Measurement and consequences of negative externalities of Urbanization in India: An empirical assessment

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DECLARATION

I hereby declare that the dissertation entitled "**Measurement and Consequences of negative externalities of urbanization in India: An Empirical Assessment"** has been prepared by me under the guidance of Dr. Sabyasachi Tripathi, Associate Professor in Economics, School of Business, Lovely Professional University, Phagwara Punjab. No part of this dissertation has formed the basis for the award of any degree or fellowship previously.

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Abstract

Urbanization has a positive link with economic growth. Most importantly, large cities have been generating larger percentage of GDP than other small town & cities, due to economic effects of agglomeration. On the other hand, India's current haphazard unplanned urbanization has brought in its wake myriad problems like increase in number of vehicles, energy consumption, air pollution, noise pollution, violence, traffic congestion, traffic injuries and fatalities etc. The study focused on these negative externalities. So that if we successful to overcome this problem then we are able to enjoy these positive effect of agglomeration economies.

In the absence of reliable city level data, the paper focuses only on 42 class I (population one lakh or more) cities in India and bases the analysis on four types of urban negative externalities i.e., number of registered motor vehicles, air pollution, road accidents, and crimes. As per from theoretical and empirical literature review, study has been formulated the following objectives: First, to study the negative externalities of urbanization in India. Second, to analyze the trends and patterns of negative externalities of urbanization in India. Third, it also analyze the impact of negative externalities on city population in India. Fourth, to estimate the effects of negative externalities of urbanization on economic growth. To study these objective, major sources of data is obtained from Census of India, Road Transport Year Book (20014-2015), Ministry of Road Transport & Highways Transport Research Wing, New Delhi, National Crime Records Bureau, Indiastat.com, Central Pollution Control Board (CPCB), Directorate of Economics and Statistics and for estimation descriptive statistics and OLS regression techniques have been used.

The trends and patterns analysis suggests that urban India is currently witnessing a higher increase in the number and density of registered vehicles, air pollution, road accidents and also crimes. The OLS regression results show that negative externalities such as city wise air pollutions, number of registered motor vehicles (measured by tractors and trucks density), and city-wise number of crimes have a negative effect on city population agglomerations. However, number of accidents, car density and total number of buses show a positive effect on city population agglomerations. The estimate results while using OLS regression model shows that negative externalities have a strong, significant relationship and negative effects on urban GDDP in future. City level GDP is measured on district level as per city level data is unavailable so city per capita income is measured on the basis gross district domestic product (GDDP)Crime per 1000 population, per capita PM_{10} emission and car density have a positive and statistically significant relationship on urban GDDP. Two wheelers density, tractors density, trucks and lorry density, total number of buses and auto density have a negative relationship on urban GDDP.

On the basis of these finding, this study seeks to suggest some policies first, to promote fuel switching vehicles. Second, scrapping of highly polluting vehicles that emit high levels of pollution. Third, to promote efficient eco-friendly public transport systems. Fourth, cordon pricing charges on automobiles that enters in high activity areas. Fifth, Build bridge on highways roads and different lanes areas funded by the government in curbing urban negative externalities in India.

Key Words: Urbanization, negative externalities, economic growth, India.

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1. GDP: Gross Domestic Product
2. GHG: Greenhouse Gas
3. OLS: Ordinary Least Square
4. GDDP: Gross District Domestic Product
5. CAGR: Compound Annual Growth Rate
6. CV: Coefficient of Variation
7. EKC: Environment Kuznets's Curve
8. UN: United Nation
9. GOI: Government of India
10. VIF: Variance Inflation Factor

CHAPTER: 1
INTRODUCTION

1.1 Introduction

Urbanization refers to moderate increase in the proportion of people living in urban areas. Urbanization plays a pivotal role in economic growth. Urbanization and economic growth have a high positive correlation which declared that high per capita income of a country is likely to have high degree of urbanization. Urbanization is a progressive report of concentration of population in urban unit. It is also linked with industrialization, commercial and service sectors. It promotes higher economic growth in India. Most probably developing countries transition to developed economy through the process of industrialization to modernization which happens through urbanization. Globally, the pace of urbanization has been faster than ever before in recent years. Fifty-four per cent of the global population lived in urban areas in 2014 as against 30 per cent in 1950, and it estimated to reach 66 percent by 2050 (United Nations, 2014). In India, in 1951 only 62.4 million i.e. 17.3 per cent population was living in urban areas[1]; it increased to 31.2 per cent, i.e. 377.71 million by 2011. As per 2011 census, the top five urbanized Indian cities are Mumbai (12.44 million), Delhi (11.03 million), Bangalore (8.44 million), Chennai (7.08 million) and Hyderabad (6.73 million).

In the 21st century, India is interfacing rapid increase in population and several economic activities is a progress report of urbanization which further lead to growth of towns and emerge into cities At present, urban population is increasing two to three times faster compare to rural population which is a reflection of developing countries (UN, 2011). A trend of population mobility is mostly influenced by social and economic factor. In the last two decades, India has experienced rise in per capita income, improvement in transportation and communication facilities. In India, from the last 10 year rise in population is reflected towards growth of metro cities. Through

[1] According to Indian Census, definition to define any place as a urban center is:
(a) Population size- 5000 or above.
(b) Density- 1000 sq. mile or above.
(c) More than 75% of the inhabitants must be in industry or service sector.
(d) Urban areas must be governed by municipality.

higher economic growth, liberalization, globalization etc. is declaration of increasing rate of urbanization.

According to Census 2011, the towns which have at least 100,000 persons as population are categorized as Class I cities. The number of proportion and the growth of the class I cities are continuously increasing over the decade.

Data presented in Table 1.1 indicates that India has been experiencing a steep increase in both total size of urban population and also percentage of urban population. However, a major chunk of urban population in India is concentrated in class I cities. The percentage of urban population rose from 17% to 31% in the period 1951 to 2011. After independence, the highest urban exponential growth rate reached 3.79% in the decade 1971-1981. During 2001-2011, urban growth rate declined to 2.76% but the level of urbanization leaped from 27.7% in 2011 to 31% in 2011. Census 2011 puts the number of such class I cities/towns as 468. The corresponding number in Census 2001 was 394. The classification of cities on the basis of population-size has resulted as a top- heavy composition of urbanization, i.e. a sharp increase in the number of Class I cities in the country. Most importantly, 264.9 million urban populations lived in class I cities/ towns in 2011 and constitute about 70% of the total urban population in the country. Being hubs for economic growth, the contribution of cities to India's gross domestic product has always been quite sizeable. In this perspective, it can be said that Class I cities play a pivotal role in accelerating economic growth and development.

Table: 1.1 Trends in Urbanization in India 1951-2011

Census Year	Urban Population (in Millions)	Percentage of Urban Population	Annual Exponential Urban Growth Rate (%)	No. of class I cities	Percentage of population in Class I cities
1951	62.4	17.3	___	76	44.6
1961	78.9	18.0	3.47	102	51.4
1971	109.1	19.9	2.34	148	57.2
1981	159.5	23.3	3.79	218	60.3
1991	217.5	25.7	3.09	300	65.2
2001	286.1	27.9	2.75	393	68.6
2011	377.1	31.2	2.76	468	70

Source: Census of India, Government of India (GOI)

Modernization of cities is one of the main factors behind the increase in the number of cities and the population. It happened largely through rural to urban migration spurred by the attraction of urban opportunities like availability of better schools, colleges and medical facilities, better transportation and primarily employment opportunities.

Urbanization plays a pivotal role in economic growth; urbanization and economic growth have always had a high positive correlation, which means higher degree of urbanization invariably leads to higher per capita income. Urbanization is also linked with industrialization and growth of commercial and service sectors. Evidently, it has promoted higher economic growth in India as well. As can be seen from Table 1.2, in 1951 urban population was about 17.3% of the total, but its contribution to national income was about 29%. In 2001, the urban population accounted for about 30% of the total, but its contribution to national income was a colossal 60%. The Mid-Term Appraisal of the Eleventh Five Year Plan shows that the urban share of GDP is about 63 per cent for 2009-10, and this share is projected to increase to 75 percent by 2030. A study by Indian Institute for Human Settlement (IIHS), "Urban India 2011: Evidence" (IIHS, 2012) estimated that India's top 100 largest (as per the population size) cities produced about 43% of the GDP, with 16 % of the population and just 0.24% of the land area.

Table: 1.2 Urban Concentrations to National Income

Year	% of Urban to Total Population	Estimate Contribution to National Income (%)
1951	17.3	29
1981	23.3	47
1991	25.7	55
2001	30.5	60

Source: Government of India (2007)

At present, India has six cities in the 'fastest growth' category and their contribution to national income is also high compared to other cities. These cities play a leading role in the growth of the country's economy as well as demographic change. Delhi is the largest city in India and in 2015, Delhi's contribution to GDP growth was 8.5%; Delhi's contribution to population growth was 3.5% in the period 2000-2015, both of which were larger than the contribution of other Indian cities. Kolkata's contribution to GDP growth was 6.8% in the period 2000-2015 and to population growth 1.7%. Hyderabad's contribution to population growth in the period 2000-2015 was 2.15% and contribution to GDP 7.2%. Chennai's contribution to population growth during the above years was 1.59% and its contribution to 7.8%. Bengaluru's contribution to population growth in the period 2000-2015 was 2.75% and contribution to GDP 7.6%. Mumbai's contribution to population growth in the period 2000 2015 was 2.3% and contribution to GDP 7.6%. Overall, India's top 6 cities have contributed the largest to the growth of GDP and population in the period 2000-2015[2].

The above discussion clearly indicates that urbanization has a positive link with economic growth. Most importantly, large cities have been generating larger percentage of GDP than other small town & cities, due to economic effects of agglomeration. On the other hand, large cities in India have also encountered several negative externalities, e.g., increase in number of private vehicles, increasing energy consumption, air pollution, noise pollution, violence, traffic congestion, traffic injuries and fatalities etc.

Negative externalities are the cause of increase in concentration of population and high per capita income. High per capita income generates affordability as well as need for personal private vehicles, which in turn results in higher energy consumption and also environmental decay. Cities' growth largely depends upon the benefits from agglomeration economy, but after reaching a certain stage cities' growth stagnates due to negative externalities. In fact, such deleterious externalities can be traced to policy failures and absence of regulatory mechanisms.

In India, the number of urban-specific private vehicles like scooter, motorcycle, etc. increased from 24.7% in 2001 to 35% in 2011. Further, the number of vehicles like car, jeep and van increased from 5.6% in 2001 to 9.7% in 2011. Increase in vehicle population leads to deterioration of environmental quality. Major greenhouse gases like Carbon Monoxide (CO), Sulfur dioxide (SO_2), Carbon dioxide (CO_2) and Nitrogen dioxide (NO_2) generate air pollution. India now ranks fifth in GHG emission after China, European Union, United States and Russian. Road accidents are caused by improper interaction between vehicles and roadway features.

[2] The data is collected from the following website: http://www.insidermonkey.com/blog/6-fastest-growing-cities-in-india-in-2015-376759/5/.

With the phenomenal increase road length (road network) the number of road accidents has also increased, i.e. from 4.89 lakh in 2014 to 5.01 lakh in 2015. Violence is also a part of negative externalities which is also the main cause for the increase seen in the growth of population and also poverty. Overall, in India, the total number of cognizable offences registered under provisions of India Panel Code (IPC) increased from 31.2 % in 2003 to 39.2% in 2013.

Table 1.3: Trends of negative externalities at India level during time period (2005-2015)

Period	Registered motors (in millions)	Cognizable Crime (in millions)	Accidents rate (in thousands)	CO_2 emissions (in micrograms)
2005	81.5	5.02	4.39	1.06
2006	89.6	5.10	4.60	1.12
2007	96.7	5.73	4.79	1.19
2008	105.3	5.93	4.84	1.31
2009	115	6.67	4.86	1.43
2010	125.7	6.75	4.99	1.39
2011	141.8	6.25	4.97	1.48
2012	159.5	6.04	4.90	1.59
2013	176	6.64	4.86	1.59
2014	190.7	7.22	4.89	NA
2015	210	7.32	5.01	NA

Source: Author's compilation using data of various sources.
Note: 1. A Cognizable crime is one in which, a police officer can arrest the offender without warrant, and is generally known as a crime of serious nature.

From the above table 1.3 we can analyze the trends of negative externalities in India during the time period of 2005- 2013. The number of registered motor vehicles increased to 210 million from 81.5 million in 2005. Increases in number of registered motor vehicles generate the problem of accidents and CO_2 emissions. Above table represents that increase in number of registered motor vehicles increases the problem of accidents from 4.39 thousand to 5.01 thousand. And, a CO2 emission also increases at the steep growth rate 1.59 micrograms in 2013 from 1.06 micrograms in 2005. The cognizable crime rate increases from 5.02 million in 2005 to 7.32 million in 2015.

Table 1.4: Trends of Negative Externalities in Large Cities in 2015

Class I Cities	Registered motors (In thousands)	Cognizable crime (in numbers)	Road accidents (in numbers)	SO_2	NO_2	PM_{10}[1]
				in micrograms		
Delhi	8851	173977	8085	5	59	221
Bengaluru	5560	35576	4834	5	20	131
Chennai	4934	13422	7328	13	20	56
Ahmedabad	3420	15964	1837	13	20	86
Mumbai	2571	42940	23468	3	23	90

Source: Authors' compilation using data from various sources
Note: 1. PM_{10}: Particular Matter

In the context of city-wise negative externalities, as can be seen from Table 1.4, that Delhi has the highest total number of registered vehicles (88.21lakh) followed by Bengaluru (55.60lakh), Chennai (4934), Ahmedabad (3420) and Mumbai (2571). The table also shows that Delhi occupies the top rank for the total number of reported cognizable offences. On the other hand, Mumbai occupies the top rank for maximum number of road accidents. It can also be seen from the table that a huge amount of PM_{10} (221) is present in Delhi which is attributed to exhaust emissions of diesel vehicles. Mumbai has relatively less number of (25.71lakh) motor vehicles as compared to Chennai (49.34 lakh) but has more amount of PM_{10} (90) in the air. Ahmedabad also has a high amount of PM_{10} (86) as compared to Chennai (56).

1.2 Researchable Issue:

India is experiencing a major chunk of urban population present in class I cities. At present, large part of gross domestic product (GDP) is contributed by class I cities. While the rising pace of class I cities tends to be reflection of healthy urban era. But the main issue of this study is as following:

1. The haphazard and unplanned urbanization is the essential factor of negative externalities in urbanization. So, for that the main researchable issue of this study is to measure the negative externalities.

2. While studying the negative externalities we want to analyze the trends and patterns of negative externalities of urbanization in India.

3. To assess the impact of negative externalities on urban concentration and economic growth?

If we succeeded in reduction of negative zone there is a great possibility of higher economic growth as evident from developed countries.

1.3 Research Gap:

As per from theoretical literature, all prior researcher investigates the impacts of environmental degradation on urban concentration and economic growth. Several international studies established a significant relationship between different negative externalities like: increase in demand of transportation vehicles, stagnant transportation infrastructure, climate change, CO_2 emissions, traffic congestion, traffic fatalities and injuries on urban concentration and economic growth in urban areas of different group of developed and developing countries. The reviews of descriptive studies make a clear picture of different negative externalities in context of Indian states and metro cities. It is evident that due to increase in urban population it also increases several types of negative externalities like: increase in demand of transport vehicles, road accidents, congestion, increase in crimes rate and air pollution. Therefore, we need some more statistical measure to assess the impact of these negative externalities on urban population concentration and economic growth as the founded research gap of this study. Wherever these negative externalities are reducing city economic growth in India it has to be empirically checked.

1.4 Research Objective:

1. To study the negative externalities of urbanization in India.

2. To analyze the trends and patterns of negative externalities of urbanization in India.

3. To analyze the impact of negative externalities on urbanization in India.

4. To estimate the effects of negative externalities of urbanization on economic growth.

1.5 Research Methodology:

The present study is based on secondary data. For this study class I cities have been selected, due to the evident that in India large number of population and GDP is contributed by Cities. Mainly in developing country like India is experiencing higher level of urbanization through cities economic growth and high level of urban concentration. High degree of urbanization invariably leads to high degree of GDP growth of Indian cities. So, the major role is played by class I cities to increase the urbanization rate in India. Presently, in India there are 468 classes I cities out of 468 cities we have selected the top 42 class one cities as a sample size of study to analyze the impact of negative externalities on urban concentration and economic growth[3]. On the basis of our research objective descriptive and empirical assessment have been formulate to give a complete justification about this study.

