would be looked at (see next section for more details).

3.3 Data Source and Collection means

The main sources for doing the data that will be used in the research would be secondary data.

Secondary data would be gathered from

- Various departments functioning within the PMC such as accounts, water supply, solid waste and sanitation, building dept and the Environment cell. The departments have been selected based on the data needs of this research.
- The Maharashtra State Electricity Supply dept.
- The Directorate of Industries
- Archival data would be collected from the Environment Status Reports that the city produces every year.
- IT company Annual reports
- Desk study

3.4 Operationalisation of data

To enable data collection, the following variables and their respective indicators have been selected based on the literature review and focussing on the PSR framework. Please see table 4.

Sub Research questions	Variables	Indicators	Questions	Data Sources
What are the main economic benefits of the IT industry to the city?	Economic	Employment to people	How many people are employed by the IT industry companies located in Pune city (area within PMC jurisdiction)? How many people employed in the IT industry are migrant population?	Secondary Data Secondary Data
	Financial	Revenue to the city,	What is the property tax revenue and the premium that the PMC receives from the IT industry	Secondary Data
What are the main environmental impacts as a result of the industry?	Industry level	Electricity,	What is the total amount of electricity that is consumed by the IT industry What is the emission factor for electricity supply in India?	Secondary Data Desk Study, Secondary Data
		Land use	What is the total green belt area (in plot size) given to the IT industry? What is the loss of Ecosystem services as a result of the loss of green belt area?	Secondary Data Literature Review and desk study
		E-waste	What is the annual quantity of e-waste generated by the IT industry If information not available, then what is the possible quantum of e-waste that can be attributed to the IT industry? What is the potential cost of treating this waste?	Secondary Data Desk Study Desk study

What are the main environmental impacts as a result of the industry	Employee level	Land use	What is the housing demand estimate for the number of employees of the IT industry?	Desk Study
		Water	What is the per capita water consumption for Pune?	Secondary Data
		Sewage	What is the per capita sewage generation for Pune? What is the water – sewage generated ratio that is used by the PMC?	Secondary Data Secondary Data
		Waste	What is the per capita waste generation for Pune?	Secondary Data
		Transport and Air Quality	What is the per capita vehicle ownership for Pune? What is the level of air pollution contribution based on per capita vehicle ownership?	Secondary Data Desk Study
		Electricity	What is the Per capita electricity consumption for Pune? What is the main source of electricity supply (nuclear/hydro/coal), to arrive at the percentage of emissions produced per unit?	Secondary Data Desk Study, Secondary Data
What particular aspects of the IT policy that promotes IT industry expansion can be improved and amended?	This question would draw from the data analysis that will come from sub research questions 1 and 2. This would deal with those aspects within the IT policy that need to be looked at (most of them have been highlighted in the Chapter 1) and linked based on the kind of analysis that comes out. Based on some of the data gathered and a preliminary analysis, then the possible areas for which the effects can be minimised and mitigated, will be touched upon. It is also possible that based on the analysis of the data, and further literature review, there would be a need for looking at other policy measures, besides the IT policy as well.			

Table 4: Data Operationalisation, Source Author

3.5 Validity and Reliability

The validity of the data will be confirmed through the interviews and through sources from secondary data. The author has already filed in Right to Information seeking data for some of the above questions. So most of the data, if available indeed, will be from the government records themselves, and if need be further validated from the respective authorities and organisations that have been listed above.

3.6 Data Analysis

Data analysis would be a crucial component which will test the framework of indicators that would be applied to this research.

Prior steps of data processing will take place before the analysis of the data. For indicators of water for the Employee level, the thesis will calculate the product of the Per Capita water consumption with the number of employees in the IT industry to get the total volume of water required by the employees. The information will be analysed, based on the performance of the PMC for water provision. Different indicators will go through different methods to enable data analysis. Some of the modes of analysis that would be used include Emissions Factor analysis, Range and Uncertainty analysis and, Ecosystem Service Analysis, Monetary Valuation technique.

Emissions Factor Analysis will analyse the emissions produced as a result of the consumption of electricity, which may be further analysed to understand health impacts or other relevant costs related to the mitigating of these emissions

Range and Uncertainty Analysis will help if the information in not available specifically of the IT industry. This would provide various scenarios of E-waste generation from the IT industry which can be used for the final analysis. Comparative data from other cities could also be used to draw estimations. The scale of effects could also be analysed in terms of cost implications and pollution impacts.

Figure 11 and 12, delineate the flow of the data processing analysis that the research will conduct, while tables 5 and 6 explain the steps for analysis for figures 11 and 12 respectively. Only few indicators would be analysed till the last level, but it would still be important to show the cause-effect outcomes of the indicators that have been selected.

3.6.1 Data Analysis for the effects at the Industry Level

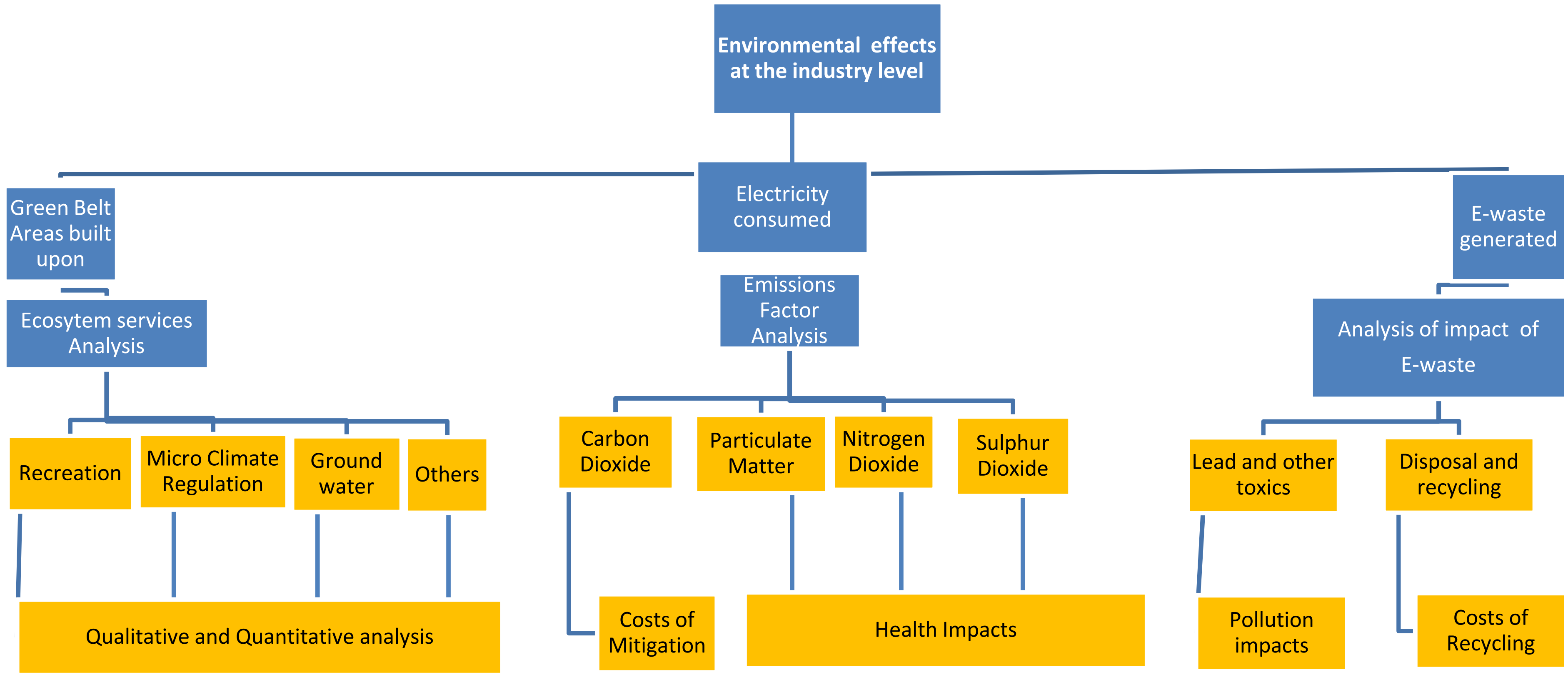


Figure 11: **Data Processing and Analysis for Industrial Level Environment Effects, Source Author**

Indicator	Step 1	Step 2	Step 3
Green Belt Zone Development	Identify green Belt zones used by the IT industry	Identify Ecosystem Services that are lost	Qualitative and/or quantitative analysis of the impacts of the loss of these services
Electricity Consumption	Gather data on electricity consumed by the IT industry	Analyse the volumes of the Emissions using Emissions Factor analysis	Mitigation costs and/or health impact costs
E-waste Generation	Estimate E-waste generated by the IT industry	Identify the quantity of toxics based on the E-waste estimate and disposal need	Analyse pollution impacts. Analyse costs for recycling the volume of waste

Table 5: Data Analysis process for environment effects at the Industry Level, Source Author

3.6.2 Data Analysis for the effects at the Employee Level

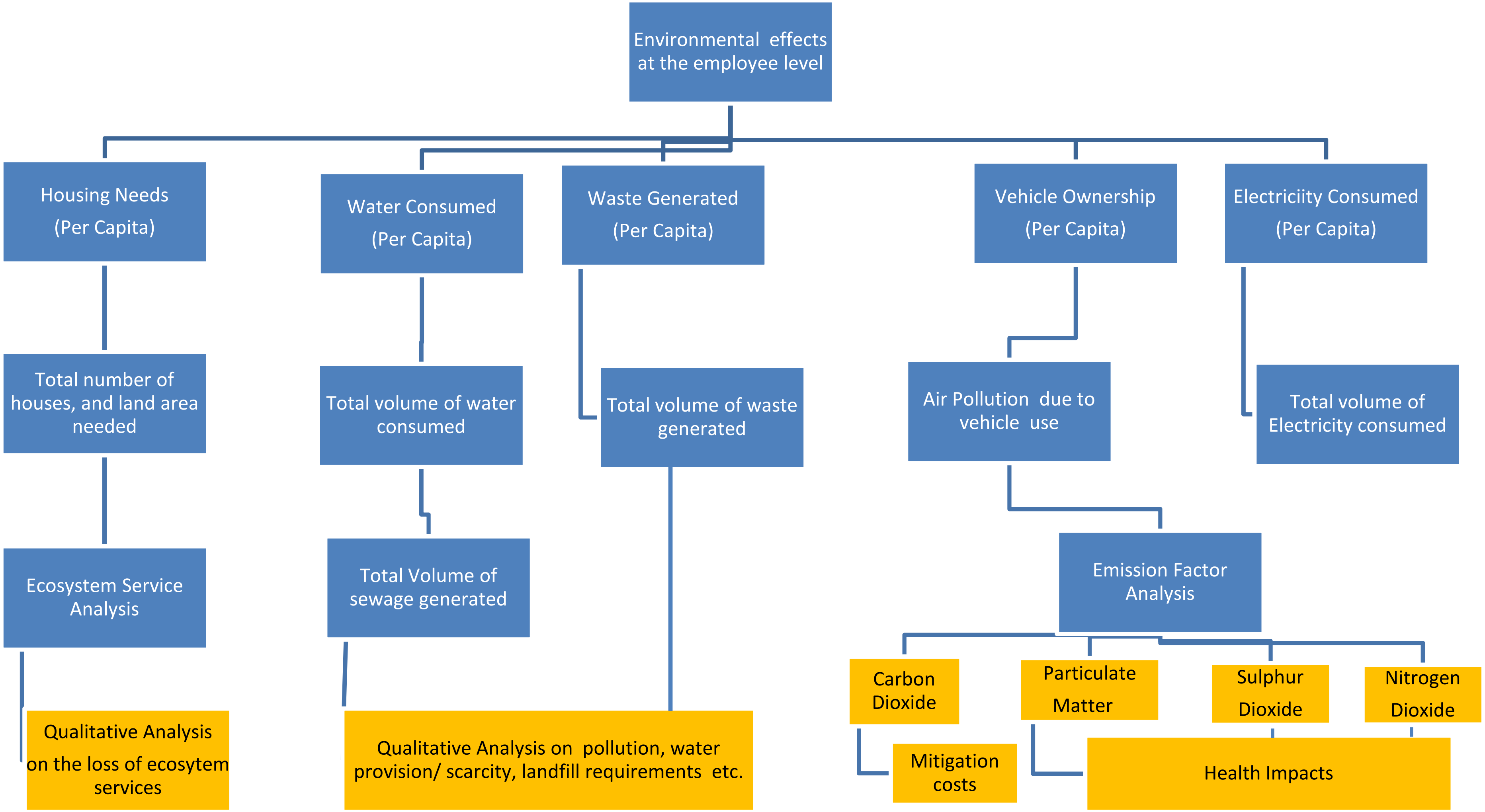


Figure 12: **Data Processing and Analysis for Employee Level Environment Effects, Source Author**

Indicator	Step 1	Step 2	Step 3
Housing Demands	Per capita housing needs	Total housing needs and estimated land requirements for such housing	Qualitative analysis of impact or loss of Ecosystem services
Water Consumption	Per capita water consumption	Total volume of water required by the employees and sewage generated.	Qualitative and quantitative analysis in relation with water availability of the city
Waste Generation	Per capita waste generated	Total volume of waste generated by the employees	Qualitative and quantitative analysis of waste disposal needs
Electricity Consumption	Per Capita electricity needs	Total electricity consumed + Analyse the volumes of the Emissions using Emissions Factor analysis	Mitigation costs and/or health impact costs
Transport	Per capita vehicle ownership	Total of vehicles + Analyse the volumes of the Emissions using Emissions Factor analysis based	Mitigation costs and/or health impact costs

Table 6: **Data Analysis process for environment effects at the Employee Level, Source Author**

Chapter 4: Research

In order to map the economic and environment effects of the IT industry on the city, a range of people and institutions were interviewed and contacted. The aim was to be able to gather more indicators, data and opinions that would add value to the research. This included 3 representatives from the IT industry; 3 experts on e-waste; 2 experts on energy and 1 for transport ; 9 Pune Municipal Corporation officials representing property tax, building dept, waste, water and transport; 1 Electricity supply official; 2 Developers, and 4 IT and industrial institutions and associations. The interviews were mostly unstructured and mostly for 45 minutes to one hour each.

