ENVIRONMENTAL ISSUES OF URBAN ROAD TRANSPORT IN ERANAKULAM DISTRICT

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DOCTOR OF PHILOSOPHY IN ECONOMICS

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CERTIFICATE

This is to certify that this Ph.D thesis entitled, **“ENVIRONMENTAL ISSUES OF URBAN ROAD TRANSPORT IN ERANAKULAM DISTRICT”**, submitted for the award of the degree of Doctor of Philosophy in Economics is a bonafide record of research work done by **INDIRA P M,** under my guidance and supervision. No part of this work has been submitted earlier for the award of any other degree, diploma, title or recognition before.

Place: Thrissur
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DECLARATION

I **INDIRA P M,** hereby declare that this Ph.D thesis entitled, **"ENVIRONMENTAL ISSUES OF URBAN ROAD TRANSPORT IN ERANAKULAM DISTRICT"**, is a bonafide record of research work done by me for the fulfillment of the award of the degree of Doctor of Philosophy, under the guidance and supervision of Dr**. D RETNARAJ**, Professor, Department of Economics, University of Calicut, Dr. John Matthai Centre, Aranattukara, Thrissur. I also declare that this thesis has not been submitted earlier for the award of any degree, diploma, title or any other similar title of recognition.

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(Indira. P. M.)

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I dedicate this Ph. D thesis to My Etta,

My Appavu, Amma, Chechi & Brothers

for their constant support and unconditional love.

I love you all dearly……!

PREFACE

Economic development and urbanization poses multitude challenges to urban transport system, which is one of the most important sectors having a direct bearing on Sustainable Development. The rapid increase in urbanization have resulted in unplanned urban development, increase in consumption patterns and higher demands for transport and energy sources which all lead to automobile pollution, road crashes and accidents, deficiency in non-renewable energy, and Green House Gas emissions at global scale. etc. Transport poses a dilemma, in that it is necessary for economic and social development, yet it is associated with environmental degradation especially with regard to atmospheric pollution. As the urbanization and urban transport are increasing, the vehicular mobility is increasing at an alarming rate. It this trend continues, there will be any more energy source left for the future generations. Thus, rapid urbanization poses an energy security concern. From the environmental point of view, the worst implication of present transportation and traffic policies are road traffic accident rather than air and noise pollution. In addition, the World will be so polluted that living organisms may not be able to live. The first and foremost important conclusion regarding urban air pollution is that it affects everybody, regardless of socio or economic conditions because people travel everywhere. Hence, we need to understand the importance of saving our environment. Our aim must be to preserve the nature and have the best transportation system, along with a Sustainable Environment.

The urban transport issues of mobility, accidents and environmental aspects are becoming increasingly important and critical in Ernakulam District. Rapid urbanization process, high vehicular population growth and that of the mobility, inadequate transportation facilities and policies, varied traffic mix with over concentration of non- motorized vehicles, absence of dependable public transport system and inadequate traffic management practices and parking facilities have created a significant worsening of traffic and environmental problems in the major urban centre of our State.

The thesis, ***"Environmental Issues of Urban Road Transport in Ernakulam District,"*** *throws light on the trend and pattern of vehicular mobility in the district and the surrounding externalities particularly related to environment over a given period. The main motto behind this study is to contribute in this direction and create value for all stakeholders, public, employees, vendors, State Government and fund providers. Being a student of Economics, I tried to analyze, reanalyze and comprehend the environmental issues of road transport in Ernakulam District.*

My Honourable Research Guide Dr. D. Retnaraj Sir taught, analyzed and highlighted the complexities of the study in a very simple manner to enable me to grasp the design of the thesis.

All credit goes to Dr. D. Retnaraj Sir.

(Indira. P. M.)

"The 'Environment' is Where we Live; and Development is What we all do in Attempting to Improve our lot Within that Abode, the two are Inseparable."

- Our Common Future

CHAPTER - 1

DESIGN OF THE STUDY

1.1 INTRODUCTION

Healthy and hygienic environment is a prerequisite for sustainable economic development of a Country. In order to achieve the objective of sustainable development, it is important to strike a balance between development and environment. From the last three decades onwards, both economists and environmentalists have become increasingly aware of the importance of environmental issues for the success of developmental efforts. This mounting realization of environmental concerns culminated in the establishment of World Commission on Environment and Development (WCED, 1983) by the United Nations General Assembly in 1983. This report was a turning point in the history of human endeavor for safeguarding the environment. In the twenty years between the Stockholm Conference on Environment and the Rio Conference in 1992, there has been a growing realization that human activities badly affect the environment. This key issue of global environmental concerns has attracted the attention of the public towards deteriorating environment. Thus, environmental issues were assigned top priority in national and international agendas. The majority of global environmental damage represents the accumulative and contemporary impact of western Industrialization. One of the long-lasting and most significant impacts of Industrial Revolution that took place from the end of the 18^{th} century to the beginning of the 20^{th} Century was Urbanization. Urbanization, by itself is not an environmental issue. Environmental problems are in fact by product of transport systems, overcrowding of human habitats, industrial activities etc. of which transport problems are the most important one.

Transport plays a crucial role in determining the prosperity of an economy by enhancing the productive capacity in a self-accelerating process of economic development. Of the various modes of transport, road transport is vital to economic development, trade and social upgradation. The global motor vehicle population is approximately 680 million vehicles. This mode is currently estimated a share of about eighty percent in passenger transport and sixty percent in freight transport in India. Transportation becomes a serious issue in the urban context from the point of view of heavy congestion, poor speed on roads, road safety of citizens, suffocating air pollution, and dumb-founding noise pollution. It is also responsible for high consumption of petroleum products, which is a precious resource in the national interest. Due to rapid growth of urban population all transport systems have been undergoing tremendous strains as the travel demand far exceeds the limited supply of transport infrastructure and services. In the case of Kerala, traffic has been growing at a rate of ten to eleven percent every year, resulting in high traffic and pressure on the roads. Its road density is nearly four times than the national average. Among the five major Municipal Corporations in Kerala, Kochi in Ernakulam district, one among the 50 most polluted cities in India, which is ranked as 24th by Central Pollution Control Board, in which road transport is the biggest emitter.

The environmental impact of transport has now attracted the global concern. It includes all adverse side effects on the environment including climate change, global warming, air, water and noise pollution, vibration, visual and social impacts etc. Such environmental externalities of transport emerge from two principal directions. The first is ever increasing and concentrated economic activities in urban settlements with narrow roads that have created high concentration of pollutants, due to congestion in the urban atmosphere. The effect is multiplied due to lack of policy initiatives in environmental quality, urbanization, lack of coordinated efforts in the planning process and all these have been the major reasons for the transport induced environmental problems. A second dimension of environmental problems persists in out of the urban settlements due to loss of bio-diversity in roads and nearby areas, soil erosion, deforestation etc. In short, the transport related environmental externality mainly concerned with the problem of sustainability.

Transport sector is one of the major emitter of Green House Gases and also responsible for twenty three percent of World energy related Green House Gases emissions, with about three quarters coming from road vehicles. '*The level of motor vehicle use is considered as a source of more air pollution than any other single human activity*' (OECD, 1995). Road transport is the largest contributor to global warming. Globally transport sector accounts for sixty percent of Carbon Dioxide, forty percent of Nitrogen Oxides and of Volatile Organic Compounds including Hydro Carbons, which leads to atmospheric Ozone , when photo reacting with Nitrous Oxides. India has the second largest road network in the World and has become one of the biggest emitters of atmospheric pollutants from the road transport sector globally. Currently, there are 16 developing Countries, which face environmental risk of vehicular air pollution constituting 25.4 percent, India is one among them. Among the five major Municipal Corporations in Kerala, Kochi is the most polluted one. It is one among the fifty most polluted Cities in India, which is ranked as 24th by Central Pollution Control Board, in which road transport is the biggest emitter.

When we look in to the accidental scenario, among the top ten causes of mortality in the Country, road traffic accident was the 10^{th} cause of two decades back. However, with the increasing expanse and life style changes, it is projected that it will occupy the fifth position in the list of major killers and third position among the causes of disease burden in 2020. Traffic in Kerala has been growing at a rate of 10 to 11 percent every year, resulting in high traffic and pressure on the roads. Its road density is nearly four times the national average. Kerala's annual total of road accidents is among the nation's highest.

The above discussions on urbanization and allied problems bring out the significance of studying problems of urban transport system particularly in the environmental perspectives.

1.2 REVIEW OF STUDIES ON URBAN TRANSPORT

Literature on urban transport ranges over a wide variety of issues. Studies encompass descriptive analysis of transport situations in various cities, quantification of externalities of urban transport, impact of transport policies, automobile ownership and use, energy consumption of various systems, public transportation systems, investment in transport infrastructure, land use patterns and their effect on transportation etc. It was presumed that the environmental impact of transportation at the district level cannot be explained in isolation, without a perspective understanding of the transport and economic infrastructure. In what follows is a review of research and literature on different aspects of transportation in the context of both developed and developing Countries. The review is not comprehensive. Nevertheless, it is fairly an indicative of the vast amount of interest that the subject has evoked among the scholars. For better understanding and comprehension, studies in the international context, studies in India, and regional studies are considered separately according to the dimensions of the problem they addressed. The first part of the review discusses studies in the international context and the second part deals with Indian studies and Kerala studies.

1.2.1 Studies on Urban Transport in International Context

Alker[1] (1938) examined the traffic problem and relation of Road to Rail. He suggested Sea and Air Transport and Science of Traffic Control to reduce accidents and smooth running of the traffic. Bonavia[2] (1954) highlighted the role and significance of transport system for the development of a country and discussed the utility of good transport system from industrial, political, social and cultural angles. Lowe and Nevile[3] (1959) studied the development of transportation system in Japan. He has dealt with the transport and communication system during the Tokugawa Era (1600-1686) and has described the process of the development of certain features, which ultimately helped the establishment of modern transport in Japan.

A study made by the Ministry of Transport[4] (1966) highlighted that the free flow of traffic at reasonable speed requires planned improvement of urban road systems. The study also suggested constructing secondary means of access to enable goods and service vehicles to load and unload at the stops. Hibbs[5] (1970) explained various approaches to study the function of transport along with control aspects. Locklin[6] (1972) concentrated on the study of rail-road systems. He opined that the Government ownership of transport system facilitates the planning and execution of transport system very effectively and the Government, in one way or the other is capable of providing necessary capital. Sharp[7] (1973) studied transport system of U.K. and studied a number of basic problems like transport economics, transport investment, transport pricing and reduction in accident rate. Payne[8] (1975) traced the history of development of transport in Europe suggests that the transportation facilities are established by the private sector on the basis of free competition and, therefore, the private sector should be allowed to continue as such. He also discussed the implications of Treaty of Rome on transportation in Europe.

Studies on transport policies consists of assessing the impact of policies and measures adopted by the cities or nations towards managing their transport problems. National Policy towards cars in Netherlands has assessed in light of the developments in motorization after Second World War, population growth, changes in population structure, changes in the economic situation and land use (Hoorn et. al[9], 1986). Similar studies on transport policies has undertaken for Hong Kong, (Mace[10], 1986), Germany (Kunert[11], 1988), Greece (Giannapoulos[12], 1985) and Singapore (Winston et. al[13], 1994, Asher[14], 1997). These studies emphasized on the national level policies and how they have affected in the transport scenes in these countries over time. Site and Pillai[15] (1995) have analyzed the effectiveness of optimal bus policy for dealing with fuel consumption in urban areas under different hypothesis of car pricing.

A study by Maunder et. al[16] (1979) explained that a faster growth in the number of passenger trips in public transport system in relation to population growth in developing countries primarily because of the increased trip rate per head. An econometric analysis by Kain and Liu[17] (1999) showed that the transit ridership growth in Houston and San Diego regions was caused principally by large service increases and fare reductions as well as metropolitan employment and population growth. A similar study of Freiburg in Germany attributes the doubling of Patronage growth for public transport to the introduction of cheap travel pass with the essential characteristics of unlimited use at zero marginal cost, interpersonal transferability and wide regional validity (Fitzroy[18], 1998), Goodwin[19] (1999). They also supported the prima facie case that public transport services levels, fares or quality had a small but possibly important effect on car ownership.

Organization for Economic Corporation and Development Compass Project Report[20] (1986) assessed the environmental implications of a variety of alternatives and improvements to the conventional, leaded- petrol burning automobile. The report explored alternative vehicle technologies that by changing the means of providing this end use of energy have different environmental effects. Webster et. al[21] (1986) highlighted the adverse effect of growing car ownership on public transport and the bleak future for public transport unless supported by huge subsidies. Roth[22] (1987) argued that private provision of public services will be more efficient and thus desirable as public transport is unable to respond to the market needs.

The appropriateness of rail- based systems as mass transit vis-a -vis bus system is discussed by Allport[23] (1986) emphasized that public sector resources have a high opportunity cost which makes all but the lowest cost mass transit systems difficult to justify. A number of studies have been undertaken on the issue of bus deregulation also (for example Glaister [24, 25], 1985 and 1986). An interesting finding in most of the studies is that bus regulation will lead to smaller size of buses, but more frequency while the fares might go up.

Gronau[26] (2000) investigated the viability of the operation of small vehicles catering to high - value - of - time travelers along side large vehicles serving low-value-of-time travelers serving the same route. In a discussion on economic and environmental characteristics of public and private modes, Nash[27] (1976) has reviewed the potential for modifying modal split in each of the main sectors-private and the public- of the transport market. They stressed the relevance of cost-benefit analysis of future infrastructure changes in the issue of the choice of modal split.

Studies on Transportation Demand Management and road pricing have also appeared in the past few years. A recent study on the evolution and effectiveness of Transport Demand Management in the U.S. concludes that measures to increase travel price for single occupant vehicle use will be most effective (Meyer[28], 1999). Battacharjee et. al[29] (1997) evaluated the commute attitudes on Transportation Demand Management in Bangkok. In an analysis of automobile dependence in various cities across the World Kenworthy et.al[30] (1999) pointed out that U.S, Australian and Canadian cities respectively exhibit the extreme dependence on automobile. This is primarily relates to land use patterns in urban density or in urban form rather than income differences across cities. A study on Asian cities (Barter[31], 2000) identified the challenge and opportunities faced by these cities due to their high densities and emphasized the role of non-automobile modes of transport and policy initiatives to promote them. Another study on three cities in U K (London, Birmingham and Manchester) over 1981-1991 revealed that auto dependence had interested the energy consumption due to more work trips being made by car-based modes (Frost[32], 1997).

There are studies that make projections on vehicle growth in cities (Dargay et. al[33], 1999; Gallez[34], 1994). Attempts at behavioral travel models (Quarmby[35], 1967; Donnea[36], 1971) gained wide acceptance with the appearance of McFadden[37] (1974) who gave a behavioral theory for demand forecasting practices, which helped to resolve the empirical questions on the determinants of travel demand. Similarly, models on factors influencing car demand and use have appeared in literature (Train[38], 1986).

Literature on behavior or attitudes of travelers has assumed importance in recent times with shifting emphasis on the role of perceptions in travel behavior. Curtis et. al[39] (1997) examined the attitudes of car commuters, found that majority of the commuters were highly car oriented and not susceptible to change making pricing the only effective measure to reduce automobile independence (Tertoolen et.al[40], 1998). Baldassare et.al[41] (1998) discussed the effectiveness of policies aims at discouraging commuters from solo driving in the U.S. metropolitan area in light of policy changes in California. In an attempt to understand how individuals perceive congestion and the range of coping strategies they adopt, Mokhtarian et.al[42] (1997) concluded that individuals are likely to adopt the low cost, travel maintaining strategies first and policies aimed at travel reduction will be slower to yield. The relevance of public attitudes were brought out also by Taylor et.al[43] (1997) in a study in Britain regarding the traffic calming schemes used. The study concluded that the success in calming schemes depends, on objective empirical measure and overwhelming support of the local community.

A discussion on the problems of political and social feasibility of environmentally friendly transport policies in Netherlands by Rietveld[44] (1996) concluded that policies that are most efficient in economic terms are also those that receive little political support. Rienstra and Rietveld[45] (1996) explored the social political feasibility in the Netherlands with the aid of a statistical analysis of perceptions of transport problems and support for policy measures. Verhoef[46] (2000) assessed the regulatory policy mixes directly aimed at the containment of market failures in road transport, in terms of efficiency as well as equity and social feasibility.

Studies analyzing the cost of externalities related to transport , particularly on costs of motor vehicle related air pollution (McCubbin and Delucchi[47], 2000; Juardo and Southgate[48], 1999; and Bart[49], 1994) and evaluation of cost of accidents (Jasson[50],1994) are also significant. Attempts at quantifying the CO_2 emissions that add to the Green House Gases increasing global warming have also been undertaken (Maddison et.al[51], 1996). Krupnick[52] (1997) has made a cross-country analysis using Global Environmental Monitoring System (GEMS) data for SO_2 and SPM levels. Button and Verhoef[53] (1998) in their analysis of Pigouvian taxes concentrated on road pricing as a possible solution for various externalities.

Goodwin[54] (1994) pointed out that, the enormous growth in traffic volumes over the course of this century could not possibly have occurred without a huge amount of road building. In the United States, the huge investment in the inter-state freeway system since the 1950s was clearly a factor in producing the present automobile oriented urban transport patterns in that country. Recently there has been much study of the issue of getting the prices right, which focuses on internalizing costs of transport including social and environmental costs (Litman et.al[55], 1996). Downs[56] (1992) pointed out that expanded road capacity influences travel patterns in both time and space in such a way that peak hour congestion on expressways can never be eliminated completely through capacity increases alone.

The level of infrastructure investment for a particular mode of transport is obviously likely to influence the use of that mode. The transport infrastructure decisions that are most widely believed to have an important influence are the levels of investment in main roads and expressways and the investment in dedicated, high-capacity, public transport systems. To some extent, it may seem to be obvious that infrastructure building affects transport demand. Recent research into the phenomenon of generated traffic suggested that much of the benefit of many new roads might be swallowed up by new traffic that would not have otherwise occurred.

Many authors have discussed links between urban form and transport (the land-use) (Hall[57], 1995). The distribution of accessibility in a city, which is strongly influence by the transport system, itself influences land-use patterns. The land-use impact of a particular new piece of transport infrastructure is likely to be strongest in cities where accessibility is a scarce resource, due to lack of infrastructure or congestion. Low accessibility by motorized vehicles (due to congestion and low-quality transport links) seems to be a feature of large parts of low and middle-income Asian cities. Therefore, transport patterns and infrastructure will probably be strong influences on urban development patterns, even in the absence of active land-use planning measures.

Another widely recognized factor influencing urban transport patterns is the level of relevant prices, especially of fuel and of private vehicles and their use. It is widely held that such prices are a crucial influence, especially in the long term. Singapore offers a spectacular and widely known example of a place, which has explicitly raised the price of owning and driving cars in order to prevent an unmanageable rise in traffic. Figueroa and Dolan[58] (1993) placed a high emphasis on fuel prices. Others focused on other car-related prices, such as parking charges. Some of this literature includes discussion of changing the balance between fixed costs and variable costs in order to make consumers more aware of the true costs of their travel and to level the playing field between public and private transport.

Zahavi [59] (1976) and Thomson [60] (1977) highlighted some of the connections of density and urban form with urban transport in low-income or middle-income cities but subsequent debate has almost totally ignored these aspects. Linn [61] (1983) mentions the importance of density as one of the three main influences on car use (along with motorization level and income). However, like the World Bank 1980s Transport Policy Review (World Bank [62], 1986), Linn does not go on to consider density as a relevant factor when discussing policy. Neglect of the urban form and density dimension may be partly because previous data on density in low-income and middle-income cities have been scant or misleading.

Discussions on transportation cost are also relevant at this context. Keeler [63] (1975) compared commuting costs of automobile, bus and rail in the San Francisco Bay area. It includes marginal congestion costs, public services, noise, air pollution, facilities, accidents, parking, and user costs. Hanson [64] (1992) identified external costs of urban roadway transport and described costing methods. It also includes recommendations for better calculating external costs, incorporating costs into user prices, and applying least-cost planning to transportation. MacKenzie et.al[65] (1992) studied U.S. motor vehicle costs, which included roadway facilities and services, parking, air pollution and security costs of importing oil, congestion, traffic accidents, noise, and land loss.

Kageson[66] (1993) estimated pollution, crash and infrastructure costs in European countries. Similar estimates are made for other countries. Miller and Moffet[67] (1993) attempted to quantify total costs for automobiles, buses, and rail transport in the U.S. Apogee Research[68] (1994) estimated user, accident, congestion, parking, road facilities and services, air pollution, water pollution, energy, and noise costs. Urban sprawl and aesthetic degradation were mentioned but not estimated. Federal Railroad Administration[69] (FRA, 1993) described various motor vehicle social costs. It includes two charts that describe taxonomy of costs and mitigation strategies.

California Transportation Energy Analysis Report[70] (CEC, 1994) attempted to fully evaluate the economic and environmental costs of petroleum use, and the economic and environmental costs of other transportation fuels. Environment Protection Authority[71] (EPA, 1994) discussed external cost implications, costing methods, and estimates some costs. Office of Technology Assessment[72] (OTA, 1994) provided a comprehensive analysis of transportation costs and their economic and environmental impacts. IBI Group[73] (1995) estimated costs for truck, rail, automobile, public transit and air travel in Ontario, Canada and reviewed cost estimates from previous studies to evaluate potential measures to encourage sustainable transport.

Black et.al[74] (1996) provided a framework for comparing highway, bus and rail projects. They discussed the economic efficiency and equity implications of roadway transport externalities and developed estimates of external costs in the U.K., including air pollution, noise, congestion, roadway facility costs, and accident costs. Federal Highway Cost Allocation Study[75] (FHWA, 1997) concerned with whether various motor vehicle categories are charged according to the costs they impose on the highway system. Zegras and Litman[76] (1997) analyzed the Full Costs and Impacts of Transportation in Santiago de Chile remarked that although automobile ownership is relatively low compared with developed countries, rapid (10% annual) growth in vehicle ownership imposes considerable medium-term costs in terms of increased congestion, facility needs, pollution, etc. The reason behind this is Chile imports most vehicles and fuel, increased automobility also imposes macroeconomic costs. Souza and Fisher[77] (1997) developed estimates of various costs for comparing investment alternatives. Ellwanger[78] (2000) provided estimates of external costs for Car, Bus, Rail, Air and Water-way transport (passenger and freight) based on four previous European studies.