The first objective has been studied on the basis of various international and national studies, we have studied the various form of negative externalities in developed and developing countries. There exists negative and positive externality across all economic activities undertaken in the urban area. Positive externalities of urbanization are generally measured through the estimation of urbanization and economic development which is measured in terms of evident economic growth by various studies (Tripathi, 2013, 2015). However, it is difficult to measure the negative externalities of urbanization as it has many facts and also because the available data is very scanty. Table1.5 presents the measurement of different urban negative externalities in India. The study mainly considers 4 types of urban negative externalities i.e., number of registered motor vehicles, degree of air pollution, number of road accidents, and crimes. It is obvious that these four factors represent the negative externalities of urbanization. Registered motor vehicles considered here in two wheelers, cars, tractors, trucks, buses, and passenger auto. The levels of SO_2, NO_2, and PM_{10} are considered to measure urban air pollution in India. The total number of accidents and cognizable crimes is also factored in, to measure the negative externalities of urbanization in India.

[3] Agra, Ahmedabad, Allahabad, Amritsar, Aurangabad, Bangalore, Bhopal, Chandigarh, Chennai, Coimbatore, Delhi, Dhanbad, Ghaziabad, Gwalior, Hyderabad, Indore, Jabalpur, Jaipur, Jamshedpur, Jodhpur, Kanpur, Kochi, Kolkata, Kota, Lucknow, Madurai, Meerut, Mumbai, Nagpur, Nashik, Patna, Pune, Raipur, Rajkot, Ranchi, Srinagar, Surat, Tiruchirappalli, Vadodara, Varanasi, Vijayawada, Visakhapatnam.

Table 1.5: Measurement of different forms of urban negative externalities in India.

Variable	Sub-variable	Variable Measurements	Data Source	Year
Total number of registered motor vehicles	Two wheelers, cars, tractors, truck and lorry, buses and passenger auto	1. Vehicle density is measured by dividing the total number of registered vehicles in a particular city by the total population residing in that city. 2. Percentage share of sub-vehicles is measured by dividing the total number of registered sub-vehicles by the total number of registered vehicles in a particular city. 3. Growth rate is measured by taking the average annual growth rate	Road transport year book	2005 to 2015
Air pollution (in microgram per cubic meter unit)	Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2) , and Particular Matter (PM_{10}) emissions	Carbon Intensity or per capita emissions is measured by dividing the total annual SO_2, NO_2, PM_{10} emissions by the total population residing in a particular city.	Indiastat.com and Central Pollution Control Board (CPCB)	2008 to 2015
Total number of road accidents	Total Number of accidents	Accidents per 1000 population: Total number of accidents occurred in a city is divided by total population of that city, and multiplying the product by 1000.	Ministry of road transport & highways transport research wing.	2008 to 2014
Total number of crimes	Cognizable crimes under the Indian Penal Code	Cognizable crimes per 1000 population: Total number of crimes occurred in a city is divided by the total population of that city. Then the ratio is multiplied by 1000.	Crimes Records Bureau (CRB)	2008 to 2015

Source: Authors' compilation

Despite of many analyzes techniques; descriptive analysis has been used to in second objective to analyze the trends and patterns of negative externalities of urbanization in India. Time period for this study is from 2005 to 2015 in order to understand the dynamic of negative externalities in context of class I cities. To analyze the trends and patterns we have been select top 5 cities and bottom 5 cities on the basis of city population out of 42 class I cities. And also, trends and patterns of negative externalities have been measure in percentage share, and growth rate in economy.

In third objective empirical analysis technique has been used to analyze the impact of negative externalities on urbanization in India. In this study OLS regression technique has been applied to analyze the impacts of negative externalities on city population for 2011.

The equation of Multiple Regressions is as following:

$$Y= \alpha + \beta X_i + \mu_i$$

Where,

Y is City population (dependent variable)

X is independent variable

The values of coefficients β and X are calculated by using STATA.

Independent variable included in this objective are increasing number of two-wheelers density, Cars density, tractor density, truck and lorries density, total number of buses, auto density, accidents per 1000 population, number of crime per 1000 population, per capita SO_2 emissions, per Capita NO_2 emissions, per capita PM_{10} emissions.

To analyze the third objective empirical analysis techniques has been used to estimate the effects of negative externalities of urbanization on economic growth. Since, city level income data is not available; the size of Gross district domestic product (GDDP) data has been used as a proxy of urban level GDP. Only non-primary GDDP (i.e., secondary and tertiary sector) is taken as it is found to be a better proxy for urban GDP. Due to non-availability of current GDDP data, this study has made use of GDDP data for the year 2011-12 at 2004-05 constant prices. This objective has been analyzed by using OLS regression model to estimate the effects of increasing number two-wheelers density, Cars density, tractor density, truck and lorries density, total number of buses, auto density, accidents per 1000 population, number of crime per 1000 population, per capita SO_2 emissions, per Capita NO_2 emissions, per capita PM_{10} emissions on economic growth.

Source of Data:

This study uses data from various sources on the basis of secondary data. The data on the number of vehicles registered of various types has been collected from Road Transport Year Book (20014-2015). The information related to road accidents profile is obtained from Ministry of Road Transport & Highways Transport Research Wing, New Delhi. The number of incidence total cognizable crime is collected from is from National Crime Records Bureau. The data of environmental effects in urban centers have been collected from Indiastat.com and Central Pollution Control Board (CPCB). The data for Gross district domestic product for non- agricultural sector has been collected from Directorate of Economics and Statistics.

1.6 Chapter scheme:

This dissertation has been divided into six chapters.

Chapter one gives a brief detail about the introduction of the topic. It includes researchable issue, research gaps, main objectives, and methodology of the study.

Chapter two the relevant literature reviewed, theoretical and empirical studies which are based on national and international level are summarized regarding the present study.

Chapter three provides an overview of negative externalities and urban concentration by describing the trends and patterns of urbanization.

Chapters four provides the empirical framework by using the OLS model and analyze the impact of negative externalities on urbanization.

Chapter five estimates the effects of negative externalities on urban economic growth.

Chapter Six summarizes the research finding of the study and some policy suggestion.

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Chapter 2

Review of literature

2.1 Review of Literature

The review of literature is based on the research objective. It explains theoretical, empirical studies and descriptive studies. Empirical studies include both international and national studies. An Overall objective of the review of literature is to identify the research gaps and researchable issue of this study.

2.1.1 Review of theoretical studies

Some theoretically literature review based on externalities of urbanization; Trussell (2010) empirically and theoretically investigates that transportation costs and rents have a negative function of distance from the city center by using bid-rent model. From the theoretical model author conclude that cities having slow transportation and bid-rent residents in urban center have negative growth. The author empirically tested in Eugene and the results show that there exist a statistically significant negative relationship between prices and distance from the city center. The author proposed a highway policy which is effective in reducing costs, congestion, air pollution and road accidents. Adhikari (2016) examined the relationship between socioeconomic activities, commercial location and land value by using bid rent model. The bid rent theory is famous in urban economies to define the association between the distance away from the urban center and house, to analyze the commuting cost of urban externalities. The author conclude that willing to pay by the squatter settlement is low as compared to willing to pay by the non-squatter settlements which generate a negative externalities impact on urbanization. Dinda (2004), theoretical reviews on Environmental Kuznets's Curve (EKC) hypothesis which postulates that EKC is inverted U-shape hypothesis describe a relationship between environmental degradation and per capita income. Through the different studies the main point come to that at the early stage of growth environmental pressure increases and consequently it improve after the earlier stage. Kolland (2006) develops a study of general equilibrium model in which resident mobile between urban core and hinterland. The study investigates the impact of transportation on environment and health effect on urban areas residents. The main issue of this study is that if there any linkage of car-related and housing location is the urban settlements effects by the interaction of agglomeration economic and transport related population while using two region general equilibrium models in urban core and hinterlands. The author formulates some assumptions related to model (a) Commuter residents are the only source of pollution. (b) Externalities emerge while market interaction involving internal economic of scale at firm level. On the basis of theoretical study empirical implementation estimated that there is housing price elasticity relationship between hinterland house and city real estate i.e. migration effects by housing congestion. The transport congestion has a direct impact on community costs. The elasticity relationship between specific amount of pollutants of the region and the number of commuters has direct impact on environment.

Some theoretical studies based on to estimate the accidents death model. Smeed (1949), investigated the relationship between accident death, population and number of vehicles while using 1938 year data in context of different countries. Andreassen (1985, 1991) criticized the Smeed model while pointing out that Smeed model investigates the relationship while using only in one year data. He also point out that Smeed model cannot be in term of different countries because different countries has distinct traffic jam, social and economic parameters. Akgungor and Dogan (2009) study used the artificial neural network (ANN) model is known as traffic accidents prediction model which is used for transportation safety studies. ANN model used to estimate the death rate during traffic accidents. ANN model is a modified formed of Smeed and Andreassen accident prediction model. ANN model is used to investigate the number of death happen due to traffic accidents while using time period data from 1986 to 2005 of 3 metropolitan cities of turkey. The model predict that population, number of vehicles as an independent variable and the number of death happen due to accidents as a dependent variable. The model estimator is used to compare with prediction and observation value. The author estimates that ANN model is more useful rather than to 2 analytical models.

2.1.2 Review of Empirical studies

Empirical studies seek to establish a link between two or more variables. We need more empirical study to compare the previous findings and to identify the research gaps for further study. Through the empirical studies we able to identify and analyze the impact of negative externalities of urbanization on population and economic growth. Empirical studies reviewed by international and national studies.

2.1.2.1 Review of International studies

Among the international descriptive studies that focus on the issues of trends and patterns of automobiles in urbanization. Ahmed et al. (2008) comparatively analyzed the trends and patterns of automobiles and urbanization in the mega cities of Beijing and Karachi. Author's analyzed that while rapid increase in automobiles and urbanization causes serious externalities like air pollution, noise pollution, traffic accidents congestion and depletion of non-renewable resources. Therefore, to mitigate these negative externalities government both cities should use advanced and oriented transport system. Shariff (2012), this paper analyzed the trends of private vehicles ownership in Malaysia. The study identified the major determined of increasing private vehicles like household characteristics, income, and travel characteristics and spatial arrangement. But the study focused on only spatial arrangement to analyze the trend of private vehicles ownership in Malaysia references of Pengang Island. As study concludes that private vehicles ownership create various types of externalities such as traffic congestion, inadequate parking spaces, accidents and pollution.

Maciel et al. (2012) examines that continues increasing in mobility of transport vehicles and expansion growth of Brazilian cities. The author analyzed that when unsustainable resource are used in the excess amount them it generate different type of negative externalities which is already at a high level in Brazil cities. The author suggest to Brazilian cities government to invest in new research proposal plan or remodel transport system. .Vasconcellos (1999) analyzes the trends and patterns of high accidents rates and its impact on economic growth in two largest cities of Brazil from 1960s. The study concludes that from 1960s Brazil experienced a high rate of accidents rate which is affected by fact fast and uncontrolled urban growth.

International empirical studies have established the impact of CO_2 emission on urbanization by considering the experience of both developed and developing countries. Parikh and Shukla (1995) found that urbanization has positive impact on greenhouse gases in case of 83 developed and developing countries. Their estimate of carbon emissions elasticity of urbanization is 0.036. Similar result is found by York et al. (2003)

with a much larger dataset of 137 countries. Holland et al. (2016) examined the environmental condition by using electric vehicles in U.S. By employing a regression model the study conclude from the damage value of air pollution from gasoline and electric vehicles that people having high income generate a positive relationship with electric vehicle from environment and people have low income gained negative relationship with electric vehicles from environment.

Several international empirical studies have established the relationship between CO_2 emission and economic growth by considering the experience of both developed and developing countries. Ozokcu and Ozdemir (2017) analyzed and investigate the relationship between CO2 and income on behalf of EKC hypothesis from the time period from 1980 to 2010. In this study first model is run for in context of 26 OCED countries having high income levels and in second model, data was analyzed for 52 emerging countries. The results for both models show that there is N-shape and an inverted N-shape relationship between CO2 and Income. Thus, the results do not supports of EKC hypothesis. Ahmad et al. (2016) analyzed and investigate the existence of EKC in Croatia during the time period of 1992-2011 by using Autoregressive Distributed Lag (ARDL) and (VECM) method. The study concluded that in Croatia there is validity of EKC in long run. Therefore, it shows that there are bidirectional relationship between income and CO2 in short run and unidirectional relationship is also possible between incomes to CO2 emission in long run. Miah et al. (2010) this study implicate the EKC hypothesis in context of climate change. SO_X, NO_X and CO_2 (GHG) are significant responsible for global warming, which lead to climate change. The study focused on EKC trajectories, an attempt to determine the implication on economic development of Bangladesh. The author studied that SO_x have hill-shaped evidences throughout the world. NO_x emissions have follow EKC hypothesis in only developed countries and CO_2 did not follow any trend of degradation cannot be reversed of environment turning point start when country per capita increases. Azomahou et al. (2006) examine the empirical relationship between CO_2 emissions and GDP per capita from the period of trend 1960-1996 by using panel approach of 100 countries. The study concludes that CO_2 emissions depend on economic activities. In rich countries, CO_2 emissions have positive effect due to extensive increase in economic activities, reduction in emissions due to extensive use of modern technologies. He and Richard (2010) empirically investigate EKC hypothesis for CO_2 and GDP. The finding of this study is that automobiles turning point of CO_2 emission is not feasible solution to fight against climate changes in Canada. Bekhet and Yasmin (2013) attempts to examine the relationship between air pollutants and per capita GDP during the time period of (1996-2010) in Malaysia while analyzing the data in context of EKC hypothesis. The author used Nemerow Index of techniques to measure the air pollutants indicator. The finding of the study conclude that level of pollution increase as country GDP increase, but decrease as riding income riches at the turning point. Thus, results support the EKC hypothesis. Crutzig and He (2008) have studied different externalities of car transportation in Beijing; China analyze that different negative externalities of car transportation in Beijing show that social costs induced by motorized transportation are equivalent to about 7.5-15.0% of Beijing's GDP.

In the international case, a large body of literature on crime and economic growth Peri (2004) analyzed and investigate the impact of social variables on economic performance in 95 Italian provinces over the period from 1951 to 1991 by using OLS and two stage least square model. The study conclude that crime have a significant impact on reducing the per capita income and employment growth. Burnham et al. (2006) this paper analyzed the relationship between urban economic growth and city crime patterns on 32 states of US from 1982 to 1997 by using OLS techniques. The results show that violent crime seem to be negative impacts on close-in suburbs, whereas less negative impacts on people live away from the central city. Cullen and Levitt (1999) investigate the relationship between city crime rates and population by using simple correlation techniques period. The study concluded that increase in crime rate is positively impact on rising out migration and decrease in new migrants. There is causality link that rise in crime rate report to city depopulation.

Table 2.1 International Empirical studies:

Author's Name	Objective	Methodology	Source of Data	Conclusion
Cole and Neumayer (2004)	1. To study examined the impact of demographic factors on air pollution.	By using Cross country and time series data STRIPAT model. Dependent variable: SO_2, CO_2 Independent variable: population size, GDP, manufacture share, energy intensity.	World Bank (2002), ITU (2002).	The study concludes that the demographics factors like household's size, age structure, urbanization, income, population size etc. have a statistically significant relationship with CO_2 emission. SO_2 has a statistically significant relationship with energy production and population.
Martínez-Zarzoso and Maruotti (2011)	1. To investigate the differential impact of demographic factors on CO_2 emissions.	From the time period of 1975-2003. STIRPAT model was used for the analysis of different countries. Independent Variable: Per-capita income, population, urban population, energy efficiency, and industrial activity over total GDP	World Development Indicators 2007	This study concluded that population growth has a greater impact on CO_2 emission. The negative relationship between urbanization and CO_2 emission is also highlighted in the study. It is also pointed out that in most high income countries, once urbanization reached a certain level, emissions contributed negatively to growth, but low- middles incomes countries have positive elasticity in the matter of emissions.