The thesis will have to depend on some basic assumptions to carry forward the methodology of research. Although Public Disclosure applications or Right to Information applications were filed a month in advance of commencement of fieldwork, most of the responses came in 20-25days later than the mandated amount of time of a month within which responses have to be given. Analysing the correctness and detail of the information from these responses was therefore very difficult.

The officers in charge of the Building departments and other departments of the PMC were busy with their regular routine work to be able to give enough time to discuss data and the information that was sought. The Building Department was also working on the finalisation of the new development plan of 2007-2027.

Even though the emphasis of Pune as an IT city is highlighted every now and then from all sections of political and administrative class, no single window information about the IT industry was available from the PMC or from the industrial institutions.

Different departments had different sets of information, and most often than not, when compared the information was not corresponding to each other. In most cases, the thesis has been unable to use certain set of information provided.

The thesis is aimed at a broad overview of mapping the economic and environment effects. Given the nature and scope of the thesis, it would not have been possible to get into the varied details of each section of the data results.

4.1 Background

The IT industry is one of the biggest and fastest growing industries in Pune. Forbes magazine has included Pune among the 10 fastest growing cities of the world (NASSCOM 2011). Pune's Software exports have increased 6 times from the financial year 2003 to financial year 2007. And Software exports as a percentage of Pune's GDP has grown more than 3 times from the financial year 2003 to financial year 2007.

Various IT institutions are present to promote the interests of the IT industry such as NASSCOM, STPI, and SEAP. As the industrial executives put it the IT industry is practically a zero raw material industry. The basic inputs of the industry are land, energy, computers and human resources. The latter of which is the fundamental input to the industry and therefore the industry becomes relatively easy to start up.

According to the records of the Pune Municipal Corporation there are 708 IT companies in Pune ranging from small to large units. NASSCOM also puts the figure to 700 IT companies operating in the city. The city has around 12-13 IT Parks and 3 Special Economic Zones to enable the cluster development of IT industry in the city. Most of the bigger companies are located in the IT parks such as Magarpatta which is within the PMC limits, and Hinjewadi which is just outside the city limits and falls under the jurisdiction of another municipality which is the Pimpri Chinchwad Municipal Corporation (PCMC). Many IT employees prefer to live in Pune and therefore travel from different parts of Pune city to Hinjewadi on a daily basis for work.

IT companies are also spread throughout the city concentrating in certain locations or administrative wards like Vimannagar, Aundh, Dhole Patil Road, Ghole Road, and Hadapsar. The latter two having some of the larger concentrations of IT companies. The red circles in the picture below (figure 13) show the IT company concentrations, while the yellow circles depict the locations of the two big IT parks that this thesis will reference. As mentioned above, Hinjewadi is located outside the city limits.

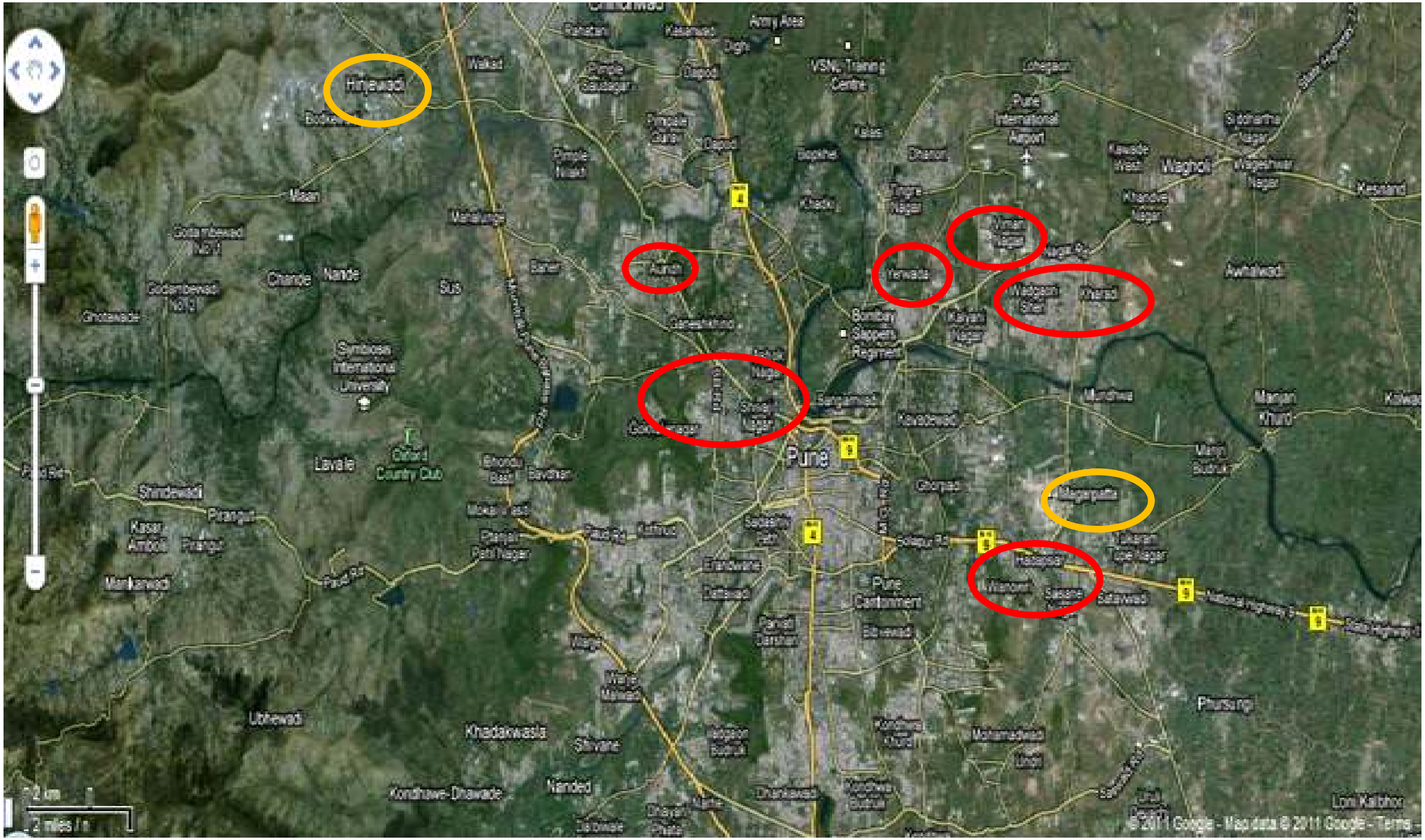


Figure 13: Location and major distribution on IT companies and IT parks in Pune

4.2 Economic Effects of the IT industry in Pune

The initial hypothesis of the thesis looked at the range of economic benefits that the Pune Municipal Corporation (PMC) receives from the IT industry. Primary indicators of this information were tax revenues and employment generation.

All the interviewees including the Pune Municipal Corporation stated that the IT industry has been economically beneficial to the city. The indirect benefits were highlighted such as that of spending or consumption by the IT industry and the employees in particular. Many interviewees referenced the national level research done by NASSCOM in 2007 and 2011 that reflected the direct and indirect effects of the IT industry on the overall economy.

NASSCOM (2007) stated that every 1 Indian Rupee (INR) spent by the IT sector (on domestically sourced goods and services), translates into a total output of about Rs 2 in the economy - driven by derived demand from firm-level expenditure such as capital expenses as well as operating expenses (CAPEX and OPEX); and high levels of consumption spending by professionals employed in this sector.

In terms of productivity, it was found that the per person contribution in the IT industry was many times higher than that of the agriculture and manufacturing industry (See table 7).

Industry	Employment	Revenues	Per person contribution
IT industry	1.96 million people	USD 52.1 Billion,	USD 26555
Agriculture	660 million people	USD 214 Billion	USD 324
Manufacturing	62.8 million people	USD 245 Billion	USD 3896

Table 7: Industry-wise breakup of performance indicators, NASSCOM 2011

4.2.1 Employment

4.2.1.1 Direct employment

A Right to Information (Public Disclosure) application was filed with the Directorate of Industries to get this information. But the office was unable to provide a suitable response.

None of the industrial institutions interviewed also had an exact count of the number of people employed in the IT industry in Pune. Apparently, it is difficult to get an exact estimate due to the characteristic floating working population. Figures ranged from 200,000 – 300,000 by NASSCOM while another IT company source stated 230,000 – 280,000. MCCIA estimated that around 200,000 people would be employed by the IT industry in Pune. The Labour Department of Pune says that the total number of people employed would be in the range of 150,000 – 200,000. For the thesis we assume the total employment for the IT industry is 200,000 people. The lower end of the range has been selected given the uncertainty of exact information, and to be able to reflect the minimum effects of the population employed. This figure will henceforth be used for data analysis through this section of the thesis.

Of this population, most sources confirmed that a huge percentage (50-60%) of the IT employee population is from outside the city.

According to NASSCOM (2011), the IT industry grew at a CAGR (Compound Annual Growth Rate) of 23.7%, which provided new employment opportunities, as a result of which Pune has a high percentage of working population of 61.8%.

4.2.1.2 Indirect employment

NASSCOM (2007) concludes that for every one job created in the IT-ITES sector, four additional jobs are created in the rest of the economy amounting to an employment multiplier effect of 1:4. Services such as catering, transport and housekeeping, security and technology have received a boost from the IT industry sector. This was also confirmed in the interviews for this research.

A significant part of the additional job creation is a result of the capital and operating expenditure of the IT industry on sectors such as construction, transportation, security, IT infrastructure, communication, education and research, fuel and power, and insurance. While the induced effect of wages and salaries of the IT employees on consumption for housing, apparel, retail, hospitality, health, insurance, transport, entertainment etc, also generates employment (NASSCOM 2007). The increased employment opportunities are not restricted to educated / skilled professionals; according to the survey, nearly three-fourths of the workforce employed by major service providers to IT industry (catering, housekeeping, transport, security) has basic school or higher secondary education or is less educated. Going by the widely used research of NASSCOM 2007, the thesis assumes the multiplier effect of employment of 1:4.

The multiplier effect of the IT industry may not be restricted to the city level and may expand to the sources outside the city (regional and national) where the production of those goods and services happens.

If we simply apply the multiplier effect for Pune to the direct employment number of 200,000 then the indirect employment would be 200,000*4 = 800,000.

The total employment resulting from this industry would then be 200,000 + 800,000 = 1,000,000 which in the context of Pune's total population of 3.5 million would mean around $1/3^{rd}$ of the total population.

4.2.2 Tax Revenues

4.2.2.1 Property Tax

Property Tax consists of general tax on properties, fire tax, tree tax, water tax, water benefit tax, conservancy tax, special conservancy tax, sewerage benefit tax and street tax. It is charged as a percentage of Annual Rateable Value (ARV). ARV is the amount of rent a property can receive over a period of one year and is calculated as - area in sq feet * basic rate per square foot.

Since 2003 IT Companies have benefitted from a reduced property tax rate of INR 2.60 per sq ft. While the commercial property rates are INR 4 onwards. This concession been withdrawn from the 1st of April 2010, and the IT industry has now to pay property tax at a commercial rate.

Table 8 reflects the property tax received from the IT industry between 2003 and 2011.

Period	Property Tax collection in Indian Rupees (INR)
2003 -2004	715,162
004-2005	9,192,584
2005-2006	29,760,677
2006-2007	69,739,799
2007-2008	63,586,795
2008-2009	84,566,223
2009-2010	84,505,672
2010-2011	118,452,792
2011- 13th July 2011	93,553,039

Table 8: Property Tax Collection for IT companies in Pune, PMC Tax department

The table reflects only the amount that has been collected from the IT industry and may not reflect the potential property tax that the PMC has to receive. The average collection performance of the PMC stands at around 72 percent of the total demand (PMC 2006). Based on the data received of actual collection of property tax from the IT industry, Table 9 looks at the year wise percentage contribution of revenue from the IT industry to the PMC budget.