Banfi[79] (2000) developed estimates of environmental and non-environmental effects, and congestion for road, rail, air and water transport modes in seventeen

European countries for 1995 and 2010. He concluded that in 2000, the total external costs for all modes combined, excluding congestion, amounted to 650 billion Euro, or 7.3 % of the GDP in Europe, up 12% since 1995, indicating a rapid increase in the burden weighing on Europe's economies and society at large. The direct causes of this increase are traffic volume growth, especially in road and air transport, and increased pollution costs. Sansom[80] (2001) compared the social costs of road and rail transport with current user charges in UK roadway. The analysis includes infrastructure, vehicle, congestion, crash, and pollution costs. The resultant analysis framework and empirical results are intending to inform policy making in the areas of charging, taxation and subsidies.

Quinet[81] (2004) compared results of 14 transportation cost studies performed in Western Europe from 1998-2003 by using regression analysis as a method to analyzes their methodologies and compares their results. It concluded that when properly applied, cost studies could provide justifiable values that are useful for economic analysis. New Zealand Ministry of Transport[82] (NZMOT, 2005) analyzed the full costs of road and rail travel in New Zealand, both passenger and freight, including estimates of external costs.

Transport Canada[83] (2003) investigated the full costs of transportation. Vermeulen[84] (2004) analyzed the social costs of various transport modes, including road and rail transport both passenger and freight) and inland shipping (freight only), in The Netherlands. Jakob[85] et.al (2006) assessed the external and internal cost of transport. It focuses on estimating the total cost of both private and public transport, using a case study for Auckland, New Zealand's largest city. The study concludes that current pricing results in economically excessive motor vehicle travel. Maibach[86] (2008) provided a comprehensive overview of approaches for estimating external transport costs for policy and pricing analysis. It provides best available input values for such calculation and default unit values of external cost for different traffic situations (e.g. air pollution cost of a vehicle in Euro per kilometer). Land Transport New Zealand[87] (2006) outlined comprehensive standards for economic evaluation of transport infrastructure projects and transportation demand management strategies.

Clarke and Prentice[88] (2009) evaluated transportation pricing efficiency in Australia. It discusses various economic principles related to efficient prices and taxes, estimates various transportation-related external costs, evaluates the efficiency of current pricing and taxes, and recommends various reforms to help to achieve transportation planning objectives. Park[89] (2009) estimated the household expenditures on transportation in South Korea during 2007 totaled 11.4% of GDP, and external transportation costs like congestion delays, accident damages and pollution emissions etc. totalized 5.4% of GDP. The study compares Korea's transport costs with other countries, and indicates changes over time.

Swiss Federal Office of Spatial Development[90] (Swiss ARE, 2005) estimated the various transportation costs, including accidents, noise, building damages, environmental damages like air pollution, climate, natural and landscape damages and traffic congestion on the basis of accident statistics, pollutant or noise emissions and aerial photo analysis. Transport Canada[91] (2008) analyzed the costs in various ways, including by activity like local passenger, intercity passenger and freight transport, by province and city, and per passenger-trip and passenger-km for various modes. The study also compared transportation costs as a portion of GDP between Canada and various other countries.

Smith et.al[92] (2009) provided general advice on the relative cost and benefits of alternatives with a focus on passenger transport in urban areas. Transmode Consultants Inc.[93] (1995) focused primarily on air pollution, particularly greenhouse gas emissions. Committee for Study of Public Policy for Surface Freight Transport[94] (1996) estimated and compared marginal costs of freight transport, including internal costs to carriers, congestion, accidents, air pollution, energy consumption externalities, noise, and public facility costs. The study revealed that the greatest external costs that are associated with urban freight distribution where congestion and high population densities.

Bjorner[95] (1999) summarized various estimates of the external costs of freight and concludes that these costs like air pollution, noise, accidents and congestion are about four times higher for one truck kilometer than for a private car. Gargett et.al[96] (1999) examined the full costs of road and rail freight to estimate the price changes that would result from full-cost pricing. Forkenbrock[97] (1999) examined the existing intercity truck internal costs and concludes that heavy truck road user charges would need to approximately triple to internalize these costs. Link et.al [98] (1999) pointed out the ways in which the costs of transport infrastructure and congestion can be calculated and allocated to different types of traffic, focusing mainly on road freight transport.

Oxford Economic Research Associates[99] (1999) investigated the full social and environmental costs of road freight, including factors such as pollution and uncovered costs of structural damage, and concludes that road freight currently pays only 70% of its full costs. Cleaner Air and Better Transport: Making Informed Choices[100] (2000) emphasized the need to make public transport attractive enough for those who currently use cars, motor cycles, and scooters and highlights the role of information technology to achieve that objective by providing quality information to users of public transport. This book highlights the fact that air in India's metropolitan cities was severely polluted and the single largest contributor to pollution is urban transport.

Santos et.al[101] (2000) estimated the environmental benefits of optimal cordon tolls in eight English towns. The study revealed the fact that cordon tolls results in a shift of the traffic from the centre of the town. ICF Consulting[102] (2001) reviewed freight transport costing and describes a comprehensive analysis tool that can capture the full benefits and costs of freight transportation improvements. Herala[103] (2003) dealt with integrating land use planning and traffic planning to promote sustainable development and how land use planning may be used as one of the means to reduce problems caused by traffic. He reveled that the growth in car-borne traffic has increased rapidly and consumes more and more land because of land-extensive structure of cities and the traffic demand between human activities.

Koop and Tole[104] (2004) discussed the importance of model uncertainty for accurate estimation of the health effects of air pollution and demonstrates its implications in an exercise that models pollution – mortality impacts using a new and comprehensive data set for Toronto, Canada. This paper used time series data to estimate the health effects of air pollution in a large metropolitan city. Vermeulen[105] (2004) analyzed the social costs of various transport modes, including road and rail transport both passenger and freight in Netherlands. They discusses cost categories, the magnitude of these costs, the share of the costs borne directly by user groups, and the extent to which existing pricing is efficient. Hossain et. al[106] (2005) presents the various aspects of traffic accidents in Khulna city in Bangladesh. The analysis revealed that pedestrians are the largest victim group of fatalities and injuries. They concluded that these problems could be minimized largely by providing round hump to slow down the fast moving vehicle.

Gorman[107] (2008) evaluated truck and rail freight social costs like congestion, safety and pollution and investments and found out that estimates that governments currently spend $18.7 billion annually on roadways to accommodate trucks, 24% of which is subsidized not paid by users, and that public investments in rail would be more cost effective overall. Piecyk and McKinnon[108] (2007) estimated the total infrastructural, environmental and congestion costs attributable to U K registered heavy goods vehicles. They also summarized the costs of vehicle ownership and operations, infrastructure ownership and operations including land opportunity costs, congestion, accidents and environmental damages for freight transport activity

Daley[109] (2009) posed the question of whether air transport is an effective tool for sustainable development, or whether it simply reinforces existing patterns of economic interest and political hegemony. Bakker and Huizenga[110] (2010) pointed out that in order to meet long-term climate change mitigation objectives, emissions cuts are required in all regions across the globe and in all sectors, including transport. They concluded that climate-funding needs to be align closely with domestic and multilateral development finance flows in order to make a difference for sustainable transport.

Government Accountability Office[111] (GAO, 2011) indicated that truck freight transport tends to generate significantly more costs like infrastructure, air pollution, accidents and traffic congestion etc. that are not passed on to consumers than rail or water freight transport. It estimated that costs not passed on to consumers were at least six times greater for truck than rail and at least nine times greater than waterways costs per ton-miles of freight transport. They identified that most of these costs were external costs imposed on society.

1.2.2 Studies on Urban Transport in Indian Context

Studies on evolution of transportation system in different countries and the role they have played in the economic development of the respective nations provide rich insights in retrospect. Such studies are also of immense practical use in prospect since they form the basis for perspective planning in transportation and development efforts undertaken by the underdeveloped countries.

In the case of India, there has been very limited theoretical or empirical work investigating the dynamics of urban transport problems. We review some of the important works. Mathew[112] (1964) emphasized that the efficiency of the transport Industry as a whole is determined by organizational considerations in the context of unit sizes. He opined that, transport, being a public utility industry, are regulated by Government policies in many ways, of which some have a direct or indirect impact on the evolution of size. Halder[113] (1967) extensively studied Calcutta's traffic problem with focus on Calcutta State Transport Corporation and evaluated performance of it for the period of 1964 to 1973. His special contribution lied in applying Linear Programming Model to the problem of efficient allocation of buses on different routes. Kalyanaraman and Sehgal[114] (1968) examined a few methods for estimating future road traffic by advocating two methods, viz., mechanical and analytical. The mechanical methods simply project forwards the past trends assuming that future experience is direct function of past experience, whereas analytical methods classify and analyze the several related components or factors that have caused the historical trend pattern.

Satyanarayana[115] (1971) observed that the cost of service of road transport depend upon the size of the fleet, the vehicle condition and the length and road condition. His study attempted to find out the inter-relationship between these factors based on the data collected from a reprehensive sample of motor vehicle operators in Andhra Pradesh. Singh[116] (1973) observed in her study that in India, the operating ratio (revenue-expenditure) is always above 100 for rail and less than 80 for road transport. She recommends a well-coordinated road transportation system based on such factors as assessment of demand for roads on vehicle requirement, distance from main roads, coordination of local bodies, land surfaces regional development and employment considerations. Sharma[117] (1976) in one array of questions fundamental to effectiveness in any social service, probes the questions: what are we trying to do not only today but for tomorrow and next year and for the unforeseeable future? How do we best use the talents of our staff and how should they be rewarded? Instead of talking about our duty to the passenger, can we find out how to get him across Delhi at lowest costs in both time and money?

Patnakar[118] (1978), with the help of a case study on Bombay, showed the superiority of an effective mass transportation system as a viable and optimal alternative and recommend public transport as against private transport. Khan[119] (1980) presented a broad outline of the network of transport system in India. He covered a wide range of information falling within the broad sphere of the subject matter of transport management.

Central Institute of Road Transport[120] (CIRT,1982) identified the problems of interest burden, constraints on increasing fare and leakages of traffic revenue and traffic management as major problems in the way of effective management of State Transport Undertakings and made some practicable suggestions. It examined the Passenger Road Transport in India, advocated for a direct exchequer subsidy to urban transport undertakings in view of the social benefits that they extend. Balasubrahmaniam[121] (1981) revealed that ever-increasing traffic resulting in road congestion, accidents and high operational cost for the vehicles is faced not only by India but by many foreign countries too.

Maunder[122] (1982) studied the problems and prospects of State Transport Undertakings in India. He concluded that the performance of company form of organization was better on almost all-important counts. He recommended that immediate relief of at least sixty percent in tax, and provision for regular revision of fare at an interval of two years, failing which provision for subsidy. In two comparative studies, one contrasting two socio-economic groups and another contrasting two suburban localities (Maunder et.al[123], 1982) in Delhi in relation to the demand of public transport, the authors have analyzed the factors effecting trip rate and pinpointing the specific problems of low income households.

Patankar[124] (1983) has studied the Road Passenger Transport in different dimensions since 1950s and analyzed the operational productivity and efficiency of STUs for the period 1973-74 to 19979-80. He opined that the future of road transport sector in India would brighten only with productivity oriented planning. Maunder[125] (1985) analyzed three medium sized cities, Jaipur, Vadodara and Patna with respect to the provision of public transport facilities and the demand for public transport services. Srivastava[126] (1987) presented the historical development of various modes (air, water, road and railways) of transport in India. He has analyzed the effect of efficient, cheap and well-coordinated development of transport system on Indian economy. Bagade[127] (1988) has suggested a model for rational fare which is applicable in different operating conditions, constraints and limitations and takes care of economic viability of State Transport Undertakings and affordability of fare to common man.

Patnakar[128] (1989) analyzed the modal splits, declining public transport provision etc. in various Indian cities and attempts to formulate policy guidelines regarding urban transportation. He developed a system dynamics based model for Delhi's urban transport system and examined the impact of several policy options on fuel consumption and traffic congestion and implicitly the environmental issues.

Baig et. al[129] (1990) pointed out that transport provided both backward and forward linkages to the economy of a region or a State or a country. Padam[130] (1990) discussed in detail, the history of bus transport in India, various forms of organizations in State Transport Undertakings, its management and performance by way of comparison from 1970-1980 in Andhra Pradesh, Maharashtra, Gujarat and Karnataka State Road Transport Corporations. He also identified the problems in performance. Swamy[131] (1993) reviewed the existing transportation scenario in Ahmadabad city and explore alternative measures to improve the situation. With the help of a detailed modeling exercise, implications of these strategies for the bus system have been analyzed concluding enhancement of trip serviceability as the most effective option. Kulkarni[132] (1994) has devoted his attention to the organizational and administrative aspects in road transport. He has also discussed the personnel and administration, and after a detailed description, has given suggestions for bringing about improvements in the areas of recruitment, selection and training.

Kulshrestha[133] (1994) selected a new area of study in the State Road Transport Undertakings. He explains that as the public sector transport has been facing competition with other means of transport and from the private operators, bus station management is important. He throws light on the bus station management and offers some practical ways and means to improve the conditions.

Johnstone[134] (1995) described a model of passenger demand, energy consumption and pollution emissions in the transport sector. The study showed that transport sector is one of the most energy and pollution-intensive sectors in the economy. Vijayaraghavan[135] (1995) highlighted that the criticism of SRTUs has become more transparent with the recent policy changes. He showed that the SRTUs in India are not really competing well in an industry, which is becoming more and more unstable. He suggests competitive types of strategies emphasizing the importance of service marketing approach.

Bhagat[136] (1997) reviewed the conceptual issues regarding the relationship between population and environment. The result revealed that the preponderance of economic variables vis-a-vis population variables in explaining the level of greenhouse gases at the cross-country level. The transportation and constructive requirements of increasing urbanization are also reflected in the positive association between percent urban populations with percapita CO_2 emissions.

Rao[137] (1997) in a study of Vishakhapatnam have documented various characteristics of the city including geographic, demographic and economic characteristics which have a bearing on the urban transport. Padam[138] (1998) traced the history of bus transport in India. Patil[139] (1998) attempted to study various facets of urbanization and regional development in the framework of the present conditions and future needs in India. The paper suggests a dynamic approach towards regional development strategy in India. Ramachandraiah[140] (1998) analyzed the rising air pollution levels as a consequence of growing number of vehicles in the twin cities of Hyderabad and Secunderabad, based on data obtained from various secondary sources.

Rajeswari[141] (1998) examined both the financial and social performance of Andhra Pradesh State Road Transport Corporation both at the state and regional levels. Particularly she dealt with the pricing policies of the transport service as implemented by the corporation. Kulkarni[142] (1999) dealt with the urban transportation problems in big cities, also has done a critical analysis of existing public transport organizations and the constraints and restraints for their growth and stability, using operating ratios as parameters for physical performance and cost of operation per bus per km as parameter for financial performance.

The study by Ramanathan[143] (1999 and 2000) across metropolitan cities in India showed that the number of vehicles in a city is likely to grow approximately along an S-shaped pattern as the city size increases. As the city size increases and if the existing transport network is enough to meet the demands, the number of vehicles tends to grow slowly until the city reaches certain critical size. Once the critical size is reached, the city witnesses a rapid rise in its vehicular population due to increasing level of income resulting from high level of economic activity in the city.

Ramanthan and Parikh[144] (1999), in their attempt to forecast the passenger traffic and freight traffic in India predicted that it will grow at more than eight percent and five percent respectively per year during 1990-2010 resulting in an equivalent increase in the energy consumption and CO_2 emissions. They also argue that modal split in favour of public transport modes (rail and public road transport) will bring about forty five percent reduction in energy requirements and CO_2 emissions.

Mishra[145] (2000) discussed measures including traffic restraint policies, ring railway etc. to relieve the congestion on Delhi's roads. Reddy[146] (2000) while analyzing the trends in passenger transport in Mumbai observed that the well- developed rail and bus transport system places the city in a better position in terms of vehicle density, energy intensity and vehicular emission compared to Bangalore. In 1993, he has undertaken a detailed study on transport in Bangalore, but the emphasis was mainly on energy implications of urban transport. Majumder[147] (2003) observed the regional aspects of distribution of infrastructural facilities in India. Principal Component analysis is used to construct composite indices for each of the groups of variables based on secondary data.

Verma[148] (2004) made a comprehensive study using system dynamic modeling to examine policy options to contain emission levels in the context of Delhi's urban transport system. He developed a number of useful model parameters through a causal loop diagram and structures the problem in terms of vehicle fleet, fuels, and pollutants considered by the policy experimentation. Vehicle composition has categorized into seven modes and eighteen technologies.

Kaur[149] (2006) examined the growth and structure of infrastructure sector in Punjab and revealed that when a country moves from low income to middle income category, the relative share of power, telecom, and roads tends to increase , while irrigation and railways decrease. The study attempted to analysis the growth, direction, structural transformation in the infrastructural developments by using secondary data analysis as methodology. Bergh and Vanden[150] (2007) studied the factors governing success and failures in innovative projects in area of sustainable transport. Bhaduri[151] (2008) attempted to study the growth and impact of vehicular population with particular reference to personalized transport in the mega cities of India and concluded that urban transport systems in Indian cities can become sustainable and provide mobility with minimal adverse effects in the environment only if safe and affordable transport for all sections of people is made available.

1.2.3 Studies on Transport in Kerala Context

Shaheem[152] (1995) pointed out that public transport system plays a vital role by providing cost effective and energy saving means of transport. He deals with the problem of the heavy loss faced by KSRTC in Kerala and suggested renewal and upgradation of the public transport system by selecting appropriate public transport vehicle mix.

NATPAC[153] (2001) highlighted that there has been a steep upswing in the number of vehicular accidents as well as fatalities in the state after 1998. The growth of two wheelers accidents in the state doubled in the last three years from 1998 onwards. It has doubled from 7,230 in 1998 to 14,024 in 2000, a rate of increase that have never been remarked anywhere else in the country.

Ramavarman[154] (2005) spelled out that vehicle-to-vehicle conflict as a major reason for the traffic problems in cities. Also the vehicle-to-capacity ratio in certain points of the city is as high as the number of vehicles flowing through such areas is double the road capacity. He suggested Innovative ways to spread out the traffic as it was the only immediately available solution.

Deepthi and Ganesh[155] (2010) examined the accident-prone zones within Kannur district, and identified that crux of the problem of urban transport is congestion of traffic. Heterogeneity of traffic, number of trips, increased journey time, travel cost etc are problems that causes severe congestion.

Elangovan[156] (2011) argued that in a fast growing city like Kochi, an ideal mode of public transport must make efficient use of road space and reduce air and noise pollution. Ramakrishna and Mohammed[157] (2011) remarked the need for an integrated public transport system and suitable road development plan for Kochi City. They proposed to restore gridiron pattern within the city by widening the major travel corridors as well as to develop ring and radial type road network outside the city, to enhance the network connectivity.

1.2.4 Conclusion

To sum up, studies in the aforesaid discussion emphasized existing transportation scenario, efficiency of the transport, forward and backward linkages of transport, traffic problem, the cost of service of road transport, effective mass transportation system, financial and social performance, organizational and administrative aspects in road transport, economic and social characteristics of public and private modes, transportation demand management and road pricing, safety problems, environmental problems, pricing policies of the transport service, studies that make projections on vehicle growth, the problems of political and social feasibility of environmentally friendly transport policies, estimating future road traffic etc.

Thus, a review of existing literature, which is made as a prelude to the present study, revealed that meaningful studies have not been made so far at the district level. It is evident from the above review that the problem of urban transport is a multidimensional one. However, studies focusing on the environmental issues of urban road transportation in cities are scarce. In the context of developing countries, studies on urban transport are few. It is important to look into the patterns emerging in developing country cities as they are expecting to be significantly different from the developed country growth patterns. There are hardly any cross-country analyses. In the case of India, most of them were case studies. Such a conspicuous absence makes our analysis more relevant and hence, it is felt desirable to make an effort to fill the gap, at least partially. The present study can be considered as one among the many bricks that will be required to bridge the gap between the research needs and research efforts made so far. In the present context, we are limiting ourselves to the study of environmental issues of urban road transport systems.

1.3 STATEMENT OF THE RESEARCH PROBLEM

Protection of the environment has to be a central part of any sustainable inclusive growth strategy. This aspect of development is especially important in the eleventh and twelfth plan, when consciousness about the dangers of environmental degradation, has increased greatly. More recently, the issue assumed special importance because of the accumulation of evidence of global warming and the associated climate change that it is likely to bring. There are mainly three factors responsible for this issue: Global Warming, Acid Rain and Ozone layer depletion. Transport is one of the main factors responsible for this.

Adequate, reliable and economic transport is essential for the economic and social development of a nation. When transport systems are efficient, they provide economic opportunities and benefits that resulted in positive multiplier effect. When transport systems are deficient in terms of capacity or reliability, they can have economic and environmental costs. Due to the problems of congestion, limited road space, high volume of traffic, longer journeys on the road, different speed of various modes, increasing trend of personalized modes, absence of improvement in city buses, inadequacy of parking facilities, health hazards, inability to cater exponential growth of population etc. urban transport is a pressing concern in Cities. The transport sector accounts for about twenty-five percent of total commercial energy consumed Worldwide, and consume approximately one-half of total oil produced. Transport sector's energy consumption and greenhouse gas emissions will likely be doubled by the year 2025. Its emissions include Green House Gases, most notably CO_2, as well as particulate matter, lead, nitrogen oxides, sulfur oxides and volatile organic compounds all of which have negative externalities. Pollution from motor vehicles produces about one-fifth of the incremental Carbon Dioxide in the atmosphere arising from human activity [which potentially contribute to global warming], one third of the Chloro Fluro Carbons or CFCs [which contribute to depletion of Ozone layer], and half of the nitrogen oxides [which contribute to continental scale Acidification and ecological damage].

In the report entitled 'Mobility 2030: Meeting the Challenges to Sustainability', the World Business Council for Sustainable Development (WBCSD) estimated that Worldwide transport related Green House Gas emissions will increase from 6 Giga-tones of CO_2 in the year 2000 to over 14 Giga-tones by the year 2050 (WBCSD, 2004). Light-duty vehicles are responsible for the majority of emissions, while freight trucks and air transport are the second and third greatest emitters respectively. In addition, it is associated with adverse noise and land use impacts.

Demand for transport services expected to grow considerably as economic growth occurs in developing countries, incomes rise, the trend toward urbanization continues and as the process of globalization moves forward with expected increases in World trade. Between now and 2020, demand is forecasted to grow by 3.6 percent per year in developing countries and by 1.5 percent per year in industrialized countries. Moreover, urban transport is increasingly being seen as a peril to the sustainability of the global ecology. Motor vehicles are the dominant source of the emissions. It accounted for more than three quarters of the transport sectors contribution did to global air pollution. Transport of hazardous materials through roads causes air and water pollution too.