Table 2.1 (Continued): International empirical studies				
Sharif and Raza (2016)	To study the impact of urbanization on carbon dioxide emission.	By using time series data for Pakistan from the time period of 1972 to 2013. (FMOLS) technique and dynamic ordinary least square (DOLS) had been used. Dependent Variable: CO_2 emissions Independent variable: GDP, Population Size, Urbanization and Energy consumption.	World Bank and several issues of economic survey of Pakistan.	The findings of the study show that energy consumption, GDP, urbanization and population are the main sources of enhanced CO_2 emissions. It was noted that there is bi- directional relationship between CO2 emissions and urbanization. The author suggested that government needs to allocate large portion for environment safeguard and proper planning for energy saving consumption.
Sodhri, and Garinwe (2015)	To investigate of the correlation between energy consumption, urbanization and CO_2 emissions.	Unit root test, Granger causality test, Co-integration test is used for analysis the study of Malaysia. Independent Variable: population, energy consumption, income per capita. Dependent variable: Energy.	Jakarta statistical yearbook, Indonesia energy statistical yearbook.	The study concludes that there is positive relationship between high per capita income and vehicle ownership. So that, results indicate that high co2 emission is due to increase in motorcycle and private vehicles and poor public transportation.

Table 2.1 (Continued): International empirical studies				
Shahbaz et al. (2015)	To examine the effect of urbanization on CO_2 emission by applying (STIRPAT) in case studies of Malaysia	VECM Granger causality test. The ARDL Bounds Testing Approach. Dependent Variable: CO_2 emissions Independent variable: Population, Income per capita, energy consumption, technology.	World Development Indicators (CD-ROM, 2012).	The empirical studies conclude that economic growth is a major contributor to CO_2 emissions. Energy consumption increase emission power. They find the urban and co2 emissions have a u-shaped relationship i.e. in the beginning it reduce co2 emission but afterward at a certain level, it increase co2 emissions
Valli (2004)	To understand the nature and extent of the causes of accidents	Used the concept of Smeed's formula and Andressen's equations. Dependent variable: Accidental deaths Independent variable: Population, Number of vehicles ownership.	The data for the 25 year period from 1977 to 2001 were analyzed to build models	This study analyzed that increase in fatalities in developing countries show that there has been significant relationship between fatality rates and levels of vehicle ownership due to increase in population.

2.1.2.2 Review of Indian Studies

In the Indian case, a large body of literature on urban economic growth and agglomeration (e.g., Tripathi and Mahey, forthcoming, Tripathi, 2013, 2015) establish the link between urbanization and economic growth. Tripathi and Mahey (forthcoming) investigates the relevant determinant of urbanization growth in Punjab for the period 1961 to 2011. The study finds the existence of a positive relationship between urbanization and economic growth in Punjab. Tripathi (2013, 2015) highlighted the positive link between urbanization and economic growth in India. The study argues that there is non-linear link between spatial concentration of economic activity and economic growth in India. The study also validates the Williamson hypothesis that GDP growth of agglomeration economy can rise only up to certain level.

In the context of cost and benefits of urbanization, Sridhar (2016) argued that urbanization has a symbiotic relationship between rural and urban segments. Urbanization and economic growth positively impacts rural to urban migration and reciprocally, rural areas benefit by the remittances made by rural migrants to their homes. On the flip side, urban areas become congested due to migration to cities/urban spaces in search of jobs. Another negative impact of rural- urban migration is unsettling of the ratio gap in state population, and also the community cost arising from altered rural- urban population ratio.

Among the Indian descriptive studies that focus on the issues of trends and patterns of automobiles in urbanization. Aggarwal and Chaturvedi (2016) examined that increasing demand of transport which is due to increase in population in India. Descriptively analyzed that increase in motorization brought high level of income mobility in the segments of urbanization, but it also adversely effects to several externalities like congestion, air pollution, and noise pollution and traffic accidents. As we know that increase in demand of private motorization due to rising income of the people but also the reason of poor public transport system. The main objective of this study that government has to formulate such type of strategy so that people reduces their need of personalized modes and move their demand towards public transport system. Singh (2012) reviewed the trends of motorized growth in India considering the time period of 1951-2009. The study found that metropolitan cities are suffering from problems such as noise pollution, air pollution, road congestion and high level of accidents and consequent worsening the people's quality of life.

There are several studies in India which highlight the relationship between different negative externalities and urbanization. Reddy and Balachandra (2012) found that motorized mobility has a positive correlation with air pollution, increasing number of vehicle and urbanization in India. The paper also suggested some policies for the improvement in overall transport system, like use of cycles, walking and also improving in public transport to make the city livable. Pucher et al. (2007) study analyzed a comparative overview of Indian and Chinese experience, focusing on four major problems faced by the two countries due to increased motorization, air pollution, and mobility problems of the poor, road accidents and roadway congestion. These problems are generally exacerbated by unorganized urbanization, rapid growth of population and unbridled motorization. To mitigate these negative externalities, it must be accompanied by strict policies for the improvement of environment such as improvement in public transport, rise in taxes, restriction of motor vehicles in congested areas, etc. Rao et al. (2016) study at the magnitude of urban air pollution particularly through motorization and its impact on environment in the metropolitan city of Hyderabad considering the time period 2005-2015. The study finds the growth of vehicular population as a matter of concern for environmental protection. The increasing demographic pressure is another reason for the increase in transportation demand. The study concludes that there is a paramount need for strict regulatory policies by the government to improve air quality and ensure future sustainability.

Some Indian empirical studies estimate that increase in automobiles negative effects on road accidents. Solanki et al. (2016) concluded that increase in vehicular population tends to increase heterogeneous traffic conditions. The study underlines the earlier findings that urban areas contribute overwhelmingly to the country's GDP. Urbanization positively impacts per capita income which in turn leads to increase in vehicle population. Rapid increase in vehicle population has a linier relationship increased congestion and delays in travel time. Singh et al. (2016) have studied that in the metropolitan city Hyderabad increase in number of road accidents effects on social and economic on various direct and indirect costs by using logistic regression analysis. From there analysis they conclude that majority of the reason of road accidents are drivers fault. Mohan's (2004) study on Bangalore stated that road accidents is a causes of traffic crashes, increasing number of registered motor vehicles mixed traffic, speed of vehicles, highway passing through semi urban area etc. . Padam and Singh (2001) states that urban population is significantly increasing day by day through which substantial increase in transport demand which affect quality of life. They highlights the need for urban transport policy because transport crises faced by metropolitan cities.

In the contest of increasing rate of transport vehicles Sharma et al. (2011) this study examined the influence of increase in urbanization, economic development and population growth on increasing rate of motor vehicles in India by using line graph method.

A large body of policy suggestion research paper to mitigate problem related to environment. Pucher et al. (2005) investigate that Indian cities are facing many crisis characterized like level of congestion , noise pollution, traffic fatalities and injuries, air pollution etc. author suggested policy improvement to mitigate this problem. Dociu and Dunarintu (2012) explained that urbanization is widely accepted process with several consequences. Such as social, economic or environmental mostly occur in developing countries. There is need to of several mitigation policies like green cities.

Chapter - 3

Trends and Patterns of negative externalities of urbanization in major class I cities of India.

3.1 Introduction

Urbanization is a continuous process of moderate growth of urban population coincide with ever increase in political, economic, social and cultural importance of cities as compared to rural areas. The level of urbanization is measured by share of country's urban population from its total population. The share of urban population is 377.1 million populations in 2011 increases from 62.4 million populations in 1951. Largest share of urban population is contribute by class I cities. Out of 377.1 million urban populations 264.9 million populations lived in class I cities in 2011. According to Census report, number of class I cities is 468 and top five cities Delhi, Mumbai, Bengaluru, Chennai and Ahmedabad play a leading role in share of population and economic growth. These are the positive indicators of urbanization but, these large cities have also encountered with several negative externalities e.g. air pollution, increase in demand of automobiles, congestion, accidents, crime etc.

3.2 Trends and patterns of negative externalities of urbanization

This present chapter overviews the trends and patterns of negative externalities in urbanization from 2005 to 2015 and urban population CAGR growth rate from 2001-2011. This chapter presents a new evidence of number of new registered automobiles, accidents and crime within and across the largest cities of India. The trends and patterns of negative externalities have been analyzed of top five cities and below five cities on the basis of city population out of 42 class I cities. And also, trends and patterns of negative externalities have been measure in percentage share, and growth rate in economy.

Table 3.1: Total urban population and in selected Class I cities

Year	Urban population (in million)	Total Population of 42 Class I cities (in million)
1951	62.4	21.29
1961	78.9	28.03
1971	109.1	40.40
1981	159.5	55.60
1991	217.5	105.08
2001	286.1	125.74
2011	377.1	130.43

Source: Author's calculation using data from census of India

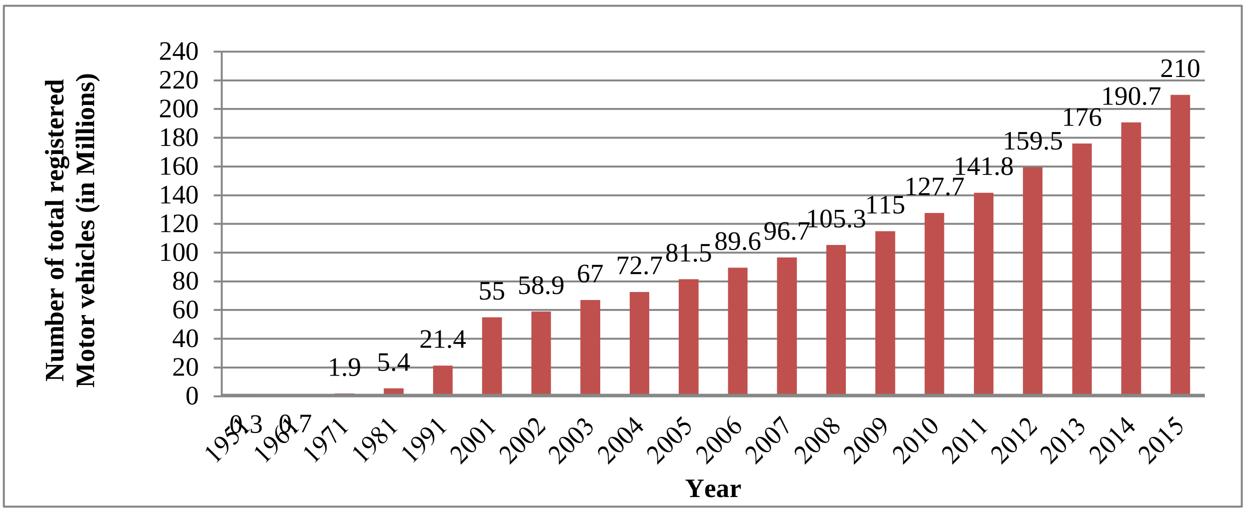
Table 3.1 represents the share of 42 class I cities in total urban population in India. In 1991, 105.08 million urban populations lived in class I cities out of 217.5 million total urban population in India. In 2001, the share of class I cities increase to 125.74 million out of 286.1million in urban population. But percentage increase in urban population is more than as compared to class I cities. In 2011, urban population increase 377.1 million populations from 286.1 million which is highest percentage increase in population as per from the last decades. At the same form, population of class I cities increase to 130.43million from 125.74 million. A high urban population growth is scène in the phase of 1951 i.e. 62.4 million to 377.1 million in 2011. And urban concentration in 42 class I cities increases from 21.29 million to 130.43 million.

In this section, four main issues of externalities which are total number of registered motor vehicles, Air pollution, total number of road accidents and total number of crimes analyzed as following:

3.2.1 Trends of registered motor vehicles in Class I cities:

India is facing numerous challenges and urban concentration is one of them which are transformation of rural to urban migration in dense urban region. As cities are expanding, consequently their transportation needs are also expanding. Cities are influenced by increased in daily mobility of people from their home to work place, shopping, journeys of social needs and for entertainment purpose. People are dependent on high rate of private vehicles ownership

Figure 3.1: Total Registered vehicles in India (in Millions)

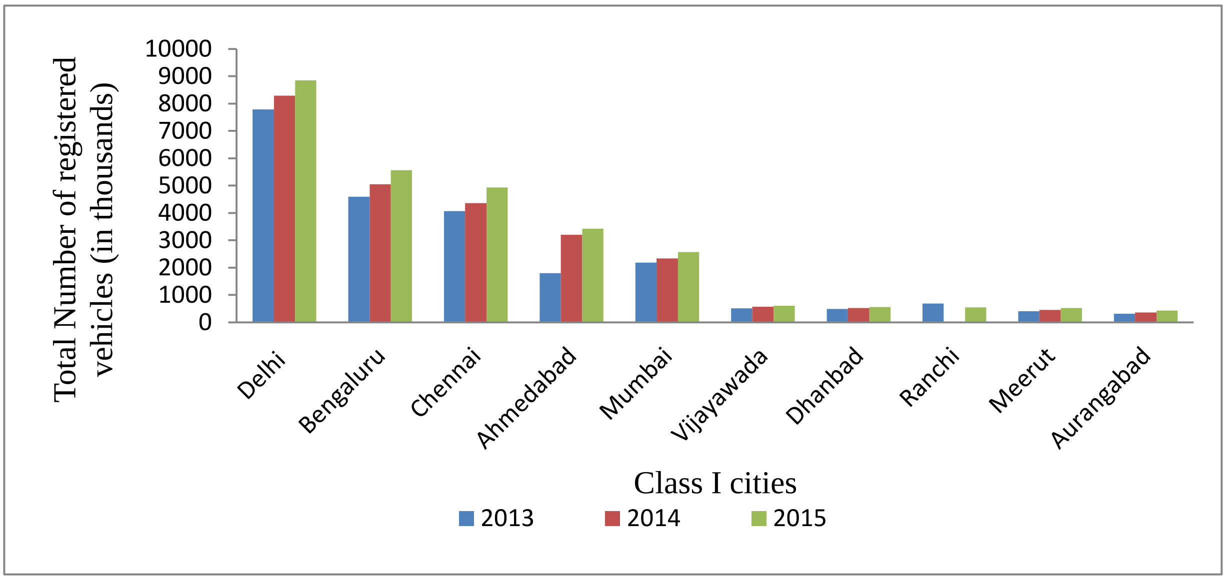


Source: Authors' using data from Transport Year Book, Government of India (GoI)

The compound annual growth rate (CAGR) of total registered vehicles in India was 9.8% in the period of 2005 to 2015. As graphically shown in Figure 3.1, the number of total registered vehicles increased to 210 million in 2015 from 0.3 million in 1951. Hence, increasing phase of transport vehicles is cause of increasing demand of population towards public and private vehicles.

Figure 3.2 shows the growth trends of total number of registered motor vehicles in top 5 and bottom 5 (as per the population size in 2011) Class I cities (out of 42 cities) in India for the period 2013 to 2015. In this period, Delhi had the highest number of registered vehicles (77.85 lakh) followed by Bengaluru (45.91 lakh), Chennai (40.72 lakh), Mumbai (21.87 lakh), Ahmedabad (17.96 lakh). Most importantly, these top five cities accounted for 34.8% of the total number of registered vehicles in urban India in 2013. Among the lowest 5 class I cities, Aurangabad had the lowest number of registered motor vehicles (3.10 Lakh) in 2013. In 2015 also, Delhi topped the list with the highest number of registered vehicles (88.51 lakh), followed by Bengaluru (55.60 lakh), Chennai (49.34 lakh), Ahmedabad (34.20 lakh), Mumbai (25.71 lakh). These top five cities accounted for an increase of 38.2% in the total number of registered vehicles in 2015 than it was 34.8 % in 2013.