Financial Period	Property Tax collection *(INR Millions)*	PMC Budget for that year *(INR Billions)*	Percentage of the budget (%)
2007-2008	63,586,795	18,640,000,000	0.34%
2008-2009	84,566,223	20,250,000,000	0.41%
2009-2010	84,505,672	30,270,000,000	0.27%
2010-2011	118,452,792	31,960,000,000	0.37%

Table 9: Property tax as percentage of the PMC budget (2007-2010), PMC Tax Department

The potential property tax figures for the year 2011-2012 as provided by the PMC stands at around INR 313 million (31,31, 55,098). If we assume that the PMC will have a hundred percentage collection this year, then this amount is almost 1% (0.96) of the total PMC budget of INR 32,47,00,00,000.00 or INR 32 Billion for the year 2011-12.

4.2.2.2 IT premium

IT premium is a one-time payment by the IT companies against the grant of 100% additional Floor Space Index (FSI) to all IT and ITES units in all private IT Parks of specified sizes. The premium amounts to 25% of the present day ready reckoner. Of this 25% goes to the state government and 75% to the respective municipal corporation, which is to be used for the development and up-gradation of off-site infrastructure required for IT companies.

Figures for the year 2007-2010 have only been provided by the PMC as they were unable to source data from 2003 onwards.

The amount received by the PMC (April 2007-2011) is around INR 520 million (529,088,773). It is directly proportional to the new development or construction of IT companies in the city.

Table 10 similarly compares the amount of premium received against the PMC budget for that period.

Financial Period	**IT Premium Amount** *(INR)*	**PMC Budget for that period** *(INR)*	**Percentage of the budget** (%)
2007-08	344,101,600	18,640,000,000	1.85%
2008-09	48,527,180	20,250,000,000	0.03%
2009-10	7,465,660	30,270,000,000	0.24%
2010-11	128,994,333	31,960,000,000	0.40%

Table 10: IT premium as percentage of the PMC budget (2007-2010), Source Author

This amount of premium that is received, as stated by the policy, is to be utilised such that the infrastructure and development around these areas are improved. But the PMC per se has no separate fund for this collection and all of which goes to the general corpus. So they are unable to track how the funds are actually utilised.

Based on the year wise information received for both IT premium and property tax, Table 11 reflects the consolidated amounts from 2007 to 2010 as a percentage of the PMC budget.

Financial Period	IT premium and property tax *(INR)*	PMC Budget for that period *(INR)*	Percentage of the budget (%)
2007-2008	407,688,395	18,64,00,00,000	2.18%
2008-2009	133,093,403	20,25,00,00,000	0.65%
2009-2010	91,971,332	30,27,00,00,000	0.30%
2010-2011	247,447,125	31,96,00,00,000	0.77%

Table 11: Sum of the property tax and IT premium (2007-2010), Source Author

4.2.2.3 Octroi Tax

Octroi is a local tax charged on all goods entering the city; it is levied based on the category of goods (weight, numbers, etc.). It is the single largest source of income accounting for 42 per cent of municipal revenue income (PMC 2006).

Despite the IT policy 2003 waiving off the octroi tax for the IT companies on the capital goods and raw material that is imported within the municipal limits, the PMC still collects an octroi tax albeit at a concessional rate. The author was not able to get octroi related information from the relevant department. The IT company and industry representatives interviewed unequivocally state that the law needs to be abided by and the IT industry should not pay any octroi. One company interviewed stated that they pay an octroi of INR 15 million to the PMC every year.

Many PMC officials interviewed spoke of the indirect benefits that the IT industry brought through the consumption patterns of the employees. They stated that these consumables increased their octroi revenue. The IT sector employs people at wages which are on an average higher than the manufacturing industry. The spending power of an employee of the IT industry is therefore higher than that of the manufacturing sector. This consumption expenditure was widely acknowledged as being beneficial for the city's economy and that of the municipality's through which local taxes are collected such as octroi, and property tax.

In the absence of data for this, the research conducted by NASSCOM 2007, based on India's IT industry across various cities including Pune can be used as a reference. Table 12 and figure 14 reflect the various consumption categories for IT employees such as spending on housing, food items, clothing, health, education, outdoor eating and holidays. It also reflects the various categories of expenditure as a percentage of the total annual income.

Category of Consumption	Total Domestic Spending by IT industry employees (*INR Billions)*	Per Capita spending *(INR thousands)*	As percentage of total income
Health	5.7	4384.62	1.4
Fuel and Power	8.5	6538.46	2.2
Entertainment	9.7	7461.54	2.5
Two wheelers	2.8	2153.85	2.7
Four Wheelers	7.8	6000.00	2.7
Transport	10.6	8153.85	2.7
Outdoor eating	11.2	8615.38	2.9
Education	11.9	9153.85	3
Telephone	11.9	9153.85	3.1
Insurance	13.4	10307.69	3.4
Clothing	15.1	11615.38	3.9
Holidays	15.6	12000.00	4.9
Consumer durables	17.2	13230.77	5.5
Food Items	22.3	17153.85	5.7
Housing	84.2	64769.23	21.6
Other	11.7	9000.00	

Table 12: Consumption Spending IT professionals (2005-06), NASSCOM 2007

Note: The study refers to a total employment of 1.3 million people in the IT industry in India.

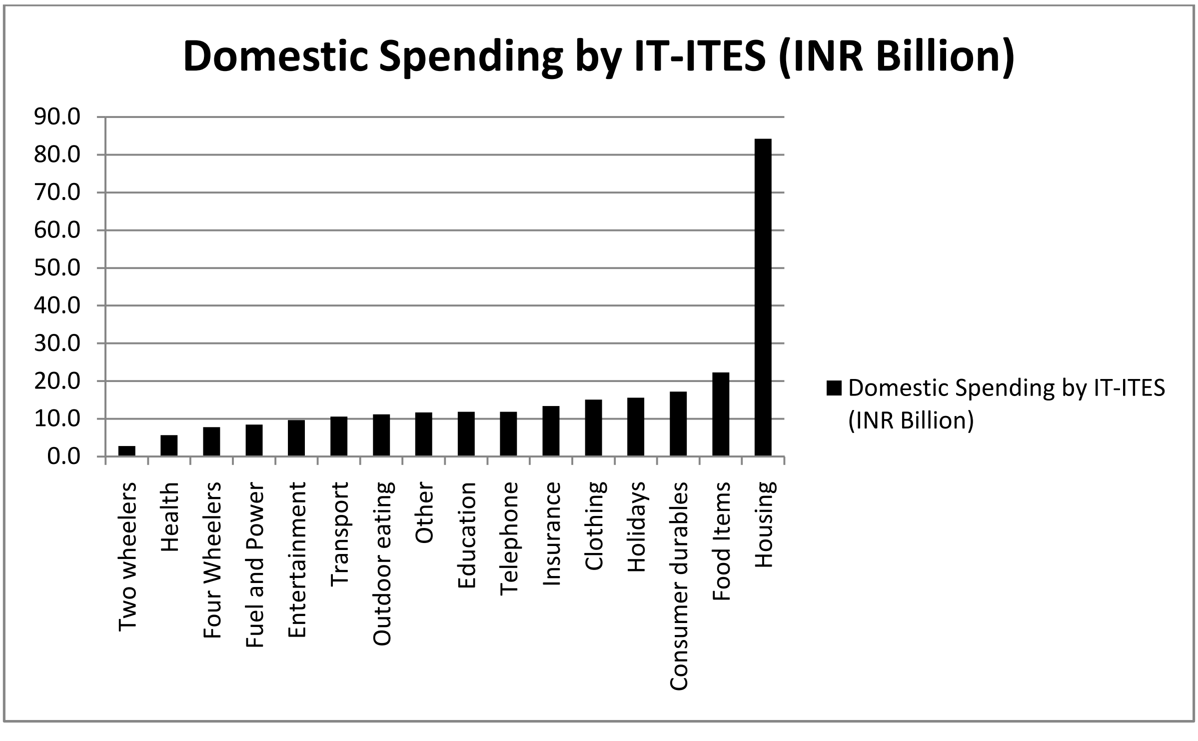


Figure 14: Domestic Spending by IT professionals, NASSCOM 2007

4.2.2.4 Development Charges

Some of the people interviewed stated that the PMC benefits from high development charges from the IT industry. Development charges are one time charges paid by the developers to the civic body while starting a new construction project. Development charges can be termed as an indirect revenue source from the IT industry. It is at the rate of Rs 6 per sq ft for residential constructions and Rs 12 per sq ft for commercial constructions. Due to the unavailability of valid data, no exact or approximate figures can be given.

Based on the field work and interviews, additional economic benefits (including financial) have been looked at in this section. Figure 15 summarises the main economic benefits.

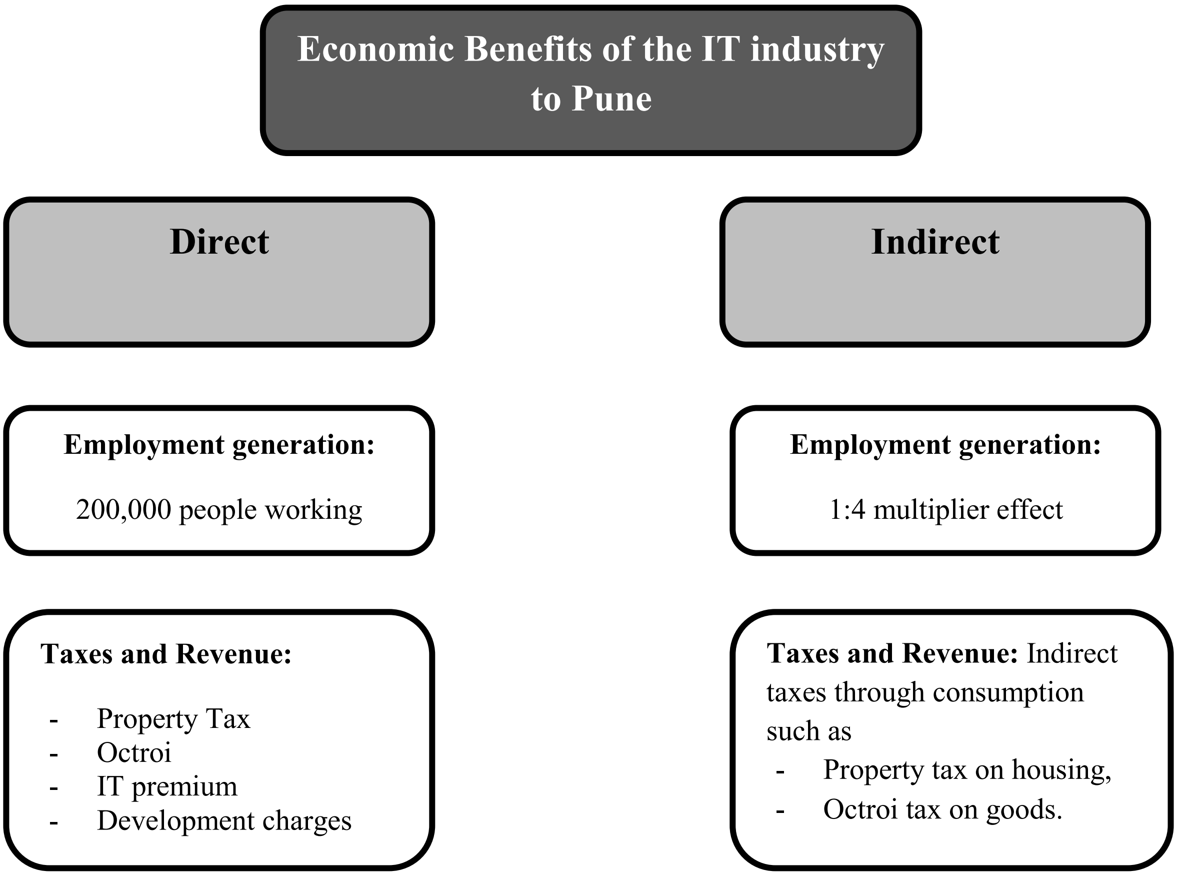


Figure 15: Economic Effects of the IT industry in Pune, Source Author.

4.3 Environment Effects of the IT industry in Pune.

Two levels of effects were to be looked at to map and assess the range of environment impacts that the IT industry has on the city of Pune – industry level and the employee level. This information will be analysed using the Pressure State Response framework. Table 13 provides a description of all the indicators that are used in the thesis to demonstrate Pressure and the State for both the industry and the employee level.