The problem of traffic accidents and congestion in urban roads is being viewed with a greater concern in the recent years. This vehicular congestion lead to significant environmental issues like noise, vibration, air pollution, visual intrusion, accidental experiences, dust and dirt, pedestrian journeys. This vehicular emission and congestion is a threat to sustainability of environment.

Transport and the environment are paradoxical in nature. From one side, transport activities support increasing mobility demands for passengers and freight, and this ranging from urban areas to international trade. On the other side, transport activities have resulted in growing levels of motorization and congestion. As a result, the transport sector is becoming increasingly linked to environmental problems. Thus, there is a challenge to balance the seemingly conflicting interest between concerns for the environment on the one hand and the economic growth on the other. Decisions taken to meet this demand are often long-term in nature and those today will affect our ability to achieve sustainable future in years to come. The absence of any attempt to reconcile the city and the vehicles has aggravated the conflict between the desire for mobility and the deleterious effect of achieving sustainability.

There is a growing awareness of the importance of the transport sector to efforts aimed at protection of environment and achieving sustainable development. Thus the scope of the problem under study covers how much fuel we are using and how much emissions we are causing, what is the trend of vehicles growth and how much is the accidental scenario.

1.4 OBJECTIVES OF THE STUDY

In a developing economy like India, road transport deserves a high priority, as it forms the backbone of the passenger mobility system and it is the principal carriers across the Country. Even after five and half decades of nationalization, passenger mobility suffers both in volume and in quality because the supply of road transport facilities is not keeping pace with rising demand. In this background, the general aim of the study is set, as to work towards unearthing the prospects and problem of urban road transportation (both passenger and freight transport). Specifically, the study would focus towards the attainment of the following objectives:

1. To review the trend and pattern of urbanization and urban road transport in national and regional context.
2. To explore the vehicular mobility in Ernakulam District.
3. To measure the extent of emission of air pollutants from motor vehicles in Ernakulam District.
4. To examine the Supply of non- renewable motor vehicle fuels in Ernakulam district
5. To analyze the extent of the road accidents in Ernakulam district

1.5 DATA SOURCES AND METHODOLOGY OF ANALYSIS

Any serious attempt on economic problems is pertinent only when it has some policy implications that deeply touch the life of humanity in general. It is the problem selected, analyzed objectives, methodology adopted, the area of study and the statistics applied, makes the conclusion of the study relevant to policy makers.

The proposed study intended to cover the road transport (both Passenger and Freight transport) in Ernakulam district. Relevant data for this research collected from both primary and secondary sources. For analyzing the vehicular mobility in Ernakulam district, the data collected from Regional Transport office, Kakkanad, and Sub Regional Transport Office, Mattanchery. To measure the in-use vehicle emission in four-selected location of Ernakulam district (Angamaly, Aluva, Kothamangalam, Kochi), Traffic Volume Survey of seven days in each stations conducted. For examining the road accident in the district, data collected from the RT offices of Kakkanad and Mattanchery. For estimating the petrol and diesel supplied in the district, the data obtained from the State level offices of Indian Oil Corporation, Bharat Petroleum Corporation, and Hindustan Petroleum Corporation (All these data are unpublished hence considered as primary data).

During the course of this study, secondary sources of data has largely used for analysis. With regard to the first objective, that is to review the trend and pattern of urbanization and urban road transport in India and Kerala, a great deal of lesson was drawn from text books, newspapers, journals on transport, various published reports and working papers like, Working Group Report on Road Transport for various Five Year Plans, Annual Reports Ministry of Road Transport and Highways, The Global Competitiveness Report, Report of Working Group on Central Road Sector (Planning Commission), Department of Transport and Highways Statistics and Road Transport Year Books. Reports of Central Road Research Institute, Central Institute of Road Transport, Association of State Road Transport Undertakings, Special Division of Planning Commission and Ministry of Surface Transport, Motor Transport Statistics of India, Reports of the Planning Commission, Kerala Economic Review, and Administration Reports of Public and Passenger transport undertakings, Basic Statistics on Indian Petroleum & Natural Gas, Report of Petroleum Planning and Analyzing Cell etc. provides relevant data. Data on population growth and urban growth has obtained from Census Reports of India.

The data on emission rate of air pollutants has taken from the Report of Automotive Research Association of India, Pune. Other sources include Ministry of Statistics and Programme Implementation-Government of India, annual publications of Central Pollution Control Board etc. In addition to this, informations derived from internet and other sources such as policy documents on transport were used.

The National Ambient Air Quality Standards (2011) was used to construct the Air Pollution Index in seven monitoring stations of Ernamkulam district. The Air Pollution Index can be determined by the following equation:

$$\text{Air Pollution Index} = \frac{1}{4}\left(\frac{SO2}{S_{SO2}} + \frac{NOx}{S_{NOx}} + \frac{RSPM}{S_{RSPM}} + \frac{SPM}{S_{SPM}}\right) X100$$

Where:

SO_2, NOx. RSPM, SPM represent the Measured Values.

S_{SO2}, S_{NOx}, S_{RSPM}, S_{SPM} represent the Annual Average Quality Standard values

Central Pollution Control Board prescribed these values. From Air Pollution Index, the sampling stations are categorized in to clean, light, moderate, heavy and severe air pollution levels based on Air Pollution Index Values:

Standard Air Pollution Index Values

Air Pollution Index Values	Air Pollution Index
0-25	Clean Air
25-50	Light Air Pollution
50-75	Moderate Air Pollution
75-100	Heavy Air Pollution
>100	Severe Air Pollution

Bottom-up approach was adopted for estimation of Gaseous and Particulate emission based on Annual Average Utilization for different vehicle category, number of registered vehicles and the corresponding emission factors. Emissions from road were quantifies based on the number of vehicles and distance travelled in a year per different vehicle type, which is given by:

$$\mathbf{Ei = \sum (Vehj \times Dj) \times Eij\ km}$$

Where; Ei = Emission of compound;

Vehj = Number of vehicles per type;

Dj = Distance travelled in a year per different vehicle type;

Eij km = Emission of compound (i) from vehicle type (j) per driven KM

Annual utilization of Buses, Omni Buses, Two Wheelers, Light Motor Vehicles (Passenger), Car and Jeeps and Taxi were assumed to be 100000 km,100000 km, 63000 km,33500 km,12600 km and 12600 km, respectively (Buses, Two-Wheelers, Cars and Autorickshaw). Similarly for Trucks and Lorries, Light Motor Vehicles (Goods), and Trailers and Tractors were assumed as 25000 to 90000 km, 63000 km and 21000 km/ year respectively. These values were assumed based on Five Year Planning reports of India. For other section of vehicles, annual utilization of vehicles calculated on an average of all the above values. In-use vehicles emission also, estimated by using the same approach. Traffic Volume Study for Seven days was conducted as per the Indian Road Congress Guidelines (04-05-2013 to 10-05-2013) at both upward and downward direction of four locations in Ernakulam district (Angamaly, Aluva, Kothamangalam and Kochi) in order to get the total number of in–use vehicles at each location (to measure the existing vehicle population). The categorized survey was carried out for a period of seven days of 24 hours at the four stations. The emission factors according to fuel types and category of vehicles for Indian vehicles established by the Automotive Research Association of India (ARAI) used for finding the emissions of different categories of vehicles. Analytical and statistical techniques used for interpretation and data representation like graphs, diagrams, percentages, growth rates like Average Annual Growth Rate, Compound Growth Rate, Exponential Growth Rate, Estimation of future values (Regression) etc.

1.6 TERMS AND CONCEPTS USED

1. **Environment**

   The Environmental Protection Act, 1986 defines environment to include, "water, air and land and the interrelationship which exists among and between water, air and land, and human beings, other living creatures, plants, microorganisms and property".

2. **Sustainable Development**

   According to the UN, sustainable development means, "meets the needs of the present without sacrificing the ability of future generations to meet their own needs."

3. **Transport/Transportation**

   (Same meaning but as per the British dictionary and American dictionary) Transport means the movement of people, animals and goods from one location to another. Transport infrastructure consists of the fixed installations including roads, railways, airways, waterways, canals, pipelines and terminals like seaports, railway stations, bus stations, warehouses, trucking terminals, refueling etc.

4. **Environmentally Sustainable Transport**

   Transport does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes. Sustainable transports have the capacity to support the mobility needs of people, freight and information in a manner that is the least damageable to the environment.

5. **Externality**

   An externality is that situation in which the actions of one agent impose a benefit or cost on another who is not party to a transaction. Externalities are the difference between what parties to a transaction pay and what society pays. It is the costs or benefits generates by a system.

6. **Pollution**

   Pollution means the presence of undesirable substance in any segment of environment, primarily due to human activity discharging by-products, waste products or harmful secondary products, which are harmful to man and other organisms. But it should be borne in mind that even in natural state no environmental components is pure in the scientific sense, there being several admixtures and impurities, but they are insignificant and do not cause appreciable harm.

7. **Air pollutants**

   Air pollutants is the presence of undesirable substance in any segment of environment primarily due to human activity discharging by products or harmful secondary products which are harmful to man and other organisms.

8. **Road Accident**

   A road accident refers to any accident involving at least one road vehicle, occurring on a road open to public circulation, and in which at least one person is injured or killed.

1.7 LIMITATIONS OF THE STUDY

The research study has the following limitations:

1. The Environment Protection Act, 1986 defines environment which includes, 'water, air and land and the inter relationship which exists among and between water, air, land and human beings, other living creatures, plants, micro organisms, and property'. However, here the study takes into account only air pollution and its impacts in relation to road vehicles.
2. Chapter eight of this thesis focused on road accident analysis. In this context, the term 'environment' was used to describe the effect of transport up on the surroundings.
3. This study provide glimpse of the present performance and the future conclusion may not be fully correct since several other factors may affect the future happenings.

1.8 CHAPTER DESIGN

The study, 'Environmental Issues of Urban Road Transport in Ernakulam District', presented in nine chapters. Chapter one, 'Design of the Study' deals with Introduction, Review of studies on urban transport, Statement of the research problem, Objectives of the study, Data sources and Methodology of analysis, Terms and concepts used, Limitations of the study and Chapter design. Chapter two, 'Economics Transport: An Overview', discussed the theoretical background of the study. It examines various Theories related to transport and environment, Environmental protection: worldwide agreements, India's environmental policy for sustainability, Sustainable development concept, Sustainable transport concept, International movements for sustainable transport and Environment and transport-focused activities of international institutions. Chapter three, 'Linkages Between Economic Development, Urbanization and Transport Development', provides a glimpse of the Link between urbanization and economic development, Transport and urbanization, Virtuous circle effects of transport in economic development, Urban transport problems, Interlink between transport and environment, Environmental impact of transport and urban air pollution in India. Chapter four, 'Urban Road Transport Network in India: An Exploration', presents an outline of the World urbanization trends, Trends of urbanization in India and Kerala, Comparison of urbanization in Ernakulam with national and state scenarios, Infrastructure investment in India, Global scenario of the development of transport, Means of transport and transport systems in India, Vehicular mobility in India and Kerala and Road transport development in Kerala. Chapter five, 'Road Transport in Ernakulam District', focused on an overview of the Profile of Ernakulam district, History of Kochi, Background to Kochi Corporation, Urban transport in Ernakulam district, Public Transport in Kochi, Financial outlay of traffic and transport in Kochi, Vehicular mobility in Ernakulam and Kochi. Chapter six, 'Vehicular Emission: The Case of Ernakulam District', explains the Air pollution from motor vehicles in India, trend of ambient air quality status of different stations in Ernakulam district, Measurement of Air Pollution Index, Registered motor vehicles emission in Ernakulam and Kochi and In-use motor vehicles emissions in selected locations of Ernakulam district. Chapter seven, 'Motor Vehicles Fuel Consumption in Ernakulam District', estimates Petroleum consumption in India, Review of consumption of petroleum products in Kerala and Petrol and diesel consumption in Ernakulam district. Chapter eight, 'Road Accident in India: An Account', analyses Factors causing road accidents, Cost of road accidents, Road accidents in India, Road accidents in Kerala and Ernakulam district. Chapter nine, 'Summary, Findings and Policy Initiatives', outlines the Summary of the study, Major findings of the study, policy Initiatives and Conclusion.

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CHAPTER - 2

ECONOMICS OF TRANSPORT: AN OVERVIEW

2.1 INTRODUCTION

The present chapter attempts to explore some theories and concepts in relation to the developmental issues of transportation and the consequential economic development in an environmental economics background. It also looks into the dimensions of how environmentalists, economists and policy makers approach the emerging concern of environmental deterioration and the various policy initiatives for the preservation of ecological balance.

Adequate, reliable and economic transport is essential for the economic and social development of a nation. When transport systems are efficient, they provide economic opportunities and benefits that resulted in positive multiplier effect. When transport systems are deficient in terms of capacity or reliability, they can have economic and environmental costs. Economic development in turn increases transportation demand and additional demand can then trigger the need for transportation improvements which in turn, decreases transportation costs and increase safety that stimulate further economic development. Thus, economic development and development of transport are interrelated.

2.2 THEORIES RELATED TO TRANSPORT

2.2.1 Views of Leading Economists

Transport developments are taking place since the beginning of industrial revolution. It is an indispensable component of the economy and place a major role in spatial relations between locations. Spatial accessibility and urban development are parallel phenomena. Because of profound changes in industrial structures and advancement of technology, modern societies tend to move towards intricate networks in which transport plays a critical structuring role (Banister, 1995). Jawaharlal Nehru rightly remarked that, *'our country needed a scientific and technological society which employs new techniques mainly in transport and industry'*. As a result of technological improvements due to industrialization, urbanization also increases, that requires infrastructure networks especially in urban areas.

Urban growth is only a byproduct of unprecedented rate of urbanization and urban population. Irma Adleman and Morris (1967) developed forty indicators of economic development, of which urbanization got the third position. According to them, as urbanization increases, it resulted in the setting up of more industries, development of means of transport etc. W.W Rostow (1960) noted that urbanization leads to increased effective demand and enlargement of market size possible through development of transport. According to Rostow, '*there is no better single yard stick than transport to measure the stages of development of a country*'. Rostow (1960), in his 'Stages of Growth: A Non-Communist Manifesto', remarked that when a society passes from traditional stage to pre-condition for take-off, economic development resulted as at this stage transport becomes cheaper and in transport sector, investment opportunities must expand. The stage of pre-condition for take-off is considered as an era for sustained growth, which is attained through expansion of Social Overhead Capital, i.e., development of transport and roads.

For determining the quantum of investments to be made for transport development, economists have developed appropriate transport planning models that indicate how much to invest in the transport sector, and where and in which mode of transport to invest the available resources for an optimal development of the transport system. There are three schools of thought; each pointing to different approaches to the role of transport in economic development. First is the 'Balanced Growth Approach' that maintains that all sectors of the economy must grow in tandem with each other; otherwise there would be bottlenecks in the economy that will curtail the growth process. Second is the 'Leading- Sector Approach', which argues that because of lumpiness and the long gestation lags associated with transport investment, transport capacity must be created ahead of demand. Accordingly, more resources need to be devoted for the provision of transport, particularly in the early stages of developmental process of a nation.

The development of transport in India during the first two Five-Year plans (1951-61) have followed the Leading-Sector Approach , with emphasizes on creating transport capacity in anticipation by transport demand (Report of the National Transport Policy Committee, 1980). Third is the 'Induced-Sector Approach', which maintains that in growth process there will always be a mismatch between demand and supply of transport capacities. Development proceeds through disequilibrium in the supply and demand of Social Overhead Capital including transport.

A.O. Hirschman (1958) in 'The Strategy of Economic Development' explained the doctrine of 'Unbalanced Growth Theory' explained the concept of Social Overhead Capital as, 'these basic services without which primary, secondary and tertiary productive activities cannot function'. Of these basic services, transport services considered as the main one. Investment in the creation and expansion of the transport services will increase trade and hence economic development. However, developed means of transport is essential for the successful implementation of unbalanced growth strategy. Hence, this strategy failed in India because of the lack of Social Overhead Capital, like developed means of transport, roads, communication, power etc. Both Hirschman and Ragnar Nurske argued that Unbalanced Growth as a means of achieving the ultimate objective of Balanced Growth. An example of this was the construction of railways in western countries.

M.Q. Dalvi (1999) in 'Transport Planning and Policy in India's rightly specified that, a growing economy needs a speedy, efficient and cheap system of transport. In a country like India the first requisite of economic development is the development of transport facilities. Road transport, particularly motor transport, by joining different parts resulting in increased demand for goods. A good road network provides every individual an opportunity to function more efficiently. Motor transport, by encouraging the growth of industries and agriculture, by fostering a balanced regional growth and by raising the overall level of consumption, ultimately brings about a rise in the living standard of people. In addition, an efficient transport system providing greater mobility, helps in intensive and extensive production, which will save foreign exchange, and this can be possible both extensively and intensively only through by securing greater mobility. An economy that possesses greater mobility brings economic development. Reduced mobility impedes development while greater mobility is a catalyst for development because it poses some kind of economic externalities that are borne not only by present generation but also by future generations. Such externalities of transport put a heavy strain on existing infrastructural facilities.

It was Clark (1957), who focused on the issue, recognized these uneasy relationships between transport and development some fifty-five years ago in, 'Transport: maker and breaker of Cities'. In a growing urban economy transportation tends to reach the limits of infrastructural capacities, resulting in various kinds of negative externalities, which prevents the achievement of economic efficiency (Kanemoto, 1980). The three major classes of negative externalities of transport are congestion, environmental decay and road safety (Shefer, 1994). Most prominent of these negative externalities is congestion.

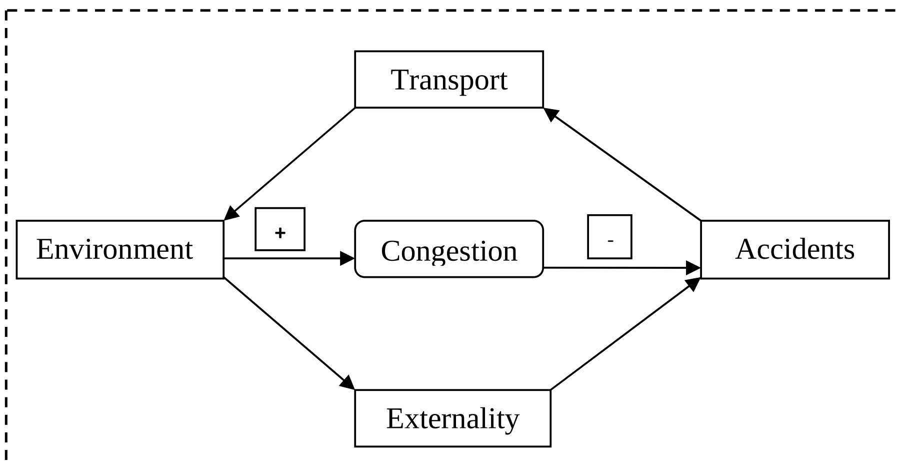
Adenle (1981) noted that traffic congestion problems becomes so manifest when measure in terms of delays, accidents, parking and maneuvering problems, that all subsumed in structural pattern in traditional areas of the cities and the unplanned growth and haphazard land use and distributions that could have been enhanced by technology.

Smith (1977) opined that an externality exists when an activity generates side effects not reflected in costs or price. Externalities can produce benefits that enhance individual well-being and costs in the form of disutility, but it is negative externalities, which attract most attention. This environmental disamenity could be serious, especially in purely residential setting because, they have indirect effects on property values, this could be serious, considering that in a purely residential, house values, and rental values play a prominent role in the allocation mechanism of transport infrastructure. Traffic congestion poses a major threat to economic efficiency and environmental pollution.

Environmental pollution caused by transport mobility has wide-ranging impacts, not only on other travelers but also on all urban citizens and on the environment large (including even global warming). These externalities are largely internal with regard to the transport as a whole. The patterns of externalities sketched concisely in Figure: 2.1 below:

Figure: 2.1

Various Externality Relationships in Transport



Environmental sustainability is now under threat due to mushroom growth in transport activities. Environmental effects of transport systems might occur in any of four stages:

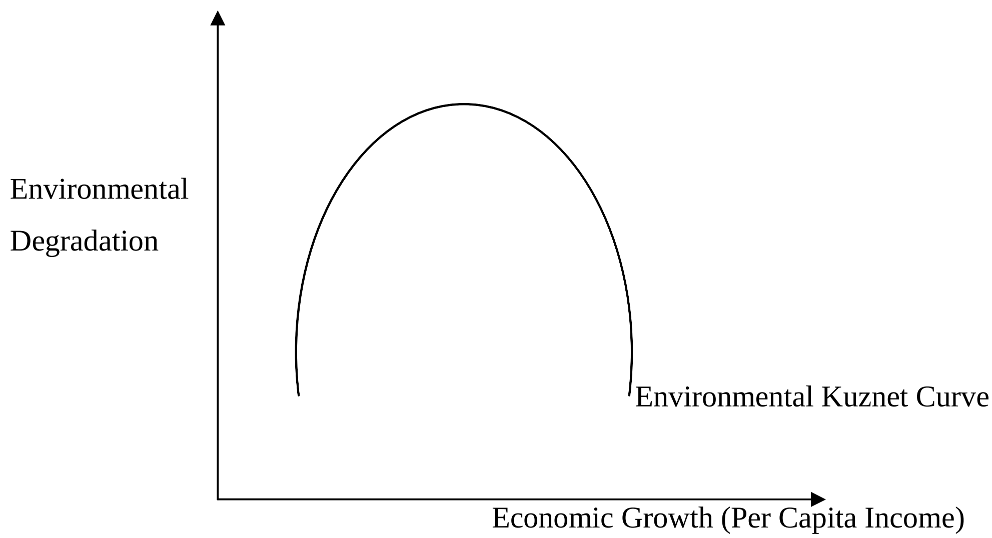
1. Production of vehicles and fuels from the extraction of raw materials through processing and manufacture, to the stage of sales.
2. Construction of the infrastructure including extraction and processing. This also includes decision on priorities in traffic.
3. Operation of the transportation system.
4. Decommissioning and disposal of vehicles and of infrastructure disposal.

2.2.2 Environmental Kuznets Curve Hypothesis

Increased transport activities require when economic activities increases and it accelerate high travel and urban metabolism. The dilemma of urban cities is that with slow economic growth and inadequate transport infrastructure, many environmental problems arises. This nature of the relationship between environmental quality and economic growth could be explained in terms of several paradigms; among these, the most important one is 'Simon Kuznets's (1955) 'Environmental Kuznets Curve Hypothesis'.