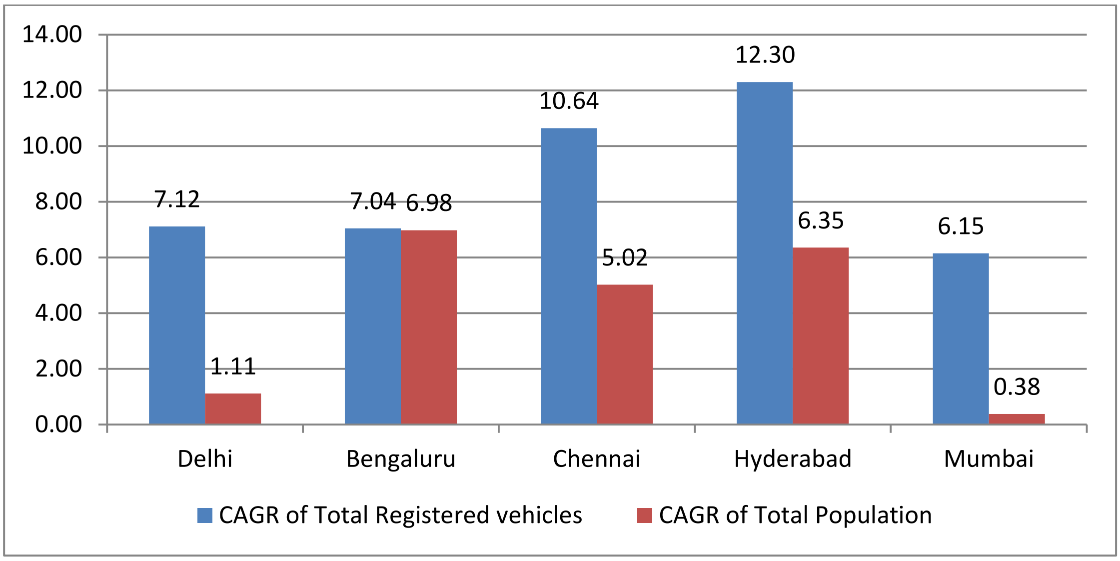
Figure 3.2: Total registered motor vehicles in Class I cities in India



Source: Author' using data from Transport Year Book

Increase in travel demand resulted in rapid growth of automobiles in the cities. Figure 3.3 present the overview of five largest cities of India growth in automobiles as compared to population residing in India during the time period of 2001-2011. Hyderabad city have a highest CAGR growth rate of registered automobiles i.e. 12.30% as compared to CAGR growth of population i.e. 6.35%. And the next Chennai CAGR growth rate of registered automobiles was 10.64% and CAGR growth rate of population was 5.02%. In Bengaluru CAGR growth rate of automobiles and population was at the same phase growth rate. But the most distinguishable result scene to be in Delhi and Mumbai city. In Delhi CAGR growth of registered transport vehicles was 7.12% as compared to CAGR growth rate of population was 1.11%. And the same place Mumbai city CAGR growth rate of registered transport vehicles was 6.15% and CAGR growth rate of population was 0.38%.

Figure 3.3: CAGR growth rate of population and vehicles top five class I cities (2001-2011)



Source: Author' calculation using data from Transport Year Book and Census of India

Table 3.2: Annual growth rate of total registered vehicles of selected Class I cities of India

Selected Class I cities	2012-13	2013-14	2014-15
Delhi	5.92	6.53	6.73
Bengaluru	10.47	10.00	10.10
Chennai	8.10	6.93	13.32
Ahmedabad	-39.77	7.99	7.54
Mumbai	7.79	6.68	10.20
Vijayawada	-6.51	9.86	7.39
Dhanbad	6.06	6.33	8.06
Meerut	-1.90	11.41	14.38
Aurangabad	10.32	16.77	17.68

Source: Same as Figure 3.2

Table 3.2 captures the annual growth rate in the number of registered vehicles in selected class I cities. The table shows the increase/ decrease in growth rate during the period from 2012-13 to 2014-15. In 2012-2013, the highest growth rate in the number of registered vehicles was registered in Bengaluru (10.47%) followed by Aurangabad (10.32%), Mumbai (7.79%), Chennai (8.10%), Dhanbad (6.06%), Delhi (5.92%). However, Ahmedabad, Vijayawada, Meerut had negative growth in the number of registered vehicles in the same period. In 2013-14 Aurangabad witnessed the highest growth rate (16.77%) in the number of vehicles from the previous period, while Bangalore achieved stable growth rate of vehicle population. In the same period, Ahmedabad, Vijayawada and Meerut witnessed increase in growth rate of vehicles. In 2014-15, the highest growth rate was maintained by Aurangabad (17.68%) followed by Meerut, Mumbai, Bangalore etc.

Table 3.3: Trends of vehicle density in selected class I cities in India

Class I cities	2005	2010	2011	2012	2013	2014	2015
Delhi	424	683	655	666	706	752	802
Bengaluru	519	679	373	492	544	598	658
Chennai	499	725	488	531	574	614	696
Ahmedabad	464	NA	NA	302	322	573	613
Mumbai	108	148	150	163	176	188	207
Vijayawada	NA	614	316	374	350	385	413
Dhanbad	NA	29	35	398	422	449	485
Meerut	NA	372	323	321	315	351	401
Aurangabad	NA	NA	216	240	265	309	364

Source: Same as Figure 3.2

Table 3.3 captures the increase in density of vehicles in selected class I cities in India. It can be clearly seen from the table that Delhi's vehicles density increased from 424 in 2005 to 802 in 2015, which is the highest growth rate among the selected 42 class I Indian cities. Interestingly, the increasing trend in vehicle density was evident during the period in all the selected cities without exception. Among the class I cities Delhi, Bengaluru, Chennai, Ahmedabad, and Mumbai had higher vehicle density than other cities like Vijayawada Dhanbad, Meerut, and Aurangabad. This proves that urban dwellers in major metro regions depend more on vehicles for their daily use compared to other metros.

3.2.2 Trends of air pollution in class I cities

As cities are expanding, consequently their transportation needs are also expanding. Increased used of transportation is a major cause of increased energy consumption and environmental degradation. Increase in emissions facts e.g. PM_{10}, SO_2, NO_2 etc. are due to increase in consumer preferences to private vehicles and increase in road travel.

Urban air pollution emanating from urban transport vehicles is measured in this study in terms of per capita emissions of SO_2, NO_2, and $PM_{10.}$ Table 3.4 shows the amount of emissions from transport vehicles in selected class I cities/ urban regions in

India. Emission here refers to the noxious gases spewed by internal combustion engines of transport vehicles. SO2, NO2, and PM_{10} level is measured in per capita terms and reveals the pollution levels in different class one cities. The table makes it clear that metro cities like Delhi, Bengaluru, Chennai, Ahmedabad, and Mumbai have better air quality and are less polluted as compared to cities which are less populated and have smaller number of motor vehicles, like Vijayawada, Dhanbad, Ranchi, Meerut, Aurangabad etc. Delhi and Mumbai have improved their performance in 2015 compared to 2011 as the level of SO_2, NO_2 and PM_{10} have decreased from their previous level. The improved air quality might be due to the rapidly developing eco-friendly urban transport in these cities/ urban regions. However, in the same period of time, Dhanbad city registered the highest amount of PM_{10} (144.63per/ capita) in 2015 followed by Aurangabad PM_{10} (70.01 per/ capita) among the selected class I cities. This indicates that as smaller class I cities grow and their population increase, their dependency on private motor vehicles also increases significantly.

Table 3.4: Emission from urban transport vehicles in selected Class I cities in India

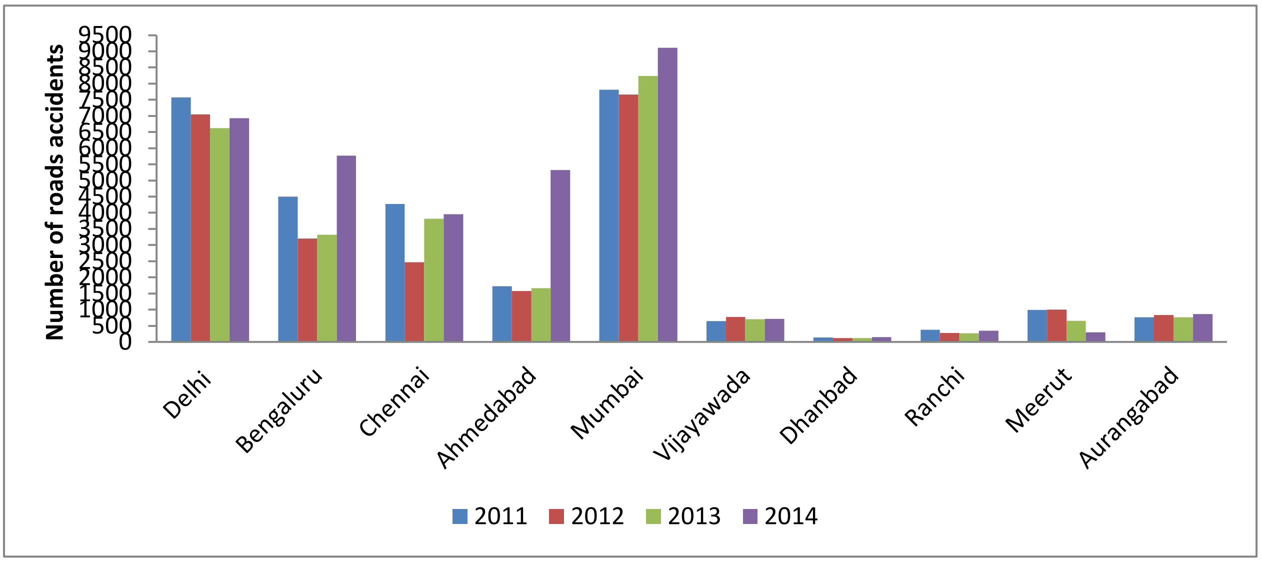
Class I Cities	**SO_2 /Capita /Year**		**NO_2 /Capita /Year**		**PM_{10} /Capita /Year**	
	2011	2015	2011	**2015**	2015	2015
Delhi	0.54	0.45	5.53	5.35	20.12	20.03
Bengaluru	1.66	0.59	3.32	2.37	10.78	15.51
Chennai	1.27	1.83	3.39	2.82	12.98	7.90
Ahmedabad	2.51	2.33	4.48	3.59	14.88	15.42
Mumbai	0.40	0.24	2.65	1.85	9.32	7.23
Vijayawada	4.06	3.39	7.45	23.02	60.94	72.45
Dhanbad	13.77	10.33	30.99	31.85	178.21	144.63
Ranchi	16.77	NA	32.61	NA	153.71	NA
Meerut	3.82	NA	34.38	NA	93.96	NA
Aurangabad	6.83	10.24	26.47	34.15	70.86	70.01

Source: Authors' calculation using data from CPCB, GoI

3.2.3 Trends of road accidents in Class I cities

India is undergoing from major social, economic and demographic transition. Rapid growth of motorization is a main cause of road traffic accidents. In India, traffic is mostly in a form of heterogeneous vehicles like Cycle, rickshaws, bull-carts, pedestrians, cars, buses, trucks etc. Road accidents are mostly happen due to improper interaction between vehicles, road users, congestion and driver's characteristic.

Figure 3.4: Trends of total number of road accidents in Selected class I cities



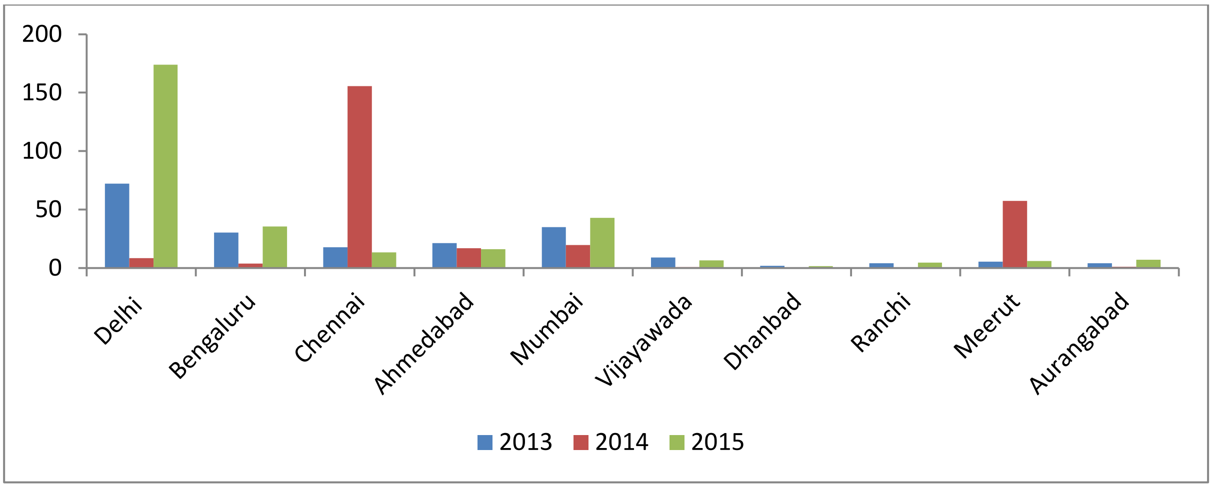
Source: Authors' using data from CRB, GoI.

Figure 3.4 provides a comparison of the total number of road accidents occurred across selected class I cities in India for the years 2011 to 2014. The figure indicates that there is a marked increase in the number of road accidents occurred in metros/urban regions in India. Increase in the number of motor vehicles over the years has been found to be the major cause of road accidents. There was an increasing trend in occurrence of road accidents in Mumbai city in the years 2011-2015. The cities of Bengaluru and Ahmedabad also witnessed increasing trend in occurrence of road accidents during the above years. The number of registered vehicles in a city has a direct relationship with increase in the number of road accidents. The cities that have fewer number of registered motor vehicles and smaller population have registered fewer number of road accidents.

3.3.4 Trends of Cognizable crimes rate in Class I cities

In the wake of the rapid urbanization, Indian economy is experiencing a transformation from an agro-based rural economy to an urbanized modern economy. Several studies have examined the impacts of intra- metropolitan cities on urban crime rates. High number of crime rate is happen in large urban concentration cities as compared to less urban concentration city.

Figure 3.5: Trends of Cognizable crimes in selected class I cities (in Thousands)



Source: Authors' using data from CRB, GoI

Finally, the chapter analyzes the trends in total number of crimes in selected class I cities in India. Urbanization and population concentration have a direct association with incidence of crime, as evidenced by the experience of major metros in India. As illustrated in Figure 3.5, in the years 2013 to 2015, Delhi registered the highest ever number of crimes followed by Chennai which also witnessed a sharp increase in crime rate. However, cities like Vijayawada, Dhanbad, Ranchi, and Aurangabad (except Meerut) have reported less number of crimes in these years presumably because of low population concentration and lesser urbanization rate.

3.3 Conclusion

The present chapter analyzes the trends and patterns of urban negative externalities in India from the period of 2005-2015.The trends and pattern analysis suggest that the class I cities accommodate about 70% of urban population in India. At all India level total number of registered vehicles increased by 55 million in 2001 to 210 million in 2015. Among the class I cities, Delhi had the highest number of registered vehicles (8851 thousands) in 2015 and Aurangabad had the lowest number of registered vehicles (426 thousands). But the Annual growth rate of registered vehicles was the highest in Aurangabad i.e., 17.68% as compared to Delhi i.e., 6.73% in 2014-15. The growth-trend in vehicle density was highest in Delhi i.e., 802 in 2015 but the lowest vehicle density was registered in Mumbai i.e., 207 during the above period.

Higher concentration of population and increase in vehicle population in a specific area generate different forms of noxious emissions like: SO_2, NO_2, and PM_{10}. Largest amounts of such emissions are presently seen in Dhanbad, followed by Vijayawada, Aurangabad etc.

The highest number of road accidents was reported in Mumbai (i.e., 9000) during the above years, followed by Delhi, Bengaluru, and Ahmedabad etc. Incidence of cognizable crimes is also a one of the negative externalities of urbanization as is the experience of cities like Delhi, Chennai, Meerut, etc.

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Chapter - 4

Impact of negative externalities on urbanization in India

4.1 Introduction

Urban concentration is a both cause and effect of urbanization. Urban concentration is like an engine to growth and development of urbanization. While increase in complexity of urbanization seems to be create a number of desirable and undesirable impacts. These impacts are known as externalities which can either be positive or negative. Thus, rapid urbanization in large metro cities has lead to negative externalities such as: increase in number of motorization, congestion, road accidents and crimes etc. These externalities became a challenges for class I cities to build-up eco-friendly and social inclusive environment for maintain sustainability of Class I cities.