INDUSTRY LEVEL						
Type of Effect	**PRESSURE**			**STATE**		
	Indicator	**Unit of Measurement**	**Description**	**Indicator**	**Unit of Measurement**	**Description**
Land	**Green Zone Development**	Area in square. metres	Area of green zones developed for the IT industry.	**Loss of Ecosystem Services**	Monetary (INR) or Functional	Quantitative or qualitative loss of ecosystem services due to development activity.
Energy	**Electricity Consumption**	Mega Watt Hour	Electricity consumed by the IT industry	**Emissions *(Greenhouse gases and Air Pollutants)***	Metric Tonnes	Level of emissions based on this amount of electricity consumed
E-waste	**E-waste Generation**	Metric Tonnes	Amount of E-waste generated by the IT industry.	**E-waste Pollution *(Air, water and soil pollution)***	Physical	Kinds of pollution and health impacts caused due to improper handling of E-waste
Basic Services	**Overall pressure on Services (Water)**	Litres	Scale of demand for basic services such as water, sewage, from the IT industry	**Additional Infrastructure requirements**	Monetary (INR) or Physical	Assessment and estimation of the additional infrastructure costs to support the provision of services to the IT industry
Transport	**Traffic Congestion**	Number of vehicles	Amount of congestion caused by the use of personal vehicles by the IT employees to travel to work	**Air pollution**	Metric Tonnes	Pollution caused due to the use of personal vehicles to travel

EMPLOYEE LEVEL						
Type of Effect	**PRESSURE**			**STATE**		
	Indicator	**Unit of Measurement**	**Description**	**Indicator**	**Unit of Measurement**	**Description**
Land	**Housing Demand**	Number of houses	Number of houses required by IT employee	**Housing Area**	Square metres	Amount of housing area developed for IT employee

			population			population
Basic Services	**Water**	Litres	Amount of water consumed by the IT employee population	**Sewage Generation**	Litres	Sewage generated due to the consumption of water.
	Waste generation	Metric Tonnes	Amount of waste generated by the IT employee population	**Pollution / Landfill space**	Metric Tonnes/ Square meters	Kinds of pollution caused due to dumping of waste or amount of landfill area needed
Energy	**Electricity Consumption**	Mega Watt Hour/Kilo Watt Hour	Electricity consumed by the IT employee population	**Emissions *(Greenhouse gases and Air Pollutants)***	Metric Tonnes	Level of emissions produced as a result of the generation of this amount of electricity consumed
Transport	**Transport**	Number of vehicles	Number of vehicles owned by IT employee population	**Air pollution**	Gms/Km or Mgs/Km, Percentage	Pollution caused due to the use of personal vehicles

Table 13: Description of the various indicators and their units of measurements

4.3.1 Environment Effects at the Industrial Level

Based on the literature review in the previous chapter, three main environment related effects were identified (see also table 13).

- Electricity consumption and Emissions
- Green zone development
- E-waste generation

4.3.1.1 Electricity Consumption and Emissions (GHGs)

The electricity supplier, MSEB for the city of Pune was contacted twice for electricity consumption information for the IT industry in Pune. Two Right to Information (public disclosure) applications resulted in no data. Ideally one would expect the information to be categorised with the electricity supplier by sectors but that is not how the information is stored. An entire list of companies with the address and contact details was also provided, but no information was given and unique consumer ids for each of the company were asked for which was impossible to do.

To be able to go around this problem, the researcher managed to get information of electricity consumption from some companies. All the IT company representatives interviewed agreed that for their operations, the electricity needs of the companies is high. The NASSCOM representative stated that the electricity consumption is directly proportional to output.

Table 14 represents the data received from the companies

IT company	Number of Employees	Electricity Consumption *(mWh per year)*	Consumption per capita *(mWh per year)*
XYZ	2500	6,200.00	2.48
IT park with 30+ companies	60,000	164,444.44	2.74

Table 14: Electricity Consumption of Companies interviewed, Source Author

Note: 1 mWh = 1000 kWh

The electricity consumed in table 14 reflects the Pressure indicator. In order to analyse the 'S' or State of this pressure, the level of emissions and or pollutants resulting from the generation of this amount of electricity was looked at. Green house gases (GHG) are primarily composed of carbon dioxide (CO_2) and methane (CH_4) as a result of the burning of fossil fuels. Effects of the GHG are known to be long term and far reaching. Air pollutants on the other hand are gases that are either emitted or that react within the atmosphere. Well known air pollutants are nitrogen oxides (NOx), sulphur dioxide (SO_2), volatile organic compounds (VOC) and particulate matter (PM).

To be able to arrive at the level of emissions, the Emission Factors of electricity generation system in India was looked at. Emissions factor is the measure of the average amount of a specific pollutant or material discharged into the atmosphere by a specific process, fuel, equipment, or source. It is expressed as number of pounds (or kilograms) of particulate per ton (or metric ton) of the material or fuel.(Anonymous 2011)

Emissions factor for India's electricity generation for air pollutants like NOx, SOx, and PM could not be sourced from the internet; and the CO_2 Baseline Database for the Indian Power Sector has the emissions factor for Carbon Dioxide only. Some experts contacted were also unable to provide the information. For the purpose of this research, Emissions Factors for electricity generation data for India is sourced from U.S. Department of Energy, Energy Information Administration Form EIA-160 (2007) (See table 15).

Emissions Factors	
Carbon Dioxide CO_2	0.999 (Metric tons /mWh)
Methane CH_4	0.1664 Kgs/mWh
Nitrous Oxide	0.1959 Kgs/mWh

To elaborate on table 15 with the approximate emission factors for India, table 16 represents the total emissions resulting from the generation of that amount of the electricity consumed by these companies, as well as the per capita emissions of each employee

Table 15: Emission Factors for India, EIA (2007)

IT Company	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)
	Metric Tonnes	*Metric Tonnes*	*Metric Tonnes*
XYZ	6,193.8	1.03168	1.21458

Per Capita Employee Emission	2.47752	0.0004127	0.0004858
IT Park with 30+ companies	164,280	27.363556	32.214667
Per Capita Employee Emission	2.73726	0.0004559	0.0005368

Table 16: Annual emissions from companies and employees based on their consumption of electricity, Source Author

According to Carbon Disclosure Report (CDP 2010), two IT companies declared their carbon emissions. One company called Tata Consultancy Services (TCS) Information Technology states its CO_2 equivalent per employee to be 2.59 metric tonnes while Wipro Information Technology states the CO_2 equivalent per employee to be 2.68 metric tonnes. The standard practice is to express greenhouse gases in carbon dioxide (CO_2) equivalents. Emissions of gases other than CO_2 are translated into CO_2 equivalents using global warming potentials. By converting Nitrous Oxide and Methane to their respective CO_2 equivalents (296 and 23 respectively) (IPCC 2001) for the per capita emissions in table 16, the result is along the range of TCS and Wipro. For company XYZ, the CO_2 equivalent is 2.63 and for the IT Park it is slightly higher at 2.9.

Information on exact employment numbers and the sectoral electricity consumption would have been useful to have been able to make a thorough analysis of the Pressure and State levels. But given that there was no data on the IT industry electricity consumption and, a range of data available for employment, the research will have to work with certain assumptions and scenarios. In order, to be able to arrive at the approximate electricity needs of the IT industry in the city of Pune, the consumption per capita is multiplied with the estimated number of employees employed in the 708 companies that are located in the PMC. At this point it would be necessary to differentiate between people working inside the city from the ones working at the Hinjewadi IT Park located just outside the city, to arrive at a city level estimate of electricity consumption.
The assumptions are:

a) Based on table 14, the annual per capita electricity consumption per person employed in the two sets of companies is 2.48 mWh and 2.74 mWh respectively. For the thesis, we assume lower end of the range of 2.48 mWh to reflect the minimum effects possible.

b) The other assumption would be to estimate the number of IT people employed in the companies operating in the city. As of 2011, the total number of companies registered in the PMC is 708. The total IT employment is assumed to be 200,000 people, many of which are employed at the Hinjewadi IT Park located at the outskirts of the city. One way to have found that figure would be to divide the total area of IT companies located in Pune by 100 square feet (which is the average amount of area provided per employee). Or by finding out how many people would be employed in Hinjewadi and getting the difference. This information was sought from the PMC and STPI which is the relevant institution for Hinjewadi, but no concrete information is available. The building department of PMC did provide certain information on the total land up for IT development, but the researcher has not been able to validate this information with other departments. So that information will not be used

One of the big IT parks located in the city of Pune has stated that they employ around 60,000 IT professionals. So for the purpose of this analysis we assume that the total people number of people working in IT companies located within the PMC area is between 80,000 - 100,000.

Based on these assumptions, the emissions factor will be applied to the amount of electricity needed by the IT industry per capita. To provide a scenario for the ranges, the total electricity needs of the IT companies in the city would be between 80,000 -100,000*2.48 mWh.

Table 17 below illustrates the emissions resulting from the generation of that amount of electricity consumed by the IT industry in Pune.

Scenario	Number of Employees in 708 companies (A)	Consumption per capita *(mWh per year)* (B)	Total Consumption *(mWh Per year)* (A*B)	Emissions		
				Carbon Dioxide *(Metric Tonnes)*	**Methane** *(Metric Tonnes)*	**Nitrous Oxide** *(Metric Tonnes)*
Low	80,000	2.48	198,400	198,201.60	33.01	38.87
Medium	90,000	2.48	223,200	222,976.80	37.14	43.72
High	100,000	2.48	248,000	247,752.00	41.27	48.58

Table 17: Range of Emissions from Electricity Consumption in the IT companies in Pune, Source Author

Just to be able to put this result in perspective, the cost of mitigating carbon dioxide (CO_2) could be taken into account. The price of mitigating one tonne of carbon dioxide in the Voluntary market for emissions reduction is anywhere between USD 6 and USD 6.50. The price is comparatively lower in the voluntary market. Based on this, the total cost for mitigating just the carbon dioxide emissions generated from this electricity use for 80,000 people employed in the IT industry would range from INR 53 to 57 million in 2011.

In terms of policy, for the moment there is no strong emphasis on the reduction of electricity use and design efficiency and improvements from the city itself, including in the revised Maharashtra IT and ITES policy 2009. The IT industry continues to pay at industrial rates which is at the rate of 5.40 kWh for 20kW and above as against 7.95 per kWh. In terms of tariff rates the MSEDCL has raised concerns with regards to categorisation of some of the IT industry activities as “Industry”. Some of these activities include GIS mapping and services, Computerised Call Centres, Multimedia Development Units, and Cyber Cafes. They explain that these activities are commercial in nature and need to be categorised accordingly. Some companies are reported to reduce unnecessary electricity usage and the use of more energy efficient products but this is not mandatory.

4.3.1.2 Green zone Development

Based on the recommendation so the IT policy 2003, allowances were given to the IT companies to be built on No Development Zones/Green Zones earmarked in the 1987 development plan of the city. The IT policy states the following

- Only 0.20 FSI to be allowed

- Development of IT companies with ancillary residential development, the latter of which should not exceed one third of the total built up area.
- 500 trees per hectare should be planted

In Pune city, so far no IT development has taken place in such zones. The PMC and the developers interviewed confirmed that the development with 0.20 (20%) FSI is not considered financially viable. The developers interviewed stated that were anticipating that the no-development reservations on certain areas such as agricultural land would be removed in the upcoming development plan (2007-2027) which is in the process of being finalised.

Currently the law enables a 4% construction on green zones for certain purposes only. The activities or development permitted is mostly temporary in nature. A larger percentage of development such as that of the IT industry would reduce that much amount of open space area available, increase paved surface area, increase intensity of land use and would result in losing certain ecosystems services depending on the location of the concerned area.

4.3.1.3 E-waste Generation

Pune ranks among the top ten Indian Cities, which are repository of WEEE (Waste from Electrical and Electronic Equipments). Specific data including scenarios for e-waste generation by the IT industry is not available. PMC authorities and various experts were contacted to see if they had any specific data for the IT industry vis-a-vis e-waste generation. Though they all agreed that it was high, no specific numbers or ranges were available. The problem of e-waste was also acknowledged by some of the IT company representatives who were interviewed. NASSCOM stated that e-waste is a big concern and added that the big companies would have formal processes to deal with e-waste, but small and medium size companies do not entirely deal with it. The experts and the recycling firm representatives stated that most IT companies do not have internal policies to deal with e-waste. The Waste Collection Co-operative representative in Pune also confirmed that a large part of the e-waste can be sourced from the IT industry. According to NASSCOM headquarters in New Delhi, since the awareness about improper handling of e-waste has risen amongst mass consumers of IT equipments, the common practise of giving away old electronics to the informal sector has plummeted considerably. Housekeeping departments in most IT companies are conscious about the end cycle of waste electronics. However a lot of companies are still ignorant about the e-waste menace and continue their old practises which are mainly more value generating.

An expert explained that making predictions of the IT generated e-waste would not be helpful due to the intrinsic nature of the waste itself which is piled and stored for periods of time, and is not disposed off immediately. This was confirmed by one formal recycling firm that stated that IT companies generally tend to pile up their IT E-waste, as that increases volume and can fetch better prices.