Figure: 2.2

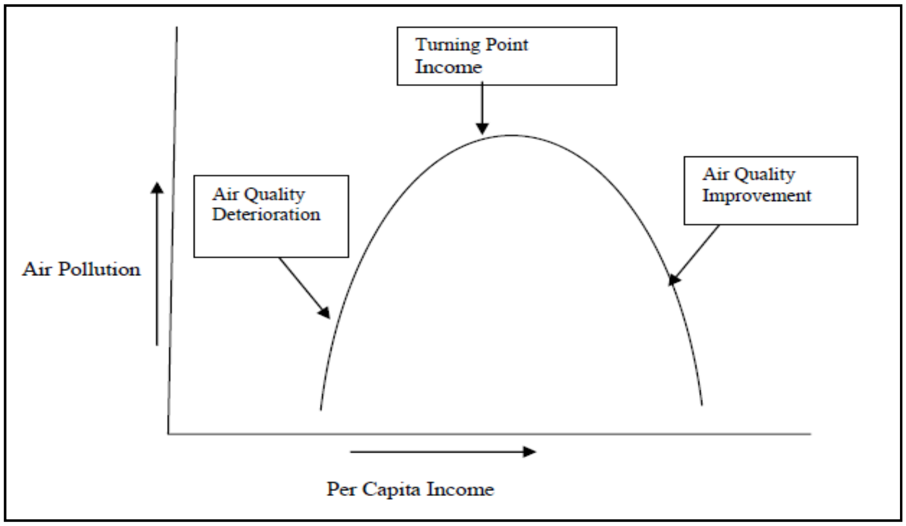
Kuznet's Environmental Curve



Kuznet's Environmental Curve suggests that the increase in economic activities would cause the environmental degradation until a point of inflexion from where environmental degradation started decreasing (Figure: 2.2 shows the same). This implies that the environmental impact indicator is an inverted 'U' shaped function of income percapita. ie, economic growth. Empirical evidence shown by the environmental Kuznet's curve supports the argument that concern for local air quality management develops as a country move along the development path. This curve (Figure: 2.3) represents a hypothesized relationship between various indicators of environmental degradation and percapita income (Per Capita Income is an index of economic development), in which pollution from transport and industry increases until development generates enough wealth to promote significant pollution control. Thus, even if pollution levels rise initially with increasing incomes, after a certain point there is improvement in environmental quality.

Figure: 2.3

Kuznets's Environmental Curve



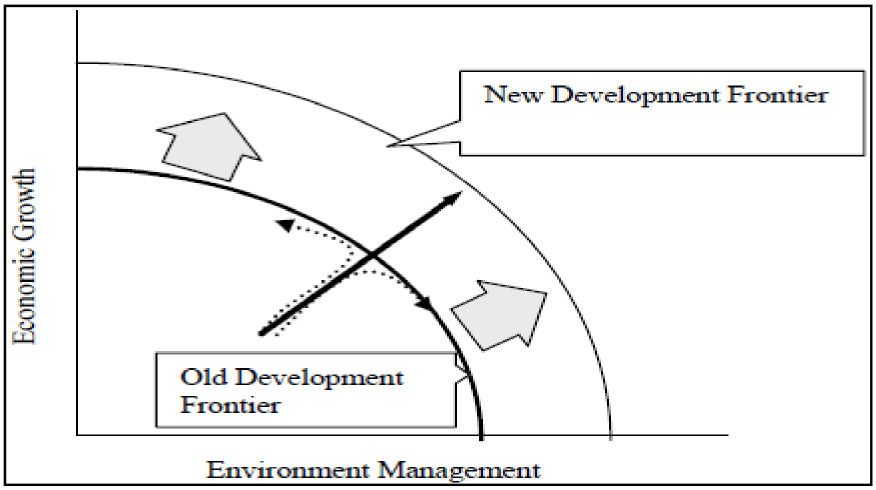
Studies have indicated the possibility that this inverted ‘U’ curve is found mainly in pollutants that have local health effects. With increasing affluence, percapita energy use rises and its structure changes away from traditional solid fuels (coal, fuel-wood, lignite) towards cleaner fuels such as gas or electricity at the point of end use. This structural shift combined with the greater emphasis on urban air quality that accompanies rising incomes results in a roughly inverted ‘U’ pattern for emissions or concentration of local pollutants. The Environmental Kuznet Curve hypothesis hold in Indian context as the environmental degradation in our country is mainly from road transport and it is the biggest emitter of atmospheric pollution. It is clear from the above description that the negative externality arises from transport sector deteriorate the fertility of environment.

2.2.3 No-Regret Option Approach

Even though economic development and environmental goals are not complementary to each other, in some cases, some sort of positive externalities generated through developmental projects that reduces the deterioration of environment. No-Regret Option would be a more pro-active approach that promotes economic growth as well as environmental protection. National policies set developmental process and major investments made on long-term infrastructure. For example, once the development process is set and major investments are made on long-term infrastructure, the environmental consequences last four decades or even centuries. If resources directed in such a way that they address developmental concerns, it have multiple dividends including positive impact on the environment. This is represented by a production possibility curve, where X-axis of it represents level of environmental management (ie, the level of emission reduction, which reflects the level of air quality) and the Y-axis represents the level of economic growth (Figure: 2.4).

Figure: 2.4

No- Regret Option Curve



Each point on the curve of the production frontier represents the maximum economic growth possible for a given level of economic activity. Therefore, when an economy is on the production frontier, there is no way to achieve further emission reduction. However, when the economy is below its achievable production frontier, there is a possibility of higher movement along ‘y’ axis irrespective of its impacts on local air quality. Therefore, in this path, targeted policies are required not only for managing local air quality but also for addressing global climate change concerns. Further movements towards a new environmental-friendly production frontier brought about through innovations, technological leap frogging and better energy resources. The superior technological alternatives provide developing countries with a window of opportunity for leap frogging developed countries in a more Sustainable Development path.

Here we highlight the case of infrastructure development to understand how policies can promote environmentally Sustainable Development. The process of infrastructure expansion also has environmental implications and could result in multiple dividends if investments directed in the right manner. For instance, if investment made for the development of transport infrastructure, including public transport systems and road infrastructure (Fly over, Bypasses, Segregated lanes etc.) that have multiple dividends by a way of reducing energy consumption due to reduced idling and wastage of fuel, reduced congestion that leads to less adverse impacts and a shift from personalized modes of transport etc. These impacts also generate positive environmental externalities, besides developing efficient transport patterns in the city. At a broader level, infrastructural designs linking urban air pollution and reduce demand for mobility. However, in some cases, the negative externalities outweigh positive externalities, and it leads to environmental problems that are long lasting and cannot be compensated.

2.2.4 Externality Theory

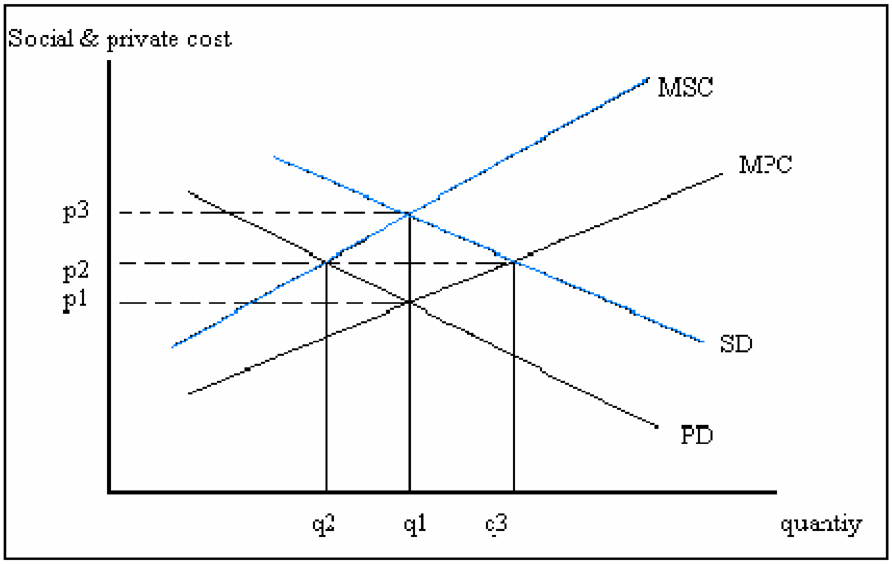
This 'Externality Theory' in Economics forms the foundation of environmental economics. The concept of externality actually originated by Marshall and it was subsequently developed by Pigou in his 'Welfare Economics' (1920), were he explains that the presence of externalities leads to inefficiencies in the free market allocation of resources that leads to non attainability of Pareto-Optimality condition of efficiency in exchange and allocation of resources. In the case of urban transport, it is partly a public good hence externality problem arises, both of them hinder the Pareto-Optimality condition of welfare so that economic growth not resulted up to the expected level. The negative externality resulted when social Marginal Cost higher than Private Marginal Cost and hence the private optimal level output will be higher than social optimal output. Pigou suggested that the imposition of a unit tax on output of the firm generating negative externality in order to correct the gap and to satisfy the condition of price equals the Social Marginal Cost.

Economic inefficiency in resource allocation would be the result of a divergence between private benefits (costs) and social benefits (costs). When negative externalities generated they should be internalized into the market economy. By internalizing i.e., by including the costs (or benefit) of the externality, environmental costs (or benefits) such as air pollution effects on human health and ecosystem, the externalities are allocated to the pollution sources and included in the economics of the activities causing the problem (e.g. industry, traffic, agriculture, energy production).

A simple illustration of the effect of internalizing positive and negative externalities shown in Figure: 2.5. In the case of a beneficial externality, assume that at marginal social cost MSC defined here as the incremental cost to society and private demand PD, the quantity produced is q2 and the corresponding price is p2. Since this production generates positive externalities, the production is expected to increase to the point where MSC equals the social demand SD i.e. q1. Observe that the price has been increased to p3 illustrating the higher willingness to pay for the product if the externalities are internalized to the market.

Figure: 2.5

Externality Theory of Environment



For the case of a negative externality, assume the production for example a polluting activity, e.g. production of cement at quantity q3 with the price p2, reflecting only the marginal private cost i.e. the additional cost to the firm producing cement. In order to reach optimality the SD should equal MSC. This is done at quantity q1 and price p3. Hence, the result is a decrease in production imposed by the corresponding increase in price, which is the result of internalizing the negative externality by way of a tax. The illustration shows the problem of negative externalities that often arise because of market and government failures.

Pigou's analysis accepted until 1960, when Ronald Coase in his 'Theory of Social Cost' examined how the assignment of some rights in the use and transition of environmental resources can be used to overcome the pollution and proposed a theorem, which is called as the Coase Theorem. It is relevant in the context of search of possible alternatives for abatement of externalities. He pointed out that inadequately defined and insecure property rights are the most important reasons for degradation and depletion of environmental resources. The environmental harm cause by motorized transport falls under the heading of a producer-upon-consumer externality. It is the result of defective-pricing system, which does not charge travelers the full social costs of their journeys.

Alfred Marshall has advocated the introduction of pollution charges to regulate externalities in production. Marshall (1890) suggested the introduction of a 'Fresh Air Levy' on polluters, the revenues of which were to be spent by local governments on air quality control. Ideally, therefore, the urban motorist would have to pay both for the costs imposed on the rest of the community. Theoretically, the latter charge known as 'Pigouvian Tax', should be calculated on the same basis as any other price. There is costs associated reducing pollution and the objective should be to equate demand for improvement with the marginal cost of undertaking it. This pollution charging policy is essential because of price, on, say, noise which leads to a reduction in the travel noise level at the same time increased other forms of annoyance. Similarly, if it is demand desirable for the local authority to construct barriers or introduced some other forms of protective policy, a full cost-benefit analysis should be undertaken to ensure that the reduction in one environmental nuisance does not simply lead to increase in others.

2.3 ENVIRONMENTAL PROTECTION: WORLD WIDE AGREEMENTS

One of the most urgent and complex challenges facing our generation is to secure a balance between Sustainable Development and environmental protection. To achieve this, countries were seeking to establish different policies and programmes for Sustainable Development. National Environmental Policy Act (1969) established in United States to promote the general welfare and fulfill the requirements of present and future generations. Environmental Protection Agency (1970) in U.S. aims to improve and preserve the quality of the environment both at the national and global level. Stockholm conference (1972), heightened awareness of the global nature of environmental problems that led to the general acceptance of the idea of Sustainable Development as a means of realizing the development needs of all people without sacrificing the earth's capacity to sustain life. United Nations Environmental Program (UNEP, 1972) was formed with a mandate to promote the idea of environmental and social development.

United Nations Conference on Environment and Development and Rio-Earth-Summit (1992) discussed environmental and developmental issues that led to the establishment of the 'Commission on Sustainable Development'. Kyoto protocol (1997) focused on carbon dioxide emissions and the problems of global warming. World Conference on Sustainable Development Called Rio+10 or Eco+10 (Johannesburg 2012) pointed out environmental protection at the local, national, international levels. Bali Conference (2007) established targets in relation to the Green House Gas emissions and solutions to global warming. Un Climate Conference (2011) held to make renovation in Kyoto protocol. In the end, the COP 17 laid the foundations of a future agreement that pollution control.

2.4 INDIA'S ENVIRONMENTAL POLICY: NEED FOR SUSTAINABILITY

Environmental quality in India has deteriorated significantly in the last two decades in spite of extensive changes in environment policy. It was only after the UN Conference on Human Environment in Stockholm in 1972 that Indian government began to install a well-developed framework for environmental protection. National Committee on Environmental Planning and Coordination (NCEPC, 1972) was formulated to advice the government on environmental problems and assess environmental consequences of large development projects. The first National Law for Pollution Control (1974) provided for the establishment for pollution control boards at the Centre and States, for the purpose of prevention, control and abatement of pollution. In 1980, Tiwari Committee recommended legislative measure and administrative machines to strengthen the existing arrangement towards environmental protection. As per the committee's recommendation, on 1981, the Department of Environment was appointed to assess major development projects and strengthens the capabilities of State governments in carrying out environmental planning, protection and review.

The Air Act of 1981 (Prevention and Control of Pollution) lay down the standards for emission of air pollutants into the atmosphere from industrial plants, automobiles. The Environmental Protection Act (1986) provided new powers to the Central Government in contrast to the decentralized approaches of the Water and Air Acts. National Environmental Tribunal Act in 1995 provided for compensation for death or injury to persons and damage to property and environment. Empowering people for Sustainable Development (EPSD, 2002) identified core sectors as transport, energy, industry because they are essential for the future growth of Indian economy and have been responsible for much of the air and water pollution in the past. Biological Diversity Act (2002) integrates the conservation, promotion and sustainable use of biological diversity. India's 9^{th} Five-Year Plan (1997-2002) explicitly recognized the synergy between environment and development and identified the need for environmental sustainability for development process. The 10^{th} Five-Year Plan (2002-2007) was a period of extensive review of environmental processes and law. The first National Environmental Policy was put into place in 2006. The 11^{th} plan (2007-12) build on this experience by integrating environmental considerations into policy making in all sectors of the economy- infrastructure , transport, sanitation etc.

Modern growth theories suggest that environmental sustainability is potentially not combatable with continuous economic growth and even becomes an obstacle in achieving long- term economic growth. Given the tradeoff between environment and development, the issue is not to maximize economic growth or achieve total environmental protection, but one of arriving at optimality both in economic progress and in environmental protection. Therefore, the concepts of sustainable development provide the guiding force.

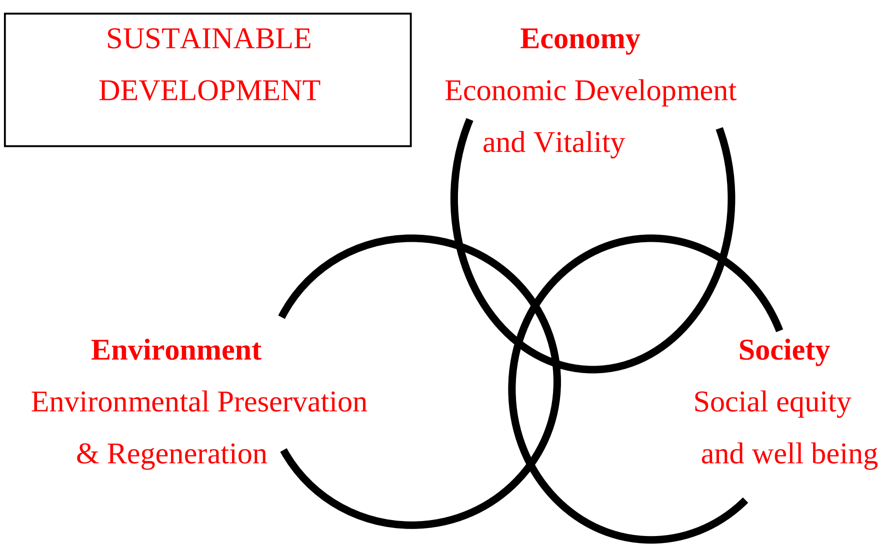
2.5 THE CONCEPT OF SUSTAINABLE DEVELOPMENT

In order to protect the environment from deterioration a new paradigm in environmental understanding is required. This lead to the idea of Sustainable Economic Development promulgated by the World Commission on Environment and Development (WCED, 1987) in 'Our Common Future'.

Bathwal (IIT, Kanpur) has highlighted some important indicators of Sustainable Development. They are (i). GDP growth rate (ii). Population stability (iii). Proportion of urban population (iv). Clean Air Index (v). Government allocation for environmental protection (vi). Energy Industry (viii). Renewable energy proportion (ix). Material intensity (x). Environmental awareness of the people etc. Robert Good Land (1995), argues that Sustainable Development should be based on three components (i) Social System (ii) Environment-Ecological System and Economic System (Figure: 2.6).

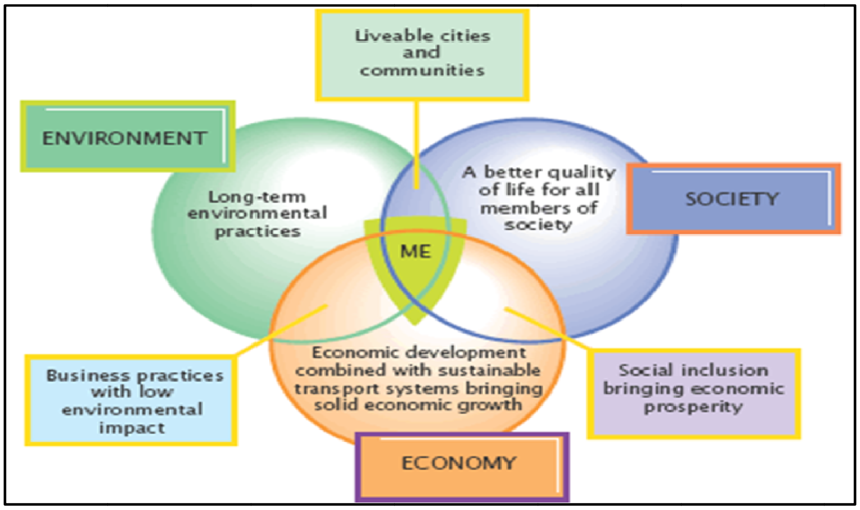
Figure: 2.6

Three components of Sustainable Development



Sustainable Development can be achieved when these three components are balanced and weighted equally at the same time. He also mentioned that Sustainable Development of ecology and economy, which is not adequate to resolve the conflict by just improving economy. Considering on the three aspects can help you to solve the conflict (Robert Good Land, 1995). This can be readily seen from Figure: 2.7.

Figure: 2.7
Sustainable Development



2.6 SUSTAINABLE TRANSPORT OR GREEN TRANSPORT

Sustainable Transport or Green Transport came into use as a logical follow-on from Sustainable Development, which refers to any means of transport with low impact on the environment, and includes walking and cycling, transit oriented development, green vehicles, car sharing and building or protecting urban transport systems that are fuel efficient, space saving, and promote healthy life styles. It helps to reduce environmental impacts of transport infrastructure, contributes to economic prosperity by maximizing transport efficiency and enhances social well being by producing greater mobility for people. Sustainable Transportation and Sustainable Development are both involved to satisfy the requirements of present generation without reducing the ability of future generations to meet their own needs (The Centre for Sustainable Transportation, 2002).

> "Sustainable Transport is the transport that does not endanger public health and eco systems and meets needs for access to people, goods and services consistent with the rate of use of renewable resources at or below the regeneration rate and the use of non renewable resources at or below the rates the rate of their renewable substitutes" - (OECD, 1995)

Developing a Sustainable Transport system has exposed as a potential solution to transport development, which helps to reduce environmental impacts of transport infrastructure; contributes to economic prosperity by maximizing transport efficiency and enhances social well being by providing greater mobility for people. This entails three dimensions: Economic Sustainability, Environmental Sustainability, and Social Stability. The advantages of increased mobility need to be weighed against the environmental, social and economic costs that transport systems pose. In Sustainable Transport policy, these costs of transport require special attention.

Cost plays a central role. Two major categories of costs have to be distinguished: (i) Internal costs and (ii) external costs. Internal costs stem from the provision and use of transport infrastructure i.e. construction and maintenances. These costs have to be recovered from infrastructure users or from the public. External costs stem from mostly negative side effects of transportation, such as congestion, delays, accidents, injuries, emissions and pollution, noise and vibration, loss of biodiversity, climate change, and aesthetic factors etc., which all negatively affect people and or future generations.

The following Table: 2.1 list various impacts, which is reflected as Sustainable Transportation indicators (Litman and Burwell, 2006).

Table: 2.1
Impacts of Transport

Environmental	Social	Economic
Air pollution	Equity and fairness	Accessibility quality
Climatic change	Impacts on mobility	Traffic congestion
Noise pollution	Affordability	Infrastructure costs
Habitat loss	Human health impacts	Mobility barriers
Water pollution	Community livability	Consumer costs
Depletion of resources	Community livability	Accident damages

Most of the tools and concepts of Sustainable Transport developed before the phrase was coined. Walking, the first mode of transport is also the most sustainable. However, today vehicular traffic threats pedestrian safety especially in busy urban areas. In order to avoid the economic and environmental impacts of transport, in U.K. the Royal Commission on Environmental Pollution (Houghton, 1995) which has outlined eight objectives for Sustainable Transport policy including (i) Achieving air quality standards that prevent damage to human health and the environment and (ii) Reduce carbon dioxide emissions from transport. An organization called Green XC started in 2011 created a national awareness campaign in the United States encouraging people to carpool by ride sharing. Ride sharing reduces individual's carbon footprint by allowing several people to use one car instead of every one using individual cars.