4.2 Impacts of negative externalities on urbanization

It is important to investigate the impact of negative externalities on urbanization in India. The following paragraphs are devoted to measure the impact of the negative externalities on population agglomeration in selected class I cities in India. To empirically investigate the impact of negative externalities on urban population agglomeration in India, the following OLS regression model is used.

$$UA = \alpha_0 + \sum_{i=1}^{11} \alpha_i X_i + \epsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where UA stands for population of urban agglomerations. The X_is are independent variables i.e. city wise accidents per 1000 population, number of crimes per 1000 population, city wise indices of air population (measured by per capita SO_2 emissions, per capita NO_2 emissions, per capita PM_{10} emissions) and city wise number of registered motor vehicles (measured in terms of two wheelers density, car density, tractors density, trucks density, number of buses, and auto density).

Table 4.1 explains the means, standard deviations, minimum, maximum, and coefficient of variation (CV) values for the variables used for the regression analysis. Most importantly, the CV aims to describe the dispersion of the variables in a way that does not depend on the variable's measurement unit. The higher values of CV for number of crimes per 1000 population, tractors density, per capita SO_2 emissions, and city populations indicate a greater dispersion in these variables. On the other hand, accidents per 1000 population, two wheelers density, and car density show a lower dispersion in these variables. Total number of buses contains highest mean value and standard deviation (i.e. 8133.35, 10968 respectively). And least number of mean and standard deviation (i.e. 0.47, 0.22 respectively) is of accidents per 1000 population.

Table 4.1: Description of data used in the regression equation

Variables	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**	**C.V.**
City population (CP)	42	2662982	2746128	601574	1.24E+07	103.12
Number of crimes per 1000 population (NCP)	42	5.01	8.46	1.28	57.61	168.82
Per capita SO_2 emissions (SO_2)	42	7.18	9.43	0.4	57.02	131.29
Per capita NO_2 emissions (NO_2)	42	17.18	13.48	2.65	76.03	78.47
Per capita PM_{10} emissions (PM_{10})	42	87.43	77.08	9.32	306.9	88.16
Two wheelers density (TWD)	39	277.08	167.79	7.55	639.06	60.56
Car density (CD)	39	51.18	45.17	4.59	191.77	88.25
Tractor density (TD)	38	7.55	10.41	0.05	44.83	137.90
Truck and lorry density (TRD)	42	8.16	7.93	0.65	35.96	97.07
Total number of buses (TNB)	34	8133.35	10968	386	45757	134.86
Accidents per 1000 population (AP)	42	0.47	0.228	0.06	1.18	48.51
Auto density (AD)	42	8.56	7.54	2.11	34.15	88.11

Source: Authors' calculation

Table 4.2 presents the raw correlation coefficients. The result indicates that per capita SO_2, NO_2, PM_{10} are negatively correlated with city population. The correlation coefficients are also statistically significant. On the other hand, it is positively correlated with car density and total number of busses. The correlation coefficients are statistically significant at 5 % level.

Table 4.2: Correlation coefficient of the regression variables

	CP	NCP	SO_2	NO_2	PM_{10}	TWD	CD	TD	TRD	TNB	AP	AD
CP	1											
NCP	-0.14	1.00										
SO_2	-0.32*	-0.05	1.00									
NO_2	-0.47*	0.06	0.82*	1.00								
PM_{10}	-0.49*	0.00	0.56*	0.71*	1.00							
TWD	0.02	0.15	-0.35*	-0.24	-0.08	1.00						
CD	0.39*	0.51*	-0.29	-0.23	-0.35*	0.42*	1.00					
TD	-0.26	-0.06	-0.09	0.20	0.23	0.28	-0.10	1.00				
TRD	-0.08	0.06	-0.08	0.03	0.15	0.49*	0.12	0.36*	1.00			
TNB	0.78*	-0.03	-0.31	-0.44*	-0.44*	0.19	0.55*	-0.25	0.17	1.00		
AP	0.13	0.28	0.06	0.15	-0.12	0.30	0.39*	0.22	0.25	0.19	1.00	
AD	0.14	0.48*	-0.02	0.01	-0.11	0.28	0.55*	-0.07	0.38*	0.30	0.33*	1.00

Note: See Table 4.1 for variable definitions. The correlation coefficients are based on 33 observations.

** Indicates statistically significant at 5 % level.*

Source: Authors calculation

Table 4.3 presents the estimated regression results from Equation (1). Regressions 1–3 report OLS results, with robust standard errors (to control for heteroscedasticity) taking care of the multicollinearity problem.[4] The population size of urban agglomeration stands as a dependent variable in the regression models 1-3. The significant values of F statistics for Regressions 1–3 indicate that the overall model is statistically significant. The test of normality, i.e., that the residuals are normally distributed, is confirmed by kernel density estimates, which are presented in Appendix Figures A1, A2, A3. A non-graphical test is also done by considering the Shapiro–Wilk test for normality. The statistically insignificant Z values do not reject the null hypothesis that the distribution of the residuals is normal at least at 5 % level of significance.. The higher values of R^2 indicate that Regressions 1–3 can explain a good percentage of total variation in the dependent variable. The study has also calculated the adjusted R^2, as it adjusts for the number of explanatory terms in a model, i.e., it incorporates the model's degrees of freedom. The multicollinearity

[4] To test the Homoscedasticity of the residuals, the Breusch–Pagan/Cook-Weisberg test is performed. The estimated significant value of the chi2 rejects the null hypothesis that the variance is constant. Therefore, to correct for heteroskedasticity the robust standard errors are used.

problem does not seem to be troublesome, as the mean VIF values do not exceed 10 for Regressions 1–3.

Regression model 1 shows that city-wise accident per 1000 population has a statistically significant (at 10% level) positive impact on the population size of the urban population. The result comes as a surprise and indicates that a 10 % increase in accidents per 1000 population increases urban population by 8.7 percent. Number of crimes per 1000 population has a negative effect on the size of urban population. The results show that a 10 % increase in the numbers of crimes reduces urban population by 0.18 %. The result is statistically significant at 1 % level. On the other hand, among the numbers of motor vehicles, city-wise tractors and trucks density has a negative effect while city-wise total number of buses has a positive effect on city population. The results contradict with each other. However, none of the variables are considered to measure the air pollutions show any statistically significant effect on population. In addition to two wheelers density, car density, and auto density do not have any statistically significant effect on the dependent variable.

Regression 2 shows that city-wise per capita NO_2 emissions and per capita PM_{10} emissions have a statistically significant negative effect on the size of city population. In particular, a 10 percent increase in per capita NO_2 emissions (or per capita PM_{10} emissions) reduces the size of urban population by 0.24 (or 0.02) percent. Car density has a statistically significant effect on size of city populations. However, per capita emission of SO_2 and two wheelers density do not show any statistically significant effect on the dependent variable as in regression 1. Finally, regression 3 shows that per capita SO_2 emission has a negative effect on city populations. The result is statistically significant at 1 % level. The coefficient value -0.025 indicates that a 10 % increase in city-wise SO_2 per capita reduces size of population by 0.25 %.

Table 4.3: Measurement of impact negative externalities on urban agglomeration

Independent variables	Log of Population in 2011		
	1	2	3
Intercept	14.68***	14.84***	14.59***
	(0.367)	(0.337)	(0.355)
Accidents per 1000 population	0.873*		0.727**
	(0.44)		(0.339)
Number of crimes per 1000 population	-0.018***	-0.039***	-0.027***
	(0.004)	(0.012)	(0.003)
Air pollution			
Per capita SO_2 emissions	-0.015	0.011	-0.025***
	(0.011)	(0.012)	(0.008)
Per capita NO_2 emissions	-0.011	-0.024**	
	(0.008)	(0.0113)	
Per capita PM_{10} emissions	0.0002	-0.002*	
	(0.001)	(0.001)	
Number of registered motor vehicles			
Two wheelers density	-0.0005	-0.463	-0.067
	(0.0007)	(0.845)	(0.075)
Car density	-0.004	0.008*	
	(0.002)	(0.005)	
Tractors density	-0.013**		-0.015***
	(0.006)		(0.004)
Trucks and lorries density	-0.017*		-0.013*
	(0.009)		(0.007)
Total number of buses	0.049***		0.044***
	(0.008)		(0.006)
Auto density	-0.003		-0.004
	(0.008)		(0.006)
F stat	36.75***	15.48***	69.8***
Mean VIF	2.78	2.47	1.48
R square	0.87	0.56	0.84
Adjusted R square	0.81	0.47	0.79
Shapiro–Wilk test for normality (Prob>z)	0.116	0.066	0.098
No. of observations	33	39	33

*Source: Estimated by using Equation (1). Figures in parentheses represent robust standard errors. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively*

4.3 Conclusion

The OLS regression results show that negative externalities such as city wise air pollution (measured by per capita emissions of SO_2, NO_2, and PM_{10}), number of registered motor vehicles (measured by tractors and trucks density), and city-wise number of crimes per 1000 population have a negative effect on city population.

On the other hand, accidents per 1000 population, car density and total number of buses have a positive effect on city population. In particulars, accidents per 1000 population has a positive and statistically significant relationship on city population, an unexpected result indicates that high number of accidents happen in large cities which have high number of registered vehicles and high urban concentration for example Delhi, Mumbai, Bengaluru etc. And, car density and total number of buses have also positive and statistically significant relationship which revealed that due to increase in number of cars and buses will increase the facility of public and private transportation which will further essence to positive impact on urban population.

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Chapter - 5

Effects of negative externalities of urbanization on economic growth

5.1 Introduction:

Urbanization is a vital characteristic of economic growth and a major component of industrialization and modernization. India economic growth is basically dependent on cities economic growth. Cities play a major role in the growth of country's economy as well as demographic change. It is accounted that 70% of new jobs and services are provided by large cities. According to US treasury report, from the last two years US companies invest over than $20 billion in Indian equities and over next two year as per from the report sign deals on worth $27 billion (US-Indian Business council). These type of investment enforced Indian government to grow cities while providing there millions of new residence with jobs, transportation, healthcare, clean water, education and entertainment etc. As India urbanises, it also faces severe challenges like air pollution, crime road accidents, increase in transport vehicles, and congestion etc.

We examines that insufficient and excessive in use of resources adds into unsustainable of economic growth. We estimated that in India from the time period of 2001 to 2015 the total number of registered automobiles increases from 55 million to 210 million. (Parry et al. 2007; Schipper and Erikson 1995) studies evidence that increase in number of transport vehicles generate eight numbers of negative effects on economic growth such as: congestion, accidents, noise pollution, air pollution, inefficient use of urban areas, emission of GHs gases, and increase in energy consumption.

5.2 Effects of negative externalities on economic growth:

This chapter provides a further estimation of effects of negative externalities on economic growth of the cities. To estimate the effects of negative externalities of urbanization on economic growth in India the following OLS regression model has been used.

$$GDDP = \alpha_0 + \sum_{i=1}^{11} \alpha_i X_i + \epsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where GDDP stands for Gross district domestic product. As per from the report, city level income data is not available, the size of Gross district domestic product (GDDP) data has been used as a proxy of urban level GDP. Only non-primary GDDP (i.e., secondary and tertiary sector) is taken as it is found to be a better proxy for urban

GDP. Due to non-availability of current GDDP data, this study has made use of GDDP data for the year 2011-12 at 2004-05 prices.

The X_is are independent variables i.e. city wise accidents per 1000 population, number of crimes per 1000 population, city wise indices of air population (measured by per capita SO_2 emissions, per capita NO_2 emissions, per capita PM_{10} emissions) and city wise number of registered motor vehicles (measured in terms of two wheelers density, car density, tractors density, trucks density, number of buses, and auto density).

Table 5.1: Details of the independent variables used in equation 1

Independent Variables	Explanation	Expected sign
X_1	Cognizable crimes	–
X_2	Road Accidents	-
Air Pollution		
X_3	Per capita SO_2 emissions	+
X_4	Per capita NO_2 emissions	+
X_5	Per capita PM_{10} emissions	+
Total number of registered motor vehicles		
X_6	Two wheelers density	-
X_7	Car density	-
X_8	Tractor density	-
X_9	Trucks and lorry density	-
X_{10}	Total number of Buses	-
X_{11}	Auto density	-

Source: Author's compilation

Table 5.1 shows that expected sign of independent variables used in equation (1) Cognizable crimes come under the category of total number of crimes has a negative influence on city economic growth (Peri, 2004). Road accidents have negative effects on city economic growth. Per capita SO_2 emissions, per capita NO_2 emissions and per capita PM_{10} emissions come under the category of air pollution have a positive impacts on Urban GDDP. The fact is that environmental Kuznets curve (EKC) is an inverted U shape relationship between air pollution and GDP in developing countries like India. On the other hand, Two wheelers, cars, tractors, truck and lorry, buses and passenger auto come under the category of total registered motor vehicles have a negative effects on urban GDDP and are the main factors to generate different type of negative externalities (Ahmed et al., 2008).

Table 5.2: Description of data used in the regression equation

Variables	Obs.	Mean	Std. Dev.	Min	Max
Gross district domestic product(GDDP)	24	13.23	2.46	9.14	17.19
Number of crimes per 1000 population (NCP)	24	8.97	0.90	7.49	10.76
Per capita SO_2 emissions (SO_2)	24	2.02	0.77	0.69	3.46
Per capita NO_2 emissions ($NO_{2)}$	24	3.30	0.40	2.56	4.11
Per capita PM_{10} emissions ($PM_{10)}$	24	4.910	0.45	3.63	5.739
Two wheelers density (TWD)	24	13.02	1.36	8.99	15.29
Car density (CD)	24	11.28	1.46	7.234	14.56
Tractor density (TD)	24	9.00	1.49	5.51	10.98
Truck and lorry density (TRD)	24	9.12	1.46	4.92	11.36
Total number of buses (TNB)	24	8.04	1.48	4.80	10.73
Accidents per 1000 population (AP)	24	6.87	1.00	5.17	8.96
Auto density (AD)	24	9.39	1.44	5.99	12.15

Source: Author's calculation

Table 5.2 explains the summary of the descriptive statistics (means, standard deviation, minimum and maximum) values for the variables used for the regression model. Two wheelers and car density contain highest mean value (13.02) and (11.28) respectively. Car density, tractor density, truck and lorry density, total number of buses and auto density have approximately equal standard deviation. Per capita SO_2 emissions contain least mean value (2.02) and standard deviation (0.77).

Table 5.3 shows the correlation of variable used in regression model. In table 5.2, the value of the correlation coefficient show that car density is strongly positively correlated with auto density (i.e. 0.90). Total number of buses is highly positive correlation with two wheelers density, car density, and trucks and lorry density (i.e. 0.83, 0.84 and 0.81 respectively). Accidents per 1000 population is moderate positively correlation with auto density (i.e.0.73). PM_{10} is weak negative correlation with Car density (i.e.-0.04). GDDP is low negative correlation with NO_2 and SO_2 (i.e.

-0.16 and -0.03 respectively). Per capita PM_{10} emissions is low negative correlation (i.e. -0.10). GDDP is positively correlated with Number of crime per 1000 population, PM_{10}, two wheelers density, car density, trucks and lorry density, total number of buses, accidents per 1000 population, and auto density. However, GDDP is negatively correlated with per capita SO_2, per capita NO_2 and tractor density.

Table 5.3: Correlation coefficient of the regression variables

	GDDP	**NCP**	**SO_2**	**NO_2**	**PM_{10}**	**TWD**	**CD**	**TD**	**TRD**	**TNB**	**AP**	**AD**
GDDP	1											
NCP	0.531	1										
SO_2	-0.16	-0.12	1									
NO_2	-0.03	0.17	0.35	1								
PM_{10}	0.11	-0.24	0.27	0.20	1							
TWD	0.14	0.65	0.14	0.40	0.06	1						
CD	0.21	0.75	0.20	0.49	-0.04	0.85	1					
TD	-0.17	-0.13	0.175	0.28	0.32	0.48	0.14	1				
TRD	0.21	0.58	0.14	0.31	0.02	0.90	0.71	0.515	1			
TNB	0.15	0.76	0.125	0.32	-0.08	0.83	0.84	0.27	0.81	1		
AP	0.22	0.68	0.18	0.59	-0.16	0.64	0.75	0.012	0.59	0.59	1	
AD	0.11	0.74	0.26	0.38	-0.10	0.87	0.90	0.18	0.78	0.89	0.73	1

Source: Author's calculation.