With the exception of a few small items or lower grade items like CDs, none of the bulk e-waste ends in the landfill site in Pune. Majority of the e-waste is purchased by the informal sector in Pune and very little waste goes to the formal sector. Except for certain activities, no major dismantling activity occurs in Pune, but the e-waste is transported to the city of Mumbai for further dismantling and processing.

Most of the recycling process of e-waste is handled by the informal sector in Pune. The recyclers (formal and informal) pay for the material that they receive from the various sources. The informal sector apparently pays more for the e-waste than the formal sector as operating and administration expenses are high in the latter. As one recycling firm representative stated, the difference could range from 20-100%. Data concerning the costs for the formal recycling e-waste was actively sought from various sources and interviewees, but only the NASSCOM headquarters in New Delhi provided some information. According to them the average cost to formally recycle one ton of PC waste is INR 200,000 which does not include the operational costs associated in formal sector.

As a basic indication for e-waste, this research could refer to a larger research conducted in 2007. The Maharashtra Pollution Control Board (MPCB 2007) states that in Pune the following materials are separated for further recycling:

- Dissembling of Monitor and extraction of components
- Wire PVC and Copper
- Plastic Shredding

In Pune, e-waste is transported to Mumbai for dismantling activities such as Regunning of Cathode ray tube (CRTs); Acid Bath for Printed Wire Boards (PWB); Integrated circuit (IC's) Extraction from PWB; Surface Heating of PWB and Extraction of components; Gold Extractions from pins and Comb; Yoke core and copper extraction from wire; Metallic Core of Transformer and Copper; Rare Earth Core of Transformer and Copper. Some part of the e-waste is again sent to Delhi for further processing and dumping to the land fill site.

Given that data was unavailable, the same report has certain statistics and figures that could be used as a point of reference. One dimension that could be explored is to look at the obsolescence rate i.e. the total numbers of Personal Computers (PCs) entering into the market for dismantling. At the time of the report, the data from secondary sources indicate that obsolescence rate of PCs prevailing in India ranges from 5 to 7 years. Assuming market additions every year is equivalent to PCs coming into market for dismantling, scenario analysis was carried out concerning two scenarios for obsolescence rates of 5 and 7 years respectively (see table 18). A discarded personal computer with a CRT monitor typically weighs 25 kg and consists of metal (43.7%), plastics (23.3%), electronic components (17.3%) and glass (15%) (Berkhout and Hertin, 2001).

Year	Penetration / 1000 Population	Installed Base	Yearly Addition	Obsolescence Rate 1 (in Numbers)	WEEE Generated 1 (in Tonnes)
2006	19.03380253	75994.4	15919.9	725.22	19.725984
2007	23.67100004	95737.5	19743.1	627.1	17.05712
2008	29.11919435	119303.8	23566.3	4450.3	121.04816
2009	35.34483116	146693.3	27389.5	8273.5	225.0392
2010	42.31523749	177906	31212.7	12096.7	329.03024
2011	49.99860265	212941.9	35035.9	15919.9	433.02128
2012	58.36395948	251801	38859.1	19743.1	537.01232
2013	67.3811661	294483.3	42682.3	23566.3	641.00336
2014	77.02088785	340988.8	46505.5	27389.5	744.9944
2015	87.25457972	391317.5	50328.7	31212.7	848.98544

Table 18: Statistics of PCs as e-waste generation and handled in Pune, Pimpri Chinchwad region, MPCB 2007

Note: Years 2002 and 2000 were taken as years for evaluating obsolescence rate

The number of PCs entering into Pune e-waste market is 2 and 1 per day for 5 and 7 year obsolescence rate, respectively. The total weight of PCs entering into the e-waste markets of Pune and the neighbouring city of Pimpri Chinchwad e-waste market considering five year obsolescence rate is depicted in the above table 17. Some of the people interviewed stated that for PCs the current obsolescence rate is anywhere between 2-4 years. Given that the obsolescence rate is now lower, this number is likely to increase. It would be difficult however to use these figures to base any estimations for e-waste for the city of Pune as these numbers include the neighbouring municipal area Pimpri Chinchwad, and it includes numbers from individual households and different sectors.

Just to put this into perspective, we assume that around 40% of the PC e- waste projection as per table 18 in the year 2011 is due to the IT industry in Pune, and the minimum cost to formally recycle this e-waste is 200,000 per ton. The total cost to recycle this amount of e-waste would be around INR 3.5 million.

Table 19 lists the potential occupational and environmental hazards stemming from the e-waste dismantling activities by the informal sector in Pune.

Computer/e-waste Components and Process Witnessed	Potential Occupational Hazard	Potential Environmental Hazard
Shredding of plastics from computer and peripherals e.g. printers, keyboards, monitors etc at low temperature to be reutilized in low grade plastics.	Probable Hydrocarbons, heavy metals and brominated dioxins	Emissions of brominated dioxins and heavy metals and hydrocarbons.
Computer wires open burning and stripping to remove copper	Brominated and chlorinated dioxins, Polycyclic Aromatic Hydrocarbons (PAH) Carcinogenic exposure to workers living in the burning works area Cuts from knife in case of implosion	Hydrocarbons ashes including PAH's discharged to air, water and soil

Table 19: Potential occupational and environment hazards of e-waste dismantling activities, MPCB 2007

But given the fact the most of the e-waste is exported to Mumbai for dismantling, one needs to also take into account the suite of problems and hazards associated with those activities considering that 95% of the processing is done by the informal sector. All the work is done by bare hands and only with the help of hammers and screwdrivers. Waste components which do not have any resale or reuse value are openly burnt or disposed off in open dumps. Pollution problems associated with such backyard smelting using crude processes are resulting in fugitive emissions and slag containing heavy metals of health concern. CRT breaking operations result in injuries from cuts and acids used for removal of heavy metals and respiratory problems due to shredding, burning etc. Strong acids are used to retrieve precious metals such as gold. Working in poorly ventilated enclosed areas without masks and technical expertise results in exposure to dangerous and slow poisoning chemicals (Kurian 2007). Environmentally, some of the substances released are discharged directly into river and banks which may lead to acidification of rivers destroying fish and flora, lead and mercury are known to leach into the ground.

Speaking with the experts, they emphasised the need to have a clear system where the PMC needs to put a good collection system and policy in place for Pune. Most interviewees concurred that the government needs to be more proactive to ensure that the e-waste is properly recycled and disposed. An official system of monitoring and collection needs to be put into place for the same. One expert commented on how the recycling of e-waste is more or less functional in SEZ areas (Special Economic Zone) as it is made mandatory but that is not existent across the entire IT industry operating in the cities of Maharashtra. The expert also mentioned how certain companies tend to process only a certain amount of e-waste formally to comply with mandatory norms, while the rest they process through the informal sector. The revised IT and ITES policy of 2009 does not explicitly mandate IT companies to recycle or process e-waste. It merely states that the development of comprehensive e-waste collection and recycling systems and their use by the State as well as private agencies for the disposal of IT products will be promoted.

In terms of Pressure, the data results do point to the fact that e-waste is of concern for the city. State of e-waste the current management practices of e-waste through the informal sector, transportation and export of e-waste to other cities for processing. The last of which has its set of environment and health impacts.

At the Response level, GIZ (Deutsche Gesselschaft fur International Zusammenarbeit), an organisation of the Government of Germany has joined hands with the PMC, to conduct a study of the e-waste situation in Pune. There are also the new e-waste (management and handling) rule 2011, notified by the Ministry of Environment and Forests which will come into effect from May 1, 2012. The revised IT policy of 2009 states that while IT/ITES units with less than 100 employees will be exempt from obtaining consent from the Maharashtra Pollution Control Board (MPCB), they will be required to submit annual statements to MPCB on the disposal of wastes, including electronic wastes, used batteries and used oil. But this was not evident during the interviews and discussions.

4.3.1.4 Overall Pressure on Services

This section deals with the perceived pressure that the IT industry has had on the infrastructure of the PMC. It is based on the allowance of the IT policy of 2003 makes for the provision of a double The Floor Space Index (FSI) or Floor Area Ratio (FAR). FSI or FAR denotes the ratio of the total floor area of buildings on a certain plot to the size of the land of that location. The quotient obtained by dividing the total covered area (plinth area) on all floors by the area of the plot.

$$\text{F.S.I.} = \frac{\text{Total covered area on all floors}}{\text{Plot Area}}$$

The IT policy also allows for IT development in residential areas.

In order to assess if the IT industry has put a pressure on the PMC service provision, a number of PMC representatives, including some experts were interviewed. Most of the PMC representatives stated that with the exception of traffic, there is no additional infrastructure pressure on account of the IT industry. One PMC representative however explained that while planning the 1987 Master plan, the question of IT industries never existed and the maximum planning was for 1.4 FSI. With the IT industry, arrangements for 2 FSI had to be incorporated. To be able to assess the validity of this, other departments were contacted as water supply, waste, transport, building department to get data to understand if additional expenses have been undertaken to service the IT industries such as more pipelines laid out, or roads widened, road furniture installed etc. Prima facie, all the representatives stated that no additional pressure has been added because of the IT industry as the norms required for commercial buildings is lesser than residential buildings. Taking the case of water supply, the standards for water provision are much higher for residential zones i.e. 135 pcld (per capita litres per day) than the commercial i.e. 45 pcld. So by that basic logic no additional pressure has been put on the PMC for water supply. Interestingly according to the (PMC 2010), the civic body supplies just ten per cent of the total demand of water for commercial purposes from the reservoirs. The rest is met by drawing ground water.

4.3.1.5 Transport

All the interviewees however agreed to the problem of traffic congestion caused because of the IT industry. This was by virtue of their location, where the roads would be congested during peak hours to facilitate employees to enter and exit the premises.

Two of the companies located within the city stated that they do not provide bus services for transport to their facilities within the city, however they provide transport services for employees to the IT park (Hinjewadi) located outside of the city. Most of the employees, the companies, confirmed used their own private transport such as two-wheelers and cars to travel to the companies in the city.

10,000 sq m plot	Residential							IT Development	
	430 sq ft per flat	500 sq ft per flat	600 sq ft per flat	700 sq ft per flat	800 sq ft per flat	900 sq ft per flat	1000 sq ft per flat	100 sq ft per employee	100 sq ft per employee (double FSI)
	1 FSI	*1 FSI*	*1.5 FSI*	*1.5 FSI*	*1.5 FSI*	*1.5 FSI*	*1.5 FSI*	*1.5 FSI*	*2 FSI*
Households /Seats	250	215	179	153	134	119	107	1076	2152
People occupancy	1001	861	717	615	538	478	430	1076	2152

Table 20: Comparative density levels for residential and IT development, Source Author

Table 20 reflects the residential occupancy of a 10,000 sq m plot based on 1.5 FSI for a residential complex based, and the IT office seats possible on 1.5 and 2 FSI based on the 100 sq ft average area requirement for each employee. The figure shows the possible ranges of people occupancy considering the average household size is 4.

Given the fact that public transport in the city is not well developed and a maximum number of IT employees depend on private transport to travel to their offices, a general scenario of traffic generation and congestion can be envisaged.

Pressure can be denoted as the travel demand, and State could be reflected by the traffic congestion and pollution as a result of that intensive travel demand in the absence of a good public transportation system and extensive use of private vehicles. As response to this particular pressure, the PMC has recently in its budget proposed to purchase 25 buses exclusively to cater to the IT industry professionals that would pick and drop them from various parts of the city. They have assigned a budget of INR 25 million.

4.3.2 Environment Effects at the Employee Level

Pune's population growth has surged with the coming of the IT industry due to migration into the city. Most of the interviewees attributed 40-50% of the population employed in the IT industry in Pune to have come from outside. Migration exists because Pune has jobs to offer and has the capacity to absorb more people because of development in the IT sector located in and around Pune (Mulay 2008).

The real estate has particularly benefitted with the IT industry lending a boost in the demand for housing and office space (TRS 2008).

This particular section aims to map the main effects of the employee level of the IT industry. Some of the main effects identified are housing demand, basic service needs, electricity consumption and transport.

4.3.2.1 Housing Demand

To be able to understand what are the implications of high rate of migration and employment where annual income is higher than most of the other professions, housing demand was looked at. As in the previous section of economic effects, the consumption categories include a huge percentage of income being spent on housing (see table 12).

Two developers were interviewed about this, one of them being the owner of a township with a very big private IT park in Pune. They confirmed that the IT industry has been beneficial for the real estate industry including the housing market, but other industries are also contributing to that demand.

One of the developers said that it was not easy to extrapolate the demand for housing from the IT employees, but broadly stated that 50% of the people working in the IT industry would be bachelors and would not necessarily demand a house on ownership, and would prefer rental or paying guest accommodation.