Sustainable Transport fuels or Green Fuels are using in some countries to reduce the emission from vehicles which includes Compressed Natural Gas, Liquefied Petroleum Gas, Bio Diesel, etc. Compressed Natural Gas can be tapped for sustaining urban transport. LPG is a very successful transport fuel in several countries in the world, widely used in urban and semi-urban areas. Bio-Diesel is a green, carbon neutral fuel produced in farms and has one potential of partially substituting mineral diesel. Gas to Liquid Technology used for the production of liquid fuels from standard natural gas. This fuel has clear benefits over conventional diesel in Nitrogen Dioxide (NO_2)and Sulfur Dioxide (SO_2) and is neutral on Carbon Dioxide (CO_2). The most commonly used bio-fuels are ethanol and bio-diesel. Ethanol blended gasoline (5-10%) can reduce emission of Carbon Monoxide (CO) and Hydro Carbons (HC) in old engines. Ethanol addition can cause increase in fuel volatility and higher emission of aldehydes, which is an ozone precursor. In Brazil, it met 17 percent of its transport fuel needs from bio ethanol in 2007. In India 5% ethanol blended gasoline has been introduced in many States from 2003. Electronic vehicle technology has the potential to reduce transport CO_2 emissions. Hybrid vehicles, which use an internal combustion engine combined with electric engine to achieve better fuel efficiency, are already common. Hydrogen Vehicles is receiving worldwide attention as a clean fuel and efficient energy storage medium for automobiles.

2.7 INTERNATIONAL MOVEMENTS FOR SUSTAINABLE TRANSPORT

There is a range of international initiatives relating to transport, injury, air pollution, physical activity and other urban issues. Some relevant initiatives described here.

2.7.1 PEP-Transport, Health and Environment Pan-European Programme

With World Health Organization support, a Pan-European policy process known as the Transport, Health and Environment Pan-European Programme, launched in 1999 at the Third Ministerial Conference on Environment and Health. PEP facilitates scientific study of health and environmental impacts from transport and policy dialogue about solutions. In 2002, European Parliament also adopted a resolution thus by carrying out health impact assessment of major transport projects.

2.7.2 Clean Air Initiative for Cities Around the World: Clean Air Initiative for Asian Cities (CAI-Asia) and Air Pollution in the Mega Cities of Asia (APMA)

CAI- Asia and CAI- Latin America are currently active in both assessing and promoting health and environmental policy linkages on urban transport-related issues. UNEP, in collaboration with WHO, the Stockholm Environment Institute and the Korea Environment Institute, initiated the APMA project in 2000 to prepare a strategic frame work for Air Quality Management in Asia. The Twin initiatives aim to provide a regional approach for improving urban air quality and pollution monitoring. Currently, CAI-Asia and APMA are finalizing benchmarking reports on urban quality in twenty Asian cities.

2.7.3 UNEP Partnerships for Clean Fuels and Vehicles

United Nations Environment Programmes (UNEP) established a Partnership for Clean Fuels and Vehicles at the 2002 World Summit on Sustainable Development together with a wide range of international partners to reduce local health damaging pollution emissions, as well as controlling Green House Gases emissions. UNEP also was participating in a one year Air Quality Monitoring Project in Sub Saharan Africa that will establish base line data for key pollutants in several African cities.

2.7.4 UN Road Collaboration

United Nations General Assembly approved resolution 58/289, improving Global Road Safety. Since then WHO has been coordinating road safety activities within the UN system, in the framework of the UN Road Safety Collaborations. In addition, road safety activities are ongoing around the world under the auspices of the Global Road Safety Partnership, an initiative of the World Bank, International Federations of Red Cross and Red Crescent Societies and other partners. On a regional level, the Asian Development Bank has produced Road Safety Guidelines for the Asian and Pacific Region.

In developing countries, there are issues related to high levels of particulate emissions from diesel vehicles, use of leaded petrol and use of two-wheelers with highly polluting two-stroke engines, this coupled with the high average vehicle age and poor maintenance, has led to more emissions per km driven (Walsh, 1999). These countries are gradually taking steps to reduce vehicular emissions by phasing out leaded petrol, introducing stricter emissions standards, converting two-stroke engine in two-wheelers into four strokes engines. China and cities such as Singapore, Hong Kong, Tokyo, kuala Lumpar and Bangkok are new developing light rail and mass transit systems to reduce pressure on road and provide an opportunity to reappraise city wide transportation plans.

India has taken substantial initiatives to make the transport sector less emission intensive. One of the major initiatives has been up gradation of vehicular emission norms such as Bharat Stage II, Bharat Stage III and Bharat Stage IV. The commercial manufacture of battery-operated vehicles has begun in India with a view to promoting low/ no carbon emitting vehicles. Also in Delhi there has been a large-scale switchover from petrol and diesel to CNG, with over 50,000 vehicles already converted. In addition to this Integrated Transport Policy (2001) promotes the use of ethanol-blended petrol and biodiesel. The National Urban Transport Policy emphasizes the development and usage of extensive public transport facilities (including non-motorized modes) over personal vehicles. Traditional, non-motorized transport example rickshaws in India can play a major role in moving towards a more Sustainable Transportation systems.

2.8 TRANSPORT AND ENVIRONMENT FOCUSED ACTIVITIES OF INTERNATIONAL INSTITUTIONS

A number of coordinated activities, under the guidance of different international and regional development agencies, are under way in the area of transport pollutant emissions and energy consumption. These include the following:

2.8.1 OECD: Environmentally Sustainable Transport

Its purpose was to identify the measures that would be necessary to attain a goal of 'Environmentally Sustainable Transport' by the year 2030 within OECD countries.

2.8.2 ECMT: Urban Travel and Sustainable Development Programme

A series of related activities centered on the theme of sustainable urban travel, including workshops on the themes of transport and land-use coordination, improving public transport, managing car use in cities, evaluating infrastructure investment impact on urban sprawl, and overcoming barriers to implementation.

2.8.3 Economic Commission for Europe (ECE): Programme of Joint Action on Transport and the Environment

The programme maintains a joint adhoc expert group on transport and the environment, touching on topics such as transport or land-use integration, internalization of costs and refining the definition of sustainable transport.

2.8.4 WHO-ECE: Programme on Transport, Environment and Health

WHO-ECE: Programme on Transport, Environment and Health overviewed the instruments relevant to transport, environment, and health and recommendations for further steps'.

2.8.5 ECE: World Forum for Harmonization of Vehicle Regulations

This forum (WP29) works towards the harmonization of vehicle regulations, protection of the environment and energy saving. Recent activity has included the harmonization of test cycles, the harmonization of regulations concerning CNG vehicles, and the development of a motorcycle test cycle.

2.8.6 UNEP: Auto Manufacturer’s Forum

UNEP has held preliminary discussions with automobile manufacturers from around the world about developing a ‘Global Manufacturer’s Forum’ for addressing the transport-related environmental problems of megacities, and preparing for the flexibility mechanisms of the Kyoto Protocol. Early dialogue focused primarily on environmental aspects of vehicle production.

2.8.7 IEA: Implementing Agreements Affecting Transport

The IEA maintains a number of implementing agreements on advanced fuel cells, advanced motor fuels, and hybrid and electric vehicles, which have indirect impacts on transportation.

2.8.8 World Bank: Regional Clean Air Initiatives

This programme has placed particular emphasis on training and support for economic analysis in addressing air quality problems, of which a significant component is transportation.

2.8.9 World Bank: URBAIR Programme

The World Bank’s URBAIR programme involved the development of a guidebook on urban air quality management, and assessments of four cities in Asia: Mumbai (Bombay), Jakarta, Kathmandu and Metro Manila.

2.8.10 World Bank: Two-stroke Initiative

A World Bank Initiative in South Asia examined the acute problem in that region caused by the prevalence of two-stroke engines in use on two- and three-wheeled vehicles.

2.8.11 ADB: Vehicle Emission Action Plans for the Asia- Pacific Region

The Asian Development Bank recently initiated a new programme to reduce the impact of transport emissions, which include workshops on fuel policy and alternative fuels, emissions regulation for new and in-use vehicles, transport planning and traffic management, and action plans for national emissions reduction.

These type of strategies and initiatives help to promote the green city concept, which considers environmental preservation compact and pedestrian friendly and energy efficient transport system, interconnected zones resources, efficiency etc.

2.9 CONCLUSION

No doubt, all economic activities done by human being either in the field of production or in consumption, involve direct and indirect suction of material and energy resource from nature. These economic activities also end up with the flowing back of effluents, emissions and wastages into nature which ultimately turns into a dirty shape in the long run. The ability of the ambient environment to receive and assimilate such wastes up to a limit increases the ratio of the bounded to the freely available amount of any resource, leading to the problem of limits to economic growth. The stoppage of its ruthless and unwarranted utilization is of an urgent necessity that to be realized by all because with high quality of environmental deterioration human life become futile and dehumanized. If the aggregate release of all forms of wastes into nature exceeds the assimilative capacity, then the earth's capacity to sustain life will gradually decline. Thus, economies of the world must be so organized that the aggregate pollution is within the assimilative capacity. The concept is identified as the central problem of sustainable development. Thus now a day, it is increasingly realized that, environmental factors and ecological imperatives must be built into the total planning process if the long-term goal of making development sustainable.

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CHAPTER - 3

LINKAGES BETWEEN ECONOMIC DEVELOPMENT, TRANSPORT&URBANIZATION

In the present chapter, we are presenting the linkages between economic development, transport and urbanization. The discussion is presented as follows:

- Introduction
- Urbanization and economic development
- Link between urbanization and transportation
- Virtuous circle effects of transport
- Significance of road transport
- Urban transport problems
- Interlink between transport and environment
- Environmental impact of transport
- Urban air pollution in India

3.1 INTRODUCTION

The Worldwide decay in environmental quality conditions and its impact on economic development have become the core agenda of contemporary economists and environmentalists. This global interest in environmental and developmental matters started right from Industrial Revolution that took place in England during 1750-1850 and the resultant modern development of industrial society. Industrialization is regarded as a sin-qua-non of economic development. At one point, the spread of the spark of Industrial Revolution paves the way for economic development but the unprecedented growth of cities both in terms of size and population, the distribution of ecological and environmental balance etc. have wider impacts that prevent the earth planet to become sustainable to exist. Because of industrialization, urban centers are the focal points of change, and it becomes the center of attraction of both man and materials. Thus, Urbanization resulted.

3.2 URBANIZATION AND ECONOMIC DEVELOPMENT

Urbanization has been one of the dominant contemporary global processes as growing share of World population lives in cities. Generally, five major factors stand out as determinants of Urbanization. They are the effect of technological revolution, Communication revolution, Agricultural revolution, increased efficiency of transportation, and demographic revolution. Urbanization is a demographic reality and appears to be an irreversible process. Its rapid growth along with increased population, increased number of cities and towns -both in volume and in size- and its consequences are very important. Therefore, analyses of the after effects of Urbanization are so significant in this context.

Urbanization is a concomitant outcome of the process of economic development. The National Commission on Urbanization (NCU), appointed by Government of India, in their recommendations has recognized urban areas as generators of economic momentum. The State Government also accepts the special economics inter-related to urban development. There is a positive correlation existed between the two by the fact that a country with higher percapita is likely to have a high degree of Urbanization (Administrative Reform Commission).

One of the main reasons why an industry or economic activities concentrated in urban areas is mainly due to the agglomeration economics that it can enjoy. As the economic activities get concentrated, it boosts the economic activities. Even though a rapidly urbanizing area will attract people from all over the surrounding country side, this rapid influx of people creates a system where wages are depressed. This in turn encourages foreign companies to take advantage of these low wages by investing, which further perpetuates the cycle of low-wage, low skilled jobs. This makes it difficult for rapidly urbanized cities to develop higher-level economies and generate more wealth. Thus, the process of concentration of economic activities, which, facilitates the production activity, gives rise to a set of urban problems. Some of these are discussed below.

The first adverse impacts of Urbanization, is the disturbance of ecological balance. With urbanization, the urban cities are out of phase with ecological beauty. Second one is urbanization affects the bio diversity badly. City growth destroys natural areas flowing with new and enlarged animal plant life. Environmental issues are another important effect of Urbanization. Due to urbanization, the environment has taken a big hit in highly populated city areas. As the metabolism of the city increases, it resulted in a higher generation of metabolic by products of air, noise, and water pollution. Trees cut down and land cleared, water, air and sewers are increasingly polluted due to the record number of people in smaller spaces. Cities are becoming warmer with lack of soil and vegetation, and Carbon Monoxide emissions intensity.

Another serious and insurmountable problem is that of housing. Due to the paucity of houses to accommodate the people, the once beautiful cities are being reduced to slums. This creates a situation where people are more likely to get sick. But they have themselves gave birth too many problems such as fire hazard, insanitary conditions, lack of civic amenities like pure drinking water, underground drainage, hospitals, etc. Inadequate water and sanitation, flimsy-over crowded housing, slums, air pollution, dangerous work places, high rates of unemployment, low wages, poverty etc, are some of the other features of an urbanized city. These combinations of factors mean that people who live in rapidly urbanized areas have a tendency towards ill health.

When urbanization increases, cities are becoming the World starkest symbol of mal distribution of resources both physical and societal. In such cities, it is difficult for infrastructure to keep up with a large influx of people. Rapidly urbanizing areas often have more people than the roads can handle. This is because it takes much longer to plan and build an effective transportation system than it does to plan and build houses and commercial buildings. So, a rapidly-urbanizing area will experience extremely heavy traffic as bottlenecks form from more people using a road than the road was designed for. From this point, we concluded that urbanization and transportation closely linked.

3.3 LINK BETWEEN URBANIZATION AND TRANSPORTATION

'Transport has transformed the entire World into one organized unit. It carries ideas and inventions to the people and has considerably contributed to the evolution of civilization'. The whole world is bound today by the ribbons of transport. Transport is the life-blood of an economy and it plays a key role in the economic, social, cultural and political progress of the country, as the main objective of transport is to increase the wealth and welfare. The availability of efficient transportation facilities is an essential accompaniment and in many cases an initiating cause of the various manifestations of development. It plays a crucial role in shaping the density of a nation. 'In fact the whole structure of industry and commerce rests upon the well-laid foundation of transport'. In traditional communities immobility perpetuate poverty, while in affluent society, mobility is an ingredient of prosperity. It influences the location and range of productive and leisure activities. It is a multidimensional activity, whose importance is historical, social, political, economical and Environmental.

As a result of Urbanization the number and size of the cities increased significantly. In the urban centers, people especially those engaged in commercial establishments, factories, offices, etc, prefer different modes to reach their places of work. It leads to sharp increase in demand for urban transport. The rapid growth of urbanization because of technical and industrial revolution occurring around the World involves an increased number of trips in urban areas. A key for understanding urban entities lies in the patterns and processes of the transport systems. It is one of the main reasons for development of different modes of transport. Demographic and mobility growth have shaped by the capacity and requirements of transport infrastructure.

Although transportation systems and travel patterns have changed considerable over time, one enduring feature remains that most people travel between 30-40 minutes in one direction. Globally, people are spending about 1-2 hours per day commuting, wherever this takes place in a low or high mobility setting. Different transport modes, however, are associated with different travel speeds and capacity. As a result, cities that are relying primarily on non-motorized transport tend to be different from auto dependent cities. Transports thus play an important role in defining urban form.

Urban transport mainly consists of those modes and means of transportation framing part of the city circulation system as well as those, which provide the city with external links framing an integral part of the entire system of urban circulation. It is organized in three broad categories of collective, individual and freight transportation. Rapid urban development occurring across much of the globe implies increased quantities of passengers and freight moving with in urban areas. Movements also tend to involve longer distances, but evidences suggest that commuting times have remained relatively similar through the last hundred years, approximately 1.2 hours per day. This means that community has gradually shifted to faster transport modes and consequently greater distances could be travelled using the same amount of time. Different transport technologies and infrastructures have implemented, resulting in a wide variety of urban transport systems around the World.

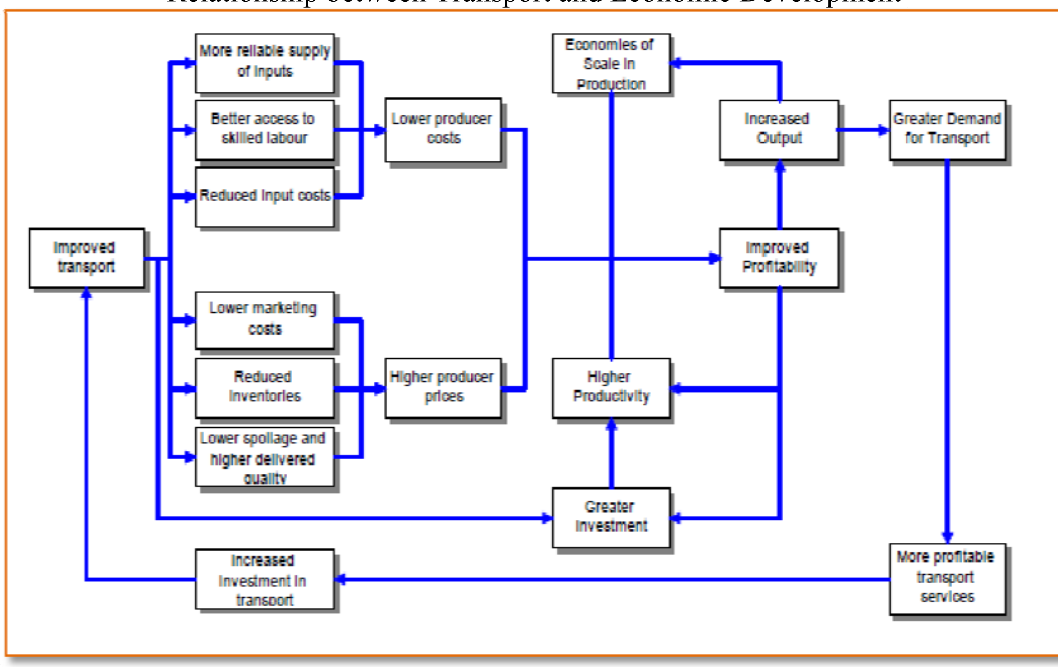
3.4 VIRTUOUS CIRCLE EFFECTS OF TRANSPORT

The relationship between transport and development is dynamic and reciprocal. This generates the demand for movement. The provision of transport system to meet this demand can itself generate further demand for movement between settlements. However, the dynamic relation ensures that economic development leads to advances in technology, production changes and the provision of services charges. These cost changes can lead to changes in the location of activities and hence their transport requirements, which may in turn boost to the development of new activities with a new range of transport requirements. This will enhance economic prosperity, and the pace of such economic development has already provided mobility to the population residing in the States and further growth is sure to add to this mobility.

Transport sector improvements can serve as a catalyst that promotes a virtuous circle of economic development. Economies of scale combine with improved productivity from capital deepening provide additional impetus for investments. Increase in levels of production bring with them increased demand for transport services, improving profitability and encouraging further investment in transport itself. This in turn leads to improved service frequency and larger scale units of production e.g., Ships in the case of marine transport, providing a basis for the next cycle of improvements in the agricultural and manufacturing production of the regions served. A schematic representation of these processes provided in the Figure below (3.1). The economic impact of transportation can be direct or indirect. Direct impacts related to accessibility change where transport enables larger markets enables to save time and costs. Indirect impacts related to the economic multiplier effects.

Figure: 3.1

Relationship between Transport and Economic Development



It is widely acknowledged that transport has a crucial role to play in economic development. The provision of a high quality transport system is a necessary pre condition for the full participation of remote communities in the benefits of national development. Transport in urban areas is highly complex because of the modes involved, the multitude of origins and destinations, and the amount of variety of traffic. Let us look into the significance of road transport.

3.5 SIGNIFICANCE OF ROAD TRANSPORT

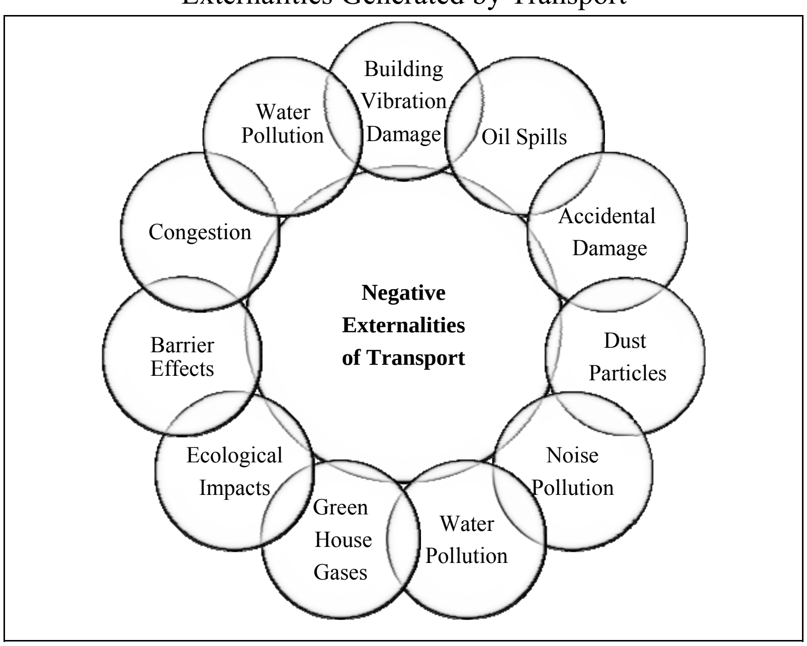
With the inability of railway system to carry all the mobile people and deliver consignments of food grains materials and consumer products, the economy has become increasingly road dominant. Road network alone could serve the remotest villages of the vast country like ours. This mode has also the maximal flexibility or travel with reference to route, and direction. It acts as the vital lifelines of the economy, which brings national integration, providing trade and commerce, helps in socio-economic development and provides linkages to other modes of transports. It is the only mode, which could be given maximum service to all as the capital cost of vehicles is relatively small. Low capital costs also ensure that innovations and new technologies can diffuse quickly through the industry. Another advantage of road transport is the high relative speed of vehicles. The risk of breakage and pilfering lessened for this mode. It has the unique advantage of providing door-to-door services for both passengers and freight. These multiple advantages have made cars and trucks the modes of choice for a great number of trip purposes, and have led to their market dominance for short-term distances trips.

It is necessary to foster the development of the various transport modes in an integrated manner that will lead to the realization of an efficient, sustainable, safe and regionally balanced transportation system, where each mode of transportation operates in its field of economy and usefulness, with competitive and on discriminating prices that are adequate to support progressive development of transport infrastructure services. Such transport system improves economic development. Even though transport possesses so many positive externalities in relation to the prosperity of an economy, it has some adverse effects that require special attention in this context.

3.6 URBAN TRANSPORT PROBLEMS

Figure: 3.2

Externalities Generated by Transport



Issues in urban transportation have become increasingly complex as our cities continue to grow due to the concentration of economic activities necessitating extensive travel from the residential areas to the work centers. It is to known that 'the penetration of motor vehicles throughout urban areas is bringing its own peculiar penalties of accidents , anxiety, intimidation by large or fast vehicles, noise, fumes, vibration , dirt, visual intrusion etc. on a vast scale. The diagrammatic presentations of the negative externalities generated by transport are given in Figure: 3.2 above.