Table 5.4 presents the estimated regression results from Equation (1). On the other hand, regression models 1-3 represent the parsimonious model by excluding the explanatory variables that did not show statistically significant results or match with the expected sign conditions. Regressions 1–3 report OLS results, with robust standard errors (to control for heteroskedasticity) taking care of the multicollinearity problem.[5] The Gross district domestic product stands as a dependent variable in the regression models 1-3. The significant values of F statistics for Regressions 1–3 indicate that the overall model is statistically significant. The test of normality, i.e., that the residuals are normally distributed, is confirmed by a non-graphical test Shapiro–Wilk test for normality. The statistically insignificant Z values do not reject the null hypothesis that the distribution of the residuals is normal at least at 5 % level of significance. The higher values of R^2 in designate that Regressions 1–3 can explain

[5] To test the Homoskedasticity of the residuals, the Breusch–Pagan/Cook-Weisberg test is performed. The estimated significant value of the chi2 rejects the null hypothesis that thevariance is constant. Therefore, to correct for heteroskedasticity the robust standard errors are used.

a good percentage of total variation in the dependent variable. The study has also calculated the adjusted R^2, as it adjusts for the number of explanatory terms in the model, i.e., it incorporates the model's degrees of freedom. The multicollinearity problem does not seem to be troublesome, as the mean VIF values do not exceed 10 for Regressions 1–3.

Table 5.4: Measurement of impact negative externalities on urban agglomeration

Independent variables	**GDDP in 2011-12**		
	1	2	3
Intercept	-13.03***	-11.59**	15.52**
	(6.88)	(5.24)	(2.60)
Accidents per 1000 population	-0.01	-0.18	-0.89
	(1.28)	(0.69)	(0.66)
Number of crimes per 1000 population	4.23**	3.24**	
	(1.02)	(0.62)	
Air pollution			
Per capita SO_2 emissions	0.06	0.35	
	(0.62)	(0.57)	
Per capita NO_2 emissions	0.44	-0.36	
	(1.30)	(1.25)	
Per capita PM_{10} emissions	1.73*	1.66*	
	(0.83)	(0.80)	
Number of registered motor vehicles			
Two wheelers density	-2.41*		
	(1.44)		
Car density	1.11*		
	(0.52)		
Tractors density	0.31		-0.85*
	(.481)		(0.40)
Trucks and lorries density	-2.07**		-1.32*
	(0.68)		(0.70)
Total number of buses	-2.07**		0.20
	(0.68)		(0.72)
Auto density	-0.01	-1.28**	-0.89
	(1.28)	(0.47)	(0.66)
F stat	3.06	11.16	1.30
Mean VIF	9.04	2.11	4.34
R square	0.73	0.56	0.21
Adjusted R square	0.49	0.44	0.04
Shapiro–Wilk test for normality (Prob>z)	0.46	0.22	0.64
No. of observations	24	24	24

*Source: Estimated by using Equation (1). Figures in parentheses represent robust standard errors. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.*

In table 5.3 regression model 1 represents the beta coefficients of regression equation, robust standard error and significant effect on GDDP. The result of the regression shows that the negative externalities variable has a negative and significant effect on urban economic growth. Number of observation are 24. R^2 is a statistical measure of how close the data are to be fitted regression line. R^2 of urban population is 0.73 it indicate that these data follow a nice tight function, which sounds great. Adjusted R^2 of GDDP in 0.49 which indicate that 49% variation in GDDP variable is explained by independent variables. According to the table there is significant impact of NCP, PM_{10}, TWD, CD, TD, TRD and TNB on GDDP. It show that number of crimes per 1000 population has a positive and statistically significant (at 5% level) effect on GDDP. In certain, a 10% increase in number of crimes per 1000 population increases GDDP by 42.3%. However, Accidents per 1000 population do not have any statistically significant relationship. Further the three proxy variable considered under the air pollution variable only PM_{10} has a positive and statistically significant (at 10% level) relationship on GDDP. Other two variable SO_2 and NO_2 have no statistically significant relationship on GDDP. Finally, number of registered motor vehicles, such as, two wheelers density, trucks and lorry density and total number of buses has a negative and statistically significant relationship effect on urban GDDP. In particular, 10% increase in two wheelers density vehicles reduces the urban GDDP by 24.1%, 10% increase in trucks and lorry density reduces the cities GDDP by 20.7% and 10% increase in total number buses reduces GDDP by 20.7%. But the result of car density shows a positive and statistical significant relationship with urban GDDP. In certain, 10% increase in car density increase the urban GDDP by 11.1%. But six proxy variables of number of registered motor vehicles two variables tractors density and auto density have no statistically significant relationship on GDDP.

Regression model 2 revealed that auto density has a negative and statistically significant relationship on GDDP. In particular, a 10 percent increase in auto density reduces the urban GDDP by 12.8%. However, per capita emission of NO_2 and per capita emission of SO_2 do not show any statistical significant relationship on GDDP as per in regression model 1.

Regression model 3 exposed that tractors density has a negative and statistically significant relationship on GDDP. In particular, a 10 percent increase in tractors density reduces the urban GDDP by 8.5 percent.

5.3 Conclusion:

The main results from the OLS regression model are that number of crime per 1000 population, per capita PM_{10} emissions and car density has a positive and statistically significant relationship on urban GDDP. In particular, number of crime per 1000 population has a positive relationship on GDDP, an unexpected result which indicates that high number of crime rate happens in those cities which have high per capita income for example in Delhi, Mumbai, Bengaluru etc.

From the air pollution proxy variable per capita PM_{10} emissions has a positive relationship on GDDP this results support to EKC hypothesis which revealed that in developing countries like India emission factors have a positive impact on GDDP because in developing country GDDP and emission factor has an inverted U shape relationship.

On the other hand, two wheelers density, tractors density, trucks and lorry density, total number of buses and auto density have a negative relationship on GDDP. It supports the expected result that due to increase in number of transport vehicles there will be negative effects on urban GDP. However, we conclude that increase in number of transport vehicles will generate number of different negative externalities which will have effect on urban economic growth in future.

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Chapter - 6

Conclusion, Findings and Policy implication

6.1 Introduction

India’s large proportion of urban concentration is living in large cities and also large proportion of urban GDP is contributed by large cities. There is a need to make a considerable attention towards negative externalities at the cities level. It is recognized that large cities are the higher consumer of natural resources and a producer of negative externalities. The quality of urban living standard is largely dependent on city size, when urban size tend to increase it also generate different form of negative externalities such as traffic jam, road accidents congestion, air pollution etc. It became a challenge in front of urban planner and economist to be succeeded in reduction of negative externalities so that there will be great possibility of higher economic growth while adopting new plan and policy as evident from developed countries.

Large cities main cause and effects of negative externalities are unplanned and haphazard urban cities development. While study about various forms of negative externalities the main cause of negative externalities are increase in demand of automobiles which directly effective to congestion, road accidents, traffic jam and air pollution etc. Firstly, with increase in number of automobiles it rise the people daily mobility from home to work, shopping, travelling trip and to complete domestic needs which directly met with congestion and traffic problem it will be more time consuming to reach at the destination. The increased use of private automobiles is a major cause of more time consuming while traveling which is directly linked with energy consumption and environmental damage. All the causes and effects of negative externalities directly linked to urban economic growth and urban concentration.

This dissertation has focused on to study the various form of negative externalities that happens in class I cities. In the context of class I cities various form of negative externalities has been estimated. On the other hand, forms of negative externalities are measured by size, percentage share and growth rate in economy. Further, by measurement we analyze the dynamic of trends and patterns of negative externalities in class I cities. Finally, to estimate the impacts of negative externalities on urban population and economic growth is measured by using key variable in 2011.

6.2 Main Findings of the study

6.2.1 Description of India's class I cities growth and urbanization.

Description of India's class I cities growth and urban concentration as compared to urban level is as following:

The trend of India's urbanization the share of urban GDP at national level during the time period of 1951 to 2011 is at the increasing pace. The trends of India's class I cities show a large contribution in urban concentration and economic growth. Over the decades, India's urbanization is manly concentrated in and around class I cities. The increasing trend of urban GDP and of large cities GDP over the decades shows that large cities service sector and manufacture sector contribution is more than other town and cities.

6.2.2 Trend of negative externalities of Class I cities in India.

Trends evidence of four main negative externalities such as air pollution, increase in registered motor vehicles, number of road accidents and number of crime in class I cities in India:

- At the overall India level air pollution, increase in registered vehicles, road accidents and number of crimes are increasing over the decades. The increasing trends of negative externalities show an expansion of negative externalities with positive externalities. At the class I cities level we observe the negative externalities while taking the sample of top five and bottom five cities. The trends of registered vehicles indicates that in large cities number of registered vehicles is high as compared to small cities during the period of 2005 to 2015 but the growth rate of registered vehicles is low in large cities than small cities for example in Delhi registered motor vehicles is 88.51 lakh in 2015 but the growth rate of registered vehicles in 2014-15 is 6.73 and in small city Aurangabad number of registered motor vehicles is in 2015 but the growth rate of registered vehicles is 17.68 in 2014-15. It imply that small cities growth rate in vehicles density is more as compared to large cities in their particular same dense area which will directly have negative impact on urban population and on economic growth.
- The data imply that air pollution SO_2, NO_2, and PM_{10} emissions have an improved level in large cities like Mumbai and Chennai. But in the less populated cities like Dhanbad, Aurangabad and Vijayawada have a high

emissions level because in these cities growth rate of transport vehicles is high.

- Increasing trends of registered motor vehicles and heterogeneous traffic of vehicles are the main cause of increase in number of road accidents. The proportion of road accidents is high in large as compared to small cities. Mumbai and Delhi is high urbanized cities the evidence of road accidents is also high in these cities. So, this evidence indicates that high populated and high number registered vehicles cities have direct relationship with increase in number of road accidents.
- The rapid growth of urbanization is also the main cause of increase in crime rate. The data imply that cities like Chennai and Delhi as a high populated and high per capita income have a high number of crime rates. So, cities having high GDP growth and high urban concentration have a direct proportional relationship with city crime rates.

6.2.3 Impacts of negative externalities on urbanization: Evidence and implication

The study finds from the results while using OLS regression model shows that negative externalities have a strong, significant and negative effect on urban population in future. The estimated results are as following:

- City wise air pollution SO_2, NO_2, PM_{10}, emissions are measured in per capita emissions, number of registered motor vehicles tractors, trucks are measured in density and city-wise crimes per 1000 population have a negative and statistically significant relationship on city population.
- Accidents per 1000 population, car density and total number of buses have a positive and statistically significant relationship on city population.

6.2.4 Impacts of negative externalities on urban economic growth: Evidence and implication

The estimated results while using OLS regression model shows that negative externalities have a strong, significant relationship and negative effects on urban GDDP in future. City level GDP is measured on district level as per city level data is unavailable so city per capita income is measured on the basis gross district domestic product (GDDP). The finding from this model is as following:

- Crime per 1000 population, per capita PM_{10} emission and car density have a positive and statistically significant relationship on urban GDDP.

- Two wheelers density, tractors density, trucks and lorry density, total number of buses and auto density have a negative relationship on urban GDDP.

6.3 Main Contribution

The main contribution of the study is as following:

Chapter first of the study explained the contribution of class I cities population in urban population in India. The study examined that in urban cities have both negative and positive externalities. India large cities contribute large amount of GDP and at the same pace large cities facing large amount of negative externalities. To reduce the negative effects of urbanization study formulate the objective to examine the impact of negative externalities on urban population and economic growth.

In Chapter second various type of national and international empirical reviews have been studied. On the basis of these studies, the present study able to found the researchable gap and the issue. Through literature review study found the main factors of negative externalities which are the main hurdle in front of positive externalities of urbanization to enjoy it.

In chapter third main contribution is on the basis of overview of negative externalities. From the past trends and patterns of negative externalities, urban concentration and urban economic growth study analyze the increasing pace of negative externalities in urbanization in India.

In chapter fourth study analyze the impact of negative externalities on urban population while using OLS regression technique. The study examines that the overall main factors of negative externalities have negative effects on urban population.

In chapter firth study examines the effects of negative externalities on urban economic growth while using OLS regression technique.

6.4 Conclusions

Based on different points of analysis and major finding, study reaches at the point of conclusions which are as following:

- After analyzing the data of various census years from 1951 to 2011 it has been found from the study that percentage of urban population of India increases to

17.3 % (1951) to 31.2 % (2011). Overall, percentage of population in class I cities has increases from 44.6% (1951) to 70% (2011). The share of number of class I cities has been increases to 76 (1951) to 468 (2011). Presently, in this study share of population growth rate in top 42 class I cities has increase from 21.29 million (1951) to 130.43 million (2011). The largest share of urban population is contributed by Class I cities. But from last 1951 to 2011 years India is experiencing a steep growth rate of urban population.

- Analysis the role of urban concentration to economic growth is that in 1951 urban population is 17.3% plus their contribution to national income is 29%. In 2001, urban concentration (30.5%) increases their contribution to nation income from 29% to 60%. So, urban area contribute highest share of GDP in India. The top largest six cities of India such as: Delhi, Mumbai, Hyderabad, Chennai, Bengaluru, and Kolkata are known as a fastest growth contributor to economic growth. These top largest cities are the top class I cities, which play a leading role in urban economic growth.
- India is experiencing steep growth rate reason for that is increasing phase of negative externalities with positive externalities. In India total number of registered vehicles increasing from 81.5 million (2005) to 210 million (2015) which are the main cause of increase in accidents rate and CO_2 emissions. Accidents rate increases to 4.39 thousands (2005) to 5.01 thousands (2015) and CO_2 emissions at India level increases to 1.06 micrograms (2005) to 1.59 micrograms (2013). Another factor, cognizable crime rate has negative impacts on urban population living in urban areas. At India level, cognizable crime rate increases from 5.02 million in 2005 to 7.32 million in 2015. Overall, all these negative externalities have an increasing phase during these time period which automatically effects on urban population and economic growth.
- As we come to know that these large cities are major generator of GDP and urban concentration which is known as positive phase of class I cities. But these class I cities are also large producer of generating negative externalities. In comparison of top five cities and bottom five cities on basis of urban population of 42 class I cities. The study analyzed that out of top five cities: Delhi, Mumbai, Bengaluru, Chennai, and Ahmedabad; Delhi has top one position in total number of registered motor vehicles. Out of bottom of five

cities: Vijayawada, Dhanbad, Ranchi, Meerut and Aurangabad. Aurangabad has a lowest number of registered vehicles i.e.3.10 lakh in 2013.

- Increase in growth of urban concentration became a main cause of increase in demand of automobiles. In top five cities of India CAGR growth rate of registered automobiles is more than CAGR growth rate of urban population. Hyderabad city has a highest CAGR growth rate of registered automobiles (i.e.12.30%) than CAGR growth rate of urban population (i.e. 6.35%) as compared to other cities. Highest growth rate of automobiles as compared to population in particular dense area of cities which will automatically generate negative effects on urban concentration.
- Through the measurement of annual growth rate of registered motor vehicles the study concludes that in top and bottom cities annual growth in 2012-13 highest growth of vehicles is present in Bengaluru (i.e. 10.47) and followed by bottom city Aurangabad (i.e.10.32) as compared to other cities. In 2013-14, Aurangabad achieved a highest growth rate of registered vehicles (i.e.16.77) as least populated city of class I cities. In 2014-15, Aurangabad maintains a highest position in growth rate of registered vehicles which increased from 16.77 to 17.68.
- After the measurement of vehicles density we analyzed the data from the time period of 2005 to 2015 of top five and bottom five cities. We conclude that highest number of vehicle density (i.e.519) is present in Bengaluru city in 2005. After 2005 Bengaluru experiencing the steep growth rate of vehicle density which increases to 658 in 2015. But after 2005 Delhi vehicles density is 424 which is less than Bengaluru, in 2010 Delhi vehicles density increased from 424 to 683. In 2015, Delhi maintained their position in growth of vehicle density (i.e. 802) which is highest number of vehicle density as compared to other cities.
- Urban air pollution is emanating from increase in number of automobiles it is measured in terms of per capita emissions in SO_2, NO_2, and PM_{10} during the time period of 2011 to 2015. The study concludes that less populated cities have highest number of SO_2, NO_2 and PM_{10} amount as compared to large cities. In point of large cities it is good environmental condition because large cities have improved their environmental level as per under the international

norms. Mumbai has been improving their emission in SO_2 from 0.40 to 0.24, NO_2 from 2.65 to 1.85 and PM_{10} from 9.23 to 7.23 levels.