The second developer stated that they basically calculate 40% of the IT employees have a housing demand on ownership basis and 15-20% as rental. And for every 100 sq ft of commercial area that is added, the developing firm calculates 1000 square feet or 92.90 square meters of housing for that target population.

For the methodology of the PSR we assume a housing demand of 50% from the total IT employee population. Assuming a total population of 200,000 people are employed in the IT sector for Pune, we can estimate that so far the housing demand from IT employees would be at least 100,000 houses.

Housing Demand	Housing Area (Square meters)
100,000	92,90,300

Housing Demand denotes the Pressure, while the State is depicted as the physical development of that much amount of area which is reflected as Housing Area in square metres.

Table 21: Housing for IT employees, Source Author

4.3.2.2 Basic Service Needs (Water, Waste Generation)

Basic service needs could either pan across the current population of the IT employees which is 200,000 or for the estimated migrant population of the IT employees in Pune which is around 50%. For the purpose of this thesis we use the latter. Assuming that 50% of the population employed in the industry is from outside the city, we can state that the PMC has to additionally cater to an estimated additional 50% for their basic service needs. The per capita information for consumption for water and waste generation are given below.

- **Water:** As per the Development Control rules for Pune, the basic minimum standards for water supply per person per day is 135 litres pcld. According to the latest PMC report on the state of the environment, the daily consumption of water per person per day is 194 – 200 litres (PMC 2010). For the thesis we will use 194 litres per day.
- **Waste Generation:** The per capita waste generation is between 450 to 500 gms per capita per day. For the thesis we will use 450 gms per day.

Table 22 reflects the annual consumption of basic services of the estimated IT employee population of 100,000 which have come from outside the city.

Scale	Annual Waste generated *(Metric Tonnes)*	Annual Water Consumption *(Litres per day)*
Per Capita	0.16425	70810
100,000 employees	16,425.00	7,081,000,000

Table 22: Annual basic service needs for IT employees, Source Author

Table 23 below depicts the consolidated picture for Pressure and State at the employee level for basic service needs. The table describe the state as a result of the pressure for services at the employee level. For water consumption, one possible State would be the amount of water pollution or sewage generated which is calculated at 80% of the water consumed by the PMC. In this case this amount would be 5 billion litres of sewage. For waste generated, the Pressure can also be described as amounting to 4.50% of the total annual solid waste generated by the city itself (at the rate of 1000 tonnes of waste generation per day). The state of waste generation could be further analysed to the level of landfill space needed for that amount of waste generation. This aspect has however not been looked into in this thesis.

Scale	Waste		Water	
	Annual Solid Waste (Metric Tonnes)	Percentage of Annual total Solid Waste generated in the city (%)	Annual Water Consumption (Litres)	Annual Sewage Generation (Litres)
100,000 employees	16,425.00	4.50%	7,081,000,000	5,664,800,000

Table 23: Overall scenario of basic needs for 100,000 IT employees and their effects on the city environment, Source Author

4.3.2.3 Electricity Consumption

As per the latest State/UT wise data on annual per capita consumption of electricity in the country for the year 2009-10, the National average is 778.71 kWh and for the state of Maharashtra it is 1028.22 kWh (MoP 2011). Based on the figures from the ESR 2010-11

(2011), the total consumption of electricity in Pune in the year 2009 -10 is around 5 billion kWh (5,286,638,000). This amounts to the per capita electricity consumption at 1510.468 kWh which is much higher than the state of Maharashtra. For the purpose of this thesis we use the figures from the state of Maharashtra – 1028.22 kWh.

Scale	Electricity Consumption	Emissions		
	Annual Electricity consumed (mWh)	**Carbon Dioxide** *(Metric Tonnes)*	**Methane** *(Metric Tonnes)*	**Nitrous Oxide** *(Metric Tonnes)*
Per Capita	1.02822	1027.19	0.17	0.20
100,000 employees	102,822.00	102,719.18	17.09	20.14

Table 24: Electricity consumption and Emissions for 100,000 IT employees, Source Author

For electricity, the State describes the emissions created as a result of that amount of electricity production as shown in table 24.

4.3.2.4 Transport

As per capita transport according to the Environment Status Report 2010 there are 473 private vehicles in the city for every 1,000 people which implies that there are two vehicles in every family in the city. In the case of IT employees who have a high level of purchasing power, every IT person will own at least one vehicle. This was also affirmed by the expert on transport and energy interviewed. In all probability they would own one car and one two wheeler, the latter of which is highly used by a maximum population to travel to their work place.

Trip length is the average distance travelled during a trip. This has been estimated as the ratio of total passenger kilo meters to the total number of trips. For Pune, it is assumed to be 6.1 kms (MoUD 2008). According to the ARAI Report on the Emissions Factor for Vehicles (2007), different kinds of two wheelers and cars that are on the roads were tested for their individual emissions factors. From that inventory, only two wheelers and cars post manufactured post the year 2000 have been selected and the average of all emissions has been calculated. Pune has around 287,000 cars and 1.5 million two wheelers (PMC 2011). If we use the similar proportion (1:5) for 100,000 IT employees then we can assume that the IT employees would own a minimum of 25,000 cars and 75,000 two wheelers. Based on this data, table 25 has been formulated. The table compares the estimated emissions from the two wheelers of the IT population with the total two wheelers in the city with the assumption that the latter are all produced post 2000.

Scale	VEHICLE EMISSIONS										
	gms/km					mg/km					
	CO	HC	Nox	CO_2	PM	Benzene	1-3 Butadiene	Formaldehyde	Acetaldehyde	Total Aldehyde	Total PAH
TWO WHEELERS											
Per Vehicle	1.69	1.17	0.17	28.46	0.02	0.00	0.01	0.02	0.01	0.03	0.58
IT Population 75,000	126375.00	87375.00	12437.50	2134750.00	1268.75	337.81	477.19	1338.44	832.50	2552.19	43388.44
Total in the city 1,543,613	2600987.91	1798309.15	255982.49	43936371.36	26112.79	6952.69	9821.24	27547.06	17134.10	52527.86	892999.42
Percentage	**4.86%**										
CARS											
Per Vehicle	1.24	0.23	0.32	144.35	0.03	0.00	0.01	0.01	0.00	0.02	0.13
IT Population 25,000	30875.00	5675.00	7950.00	3608850.00	732.50	112.75	162.50	370.00	37.25	502.00	3172.75
Total in the city 287,176	354662.36	65188.95	91321.97	41455004.30	8414.26	1295.16	1866.64	4250.20	427.89	5766.49	36445.51
Percentage	**8.71%**										

Table 25: Vehicle Emissions Factor for IT employee Population, Source Author

Table 25 calculates the State of this indicator as the percentage contribution of the IT employee population to the emissions per km to the total number of vehicles in the city. For two wheelers it is around 5% while for cars it is around 9 %.

INDUSTRY LEVEL						
Type of Effect	**PRESSURE**			**STATE**		
	Indicator	**Unit of Measurement**	**Data Availability**	**Indicator**	**Unit of Measurement**	**Data Availability**
Land	**Green Zone Development**	Area in square. metres	Yes	**Loss of Ecosystem Services**	Monetary (INR) or Functional	Yes
Energy	**Electricity Consumption**	Mega Watt Hour/Kilo Watt Hour	Information from the sector not available but scenarios generated with data from some IT companies	**Emissions**	Metric Tonnes	Yes, quantitative analysis provided.
E-waste	**E-waste Generation**	Metric Tonnes	No but some scenarios depicted	**E-waste Pollution**	Physical	Qualitative information provided.
Basic Services	**Overall pressure on Services (Water)**	Litres	Yes	**Additional Infrastructure requirements**	Monetary (INR) or Physical	Yes, qualitative analysis provided.
Transport	**Traffic Congestion**	Number of vehicles	No but some scenarios depicted	**Air pollution**	Metric Tonnes	No.

EMPLOYEE LEVEL						
Type of Effect	**PRESSURE**			**STATE**		
	Indicator	**Unit of Measurement**	**Data Availability**	**Indicator**	**Unit of Measurement**	**Data Availability**
Land	**Housing Demand**	Number of houses	No but some scenarios depicted	**Housing Area**	Square metres	Yes
Basic Services	**Water**	Litres	Yes	**Sewage Generation**	Litres	Yes
	Waste generation	Metric Tonnes	Yes	**Pollution/ Landfill Space**	Metric Tonnes/ Square Meters	No
Energy	**Electricity Consumption**	Mega Watt Hour/Kilo Watt Hour	Yes	**Emissions**	Metric Tonnes	Yes
Transport	**Transport**	Number of vehicles	Yes with scenarios	**Air pollution**	Gms/Km or Mgs/Km, Percentage	Yes

Table 26: Indicator level Data Availability, Source Author

Table 26 concludes and summarises the overall data collection and analysis by this thesis.

4.4 What particular aspects of the IT policy that promotes IT industry expansion, can be improved and amended

Based on the interviews conducted and the overall field work, this section looks at the various aspects of the IT policy.

Overall the IT company representatives were content with the IT policy itself. One of the vital clauses of the IT policy which is not being implemented is that of the waiver of the octroi tax. The PMC collects octroi from the PMC but at a concessional rate. For the PMC, octroi tax is the largest revenue source. Most companies and IT institutional representatives were unhappy about this. Since 2003, the IT industry has been paying property tax at a residential rate which is lower than commercial rates that are usually charged. In April 2010, the PMC increased the property tax rate for the IT industry. The recent property tax by the PMC increase also conflicts with the IT policy which makes an allowance for the companies to pay property tax at residential rates. The IT premium that the city receives and is specifically meant to provide development infrastructure around the IT areas, ends up in the general corpus funds which makes it difficult to track if the PMC has indeed improved development infrastructure around those spaces, as specified by the policy. Had these funds been managed separately, it would have been easier to have also understood the level of needs for infrastructure of the IT industry and the level of costs that the PMC has to bear.

From the point of view of the environment effects of the IT policy, even though no IT companies have been developed on green zones, this allowance by the IT policy is in conflict with the principles and rules of the development plan itself. While development and planning needs to be a continuous process, there also needs to be a periodical review of the consequences of such land use change decisions. For the city, E-waste is of concern. There is national policy for e-waste rules that will be operational in 2012 and the PMC is currently doing a study with GIZ to look at the proper management of e-waste. Since 2003, there has been no effort to streamline the problem of e-waste of the IT industry in particular despite the fact that Pune is one of the top ten cities generating high quantities of e-waste. The IT policy of 2009 reflects on e-waste and the need to have formal and state recycling units. It specifies the need for certain units to submit annual statements on the disposal of waste, e-waste, used batteries and used oil to the state pollution control board but does not mandate the proper processing and recycling of e-waste.

The MSEDCL which is the government electricity supply authority has out forward recommendations to reconsider the application of tariff charges of industrial rates across. MSEDCL states that some of the activities are commercial in nature and that they should pay according to commercial rates. In the end, the mix of residential, commercial and industrial categories for different elements of policy is interesting. This could be expressed as property tax at residential rates, commercial standards for construction and industrial categorisation for electricity.

The IT policy of 2009 encourages Green IT parks but so far there are no Green IT parks or any framework of establishment of Green IT parks in Pune. None of the people interviewed including PMC authorities also mentioned about it.

The IT policy has enabled mixed land use by allowing for commercial areas in residential areas. Mixed land use in one sense is being promoted as strong planning practice. But the IT policy also promotes a cluster approach. The PMC officials preferred the cluster approach to the mixed land use planning so that transport is concentrated in certain areas specifically for access and entry. The experts however felt that the mixed land use pattern is better for improved transport efficiency in the city.

The section on recommendations in chapter 5 deals with some policy suggestions.

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

The process of data analysis is slightly constrained by the lack of concrete and substantial data for the IT industry from the Pune Municipal Corporations and from the institutions that represent the interest of the IT industry. Ranges and assumptions have been mostly provided on the basis of the information/data received.

5.1.1 Economic effects of the IT industry

The purpose of mapping the economic effects was to understand the flow of benefits that Pune receives from the IT industry. Based on the field work conducted, different economic and financial gains were highlighted by the different interviewees. There is a range of economic benefits that the city receives from the IT industry, while the initial hypothesis looked only at very limited sources of economic benefits.

All the PMC official interviewed agreed on the overall economic and financial gains of the IT industry to the city but more in terms of the indirect benefits and employment generated. It was interesting to see that there was no figure on the amount of employment of IT professionals working in the city was available and accessible either from the IT based institutions or from the PMC itself.

Revenue and taxes from the IT industry can be categorised as direct and indirect. This was considered as a significant contribution along with the scale of employment including the multiplier effect; and employee consumption expenditure. The latter is also said to contribute to additional revenue earning through taxes like octroi tax and the logic of which can also be extended to taxes such as property tax due to high housing demand. In the paradigm of the way economy operates including the cumulative effects of indirect consumption demand and supply, the IT industry has its set of benefits.