Transport especially in urban areas faces so many problems due to prevailing imbalances in model split, inadequate transport infrastructure and its sub optimal use, lack of integration between land use and transport planning, inadequacy or absence of improvements in city bus services, and increasing trend towards use of personalized modes. These problems are discussed under the following headings.

3.6.1 Traffic Congestion and Its Impacts

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, impact on quality of life, emission of GHGs and increased vehicular queuing. It occurs when transport demand exceeds transport supply at a specific point in time and in a specific section of the transport system. As demand approaches the capacity of a road, extreme traffic congestion set in. The spatial imprint of parked vehicle is significant. The impacts of congestion includes wastage of time, health hazards, economic cost, wastage of fuel, wear and tear on vehicles, spillover effects, pollution and associated global warming.

3.6.2 Public Transport Inadequacy

Many public transit systems, or part of them, are either over or under used. During peak hours, crowdedness creates discomfort for users as the system copes with a temporary surge in demand. Low ridership many services financially unsustainable. In spite of significant subsidies and cross-financing (example toll roads) almost every public transit system cannot generate sufficient income to meet its capital costs.

3.6.3 Difficulties for Pedestrians

These difficulties are either the outcome of intense traffic, where the mobility of pedestrians and vehicles is impaired, or because of lack of consideration for pedestrians in the physical design of facilities.

3.6.4 Loss of Public Space

The streets once crowded with markets, agoras, parades and processions, game and community interactions, have gradually disappeared replaced by automobiles.

Traffic flows influence the life and interactions of residents and their usage of street space. More traffic impedes social interactions and street activities. People tend to walk and cycle less when traffic is high.

3.6.5 Accidents and Safety

Growing traffic in urban areas is linked with a growing number of accidents and fatalities, especially in developing countries. Accidents account for significant share of recurring delays. As traffic increases, people feel less safe to use the streets.

3.6.6 Land Consumption

The territorial imprint of the transportation is significant, particularly for the automobile. Between 30 and 60 percent of metropolitan area may be devoted to transportation. This land consumption also underlines the strategic importance of transportation in the economic and social welfare of cities.

3.6.7 Environmental Impacts and Energy Consumption

Pollution, including noise, generated by circulations has become a serious impediment to the quality of life and even the health of urban populations. Further, energy consumption by urban transportation has dramatically increased and so the dependency on petroleum.

3.7 INTERLINK BETWEEN TRANSPORT AND ENVIRONMENT

With the rapid urbanization and economic development, urban transportation has already become one of the prominent environmental issues that are contributing to both local and global environmental concerns. It is paradoxical in nature as on one side, transportation activities support increasing mobility demands for passengers and freight and this ranging from urban areas to international trade and on the other side, has resulted in growing levels of motorization and congestion. As a result, the transport sector is becoming increasingly linked to environmental problems. It was in this context, the term '*environment*' was used to describe '*the effect of transport up on the surroundings'*. Transport also became an important dimension of the concept of sustainability, ranging from vehicle emissions to green supply chain management practices. These impending developments require a deep understanding of the reciprocal influence between the physical environment and transport infrastructures.

It is a fact that urban transport system is a great strain and stress. The main environmental dimensions of transportation are related to the causes, the activities, the output and the result of these transport systems. Establishing the linkages between these dimensions is a difficult undertaking. For instance, to what extent Carbon Monoxide emissions are linked to land use patterns? The relationship between transport and the environment are also complicated by two observations.

1. Transport activities contribute among other anthropogenic and natural causes, directly, indirectly and cumulatively to environmental problems. In some cases, they may be a dominant factor, while in some others their role is marginal and difficult to establish.
2. Transport activities contribute at different geographical scales to environmental problems, ranging from local (noise and emissions) to global (climatic change, smog, acid rain).

Transport sector presents a wide range of issues viz. air pollution, noise, congestion, accidents and increased travel time. These impacts can fall within three categories.

1. Direct impacts, means the immediate consequences of transport activities on the environment where the cause and effect relationship is generally clear and well understood.
2. Indirect impacts which are the secondary or tertiary effects of transport activities on environmental systems. They are often of higher consequences than direct impacts, but the involved relationships are often misunderstood and difficult to establish.
3. Cumulative impacts are the additive, multiplicative or synergetic consequences of transport activities. They take into account the varied effects of direct and indirect impacts on an eco system, which are often unpredicted.

Some of the striking environmental impacts of transport are discussed below:

3.8 ENVIRONMENTAL IMPACT OF TRANSPORT

3.8.1 Transport and Air Pollution

Economic development and the consequential transport development have always accompanied the problems of environmental pollution. Environmental pollution has defined as the contamination of environments pure elements by the harmful agents or increase in their percentage above a certain permissible limit. Transport is mainly oil based and the motor vehicle is the biggest consumer of energy consumed with all other transport modes. Energy consumed by transport is closely related to air pollution. Fossil fuel combustion produces CO_2, CO, NO_X, and VOC_S which precursors to tropospheric ozone and acid rain, as well as contributing directly or indirectly to global warming.

The emission takes place in the following way: In use, with an internal combustion engine, chemical processes take place between the hydrocarbons of the fossil fuel, the fuel additives and the gases that naturally occur in atmosphere. This process include complete and partial oxidation of the fuel, which produces, Carbon Dioxide (CO_2) and Carbon Monoxide (CO), Nitrogen from the air is also oxidized to Nitrogen Oxides (NO_x). Partially burnt and unburned fuel is present in the exhaust gases and forms a complex cocktail of Volatile Organic Compounds (VOCs) together with small Particles of Matter (PM), which are especially prevalent in diesel fumes. To a lesser degree, lead (Pb) is emitted with the exhaust gases and Ozone (O_3) is produced by the chemical action of sunlight on (VOCs).

Transport sector is fast becoming a major source of air pollution in the cities all over the World, due to rapid industrialization and Urbanization, age of fleet, technology used, poor maintenance of vehicles, non-availability or improper use of appropriate fuels, rapid rise in the automobiles population, excessive vehicle use, narrow roads, slow moving traffic, unfavorable driving cycles, poor enforcement of laws relating to vehicle road worthiness, poor emission control measures etc. The two automobile types responsible for pollutants emission are the (i) spark ignition engines using petrol as fuel, and (ii) compression ignition engine using diesel oil as fuel. Two and three wheelers, motor cycles, scooters, autorickshaws, and tempo are most serious offenders from an air pollution standpoint. Passenger cars and jeeps powered by four stroke spark ignition engines are less serious offenders of air pollution. Compression ignition engines, which propel trucks, buses, railway locomotives and ofcourse now cars and jeeps, have lower concentrations of pollutants emissions than spark ignition engines (Rao, 1999). The major pollutants emitted by motor vehicles are: Carbon Dioxide, Carbon Monoxide, Hydro Carbons, Nitrogen Oxides, Sulphur Dioxides, Particulates, Ozone, Photochemical Oxidants, Lead and other heavy metals etc.

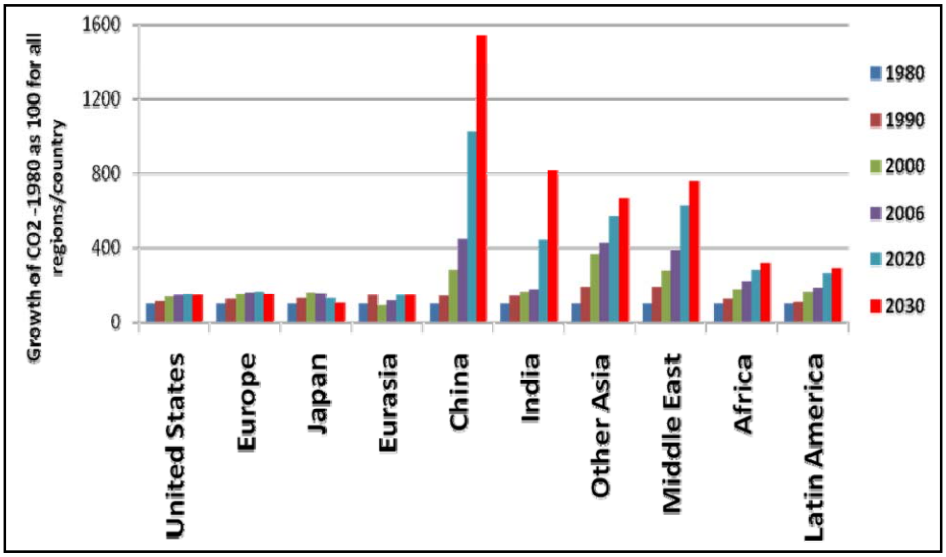
The following factors have been identified as the main contributors to the levels of pollution from the roads and highways: 1) Traffic characteristics (volume, speed, braking), 2) Climatic conditions (intensity, wind, temperature), 3) Maintenance policies (sweeping, mowing, repair, vegetation control), 4) Surrounding land use (residential, commercial, industrial, rural), 5) Percent pervious and impervious areas, 6) Age and condition of vehicles, anti-litter law and regulations covering vehicle emissions, 7) Vegetation type and highway right of way and 8) Accident spills. There are four basic sources of air pollution from the motor vehicles: 1) Fuel tank: Hydro Carbons, 2) Carburetor: Hydrocarbons, 3) Crank Case Blowby: Hydro Carbons, Particulates and 4) Exhaust Pipe: Carbon Monoxide, Nitrogen Oxides, Hydrocarbons, Particulates, Sulfur

Oxides (Rao, 1979, Automobile Emission Sources). The chief air pollutants emitted from vehicles are described below:

3.8.1.1 Carbon Dioxide

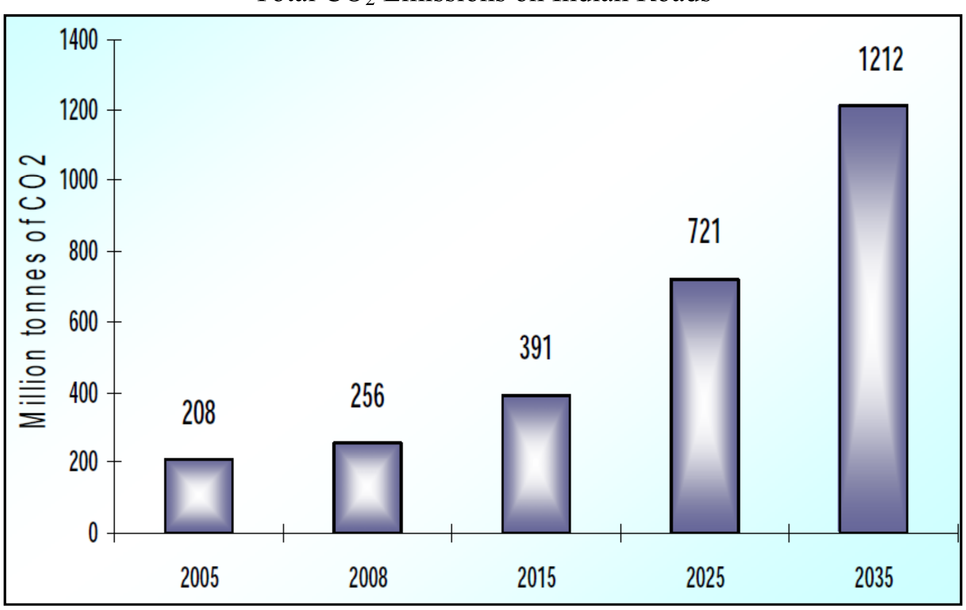
Carbon Dioxide emissions largely a byproduct of energy production and use, account for largest share of Green House Gases associated to global warming. Table: 3.1 shows the five major Carbon Dioxide emitters in the World.

Figure: 3.3
CO_2 Emissions Transport Sector 1980-2030



Source: IEA 2008, World Energy Outlook

Figure: 3.4
Total CO_2 Emissions on Indian Roads



Source: IEA 2008, World Energy Outlook

From Table: 3.1, it is clear that India is one of the five countries responsible for highest Carbon Dioxide emissions in the World. World CO_2 emission from transport sector and particularly on India roads are given in Figures: 3.3, 3.4.

Table: 3.1
Major CO_2 Emitters in the World

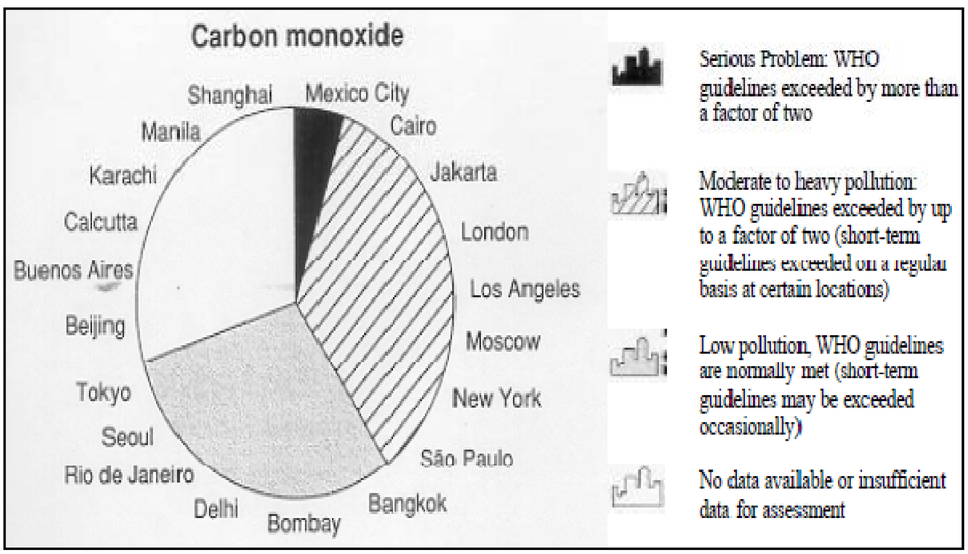
Countries	Million Metric Tones/ Year
USA	5447.6
China	3108.0
Russia	1434.0
Japan	1133.5
India	1061.0

Source: World Bank (2002)

3.8.1.2 Carbon Monoxide

Carbon Monoxide is a gas produced by the incomplete combustion of petrol. It is present in the ambient air of cities, but often reaches maximum concentrations near major highways during the peak traffic conditions. Carbon Monoxide emission in different countries shown below (Figure: 3.5).

Figure: 3.5
Problem of CO in World Mega Cities



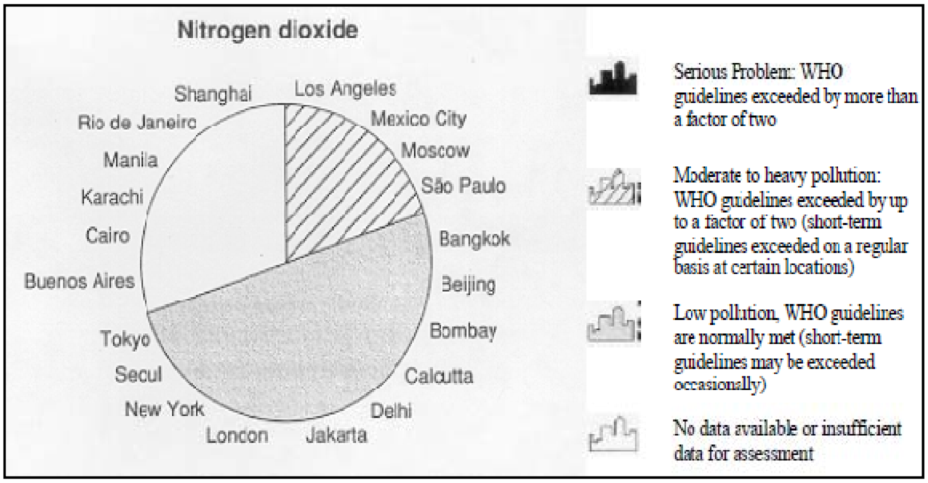
Source: WHO/ UNEP, Urban Air Pollution in Mega Cities of the World

3.8.1.3 Nitrogen Dioxides

Nitrogen Dioxide is a resultant of combustion of fuel by motor vehicles. The major concentrations would be higher near roads during peak traffic conditions. Nitrogen Dioxide emission in mega cities shown below (Figure: 3.6).

Figure: 3.6

Problem of NO_2 in World Mega Cities



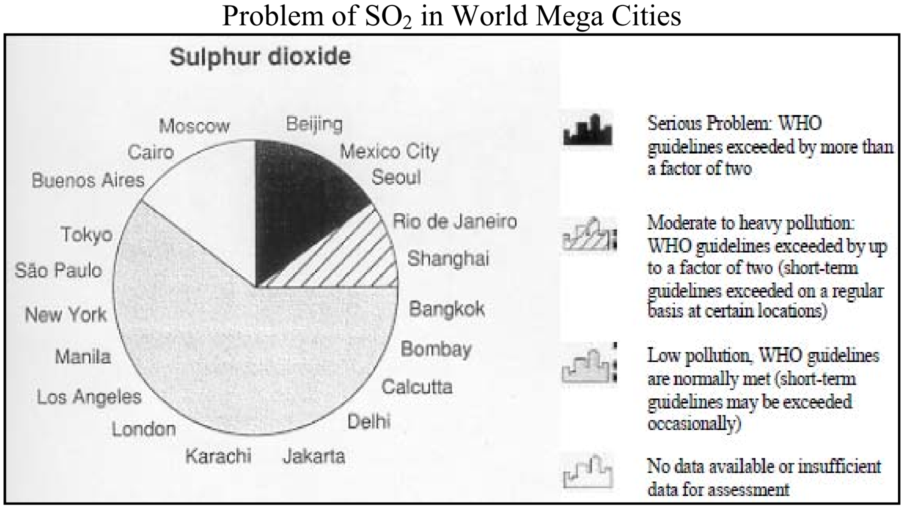
Source: WHO/ UNEP, Urban Air Pollution in Mega Cities of the World

3.8.1.4 Sulphur Oxide

Sulphur Oxides is the resultant of combustion of diesel and is a colorless gases, which react catalytically and photo-chemically with other pollutant or natural components of the atmosphere to produce Sulphur Trioxide, Sulphur Acid and Sulphates and is an important component of acid deposition and haze. The ambient concentrations of Sulphur Dioxide show considerable spatial and temporal variations. It formed in the spark ignition and compression ignition engines due to oxidation of Sulphur during the combustion process. The diesel oil has a higher Sulphur content, which could be as high as twenty time that in Petrol. The oxidation of sulphur produces Sulphur Dioxide. Sulphur Dioxide emission in mega cities are shown below (Figure: 3.7).

Figure: 3.7

Problem of SO_2 in World Mega Cities



Source: WHO/ UNEP, Urban Air Pollution in Mega Cities of the World

3.8.1.5 Hydrocarbons

The toxic organic compounds that are emitted through vehicle emissions include Vinyl Chloride and Benzene, which are very harmful to the human being. Advanced injection timings result in higher hydrocarbons emissions due to longer ignition delay, which allows more fuel vapors and small droplets carried away from the combustion zone. Diesel engines, an attractive alternative to petrol-powered motor vehicles in some developing countries, have the advantage that they produce virtually no Hydro Carbons that can take part in photochemical reactions and no Carbon Monoxide is evolved. Unless correctly maintained, however, they can produce Smoke, Odour, and Noise (WHO, 2009)

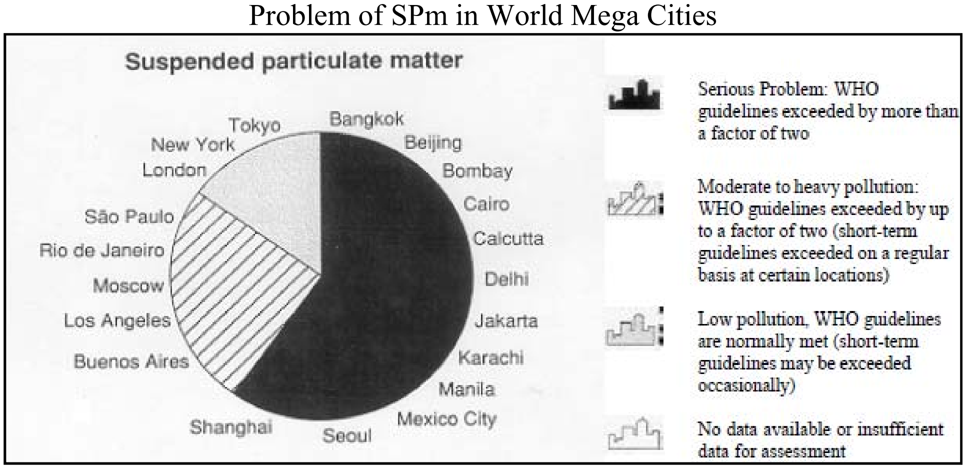
3.8.1.6 Lead and other heavy metals

Manganese is widely distributed metal, which is the resultant of combustion of fuel in motor vehicles.

3.8.1.7 Particulates

Particulates of air pollution refer to the presence in air of solid and liquid particulates of various physical dimensions and chemical properties. These Particulates cause the occurrence of photochemical Smog. Small Particulates of less than 10 microns diameter (PM10) and fine particulate of less than 2.5 microns in diameter (PM2.5) are linked most closely to quantifiable impact on public health. Such particles bypass the body’s usual defenses. Small Particles emitted by road vehicles may comprised of elemental Carbon compounds, heavy metals and sulfurs, and carcinogenic. In many developing countries, old and poorly performing diesel vehicles often are responsible for the greatest proportion of small particle emissions from vehicles (Figure: 3.8).

Figure: 3.8
Problem of SPm in World Mega Cities

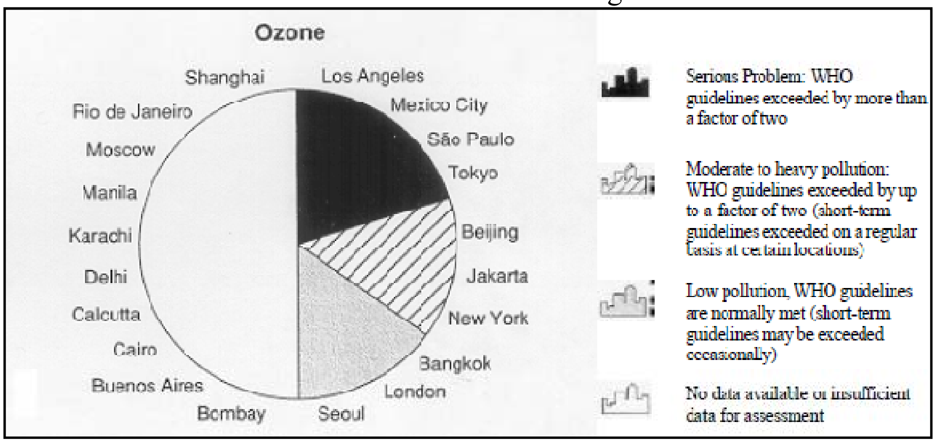


Source: WHO/ UNEP, Urban Air Pollution in Mega Cities of the World

3.8.1.8 Ozone

Ozone and other toxic chemical Oxides are formed by the action of sunlight of mixtures of Nitrogen Dioxide and Volatile Organic Compounds. The complexity of photochemical reactions produces various oxidants. The important oxidants are Ozone and Peroxy Acetyl Nitrate (PAN). Problem of ozone in world mega cities are shown below (Figure: 3.9).