- Analyzing the trends of road accidents in top five cities and bottom five cities of class I cities in the time period of 2011 to 2014. The study concludes that there are marked increased in road accidents in large cities such as Mumbai, Delhi Ahmedabad and Bengaluru. It can be the reason of high population rate plus high number of registered vehicles and heterogeneous vehicles on road.
- Through the analysis of crime data during the time of 2013 to 2015. The study analyzed that in large cities number of crimes happens in high amount as compared to less populated cities. Delhi and Chennai have highest number of crime rate from 2013 to 2015 which evident that crime has a direct association with urbanization and population concentration.
- The results estimated from OLS regression model to analyze the impact of four main negative externalities on city population. The study concludes that city population is influenced by increase in two wheeler and tractors density. Increase in two wheeler density and tractors density effect on traffic, congestion etc. which has direct influence on city population. On the other hand, air pollution such as SO_2, NO_2, and PM_{10} emissions also have direct impact on city population because increase in air pollution have negative effects on people health which will automatically put a bad impact on city population. Another factor of negative externalities is city crime rate. People residing in the city or the migrated people in the city are directly influenced by increase in crime rate. Increase in crime rate has direct negative impacts on city population.
- Factors such as car density and total number of buses have positive impacts on city population because it reduces the problem of heterogeneous vehicles. Whereas, accidents per 1000 population also has positive effects on city because it evident that city having high population rate have a high number of accidents rate.
- On the basis of our fourth objectives, we estimate the impacts of negative externalities on urban GDDP. City level per capita income is measured on the basis of gross district domestic product due to unavailability of city level data. The study concludes that urban GDDP has a positive influenced on city crime rate. City crime rate has positive relationship with those cities having high

GDDP. Another factor, PM_{10} emission has positive impact on economic growth as per the Kuznets's hypothesis i.e. in developing countries urban GDP have an inverted U-shaped relationship with emission factors.

- Another factor such as two wheeler density, tractor density, trucks and lorry density, total number of buses and auto density has a negative impact on urban GDDP. Urban GDDP is negatively influenced by increase in number of vehicles because due to increase in heterogeneous vehicles on roads it increases the chances of road accident, traffic and congestion which will directly influence on people per capita income.

6.5 Policy Implication

The study suggests the following policy options for the promotion of urbanization in India by minimizing negative externalities. The present study estimated that increase in amount of SO_2, NO_2, PM_{10} emissions have a negative impact on urban population to reduce the negative effects on urban population some policy options has been suggested as following:

- **Scrapping of highly polluting vehicles:**

  Indian class I cities need to adopt this policy to mandate that motor vehicles like cars, jeeps, trucks, etc. and such other vehicles that emit high levels of pollution should be scrapped outright or disallowed to be used. Third, investment in transport sector: there is a need make appropriate investments in the transport infrastructure of the class I cities. Such investments are direly needed if the country wants to reduce the traffic jam and accidents and ultimately overcome the negative externalities of urbanization and reaping its positive externalities.

- **Promoting fuel switching vehicles:**

  Recently, China jointly with European companies has designed a car which is capable of meeting to revised emissions standards. Another suggestion is that the government should acquire the technology to produce such type of cars in order to control pollution in Indian cities. In this apart, there is also a need to provide significant subsidies to adopt electric vehicles in place of gasoline vehicles. Electric vehicles can play a significant role in the years to come in accomplishing the desired levels of environmental protection.

The present study analyzes that increase in public and private vehicles have a negative impact on urban population and economic growth. To tackle this problem some policies have been suggested for improvement of public transport infrastructure which are as following:

- **Efficient eco-friendly public transport systems:**
  Cities are searching for sustainable ways to transport residents quickly, efficiently and safety throughout their streets. Once such solution is Bus Rapid Transit (BRT), a City-based, high-speed bus transit system in which buses travel on dedicated routes. India First BRT system was launched in the western city of Pune in 2007, in Delhi is was projected in 2008. After that, in 2009 BRT was launched in Ahmedabad which is known as emerged as a successful leader in the country BRT movement. While Delhi made many strategic mistakes errors in design, according to experts associated with the Ahmedabad project observed that the first mistake was creating an open system which again resulted in traffic jams. The second mistake was to create only a stretch of 6 km, which offered little advantages to commuters. The third one was to create a bus stop at crossroads which lead to blockage of buses. Delhi blunders mistakes offered a valuable lessons for the Ahmedabad BRTS. By building central lanes, the interference from the traffic was minimized. While construct bus stops about 400 metres beyond crossroads and queues of buses do not create jams. It will be significantly positive impact in cities wherever BRT system operates. A leading urban development strategy should be head for integrated urban transport. India smaller cities are now demanding for metros, even though BRT is typically cheaper and more efficient than metros as a capital investment. It is finally hoped by giving due consideration to the policies suggested herein, Indian cities will be turn a new leaf in history and morph into engines of economic growth.

- **Cordon Pricing:**
  The implementation of cordon pricing charges on automobiles that enters in high congested area. More congested areas should be encircled as cordon areas. The fees should be collected from the people while driving into the encircled region via booths or parking permits. Additionally, charges on

automobiles should be varying by time of day in order to reports crowning congestion areas. Cordon pricing aims to covers the infrastructure maintenances costs, improve air quality and to cover health costs through cordon taxes. For example in large cities Delhi, Mumbai, Ahmedabad etc. have a high congested area. In Delhi there are eleven numbers of congested areas such as: Karol bagh market, Saket metro station, Lagpat nagar, Vikas marg etc. were this policy can be adopted to reduce congestion, road accidents, air pollution.

- **Build bridge on highways roads and different lane areas:**
  To reduce the accidents rates government should build bridge on highways roads in small cities congested areas. Due the heterogeneous automobiles congestion and accidents rate increases. To reduce the problem of congestion and accidents rate government should build different lane areas for two wheelers and four wheelers vehicles in small and large cities to maintained heterogeneous traffic jam for example: Chandigarh as planned city have different lane areas for different heterogeneous vehicles.

6.6 Financial suggestion to promote policies

- **Betterment Levies:** Any infrastructure project enchases the economic prospects of the land. Therefore, it would be justified for the local body to impose betterment levy, or impact fees to recover the costs incurred in development of the project that led to the economic growth.
- **User Charges:** The recovery of operational expenses as a pre-condition for sanction of central grants, which led not only for imposition of user charges, but also to realization that people were willing to pay for service. Imposition of tax user would suffice to recovering of the operational costs for transport management.
- **Public- private financing partnership:** Public-Private financing partnership is between government agency and private sector company can be used to finance, build and operate objects such as public transportation, parks and city centers while projects through public-private partnership allow a project to complete sooner.

Bibliography

Agarwal, R., & Chaturvedi, S. (2016). An Analytical Study of Indian Transport System-Challenges and Strategies. *Imperial Journal of Interdisciplinary Research*, *2*(10).

Adhikari, S. R. (2016). Economics of Urban Externalities: Analysis of Squatter Settlements in Kathmandu and Quito. *Springer*.

Ahmed, Q. I., Lu, H., & Ye, S. (2008). Urban transportation and equity: A case study of Beijing and Karachi. *Transportation Research Part A: Policy and Practice*, *42*(1), 125-139.

Andreassen, D. (1991). Population and registered vehicle data vs. road deaths. *Accident Analysis & Prevention*, *23*(5), 343-351.

Andreassen, D. C. (1985). Linking deaths with vehicles and population. *Traffic engineering and control*, *26*(11), 547-549.

Azomahou, T., Laisney, F., & Van, P. N. (2006). Economic development and CO_2 emissions: a nonparametric panel approach. *Journal of Public Economics*, *90*(6), 1347-1363.

Bekhet, H. A., & Yasmin, T. (2013). Exploring EKC, trends of growth patterns and air pollutants concentration level in Malaysia: A Nemerow Index Approach. In *IOP Conference Series: Earth and Environmental Science* (Vol. 16, No. 1, p. 012015). IOP Publishing

Burnham, R., Feinberg, R. M., & Husted, T. A. (2004). Central city crime and suburban economic growth. *Applied Economics*, *36*(9), 917-922.

Cole, M. A., & Neumayer, E. (2004). Examining the impact of demographic factors on air pollution. *Population and Environment*, *26*(1), 5-21.

Creutzig, F., & He, D. (2009). Climate change mitigation and co-benefits of feasible transport demand policies in Beijing. *Transportation Research Part D: Transport and Environment*, *14*(2), 120-131.

Cullen, J.B., Levitt, S. (1999). Crime, urban flight, and the consequences for cities. *Review of Economics and Statistics, 81*(2), 159-169.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological economics*, *49*(4), 431-455.

Dociu, M., & Dunarintu, A. (2012). The Socio-Economic Impact of Urbanization. *International Journal of Academic Research in Accounting, Finance and Management Sciences,2*(1), 47-52.

He, J., & Richard, P. (2010). Environmental Kuznets curve for CO 2 in Canada. *Ecological Economics, 69*(5), 1083-1093.

Holland, S. P., Mansur, E. T., Muller, N. Z., & Yates, A. J. (2016).Distributional Effects of Air Pollution from Electric Vehicle Adoption (No. w22862). National Bureau of Economic Research.

Indian Institute for Human Settlements (2012): *Urban India 2011: Evidence*, Bangalore, India, accessed on 5 June 2013 from iihs.co.in/wp-content/uploads/2013/12/IUC-Book.pdf.

Koland, O. (2006). Urban sprawl, car-related pollution and settlement structure: Insights from a two-region CGE model. *European summer school on Computable General Equilibrium Modelling in Environmental and Resource Economics, Venice*.

Maciel, M., Rosa, L., Correa, F., & Maruyama, U. (2012). Energy, pollutant emissions and other negative externality savings from curbing individual motorized transportation (IMT): a low cost, low technology scenario analysis in Brazilian urban areas. *Energies*, *5*(3), 835-861.

Martínez-Zarzoso, I., & Maruotti, A. (2011). The impact of urbanization on CO_2 emissions: evidence from developing countries. *Ecological Economics, 70*(7), 1344-1353.

Miah, M. D., Masum, M. F. H., & Koike, M. (2010). Global observation of EKC hypothesis for CO 2, SO x and NO x emission: A policy understanding for climate change mitigation in Bangladesh. *Energy Policy*, *38*(8), 4643-4651.

Mohan, D., (2004). The road ahead: Traffic injuries and fatalities in India. Transportation

research and injury prevention programme. Indian Institute of Technology, Delhi. Available at: http://tripp.iitd.ernet.in/publications/paper/safety/road_ahead.pdf.

Ozokcu, S., & Ozdemir, O. (2017). Economic growth, energy, and environmental Kuznets curve. *Renewable and Sustainable Energy Reviews*,*72*, 639-647.

Parikh, J. & Shukla, V. (1995). Energy use and greenhouse effects in economic development: results from a cross-country study of developing economies. *Global Environmental Change*, *5*(2), 87-103.

Peri, G. (2004). Socio-cultural variables and economic success: evidence from Italian provinces 1951-1991. *Berkeley Electronic Journal, Topics in Macroeconomics*, *4*(1), 12.

Pucher, J., Peng, Z.R., Mittal, N., Zhu, Y., & Korattyswaroopam, N. (2007). Urban transport trends and policies in China and India: impacts of rapid economic growth. *Transport Reviews*, *27*(4), 379-410.

Pucher, J., Korattyswaroopam, N., Mittal, N., & Ittyerah, N. (2005). Urban transport crisis in India. *Transport Policy*, *12*(3), 185-198.

Rao, B.V., Ramjee, E., & Reddy, V.V., (2016). Analysis of increase in vehicle population and its effect on air pollution in Hyderabad: India. *India Journal of Applied Research*, *6*(5), 401-405.

Reddy, B.S., & Balachandra, P. (2012).Dynamics of urban mobility: A comparative analysis of megacities of India. *Transport Policy*, *21*, 152-164.

Smeed, R. J. (1949). Some statistical aspects of road safety research. *Journal of the Royal Statistical Society. Series A (General)*, *112*(1), 1-34.

Sharma, R. D., Jain, S., & Singh, K. (2011). Growth rate of motor vehicles in India-impact of demographic and economic development. *Journal of economic and social studies*, *1*(2), 137.

Shariff, N. M. (2012). Private Vehicle ownership and transportation planning in Malaysia. *In International Conference on Traffic and Transportation Engineering*.

Sharif, A., & Raza, S. A. (2016). Dynamic relationship between urbanization, energy consumption and environmental degradation in Pakistan: Evidence from structure break testing. *Journal of Management Sciences*, *3*(1), 1-21.

Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., & Jabran, M. A. (2016). How urbanization affects CO_2 emissions in Malaysia? The application of STIRPAT model. *Renewable and Sustainable Energy Reviews*, *57*, 83-93.

Singh, P., & Padam, S. (2001). Urbanization and urban transport in India: the sketch for a policy. *Pune: Central Institute of Road Transport, Pune, nd*.

Singh, S.K. (2012). Urban transport in India: issues, challenges, and the way forward. European Transport/ Transporti Europie (2012). Issue, *52*(5), 1-26.

Singh, S.G., Bhardwaj, T.S., Ibrahim, M., & Raju, A. (2016). Road Accident Severity Analysis for Hyderabad City. ICRTSTM -16, ISBN: 978-93-86171-05-4.

Solanki, M.J., Umrigar, F.S., Zallu, L.B., & Amin, A.A. (2016). Travel Time & Congestion. Analysis under Heterogeneous traffic condition of C.B.D. Area Case Study of Surat- Rajmarg(Chowk Bazar to Delhi Gate). *International Journal of Current Engineering and Technology*, *6*(4), 1224- 1234.

Sodri, A., & Garniwa, I. (2016). The effect of urbanization on road energy consumption and co_2 emissions in emerging megacity of Jakarta, Indonesia. *Procedia-Social and Behavioral Sciences*, *227*, 728-737.

Sridhar, K.S. (2010). Carbon Emissions, Climate change, and Impacts in India Cities. Indian Infrastructure Report, in India Infrastructure Report2010: Infrastructure

Development in a Sustainable Low Carbon Economy: Road Ahead for India, (eds., 3iNetwork),pp.345-354,Oxford University Press: New Delhi, 2010.

Tripathi, S. (2013). Do large agglomerations lead to economic growth? Evidence from urban India. Review of Urban & Regional Development Studies, *25*(3), 176-200.

Tripathi, S. (2015), Large agglomerations and economic growth in urban India: An application of panel data model, *Urban India, 35*(1), 45- 62.

Tripathi, & Mahey, K.(forthcoming). Urbanization and economic growth in Punjab (India): An empirical analysis. Urban Research & Practice, 1-24.

Trussell, B. (2010). The Bid Rent Gradient Theory. *Journal in Empirical investigation*.

United Nations (2014): *World Urbanization Prospects: The 2014 Revision, Highlights*, New York, United Nations, Population Database, Population Division, Department of Economic and Social Affairs, accessed on 15 June 2014 from http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf.

Vasconcellos, E. A. (1999). Urban development and traffic accidents in Brazil. *Accident Analysis & Prevention*, *31*(4), 319-328.

York, R., Rosa, E.A., & Dieta, T. (2003). Stirpat, Ipat and Impact: analytic tools for unpacking the driving forces of environmental impacts. *Ecological economics, 46*(3), 351- 365.

Appendices

Appendix 1

Total Number of registered vehicles in selected 42 class I cities In India.