In terms of revenue, a clear time series data would have been more helpful in analysing the yearly revenue received from the IT industry from all the sources against the PMC yearly budgets. This is only possible with the property tax based on the current data that is available.

5.1.2 Environment Effects of the IT industry

Detailing the environmental effects of the IT industry has been difficult as there is no sectoral level information maintained by the city's administration. Four aspects of the environment were looked into – electricity consumption, e-waste generation, green zone development and overall pressures of the IT industry on city infrastructure.

Based on the interviews conducted and data and responses received from certain IT companies, some scenarios on electricity consumption and the emissions were created in chapter 4.

For electricity, the various scenarios created are fairly indicative and try to put into perspective the electricity consumption of the entire industry. One company shared that the break-up of the total electricity usage is 40% cooling and conditioning, 40-50% for computers and equipment and 10-20% lighting. The expert on energy pointed out that the very design of the IT buildings increase the consumption of electricity. An environmentalist commented on a site visit to one of the state-of-the-art IT buildings with a huge glass facade based in the outskirts of Pune where the employees sat with umbrellas to prevent the glare of the sun, as they did not know how to screen the voluminous layers of glass.

Apart from some instances of internal electricity efficiency and management by companies themselves, there does not seem to be an overt concern with regards to the scale of use of electricity. This can also be seen from the revised IT and ITES policy which continues to provide tariff rates to the IT industry according industrial category. To get a sense of electricity consumption compared to other economic activities, a larger sectoral comparison would have been useful as some industrial experts during the interview also pointed out the electricity consumption of the IT industry could be far less in comparison to other manufacturing industries. One source states that a particular automobile industry requires 50-55 mWh per day for its operations in Pune. This is no doubt high in comparison to the IT industry but then having a total cumulative figure of electricity consumption for different sectors based on the total number of units and people employed would help in making concrete comparison. But prima facie, this industry cannot be easily compared to a manufacturing unit for reasons that the processes involved are much different, and there are different kinds of manufacturing. A more conclusive way to know the intensity of impact would be to compare this industry with another service level industry like banking, finance or insurance.

In terms of e-waste, one IT representative fairly defended the low footprint of the industry till the question of e-waste was brought up. Most of the experts or formal recycling units interviewed did not divulge the cost price for recycling one ton of e-waste; or were unable to provide a basic estimation of the percentage contribution of e-waste by the IT industry in Pune. A detailed web search also did not yield any information.

The overall conclusion from the field work and analysis suggest that is that it is high, and the experts suggested stronger policy action and initiatives on the part of the government to attend to the problem of e-waste. According to the NASSCOM, with the help of government bodies, NGO's and industry federations more awareness can be spread and businesses can be persuaded to adopt best practises in terms of safe disposal of electronic waste. In terms of direct implications for the city in terms of environment problems, it may not be high as most of the waste processing takes place outside of the city. But the fact of the matter is that most of the e-waste is being treated informally inside the city and outside the city which has environment and health implications. The PMC has been since the last couple of years trying to set up an e-waste recycling facility but that has yet to be implemented.

Whereas the overall infrastructural pressure caused by the IT industry is concerned, the PMC does not think that there is an additional pressure on infrastructure with the exception of traffic and transport that creates a pressure on the city roads. They also highlighted that the city had to bear the burden for road infrastructure to cater to the travel for IT employees from the city to the entry points of the Hinjewadi IT park vis-a-vis not having the direct economic benefits from that IT park.

The thesis attempts to couple the industry level impact with overall impact as a result of the creation of more jobs because of the IT industry. More jobs translate into more people coming into the city as all interviewees agree is the case with the IT industry. One of the consequences of this would mean increase in the pressure in terms of servicing the basic needs and services of the people. One main outcome of the research at the employee level was to understand the demand for housing and the way some developers assess the needs for housing for the IT employees. At the employee level, with basic data on per consumption and certain assumptions, a scenario of basic service needs in terms of pressure and state has been created. It is fairly indicative but the methodology and flow enables to understand the pattern of urban growth due to IT industry. This information needs to be looked into the context of the performance of the PMC in the provision of the basic services and needs. The performance of the PMC in providing services is assessed by comparing the expenditure incurred on major core services (water, sewage, roads, waste disposal etc) with national standards. Pune has been under spending on these expenses, thereby also affecting the level of service provision. Figure16 attempts to illustrate the scale of economic and environment effects of the IT industry as per the research and analysis and based on the responses of the interviewees.

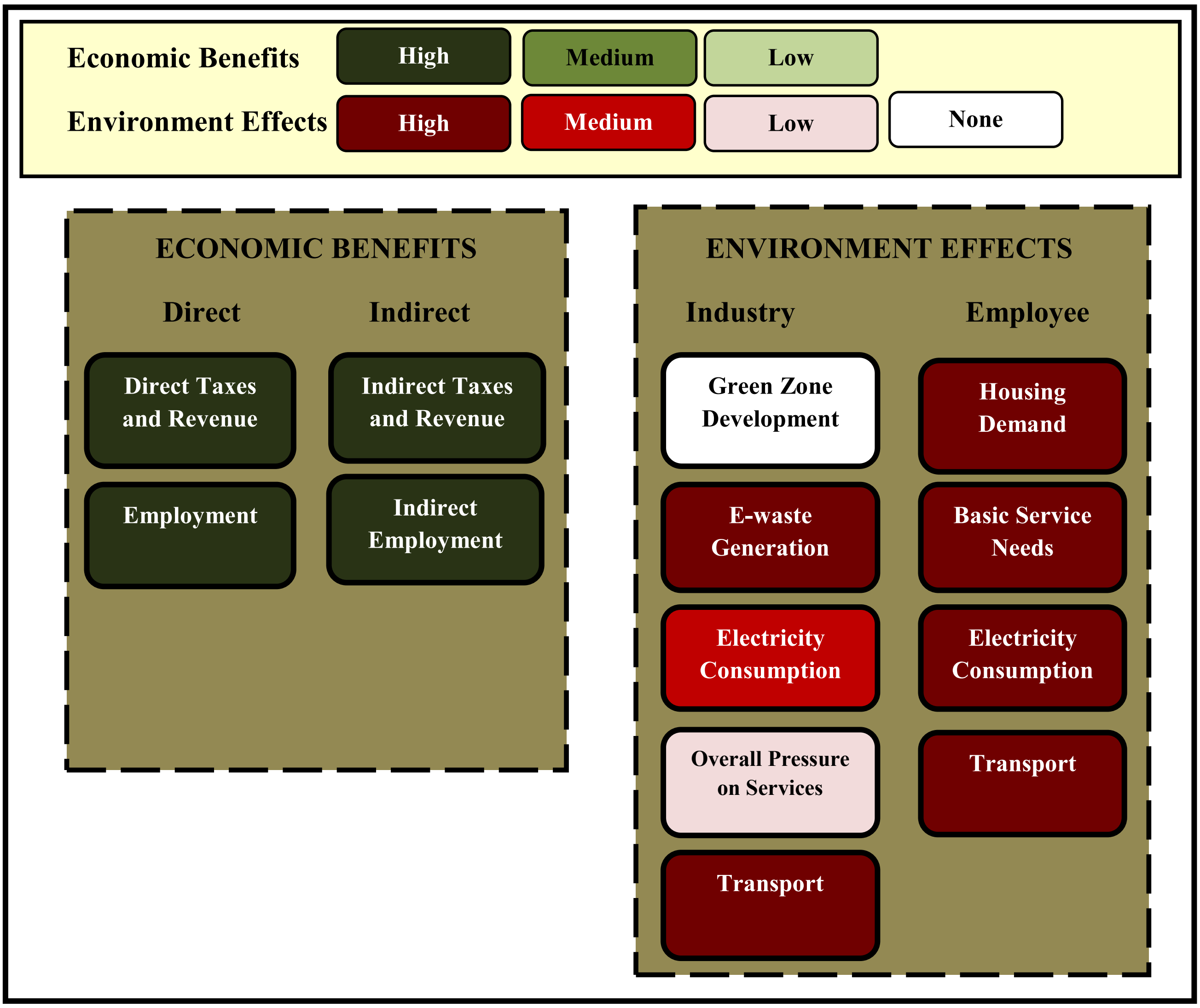


Figure 16 : Scale of Economic and Environment Effects of the IT industry in Pune, Source Author

The literature review looks at certain first order impacts of the IT such as e-waste and energy; externalities due to economic activity; and examples of fast growth IT cities such as Bangalore, Taiwan and Silicon Valley US. The research confirms the scale of the first order impacts of e-waste and energy; and like Bangalore and Silicon Valley, the research also demonstrates some of the main pressures that the city has to deal with for providing basic services including transport; and their subsequent externalities.

The OECD PSR framework effectively demonstrates the various levels of pressures and state as a result of the IT industry. It could also be expanded to include other elements that are considered important, and could be used to understand the consequences of various activities that the city undertakes. But in this way it enables the establishing of the cause and effect relationship of the entire IT industry, within different aspects such as industry and employee level. After having identified the pressures through the literature and substantiating that with data, the state for each of the pressure was identified and/or estimated. Some pressures had already a level of response to deal with the pressure, though it may or may not be substantive. The recommendations section will deal with some of the possible responses.

If one takes into consideration that the IT industry has more productivity per person, ease of establishment and initiation and relatively lower environment footprint compared to the manufacturing industry, then the IT industry is beneficial to a city. Having said that, some of the problems the city faces because of the fast paced expansion cannot be discounted. They need to be addressed and incorporated in the planning and administration systems for better decision making in the future.

5.2 Recommendations

It is indeed ironic that in a city that has its identity tied to the IT industry does not make apparent good use of the information systems that could help organise data, and get suitable feedback.

5.2.1 City Administration and Authorities

A fundamental recommendation for the PMC would be to organise information according to IT industry, tracking the economic data and the land use data from various departments. This will enable the comparison of economic benefits vis-a-vis level of expenditures that need to be undertaken to service the IT industry, and deal with certain pressures. IT premiums received henceforth need to be maintained in a separate fund or account to ensure that the areas around private IT parks have suitable infrastructure. This will also help the PMC to track the level of infrastructure needs of the IT industry and the costs incurred. A more detailed cost and benefit analysis would help the PMC and the State authorities with further policy level decision making.

Ideally all the income received from the IT industry such as property tax, octroi, development charges and the IT premium must be retrievable under one account. With this a comprehensive information system for the IT industry could be put in place to incorporate a sophisticated cost and benefit analysis for more informed decision making.

The MSEB which is the electricity supplier for the city needs to organise information on a sectoral basis which includes the IT industry. This would enable the city and the state authority to track the scale of electricity consumption between different sectors.

One of the main pressures by the IT industry on the city is considered to be traffic and transport. This issue can be addressed at various levels. The PMC has taken the initiative to improve public transport but that has not been very effective. What could help is companies at their individual level in the city cater to employees travel needs by providing a good frequency and spread of bus service.

There needs to be a formalised system to facilitate the collection and monitoring of e-waste for the industry. This system needs to incorporate the informal market that exists for e-waste. Like other industries, the IT industry, should be mandated to make public the amount of e-waste generated on a yearly basis, which is becoming one of the major waste components. More regional planning is required in this case in terms of road infrastructure. The issue of the city of Pune having to provide for roads that lead to Hinjewadi situated in the neighbouring municipality, while not getting any direct economic benefit from it was brought up many times.

5.2.2 IT policy

Both the state and the city level administration should conduct a periodic review and assessment of the IT policy to assess the implementation of the policy in Pune. The revised IT policy of 2009 incorporates certain clauses that merely touch upon E-waste and greener principles such as Green IT Parks but overall it does address the other pressures at the industry level such as energy and transport. It also continues with the Tax concessions to the IT industry.

The clause that allows for the development of IT on green zones needs a proper review. Cities like Pune are constantly losing their open spaces to development activities. Green Zones and No Development zones provide some provision to preserve these areas. Open spaces besides parks and gardens play a vital role in protecting the physical environment of the city, and perform important ecosystem services (water filtration, micro climate, recreation, wildlife habitats etc). Policies that enable economic development on these areas can be regressive and need to be looked into.

Current electricity charges for the IT industry are at industrial rates which are lower than commercial rates. The policy could deliberate on a certain amount of electricity supply at the industrial rates, beyond which commercial rates could be charged.

The revised IT policy of 2009 recommends the creation of green IT parks. At the city level this should be made compulsory, and additional efforts to incorporate some basic rules and principles within the existing IT parks should be persevered.

There also needs to be a resolution on the collection of the Octroi tax, which in one sense can be expressed as the non implementation of the IT policy, and is a strong bone of contention between the IT representatives and the PMC.

5.3.3 IT Industry

The IT industry constitutes enlightened professionals, and in some of the larger companies green practices and efforts are already in place. Such systems and practices need to be institutionalised more strongly and not only through basic level of Corporate Social Responsibility. The IT industry at the individual level can easily track some of the environment effects from electricity use, e-waste and transport for employees. This could be consolidated on a yearly basis and through joint planning and action most of these issues could be addressed as an industry which would have a wider outreach and would be very effective.