Figure: 3.9
Problem of Ozone in World Mega Cities



Source: WHO/ UNEP, Urban Air Pollution in Mega Cities of the World

Over the past 100 years, the global average temperature has risen by about 0.6^0C. Doing nothing is no sensible option. The more action is postponed, the greater the risk of irreversible climate change, as costs rise and options to stabilize Green House Gases concentrations at lower levels are closed off. Without further action, global emissions are likely to grow within the next two decades. One of the main causes of global warming is automobile pollution. It is posing a serious problem especially in metropolitan areas. Pollution substances emit by petrol and diesel vehicles in India, in comparison to those of the World, revealed that Carbon Monoxide is the chief pollutant followed by Hydro Carbons, Suphur Dioxide, and Nitrogen Oxides and so on. In India, the Central Board for the Prevention and Control of Water Pollution has conducted a study on the vehicular emissions. The results indicate that Indian vehicles release a much higher concentration of pollutants than the vehicles in the West. In India, maximum permissible limit of the intensity of smoke released is 65 on Hartridge scale. However, the study revealed that most of the vehicles do not confirm to this limit (Gupta, 1998).

3.8.2 Climatic Change

The activities of the transport industry release several million tons of gases each year into the atmosphere. These include lead (Pb), Carbon Monoxide (CO), Carbon

Dioxide (CO_2; not a pollutant), Methane (CH_4), Nitrogen Oxides (NOx), Nitrous oxide (N_2O), Chloro Fluoro Carbons (CFCs), Per Fluoro Carbons (PFCs), Silicon Tetra Flouride (SF6), Benzene and Volatile Components (BTX), Heavy Metals (zinc, chrome, copper and cadmium) and Particulate Matters (ash, dust). There is an ongoing debate to what extent these emissions linked to climate change and the role of anthropogenic factors. Some of these gases, particularly Nitrous Oxide, also participate in depleting the Stratospheric Ozone (O3) layer, which naturally screens the earth's surface from ultraviolet radiation.

3.8.3 Noise Pollution

Traffic generates noise. It is irritating and it many, in the end, are harmful to a person's health. Buchanan in his report to the British Ministry of Transport has placed a great deal of emphasis on it: '*In addition to danger and anxiety, the motor vehicle is responsible for a great deal of noise. In large towns and cities traffic is, at the present time, the predominant source of annoyance, and no other single noise is of comparable* importance'. The committee distinguished five main kinds of noise from vehicles: (i) propulsion noise from engines gears, transmission and exhausts, (ii) horns, (iii) brake, (iv) squeal, (v) door slumming and loose roads. Traffic noise depends on the interaction of six main factors: a) Noise from individual vehicles b) Traffic volume c) Traffic composition d) Traffic speed e) Road gradient f) Road surface.

Automobile noise pollution is assuming increasing dimensions with increase in the number of vehicles and urbanization. The explosion of gases inside the engine cylinder puts a force on the bearings, causing the outside of the engine to vibrate and produce noise. Wheeling buses and racing cars and trucks are yet another source of noise produced due to friction of tires on road. Most annoying source, however, is horn-honking and driving silencerless vehicles. Diesel engine trucks are generally 10dB noisier than petrol engine trucks and 12 to 18 dB noisier than cars. Excessive noise pollution is associated with sleep dysfunction, impaired school performance and communication, hearing impairment and increased annoyance and aggression. WHO noise guidelines classify background noise levels above 55 dB LAeq in community settings. Noise thresholds for indoor spaces and nighttime sleeping areas are much lowers (30-35 Dd LAeq).

3.8.4 Water Pollution

Transport activities have an impact on hydrological conditions. Fuel, chemical and other hazardous particulates discarded from cars, trucks, trains etc. can contaminate rivers, lakes, wetlands and oceans. Because demand for shipping services is increasing, marine transport emissions represent the most important segment of water quality inventory of the transportation sector. The main effects of marine transport operations on water quality predominantly arise from oil spills, waste, ballast waters and dredging. Major oil spills from oil cargo vessel accidents, are one of the most serious problems of pollution from maritime transport activities. Waste generated by the operators of vessels at sea or at ports cause serious environmental problems, since they can contain a very high level of bacteria that can be hazardous for public health as well as marine eco systems when discharged in waters. Modification of water system by road building is also a serious environmental effect.

3.8.5 Soil Quality Deterioration

The environmental impact of transportation on soil consists of soil erosion and soil contamination. Coastal transport facilities have significant impacts on soil erosion. Shipping activities are modifying the scale and scope of wave actions leading to serious damage in confined channels such as riverbanks. The removal of earth's surface for highway construction or lessening surface grades for port and airport developments have led to important lost of fertile and productive soils. Soil contamination occur using toxic materials by the transport industry. Fuel and oil spills from motor vehicles washed on roadsides and enter the soil. Hazardous materials and heavy metals have found in areas contiguous to railroads, ports and airports.

3.8.6 Loss of Biodiversity

Transportation also influences natural vegetation. The need for construction materials and the development of land-based transportation has led to deforestation. Many transport routes have required draining land, thus reducing wetland areas and driving-out water plant species. The need to maintain road and rail right-of-way or to stabilize slope along transport facilities has resulted in restricting growth of certain plants or has produced changes in plants with the introduction of new species different from those, which originally grew in the areas. Many animal species are becoming extinct because of changes in their natural habitats and reduction of ranges.

3.8.7 Land Take

Transportation facilities have an impact on the urban landscape. The development of port and airport infrastructure is significant features of the urban and semi-urban built environment. Social and economic cohesion can be severed when new transport facilities such as elevated train and highway structures cut across an existing urban community.

Arteries or transport terminals can define urban borders and produce segregation. Major transport facilities can affect the quality of urban life by creating physical barriers, increasing noise levels, generating odors, reducing urban aesthetic and affecting the built heritage.

3.8.8 Accidental Risk

Every day, almost 3000 people in low and middle-income developing countries die from road traffic injuries. Pedestrians, cyclists and motorized two-wheeler riders are among the groups most vulnerable to traffic injury. Environmental factors that may increase vulnerability include rapid growth in motor vehicle traffic, lack of separation between motorized and non-motorized traffic, poor control or connectivity at pedestrian crossways, traffic encroachment into pedestrian space, and increase the speed of motor vehicles at the risk of pedestrians etc. Inefficient transport system is considered as the 9th leading cause of morbidity and mortality (WHO), and it is projected that road accident traffic injury to be the third most significant global factor in death and morbidity by 2020, due to rising motorization, unsafe road, and urban design, unsafe vehicles, lack of effective law enforcement and increased exposure of vulnerable populations (WHO).

3.9 URBAN AIR POLLUTION IN INDIA

The impacts of urban transport on air pollution in Indian cities are significant and have been gradually increasing over the last few decades (ADB, 2010). Urban transport related air pollution, such as NOx and SPM, is posing an increasingly serious challenge to policy makers. Industry related air pollutants are decreasing, but, on the other hand, transport related pollutants are becoming increasingly difficult to control (IGES, 2004). Due to rapid motorization and little competition for private modes, managing air pollution has become a greater burden than it ever was. In big cities, industries are slowly but steadily relocated to the peripheries of cities or even outside city boundaries. As this change occurs, urban mobility, rather than levels of industrialization, gradually has become the primary determinant of urban air pollution.

Epidemiological studies show that air pollution results in thousands of deaths and a number of health problems in cities. Of course, transport is only one of the many contributors to urban air pollution, but as household cooking switches to modern fuels (gas, LPG, and electricity), as low-quality industrial fuels like lignite or low-grade coals and dirty heavy diesel are replaced by cleaner coals, oils and natural gas, and as industries are moved out of cities, the contribution of transport rises dramatically. The growth of vehicles has out passed the growth in the length of road network resulting in severe strain on the existing road, poor riding quality, vehicular emission, accidents, traffic congestion etc. The vehicles operating on our roads release large quantity of pollutants into the atmosphere in gaseous and particulate forms running into lakhs of tons annually. The situation has turned from bad to worse now days. Stationary sources are easy to spot and regulate, especially as they often cause annoyance to the polluters themselves. The impacts of these pollutants are highly location-specific. Before leaded gasoline phased out, lead was a major health threat. Recently, Respirable PM and Ozone have become increasingly more serious pollutants in Indian cities and urban transport is becoming more responsible for creating them.

World Bank's Urban Air study conducted in Greater Mumbai, Kathmandu Valley, Jakarta and Metro Manila shows that urban transport accounts for the majority of air pollutants and that its health impact runs into millions of dollars (Shah and Nagpal, 1997). Another study conducted by the World Bank in Mumbai, Shanghai, Manila, Bangkok, Krakow and Santiago indicates that the total social cost of air pollution in these cities was as high as 2.6 billion 1993 US$ (Lvovsky et al., 2000). A 1998 study of Delhi suggested that 7,500 premature deaths, four million hospital admissions and 242 million incidences of minor sickness could be avoided if air pollution conformed to the WHO suggested levels in areas where the transport sector accounts for over 70% of air pollution (Xie et al., 1998). A recent report by the Asian Development Bank shows that SPM and PM_{10} levels in Asian cities are higher than WHO and U.S. EPA 1997 limits respectively (1990- 1999 average, citing WHO's Air Information Management Database). In particular, SPM concentrations in Shanghai, New Delhi, Mumbai, Guangzhou, Chongquin, Calcutta, Beijing and Bangkok exceed WHO limits (90 $\mu g/m^3$) by between two and five times (ADB, 2003). PM_{10} exceeds the US EPA limit (50$\mu g/m^3$) by several times in a number of cities; New Delhi and Calcutta, for example, have four times the limit. Similarly, a benchmark report of the Air Pollution in Mega-Cities of Asia Project shows that NOx and PM are a serious challenge for Asian cities (APMA, 2002). Data from Tokyo shows that SPM increased rapidly from 40µg/m3 in the early 1980s to over 70µg/m3 in the early 1990s. Since then, levels of SPM have decreased or stagnated but it is again becoming increasingly difficult to contain them (TMG, 2004).

All these reports indicate that SPM, PM_{10} and NOx are particularly problematic and that the transport sector is a major contributor to their creation. In addition to its impact on local air pollution, growing motorization results in a significant toll on congestion, too. Incomes in cities are rising rapidly and improvements in the efficiency of public transportation, especially mass transportation, have been slow. As a result, personal, low occupancy vehicles dominate Indian cities, whose numbers exacerbate congestion and pollutant concentrations. The expansion and improvement of roads only serves to encourage increased vehicle numbers and use. Transport can be considered as catalyst for development for development as well as curse on the environment as its activities on the one hand increases future development but creates a number of environmental hazards on the other. The major environmental hazards contributed by them are:

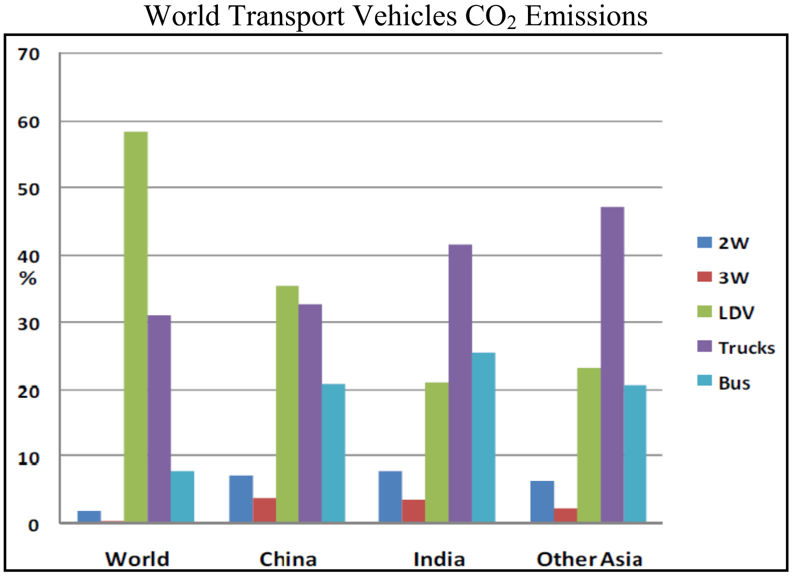
1. Air Pollution
2. Accumulation of solid wastes (oil, tyres, vehicle parts, old vehicles etc.)
3. Noise pollution and vibration affecting urban dwellers and urban activities
4. Traffic congestion, accidents and risk of transport of hazardous wastes
5. Visual and aesthetic disruption due to overcrowding of vehicles

India is one of the emerging urban economies in the world. It is estimated that, 60% of India's Gross State Domestic Product is generated in urban areas. The pace of urbanization continues to be rapid, and this rapid urbanization has generated corresponding increase in the demand for travel as seen in the sharp rise in ownership of private vehicles. However, transport infrastructure development has not kept pace with the increase in travel demand. On the other hand, the share of public transport vehicles has declined in the same period. As a result, the problem of congestion and its consequences in the form of travel delays, loss of productivity, deterioration in the quality of air, noise pollution and mounting number of road fatalities are the debilitating downsides of life in the urban areas. The negative externalities of the transport sector have gradually harmed the environmental conditions in urban areas and are continuing to exacerbate the quality of life. The unchecked growth in the vehicle fleet combined with an aging and ill-maintained vehicle stock has degraded the road environment, which has resulted in severe congestion on the roads along with serious levels of air and noise pollution. Non-motorized mode of transport seems to have lost its earlier importance in the larger metropolises. The increased consumption of fossil fuels also has adverse impact on the energy security of the nation.

Most Indian cities are characterized by high densities, intensely mixed land use patterns, short trip distances, and high share of walking and non-motorized transport. The transport and land-use patterns found in these cities are so influenced by poverty and high level of complexity that it becomes difficult to analyze their characteristics using the same indices as used for cities in highly motorized countries. There is ample evidence to illustrate the mismatch between urban transportation planning methods and the growing transportation problems. Consequently, these cities continue to face environmental decay, congestion, poor health conditions, etc. India's uncontrolled and badly maintained automobiles rival with those in the West in their pollution generation capacity. They are adding large amount of pollutants to the atmosphere, triggering off a host of environmental problems. These atmospheric pollutants cause serious health problems. On the global scale, a steady increase in the Carbon Dioxide content of the atmosphere (accumulation of Green House Gases) is undoubtedly the most serious environmental problem confronting the whole world, since it holds out the threat of catastrophic climatic changes.

Emissions from the transport sector depend mainly on type of transport and fuel apart from type of combustion engine, emission mitigation techniques, maintenance procedures and vehicle age. The major pollutants emitted from transport are Carbon Dioxide (CO_2), Methane (CH_4), Carbon Monoxide (CO), Nitrogen Oxides (N_2O), Sulphur Dioxide (SO_2), Non-Methane Volatile Organic Compounds (NMVOC), Particulate Matter (PM) and Hydro Carbon (HC).

Figure: 3.10
World Transport Vehicles CO_2 Emissions



Source: IEA-SMP Estimates, 2005

After a 1% decline in 2009 and an unprecedented 5% surge in 2010, global CO_2 emissions increased by 3% in 2011, compared to the previous year, reaching an all-time high of 34 billion tonnes. The five largest emitters are: China (29%), the United States (16%), the European Union (EU27) (11%), India (6%) and the Russian Federation (5%), closely followed by Japan (4%). Global consumption of coal (responsible for about 40% total CO_2 emissions) grew in 2011 by 5%, whereas global consumption of natural gas and oil products increased by only 2% and 1%, respectively. Over the past decade, average annual emissions increased by 2.7%. So, with a 3% increase in 2011, global CO_2 emissions resumed this decadal trend. A comparison of CO_2 emission in the World, Asia and India are depicted graphically (Figure: 3.10).

3.9.1 Vehicular Pollution Problems in India

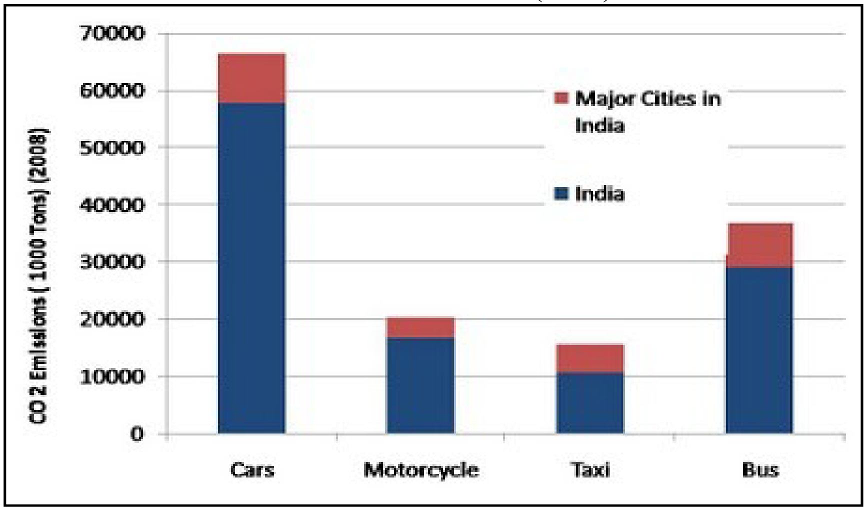
Vehicles are one of the major sources of air pollution in major cities. In India, air pollution due to vehicles can be attributed to following:

- High vehicle density in Indian urban centres results in air pollution build-up near roadways and at traffic intersections.
- Older vehicles are predominant in vehicle vintage. These older vehicles are grossly polluting though in cities like Delhi grossly polluting vehicles phased out.
- Inadequate inspection and maintenance facilities result in high emission of air pollutant from vehicles. Emission can be reduced by proper and regular inspection and maintenance of vehicles.
- There are large numbers of old 2-stroke 2/3-wheelers in most of the cities, which are a significant contributor of air pollution.
- Adulteration of fuel and fuel products result in high emissions from vehicles.
- Improper traffic management system and road conditions result in build-up of air pollutants near the roadways as the emissions are higher when the vehicle is idling.
- Absence of an effective mass rapid transport system and intra-city railway networks have resulted in people using their own vehicles for commuting to work. This has resulted in uncontrolled growth of vehicles.
- High population exodus to the urban centers has also resulted in increase in the number of vehicles, resulting in high levels of vehicular air pollution.

The following graph (Figure: 3.11) shows the CO_2 emission in India calculated by Central Pollution Control Board during the year 2008. In India, transport sector emits an estimated 258.10 Tg of CO_2, of which 94.5% contributed by road transport. Among all the States and Union Territories, Maharashtra's contribution is the largest, 28.85 Tg

(11.8%) of CO_2, followed by Tamilnadu 26.41 Tg (10.8%), Gujarat 23.31 Tg (9.6%), Uttar Pradesh 17.42 Tg (7.1%), Rajasthan 15.17 Tg (6.22%) and Karnataka 15.09% Tg (6.19%). These six states account for 51.8% of the CO_2 emissions from road transport.

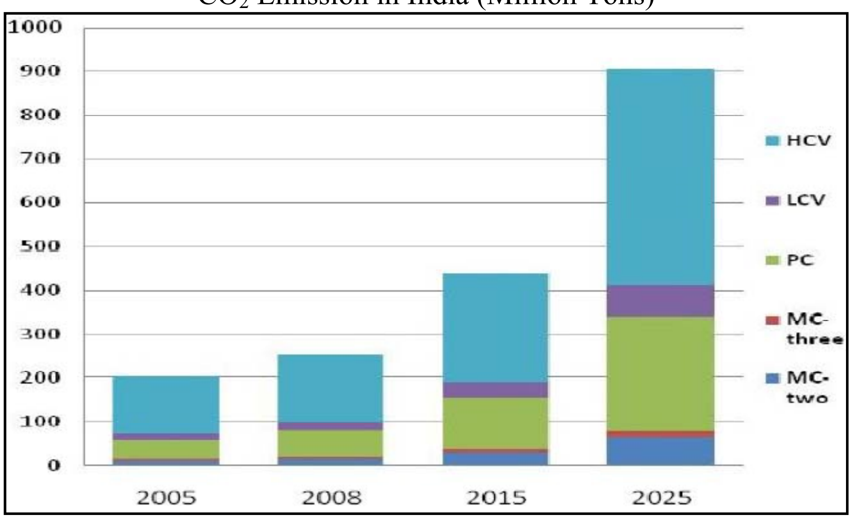
Figure: 3.11
CO_2 Emission in India (2008)



Source: CPCB, 2008

3.9.2 Main Trends of Motorization and Emission in India

Figure: 3.12
CO_2 Emission in India (Million Tons)



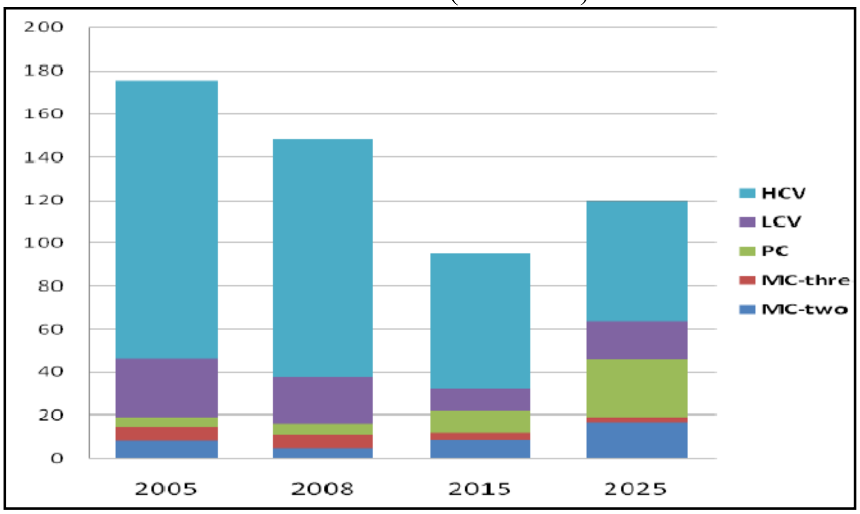
Source: ADB/CAI/Asia, 2008

- The number of total vehicles would grow at 8.70% per year, an increase from 49 million to 246 million between 2005 and 2025.
- CO_2 emission in India from transport is 1061 million metric tons per year.
- CO_2 emissions from road transport would increase at 7.75% per year, which is higher than many other Asian countries, from 203 million tons in 2005 to 905

million tons by 2025. The estimation of CO_2 by ADB in India shown in Figure (3.12).