Total Registered vehicles (in thousands)											
Cities	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mumbai	1295	1394	1503	1605	1674	1768	1870	2029	2187	2333	2571
Delhi	4186	4487	5492	5899	6302	6747	7228	7350	7785	8293	8851
Bangalore	2232	2617	2338	2518	2701	2919	3146	4156	4591	5050	5560
Chennai	2167	2338	2518	2701	2919	3149	3456	3767	4072	4354	4934
Hyderabad	1433	1522	2181	2444	2682	2728	3033	3387	2040	2203	2369
Ahmedabad	1632	1780	1451	1586	1691	NA	NA	1682	1796	3196	3420
Kolkata	911	948	987	573	581	411	445	496	1278	1339	1402
Surat	692	692	912	982	1036	NA	NA	1145	1241	2244	2459
Pune	827	874	930	1141	1153	1908	2094	2267	2347	2185	2337
Jaipur	923	1051	1177	1289	1387	1549	1694	1871	1962	2121	2249
Lucknow	615	615	801	962	1025	1107	1211	1315	1424	1553	1710
Kanpur	425	424	553	598	642	940	1002	1067	1143	1227	1462
Nagpur	770	824	884	946	1009	1079	1157	1237	1270	1274	1276
Visakhapatnam	435	462	472	515	559	586	617	683	643	690	731
Indore	705	771	844	929	1007	1098	1213	1338	1491	1568	1713
Bhopal	428	476	524	571	617	674	755	829	877	933	1080
Patna	378	405	437	471	516	581	658	743	829	941	1019
Vadodara	586	586	861	934	1009	NA	NA	839	914	980	1042
Ghaziabad	NA	NA	NA	NA	NA	409	470	525	628	685	752
Coimbatore	682	750	827	910	1002	1110	1241	1386	1528	1649	1901
Agra	NA	NA	NA	NA	NA	580	640	704	752	825	905
Madurai	NA	NA	NA	NA	NA	NA	NA	NA	768	833	955
Nashik	NA	NA	NA	NA	NA	358	398	444	490	541	622
Vijayawada	NA	NA	NA	NA	NA	523	466	553	517	568	610
Meerut	NA	NA	NA	NA	NA	387	423	420	412	459	525
Rajkot	NA	NA	NA	NA	NA	NA	NA	760	827	888	979
Varanasi	366	366	456	482	522	497	538	588	633	695	769
Srinagar	NA	NA	NA	NA	NA	172	184	201	218	218	236
Aurangabad	NA	NA	NA	NA	NA	NA	253	281	310	362	426
Dhanbad	NA	NA	NA	NA	NA	31	41	462	490	521	563
Amritsar	NA	NA	NA	NA	NA	NA	NA	803	NA	NA	NA
Allahabad	NA	NA	NA	NA	NA	NA	NA	738	747	817	897
Ranchi	NA	NA	NA	NA	NA	NA	NA	729	684	NA	547
Jabalpur	NA	NA	NA	NA	NA	516	559	605	646	585	638
Gwalior	NA	NA	NA	NA	NA	NA	NA	490	530	573	618
Jodhpur	NA	NA	NA	NA	NA	577	636	868	793	854	916
Raipur	NA	NA	NA	NA	NA	469	527	579	639	980	1112
Kota	NA	NA	NA	NA	NA	440	473	953	554	597	654
Chandigarh	NA	NA	NA	NA	NA	NA	NA	1058	1106	631	746
Tiruchirappalli	NA	NA	NA	NA	NA	400	457	521	593	649	763
Jamshedpur	NA	NA	NA	NA	NA	56	67	682	682	421	472
Kochi	166	166	257	247	303	322	409	480	547	576	606

Appendix 2
Selected City-wise levels of Ambient Air Quality in India (2008 to 2015)

SO_2(In microgramme per cubic metre)								
Cities	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mumbai	9	6	4	5	5	3	4	3
Delhi	5	6	5	6	5	4	5	5
Bangalore	15	16	15	14	14	13	13	5
Chennai	6	9	9	9	12	14	13	13
Hyderabad	6	5	5	5	4	5	5	5
Ahmedabad	12	16	16	14	12	12	13	13
Kolkata	9	16	11	12	12	11	15	6
Surat	16	19	18	20	16	13	15	14
Pune	22	23	26	32	22	20	23	20
Jaipur	6	6	NA	6	9	7	7	7
Lucknow	8	8	8	8	8	8	8	8
Kanpur	7	8	7	10	8	7	5	6
Nagpur	8	6	7	8	10	8	10	10
Visakhapatnam	10	13	7	13	12	13	13	8
Indore	9	9	14	12	12	11	11	11
Bhopal	7	7	7	4	3	3	2	3
Patna	7	5	7	4	6	NA	NA	NA
Vadodara	11	16	17	18	16	14	15	14
Ghaziabad	NA	NA	NA	31	30	26	26	23
Coimbatore	5	6	6	4	3	4	5	4
Agra	9	6	9	3	5	5	8	8
Madurai	10	10	11	11	14	14	13	13
Nashik	30	23	22	25	24	28	25	19
Vijayawada	5	5	6	6	6	5	5	5
Meerut	10	8	8	5	4	5	8	
Rajkot	10	11	14	13	13	12	13	13
Varanasi	16	17	18	17	18	19	19	19
Srinagar	NA	NA	NA	NA	NA	NA	NA	NA
Aurangabad	NA	NA	NA	8	9	10	12	12
Dhanbad	19	17	15	16	17	16	14	12
Amritsar	15	15	14	14	15	13	14	12
Allahabad	8	NA	5	5	4	5	4	3
Ranchi	NA	NA	NA	18	18	19	18	NA
Jabalpur	NA	NA	NA	2	2	2	2	9
Gwalior	NA	NA	NA	12	13	13	11	10
Jodhpur	NA	NA	NA	5	6	5	7	6
Raipur	NA	NA	NA	15	14	15	16	13
Kota	NA	NA	NA	7	8	7	7	6
Chandigarh	NA	NA	NA	2	NA	NA	NA	NA
Tiruchirappalli	NA	NA	NA	NA	NA	NA	NA	NA
Jamshedpur	37	36	36	36	NA	NA	NA	NA
Kochi	NA	NA	NA	3	NA	NA	NA	NA

Appendix 3

Selected City-wise levels of Ambient Air Quality in India (2008 to 2015)

NO_2 (In microgramme per cubic metre)								
Cities	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mumbai	42	42	21	33	20	13	20	23
Delhi	45	49	55	61	59	66	61	59
Bangalore	40	40	31	28	28	26	30	20
Chennai	9	17	15	24	21	22	22	20
Hyderabad	27	22	25	28	28	24	24	25
Ahmedabad	20	21	21	25	24	17	20	20
Kolkata	58	56	62	65	70	70	NA	53
Surat	23	26	25	29	26	20	20	20
Pune	38	40	36	58	45	41	45	59
Jaipur	34	36	NA	37	52	40	41	35
Lucknow	35	36	34	33	32	29	28	28
Kanpur	23	31	34	31	34	31	34	35
Nagpur	32	30	29	35	32	27	25	29
Visakhapatnam	31	32	16	21	13	18	20	18
Indore	17	17	18	14	20	19	20	20
Bhopal	15	18	15	16	21	26	20	23
Patna	39	37	36	36	36	NA	NA	NA
Vadodara	21	30	29	30	33	19	21	21
Ghaziabad	NA	NA	NA	39	34	34	39	37
Coimbatore	28	29	28	26	27	24	25	25
Agra	10	21	11	23	23	21	12	15
Madurai	23	25	25	24	30	22	26	26
Nashik	25	29	34	27	27	29	26	22
Vijayawada	26	14	13	11	12	19	24	34
Meerut	42	43	48	45	43	39	48	NA
Rajkot	13	15	18	18	17	17	19	19
Varanasi	19	20	20	20	21	28	32	36
Srinagar	NA	NA	NA	NA	NA	NA	NA	NA
Aurangabad	NA	NA	NA	31	32	37	39	40
Dhanbad	44	41	38	36	40	40	37	37
Amritsar	36	35	36	26	39	40	42	34
Allahabad	35	24	24	20	32	29	28	28
Ranchi	NA	NA	NA	35	35	36	34	NA
Jabalpur	25	24	NA	25	24	23	23	26
Gwalior	NA	NA	NA	20	27	27	17	14
Jodhpur	NA	NA	NA	23	24	23	31	24
Raipur	NA	NA	NA	42	40	41	41	36
Kota	NA	NA	NA	31	32	33	35	33
Chandigarh	NA	NA	NA	16	NA	NA	NA	NA
Tiruchirappalli	NA	NA	NA	NA	NA	NA	NA	NA
Jamshedpur	51	49	48	48	NA	NA	NA	NA
Kochi	NA	NA	NA	13	NA	NA	NA	NA

Appendix 4
Selected City-wise levels of Ambient Air Quality in India (2008 to 2015)

PM_{10} (In microgramme per cubic metre)								
Cities	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mumbai	132	109	94	116	117	117	95	90
Delhi	198	243	259	222	237	221	215	221
Bangalore	90	122	94	91	121	113	140	131
Chennai	48	70	59	92	57	75	59	56
Hyderabad	87	80	81	74	79	90	98	94
Ahmedabad	80	95	96	83	83	79	85	86
Kolkata	148	187	98	113	135	159	107	108
Surat	81	91	77	106	97	88	89	89
Pune	99	82	65	113	92	88	92	96
Jaipur	112	151	NA	139	187	160	154	167
Lucknow	186	197	204	189	211	192	175	172
Kanpur	209	211	208	183	215	201	199	200
Nagpur	98	99	86	108	103	89	93	85
Visakhapatnam	87	97	69	80	65	67	64	60
Indore	174	183	120	132	143	156	144	95
Bhopal	93	115	116	170	173	220	156	168
Patna	120	146	165	158	166	NA	NA	NA
Vadodara	57	86	94	92	102	89	87	89
Ghaziabad	NA	NA	NA	231	248	285	246	247
Coimbatore	55	74	75	102	68	56	48	47
Agra	184	185	156	155	196	184	182	192
Madurai	41	42	47	44	48	41	45	65
Nashik	80	89	79	96	95	85	73	78
Vijayawada	91	80	98	90	97	104	100	107
Meerut	115	118	170	123	129	134	154	NA
Rajkot	89	105	97	98	99	87	82	83
Varanasi	106	125	NA	127	138	145	139	174
Srinagar	NA	NA	NA	NA	NA	NA	NA	NA
Aurangabad	NA	NA	NA	83	80	84	85	82
Dhanbad	131	164	112	207	178	151	162	168
Amritsar	NA	190	218	210	202	180	187	169
Allahabad	128	160	218	258	317	235	250	249
Ranchi	NA	NA	NA	165	202	177	197	
Jabalpur	136	136	NA	73	75	69	69	88
Gwalior	NA	NA	NA	311	329	197	148	127
Jodhpur	NA	NA	NA	168	189	176	189	151
Raipur	NA	NA	NA	310	268	305	329	186
Kota	NA	NA	NA	139	156	122	128	115
Chandigarh	NA	NA	NA	102	NA	NA	NA	NA
Tiruchirappalli	NA	NA	NA	NA	NA	NA	NA	NA
Jamshedpur	172	172	154	152	NA	NA	NA	NA
Kochi	NA	NA	NA	38	NA	NA	NA	NA

Appendix 6

Selected City-wise Incidence of Accidental Death in India (2008 to 2015) Incidence of total Cognizable crimes (IPC) In cities (in Number)								
Cities	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mumbai	32770	31262	33932	32647	30508	34840	40361	42940
Delhi	44573	45247	45994	47212	47982	72090	139707	173947
Bangalore	29664	32380	32188	30283	29297	30318	31892	35576
Chennai	11829	10905	10869	21346	19881	17747	16861	13422
Hyderabad	18567	17840	17549	15657	15992	16355	18940	16965
Ahmedabad	18544	20726	21442	20203	21347	21258	15286	15964
Kolkata	13005	13615	15510	17152	25370	26319	26161	23990
Surat	10741	7564	7426	8446	9246	24307	4397	3985
Pune	14467	13848	13602	12622	12308	13159	14468	15349
Jaipur	15407	16788	16717	18897	18678	23988	26070	26288
Lucknow	11735	10482	10316	8891	9147	11688	12742	11981
Kanpur	8885	6812	6747	7661	4558	4226	5211	4960
Nagpur	8661	7785	7728	8063	8277	9426	10359	11018
Visakhapatnam	5015	5416	7112	4886	4626	6775	7728	6005
Indore	15430	14101	14230	14504	16526	17551	19197	18463
Bhopal	11515	12169	11974	12570	11732	11274	12962	14857
Patna	9014	8806	9017	9292	10749	14387	15396	16871
Vadodara	5386	5060	5352	5727	6440	12786	12651	13243
Ghaziabad	NA	NA	NA	5488	5254	6487	6755	6441
Coimbatore	4180	4318	4180	4030	10357	17945	4281	3827
Agra	4826	4836	4802	8380	6537	6375	6792	6299
Madurai	2470	3000	2672	2873	3261	3031	3226	4388
Nashik	3813	4218	4484	4512	4390	4401	3883	3963
Vijayawada	5127	5180	5833	7225	7686	8978	7876	6438
Meerut	2765	2431	3307	4353	4404	5251	6141	5823
Rajkot	5525	4475	4024	3939	4319	3572	3516	3385
Varanasi	2734	2254	2129	2020	2282	3311	2589	2779
Srinagar	NA	NA	NA	2756	2614	2792	2533	2818
Aurangabad	NA	NA	NA	3781	3659	4033	4821	7051
Dhanbad	1302	1316	1006	1482	1613	1688	1730	1672
Amritsar	2327	2157	1833	1807	1964	1652	1998	1939
Allahabad	2068	2073	1973	2702	2788	3895	4694	3909
Ranchi	NA	NA	NA	3761	3990	3936	4351	4663
Jabalpur	5128	6195	6205	6560	7212	6996	8377	9253
Gwalior	NA	NA	NA	7816	7561	7886	9369	8531
Jodhpur	NA	NA	NA	4270	4531	5807	5645	11822
Raipur	NA	NA	NA	6222	5997	6466	5975	5368
Kota	NA	NA	NA	4176	3972	4872	5248	5366
Chandigarh	NA	NA	NA	3299	3372	3921	3064	3136
Tiruchirappalli	NA	NA	NA	3496	2926	2783	3074	3324
Jamshedpur	2685	3075	2732	2362	3192	3961	3340	3541
Kochi	7956	8757	25715	34658	17324	13476	17088	13781

Appendix 6
Selected City-wise Incidence of Accidental Death in India (2008 to 2014)

Incidence of Accidental Death (in Numbers)							
Cities	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Mumbai	8681	8563	9093	7814	7663	8238	9106
Delhi	7016	7037	7717	7576	7048	6621	6926
Bangalore	2762	3159	3396	4499	3200	3318	5771
Chennai	2046	1646	2129	4271	2473	3821	3960
Hyderabad	2227	2123	1870	1360	1535	1554	2377
Ahmedabad	1361	1426	1749	1723	1576	1665	5326
Kolkata	867	837	803	858	786	818	695
Surat	1496	1376	1682	1546	1767	2000	3343
Pune	3763	3380	3822	3685	4070	4141	3882
Jaipur	1551	1497	1592	2094	2028	2244	3545
Lucknow	609	561	550	569	541	554	376
Kanpur	1234	1286	1425	2219	1971	1677	1051
Nagpur	1481	1599	1834	1349	1638	1711	1814
Visakhapatnam	408	714	776	711	799	1011	739
Indore	1257	1417	1473	1428	1477	1034	1110
Bhopal	248	1052	343	514	428	930	3241
Patna	256	262	500	729	893	812	678
Vadodara	629	580	735	673	714	796	1520
Ghaziabad	NA	NA	NA	891	995	337	643
Coimbatore	577	515	563	475	515	524	602
Agra	379	729	761	912	330	808	684
Madurai	269	263	357	264	358	350	279
Nashik	996	914	1149	938	1181	1070	1260
Vijayawada	615	586	715	646	778	708	717
Meerut	1078	1006	1014	997	1003	660	301
Rajkot	NA	NA	NA	587	721	712	1020
Varanasi	567	596	697	612	861	578	668
Srinagar	NA	NA	NA	76	169	260	367
Aurangabad	NA	NA	NA	760	833	761	862
Dhanbad	144	441	101	142	117	123	150
Amritsar	300	274	331	311	353	329	334
Allahabad	966	870	545	233	177	294	1080
Ranchi	NA	NA	NA	382	274	264	345
Jabalpur	260	429	724	679	1174	592	1067
Gwalior	NA	NA	NA	176	210	219	237
Jodhpur	NA	NA	NA	625	607	617	690
Raipur	NA	NA	NA	587	721	712	1020
Kota	NA	NA	NA	512	496	564	773
Chandigarh	NA	NA	NA	404	312	370	422
Tiruchirappalli	NA	NA	NA	286	249	301	358
Jamshedpur	236	498	506	340	293	276	331
Kochi	513	432	428	488	443	457	423