NASSCOM, MCCIA and STPI could come together to work on some of these issues as they have the accessibility and the influence. Given that the IT industry is well equipped with finance and human resources, they could enable further research on environment effects which is very much needed on this subject on the same lines of the economic research that they have conducted.

This thesis attempts to develop a possible framework to assess the environment effects of the IT industry on the city. Using this framework as a starting point, a more comprehensive and large research can be initiated by the city. With the economic and financial information, a detailed comparative analysis between the environment and the economic effects can be done.

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ANNEX 1: Right to Information Applications

FORM - 1

Form of application for seeking information

Under the Right to Information Act, 2005.

I.D. No

(For official use)

To
The Public Information Officer,
Accounts dept.
Pune Municipal Corporation (PMC).

1. Name of the Applicant :
2. Address :

3. Particulars of information. - : IT industry

(a) Concerned department : Accounts

(b) Particulars of information required :

Taxes paid by the IT industry

i. Details of information required :

- Please provide a yearly break-up of the **annual property tax revenue** that the PMC received from the IT and ITES units **from 2003-2011?** What is the property rate charged for this period?
- Please provide a yearly break-up of the **annual octroi revenue** that the PMC has refunded to the IT and ITES units **from 2003-2011**?
- What is the **amount of premium** that the PMC has received **from the IT parks for providing 100% FSI to them?**

ii. Period for which information asked for : 2003-2011

iii. Other details :

iv. Whether information is required by post or in person : person

v. In case by post (Ordinary, Registered or Speed) :

FORM -1

Form of application for seeking information

under the Right to Information Act,2005.

I.D. No
(For official use)

To
The Public Information Officer,
MSEDCL Office Ltd.
Deccan Gymkhana, Pune, Maharashtra, India

1. Name of the Applicant :

2. Address :

3. Particulars of information. - : Electricity supply to IT industry

(a) Concerned department : Electricity supply

(b) Particulars of information required :

Electricity needs of the IT industry

i. Details of information required :

- Please provide **a yearly break-up of the annual total amount of electricity that** has been supplied to the IT and ITES companies in Pune city (within Pune Municipal Corporation jurisdiction) **from the year 2003-2011?**

- What is the current rate charged for the electricity to the IT and ITES units?

- What would have otherwise been the rate charged, and under which category, if the IT Policy did not provide concessions for the IT and ITES units?

ii. Period for which information asked for : 2003-2011

iii. Other details :

(iv) Whether information is required by post or in person : person

(v) In case by post (Ordinary, Registered or Speed) :

FORM -1

Form of application for seeking information

under the Right to Information Act,2005.

I.D. No
(For official use)

To
The Public Information Officer,
Directorate of Industries
Pune Region, Pune
Pune Agricultural College Campus,
Shivajinagar, Pune- 411 005

1. Name of the Applicant :

2. Address :

3. Particulars of information. - : IT industry

(a) Concerned department : Directorate of Industries

(b) Particulars of information required :

IT industry relevant information

i. Details of information required :

- In total what are the number of IT and ITES companies located in Pune city (area within Pune Municipal Corporation jurisdiction) at present?

- Currently, how many people are employed by the IT and ITES companies located in Pune city (area within Pune Municipal Corporation jurisdiction)?

ii. Period for which information asked for : recent

iii. Other details :

FORM - 1

Form of application for seeking information

Under the Right to Information Act,2005.

I.D. No
(For official use)

To
The Public Information Officer,
Solid waste and Sewage
Pune Municipal Corporation (PMC).

1. Name of the Applicant :

2. Address :
3. Particulars of information. - : IT industry

(a) Concerned department : Solid waste and sewage

(b) Particulars of information required : Waste and sewage generated by the IT industry

i. Details of information required :

- What is the year wise break-up of the **annual waste generated by the IT and ITES companies** in Pune from **2008-2011?**
- What is the year wise break-up of the **annual sewage generated by the IT and ITES companies** in Pune from **2008-2011?**
- What is the year wise break-up of the **annual e-waste that is collected from the IT and ITES companies** in Pune **from 2008-2011?**
- Is there a standard average figure of waste, sewage and e-waste generation that the PMC assigns for IT and ITES companies?
- What does the PMC do with the e-waste that it collects from the city?

ii. Period for which information asked for : 2008-2011

iii. Other details :

(iv) Whether information is required by post or in person : person

(v) In case by post (Ordinary, Registered or Speed) :

FORM -1

Form of application for seeking information

under the Right to Information Act,2005.

I.D. No
(For official use)

To
The Public Information Officer,
Solid waste and Sewage
Pune Municipal Corporation (PMC).

1. Name of the Applicant :

2. Address :

3. Particulars of information. - : IT industry

(a) Concerned department : Water Supply

(b) Particulars of information required :

Water needs of the IT industry

i. Details of information required :

- What is the year wise break-up of the annual **water supplied to the IT and ITES companies** in Pune from **2008-2011?**
- Is there a standard average figure of water supply needs that the PMC assigns for IT and ITES companies?

ii. Period for which information asked for : 2008-2011

iii. Other details :

(iv) Whether information is required by post or in person : person

(v) In case by post (Ordinary, Registered or Speed) :

FORM -1

Form of application for seeking information

under the Right to Information Act,2005.

I.D. No
(For official use)
To
The Public Information Officer,
City Engineer,
Building Department.
Pune Municipal Corporation (PMC).

1. Name of the Applicant :

2. Address :

3. Particulars of information. - : IT industry

(a) Concerned department : Building Department.

(b) Particulars of information required :

Land use by the IT industry, and their location

i. Details of information required :

- What **is the total number of IT and ITES companies in Pune**? **How much land (plot size) do they occupy?**
- Please provide the breakup of the **number of the IT and ITES companies, and the administrative wards they are located in?**
- How many **IT and ITES companies have been given permission to build on Green belt areas** in Pune from **2003-2011**? What is **the total green belt area (in plot size)** given for these IT and ITES companies?

ii. Period for which information asked for : 2003-2011

iii. Other details :

(iv) Whether information is required by post or in person : person

(v) In case by post (Ordinary, Registered or Speed) :

ANNEX 2: Questionnaire to some IT companies

(For facilities in Pune city only)

Name of the company:

Address:

Employee size:

a) What is the basic infrastructure requirement to set up an IT industry? What standards has your company used?
   - land,
   - electricity/power,
   - transport,
   - computers and other ICT infrastructure?).

   This could be overall or per employee.

b) What is the average monthly electricity consumption of your company? Or any periodical data if possible? Is it going higher? Is it going lower? Is it stable?

c) What is the preferred mode of transport used by the employees? Can you re-order the following according to use.
   1) Cars
   2) Two wheelers
   3) Buses
   4) Car pools (or Indica services)
   5) Walking
   6) Cycling

d) How much is the e-waste generated per year? What happens to the E-waste generated in the company?

e) Initiatives of your company or the IT industry in Pune to get "Green"

f) How in your opinion does the IT industry benefit the municipal corporation and also the city?

g) How does the IT industry compare to other industries in terms of productivity (per employee or per unit of energy consumption or if there are any other ways to benchmark this?)

h) Your opinion about the IT policy and its implementation in Pune.

ANNEX 3 – Emissions Factor for Vehicles, India (AR1, 2007)

Sr. No.	Type of vehicle.	Sub-Category	Vintage	Fuel	Emission Factors g/km CO	HC	Nox	CO2	PM	mg/km Benzene	1-3 Butadiene	Formaldehyde	Acetaldehyde	Total Aldehyde	Total PAH
1	Moped (2 Stroke)	< 80cc	Post 2000	BS-II	0.45	3.1	0.04	29.69	-	0.0008	0.0032	0.0024	0.001	0.0053	0.0017
2	Moped (2 Stroke)	< 80cc	Post 2005	BS-II	0.46	0.6	0.02	36.81	0.018	0.0008	0.0004	0.0371	0.0071	0.0441	1.75
3	Moped (4 Stroke)	< 100cc	Post 2000	BS-II	0.81	0.5	0.29	20.09	0.01	0.0032	0.0061	0	0.0037	0.0089	0.3373
4	Scooter (2 Stroke)	< 80cc	Post 2000	BS-II	7.52	3.6	0.02	21.67	0.055	0.00235	0.00295	0.01095	0	0.01765	0.28035
5	Scooter (2 Stroke)	> 80cc	Post 2000	BS-II	3.435 (19.69)	1.905 (4.71)	0.03 (0.02)	25.92 (18.75)	0.065 (NA)	0.00613 (1.037)	0.00321 (0.055)	0.00834 (0.008)	0.0048 (0.0015)	0.0147 (0.02)	0.498 (0.00075)
6	Scooter (2 Stroke)	> 80cc	Post 2005	BS-II	0.16	0.86	0.02	38.54	0.057	0.0106	0.0123	0.0403	0.0573	0.1209	1.0075
7	Scooter (4 Stroke)	>100cc	Post 2000	BS-II	0.93	0.65	0.35	33.83	NA	0.0051	0.0168	0.0062	0.0009	0.0087	0.0062
8	Scooter (4 Stroke)	>100cc	Post 2005	BS-II	0.4	0.15	0.25	42.06	0.015	0.0015	0.0128	0.1048	0.0576	0.1716	1.52
9	Motorcycle (2 Stroke)	< 80cc	1991-96	BS-II	5.64	2.89	0.04	23.48	NA	0.0088	0.0082	0.0023	0.0003	0.0081	0.0035
10	Motorcycle (4 s)	<100cc	Post 2000	BS-II	1.65	0.61	0.27	24.97	0.035	0.0016	0.0101	0.003	0	0.01	1.5752
11	Motorcycle (4 s)	100-200cc	Post 2000	BS-II	1.48	0.5	0.54	24.82	NA	0.0174	0.0019	0.0014	0	0.0022	0.0004
12	Motorcycle (4 s)	>200cc	Post 2005	BS-II	0.72	0.52	0.15	45.6	0.013	0.0019	0.0016	0.0057	0.0053	0.0109	0.46
					1.685	**1.165**	**0.165833**	**28.46333**	**0.0169**	**0.004504**	**0.00636**	**0.01785**	**0.0111**	**0.034029**	**0.57851**

Sr. No.	Type of vehicle.	Sub-Category	Vintage	Fuel	Emission Factors g/km CO	HC	Nox	CO2	PM	mg/km Benzene	1-3 Butadiene	Formaldehyde	Acetaldehyde	Total Aldehyde	Total PAH
1	Passenger Cars (Petrol) BS-II	<1000cc	Post 2000 (MIDC)	BS-II	1.3	0.24	0.2	126.37	0.004	0.0002	0.0031	0.0034	0.0012	0.0088	0.0955

2	Passenger Cars (Petrol) BS-I	1000-1400cc	Post 2000 (MIDC)	BS-II	3.01	0.19	0.12	126.5	0.006	0.0007	0.0034	0.0034	0.0012	0.0079	0.1324
3	Passenger Cars (Petrol) BS-I	>1400cc	Post 00 MIDC	BS-II	2.74	0.19	0.21	142.86	0.006	0.0009	0.0001	0.0086	0.0012	0.0101	0.4636
4	Passenger Cars (Petrol)	>1400cc	Post 05 MIDC	BS-II	0.84	0.12	0.09	172.95	0.002	0.0003	0.0003	0.0003	0	0.0096	0.05
5	Passenger Cars (Diesel) **BS-I**	<1600cc	Post 2000(MIDC)	BS-II	0.72	0.14	0.84	156.76	0.19	0.0386	0.0528	0.0206	0.0021	0.0422	0.149
6	Passenger Cars (Diesel) **BS-II**	<1600cc	Post 2000(MIDC)	BS-II	0.3	0.26	0.49	154.56	0.06	0.001	0.0025	0.0108	0.0015	0.0131	0.1112
7	Passenger Cars (Diesel)	<1600cc	Post 2005 (MIDC)	BS-II	0.06	0.08	0.28	148.76	0.015	0.0018	0.0007	0.0889	0.0033	0.0922	0.2109
8	Passenger Cars (CNG) BS-I	1000-1400cc	Post 2000 (MIDC)	BS-II	0.6	0.36	0.01	131.19	0.002	0.0009	0.0002	0.0007	0.0011	0.0018	0.0154
9	Passenger Cars (CNG) BS-I	<1000cc	Post 2000 (MIDC)	BS-II	0.06	0.46	0.74	143.54	0.006	0.0001	0.0003	0.0108	0.0022	0.013	0.0164
10	Passenger Cars (LPG) BS-I	>1400cc	Post 2000 (MIDC)	BS-II	2.72	0.23	0.2	140.05	0.002	0.0006	0.0016	0.0005	0.0011	0.0021	0.0247
					1.235	**0.227**	**0.318**	**144.354**	**0.0293**	**0.00451**	**0.0065**	**0.0148**	**0.0015**	**0.02008**	**0.12691**