- Passenger transport represents 45% and freight transport represents 55% of total CO_2 emissions from road transport in 2005; this ratio would remain approximately the same in 2025 (Figure: 3.13).

Figure: 3.13
PM Emission in India (Kilo Tons)



Source: ADB/CAI-Asia, 2008

- Particulate Matter (PM) emissions from road transport would decline until 2025 by 1.88% per year due to the adoption of stricter fuel and vehicle emission standards, while NO_x emissions would increase at a rate of 2.37% per year. However, PM emissions would subsequently rise again due to the continued rapid vehicle growth, especially if emissions standards are not further tightened (Euro IV and above).
- Only about 22% of total CO_2 emissions from land passenger transport in India attributed to intra-city movement in 29 mega cities (more than 10 lakh people) of India. It is probable that the remaining 78% of CO_2 emissions come from other 498 cities (India has a total of 527 cities with over 100,000 people) and movement of passengers and freight from one city to another (inter-city transport).
- If the current city trip mode share retained, CO_2 emissions would increase two or three fold between 2008 and 2025, due to a rapid growth in urban population and in the number of trips.

- Intercity transport contribution to India's total CO_2 emissions from road transport indicates that a 442 km stretch of 4-lane National Highway may approximately correspond to the total passenger transport emissions from intra-city movement in Bangalore. Similarly, CO_2 emissions from intra-city passenger transport in Delhi are comparable to a 772 km stretch of highway.
- The high emission from traffic in National Highways needs to be tackled by the government to reduce the environmental impact. The reason for relatively high emissions from National Highways is that freight transport dominates the highways (52% of the vehicle mode share) whereas 2-wheelers and 3-wheelers are more present on typical urban roads (about 40% of vehicle mode share). Because 2-wheelers and 3-wheelers are more fuel efficient and emit less CO_2 than larger vehicles, emissions from urban road transport are relatively lower compared to highways. A second reason could be high empty truck movements due to inefficiencies in freight logistics. Nearly 88% of the truck fleet is under unorganized operators.

3.10 CONCLUSION

While motorized transport has conferred many benefits on those who choose to live in urban areas, including many who do little travelling themselves, it has brought with it considerable adverse environmental consequences. Certainly old forms of transport were not free of pollution but the problem has compounded with the widespread use of internal combustion engine. Current traffic levels and modes of transport initialize anxiety and stress on the urban community as well as presenting a health hazard and damage to buildings and property. The damage that we cause to the environments makes it difficult for the future generation to live on earth comfortably.

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CHAPTER - 4

URABN ROAD TRANSPORT NETWORK IN INDIA: AN EXPLORATION

4.1 INTRODUCTION

Urbanization is a concomitant process of industrialization and it is the key index of economic growth both at the global and national level. It is an irreversible process by which, villages turns into towns and towns develop into cities. It is a measure of the process by which the proportion of the total population concentrated in the urban settlements increase. The National Commission on Urbanization appointed by Government of India in their recommendations has recognized urban areas are generators of economic momentum. The State Government also accepts the special economics inter-related to urban development. Urban areas are characterized by their concentrations of different economic activities. Hence, the rates of urbanization vary from global to national and regional level. The present chapter attempts to review the global and national trends in urbanization and the consequential development in urban transport in an infrastructural provision background.

4.2 TRENDS IN WORLD URBANIZATION

Between 2011 and 2050, the World population is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion (United Nations, 2011). At the same time, the population living in urban areas projected to gain 2.6 billion, passing from 3.6 billion in 2011 to 6.3 billion in 2050. Thus, the urban areas of the World expected to absorb all the population growth expected over the next four decades while at the same time drawing in some of the rural population. As a result, the World rural population projected to start decreasing in about a decade and there will likely be 0.3 billion fewer rural inhabitants in 2050 than today. Furthermore, most of the population growth expected in urban areas will be concentrated in the cities and towns of the less developed regions. Asia, in particular, is projected to see its urban population increase by 1.4 billion, Africa by 0.9 billion, and Latin America and the Caribbean by 0.2 billion. Population growth is therefore becoming largely an urban phenomenon concentrated in developing World.

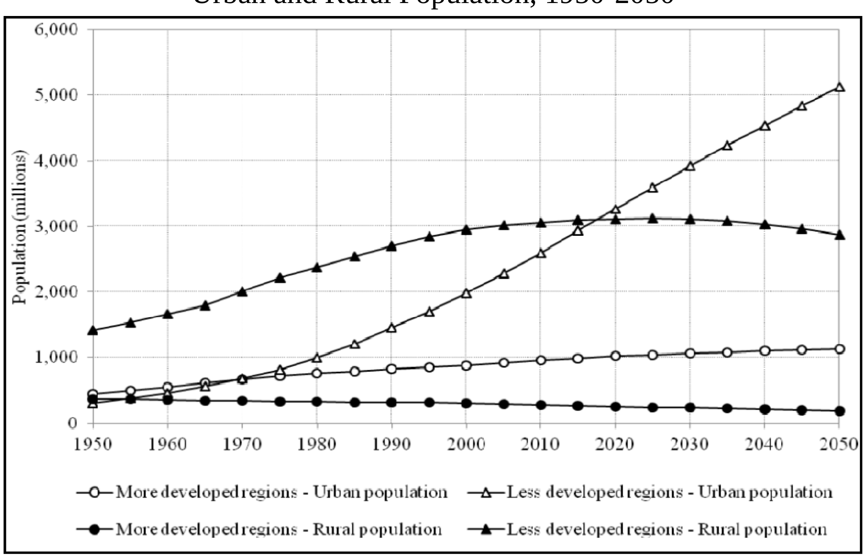
The World urban population would increase to 7.4 billion by 2050 instead of the 6.3 billion expected when fertility is assumed to continue declining in all developing regions. In many countries, natural increase (the difference of births minus deaths) accounts for 60 per cent or more of urban population growth. Consequently, policies that facilitate the reduction of fertility by ensuring that couples have access to the modern contraception and that they can decide freely the number of children they desire, can contribute to moderate increases in the number of urban dwellers, thereby making it easier for developing countries to adjust to the transformations associated with growing urbanization.

There is significant diversity in the urbanization levels reached by different regions. The transformative power of urbanization was felt earlier in today's more developed regions and they have reached high levels of urbanization. Thus, 78 per cent of the inhabitants of the more developed regions lived in urban areas in 2011, whereas just 47 per cent of those in the less developed regions did so. Urbanization is expected to continue rising in both the more developed and the less developed regions so that, by 2050, urban dwellers will likely account for 86 per cent of the population in the more developed regions and for 64 per cent of that in the less developed regions. Overall, the World population expected to be 67 per cent urban in 2050. Today's 3.6 billion urban dwellers are distributed unevenly among urban settlements of different size. In discussing urbanization, the focus often is on large cities, cities whose populations are larger than those of many countries are. In 2011, 23 urban agglomerations qualified as megacities because they had at least 10 million inhabitants.

The urban global tipping point reached in 2007, when for the first time in the history over half of the World's population (3.3 billion) people living in urban areas. It was estimated that a further 500 million people would be urbanized in the next five years. Projection indicate that World urban population is expected to reach 4.9 billion by 2030 (60 percent of the World population) from 3.49 billion in 2010 (World Urbanization Prospects, 2009 revision).

Figure: 4.1

Urban and Rural Population, 1950-2050



Source: World Urbanization Prospects, 2011

According to UN demographers, past and future World urban growth rates are higher than those for the overall population. They estimated that between 2009 and 2050, the global urban population rate (100 percent) will dwarf the total population rate (44 percent). The Global South (121 percent urban, 54 percent overall) will surpass the Global North (22 percent urban, 8 percent overall) with Africa showing the greatest change (167 percent urban, 122 percent overall) followed by Asia (119 percent urban, 33 percent overall). As per the 2010 estimates, the pattern on urbanization has revealed that North America is the highest urban continent followed by Latin America; by future potentials, Europe and Latin America would be more prominent in level of urbanization (World Urbanization Prospects, 2010). The World urban population expected to increase by 72 percent by 2050, from 3.6 billion in 2011 to 6.3 billion in 2050. The World urbanization trend given in Figure: 4.1.

The World urban population expected to increase by 72 per cent by 2050, from 3.6 billion in 2011 to 6.3 billion in 2050. Virtually all of the expected growth in the World population will be concentrated in the urban areas of the less developed regions, whose population projected to increase from 2.7 billion in 2011 to 5.1 billion in 2050. Over the same period, the rural population of the less developed regions expected to decline from 3.1 billion to 2.9 billion. In the more developed regions, the urban population projected to increase modestly, from 1 billion in 2011 to 1.1 billion in 2050. The World rural population expected to reach a maximum of 3.4 billion in 2021 and to decline slowly thereafter, to reach 3.05 billion in 2050. These global trends are driven mostly by the dynamics of rural population growth in the less developed regions, which house today almost 92 per cent of the World rural population. Whereas the rural population of the more developed regions has been declining steadily during the second half of the twentieth century and will continue to do so for the foreseeable future. The rural population of the less developed regions more than doubled since 1950 and will likely continue to grow until 2021 before a long-term decline sets in.

The rate of growth of the World urban population is slowing down. Between 1950 and 2011, the World urban population grew at an average rate of 2.6 per cent per year and increased nearly fivefold over the period, passing from 0.75 billion to 3.6 billion. During 2011-2030, the World urban population projected to grow at an average annual rate of 1.7 per cent, which, if maintained, would lead to a doubling of the urban population in 41 years. During 2030-2050, the urban growth rate is expected to decline further to 1.1 per cent per year, implying a doubling time of 63 years (Table: 4.1).

Table: 4.1
Total Urban and Rural Population, 1950-2050

Development group	Population (billion)					Average annual rate of change (percentage)			
	1950	1970	2011	2030	2050	1950-1970	1970-2011	2011-2030	2030-2050
Total population									
World	2.53	3.70	6.97	8.32	9.31	1.89	1.55	0.93	0.56
More developed regions	0.81	1.01	1.24	1.30	1.31	1.08	0.51	0.23	0.06
Less developed regions	1.72	2.69	5.73	7.03	7.99	2.23	1.85	1.07	0.65
Urban population									
World	0.75	1.35	3.63	4.98	6.25	2.98	2.41	1.66	1.13
More developed regions	0.44	0.67	0.96	1.06	1.13	2.09	0.89	0.52	0.29
Less developed regions	0.30	0.68	2.67	3.92	5.12	4.04	3.33	2.02	1.34
Rural population									
World	1.79	2.34	3.34	3.34	3.05	1.36	0.87	-0.01	-0.44
More developed regions	0.37	0.34	0.28	0.23	0.18	-0.48	-0.48	-0.92	-1.14
Less developed regions	1.42	2.01	3.07	3.11	2.87	1.74	1.03	0.07	-0.40

Source: World Urbanization Prospects, 2011

The sustained increase of the urban population combined with the pronounced deceleration of rural population growth will result in continued urbanization, that is, in increasing proportions of the population living in urban areas. Globally, the level of urbanization expected to rise from 52 per cent in 2011 to 67 per cent in 2050 (Table: 4.2). The more developed regions expected to see their level of urbanization increase from 78 per cent to 86 per cent over the same period. In the less developed regions, the proportion of urban will likely increase from 47 per cent in 2011 to 64 percent in 2050.

Table: 4.2
Percentage of Urban in Developed and Developing Regions, 1950-2050

Development group	Percentage urban					Rate of urbanization (percentage)			
	1950	1970	2011	2030	2050	1950-1970	1970-2011	2011-2030	2030-2050
World	29.4	36.6	52.1	59.9	67.2	1.09	0.86	0.74	0.57
More developed regions	54.5	66.6	77.7	82.1	85.9	1.01	0.38	0.29	0.23
Less developed regions	17.6	25.3	46.5	55.8	64.1	1.81	1.48	0.95	0.69

Source: World Urbanization Prospects, 2011

The World urban population not distributed evenly among cities of different sizes. Over half of the World's 3.6 billion urban dwellers (50.9 per cent) lived in cities or towns with fewer than half a million inhabitants. Such small cities account for 55 per cent of the urban population in the more developed regions and for 50.2 per cent of that in the less developed regions. In 2011, cities with fewer than 500,000 inhabitants accounted for about half of the World urban population, amounting to 1.85 billion.

Cities with populations ranging between 500,000 and 1 million were home to a further 365 million people, equivalent to 10.1 per cent of the World urban population. Cities with fewer than 1 million inhabitants account for 61 per cent of the urban population. During 2011, three in every five people living in urban areas reside in cities smaller than 1 million inhabitants. This proportion expected to decline in the future. By 2025, only one person out of two will live in cities of this size. In contrast, cities of 1 million and more inhabitants, accounting for about 40 per cent of the World urban population in 2011, expected to account for 47 per cent of the World urban population by 2025. Indeed, the future urban population will be increasingly concentrated in large cities of one million or more inhabitants.

In fact, among the million plus cities, the megacities of at least 10 million inhabitants will experience the largest percentage increase. This increasing urban concentration in very large cities is a new trend, which contradicts previous observations. By 1970, the World had only two megacities: Tokyo and New York. Since then their number has increased markedly and most new megacities have arisen in developing countries. Today, Asia has 13 megacities, Latin America has 2, and Africa, Europe and Northern America have 2 each. Thirteen of those megacities are capitals of their countries. In 2011, the World counted 23 megacities of at least 10 million inhabitants accounting for 9.9 per cent of the World urban population. The number of megacities is projected to increase to 37 in 2025, Asia would have gained another nine, Latin America two, and Africa, Europe and Northern America one each. This indicates a clear trend of accelerated urban concentration in Asia.

Between 1970 and 2011, the number of people living in megacities has multiplied almost 10 times, passing from 39.5 million to 359.4 millions. It is expected that this number will almost double by 2025 and reach 630 millions. Today, about one person out of 10 living in urban areas resides in a megacity of at least 10 million inhabitants. By 2025, it is expected that about 1 person out of 7-8 living in urban areas will live in a megacity. In relation to the overall population of the World, the share of megacities was 5.2 per cent in 2011, implying that just about one in every twenty people on Earth live in megacities. By 2025, the population living in megacities is expected to reach almost 8 per cent of the overall World population.

The World urban population is highly concentrated in a few countries. In 2011, about three quarters of the 3.6 billion urban dwellers on earth lived in 25 countries, whose urban populations ranged from 31 million in Ukraine to 682 million in China. China, India and the United States accounted for 37 per cent of the World urban population. Most of the 25 countries with the largest urban populations are highly urbanized, but eight have levels of urbanization ranging from 28 per cent to 51 per cent and they include some of the most populous countries in the World: Bangladesh, China, India, Indonesia, Nigeria and Pakistan.

The increase in the World urban population are concentrated in a few countries, with China and India together projected to account for about a third of the increase in the urban population in the coming decades. Between 2011 and 2030, the urban areas of the World expected to gain 1.4 billion people, including 276 million in China and 218 million in India, which account together for 37 per cent of the total increase. A further urban increment of 1.3 billion people expected globally during 2030-2050, with India being the major contributor (270 million). Thus the urban population scenario, India occupies a dominant role.

4.3 TRENDS OF URBAN GROWTH IN INDIA

India is in a phase of rapid economic and demographic transition. As result of economic reforms and globalization, rural urban migration increases, that fastens the rate of urbanization. In India, The definition of 'Urban' given by Census of India is as follows:

1. A minimum population of 5000
2. At least 75 percent of male working population engaged in non-agricultural pursuits and
3. A density of population of at least 400 persons per sq.km.

Urban areas account for about 60 percent of the Gross National Product of the Country. In the year 1951, there were 2843 Census urban towns accommodating 17.29 percent of the Country's population. By the year 2001 Census urban towns increased to 4378 and our urban population was 27.8 percent of the nation's population. It expected to increase up to around 37 percent by the year 2021. Consequently, the number and size of cities have also increased considerably.

India shares most characteristic features of urbanization in the developing countries. Number of urban agglomeration /town has grown from 1827 in 1901 to 5161 in 2001. Number of total population has increased from 23.84 crores in 1901 to 102.7

crores in 2001 whereas number of population residing in urban areas has increased from 2.58 crores in 1901 to 28.53 crore in 2001. India is at acceleration stage of the process of urbanization. The current trends of population growth coupled with urban growth are light debilitating in India. Over the last ten decades, India has experienced more than two-fold increase in its level of urbanization during 1901 to 2001. It is very clear that the proportion of urban population in India was only 10.84 percent in 1901 and steadily increased to 17.29 percent in 1951 and to 27.8 percent in 2001. Now it is 31.2 percent (2011 Census). India's 2011 Census shows that once in every three Indians now lives in an urban habitat. The recommendations of the Administrative Reforms Commission appointed by Government of India submitted in October 2007 State that 'by 2050, over half of the India's population is expected to be urban dwellers'.

The distribution of urban population by city size widely varies and skewed towards larger cities. One specific feature of India's urbanization is the increasing metropolitaisation, that is, growth in the number and size of cities with a million plus population. One fifth of the population of India lives in six mega cities (Shukla, 1996). As per the UN agglomeration chart of 1990, there were 12 cities in the World with a population of 10 million or more. Two of these 12 World cities, viz, Bombay and Calcutta were in India. The number of metropolitan cities in India rose from 23 in 1991 to 35 in 2001. India's metropolises grew rapidly during the 1990s with Surat registering the fastest growth of 85.1 percent followed by Faridabad (70.8 percent), Nasik (58.8 percent), Patna (55.3 percent), Jaipur (53.1 percent), Delhi (51.9 percent).

Table: 4.3

Degree of Urbanization in India (1901-2001)

Census Year	Percent Urban	Percent Rural	Urban-Rural Ratio(Percent)
1901	10.84	89.15	12.16
1911	10.29	89.71	11.47
1921	11.18	88.82	12.58
1931	11.99	88.01	13.63
1941	13.86	86.14	16.08
1951	17.29	82.71	20.91
1961	17.97	82.03	21.91
1971	18.24	81.76	22.31
1981	23.33	76.66	30.44
1991	25.72	74.28	34.63
2001	27.78	72.22	38.47
2011	31.16	68.84	41.06

Source: Census Reports, Various Years

The degree or level of urbanization defined as relative number of people who live in urban areas. It is clear from Table: 4.3 that urban percent has increased from 11percent in 1901 to 27.78 percent in 2001 census and 31.6 percent in 2011 census, whereas proportion of rural population has shown gradual decrease from 89.15 percent to 72.22 percent over a century. Now rural population is 68.84 percent as per 2011 census. Urban rural ratio, which is a simple index measuring number of urbanites for each rural person in a real unit experiences an increasing trend during hundred years in the process of urbanization in India. The urban-rural ratio for India in 2001 turns out to be around 38, meaning that against every 100 ruralites there are 38 urbanites in India in 2001. All these indices pin point that India is in the process of urbanization (Sovani, 1966) and it is at the acceleration stage of urbanization. The correlation between the urban and rural population growth is negatively related with -1 value. As per the 2011 census, there are 7935 towns in India (an increase of 2774 from 2011 census), out of that, 4041 are statutory towns (an increase of 242 from 2001 census) and 3894 are census towns (an increase of 2532 from 2001 census).

4.4 VOLUME AND TREND OF URBANIZATION IN KERALA

The district wise population in Kerala as per the 2011 Census shown below in Table: 4.4.

Table: 4.4

District Wise Population in Kerala

District	Population	Males	Percentge Share	Females	Percentge Share
Thiruvananthapuram	33,07,284	15,84,200	47.90	17,23,084	52.09
Kollam	26,29,703	1244815	47.34	1384888	52.66
Alappuzha	2121943	1010252	47.61	1111691	52.39
Pathanamthitta	1195537	561620	46.98	633917	53.02
Kottayam	1979384	970140	49.01	1009244	50.99
Idukki	1107453	551944	49.84	555509	50.16
Ernakulam	3279860	1617602	49.32	1662258	50.68
Thrissur	3110327	1474665	47.41	1635662	52.59
Palakkad	2810892	1360067	48.39	1450825	51.61
Kozhikode	3089543	1473028	47.68	1616515	52.32
Wayanad	816558	401314	49.15	415244	50.85
Malappuram	4110956	1961014	47.70	2124942	51.69
Kannur	2525637	1184012	46.88	1341625	53.12
Kasargod	1302600	626617	48.11	675983	51.89
Total	33387677	16021290	47.99	17366387	52.01

Source: Census India 2011

Compared to other Indian States, Kerala occupies the fourth position with regard to urbanization. The share of urban population in Kerala recorded steady growth from 7.11 percent in 1901 to 47.72 percent in 2011. The higher growth of urban population is mainly due to the increase in the number of town's from 159 to 520 during the period 2001 to 2011. The percentage of urban population growth in the State has increased to 6.3 percent per annum. The State exhibits a steady increase in urban population from 16.24 percent in 1971 to 25.97 percent in 2001 and 47.72 percent in 2011. However, the percentage of urban population has declined from 1991 to 2001, because of reduction in number of Census towns and the change in jurisdiction in statutory urban areas in the State. Kannur district shows the highest share of females in total population, 53.12 percent, and Idukki district shows 49.84 percentage of males, the highest in Kerala as per 2011 Census. The following Table: 4.5 shows the indices of urban population of State/Districts or the period of 1901-2011. The Compound Annual Growth rate of this in Kerala is 34.49 percent.

Table: 4.5

Indices of growth of urban population of State/District (1901-2011)

State/ Districts	2011	2001	1991	1981	1971	1961	1951	1941	1931	1921	1911
Kerlala	3505	1819	1690	1050	763	562	402	263	202	150	115
Kasaragod	6090	2817	2124	520	1373	1072	506	139	111	88	100
Kannur	2950	2178	2057	1100	379	380	148	127	116	99	105
Wayanad	138	129	100	100-	100	100	100	100	100	100	100
Kozhikode	2350	1247	1138	691	636	430	258	185	125	104	101
Malappuram	17198	3372	2674	1683	1182	719	603	400	241	204	212
Palakkad	1158	610	640	353	366	255	251	170	126	117	109
Thrissur	6698	2691	2308	1650	801	595	526	384	283	166	130
Ernamkulam	3009	1991	1851	1352	857	533	353	256	203	130	118
Idukki	1506	1667	1473	1292	731	100	309	121	100	100	100
Kottayam	1778	942	1009	500	656	520	482	296	246	179	102
Alappuzha	3741	2027	1988	1123	1047	901	632	405	346	248	103
Pathanamthitta	1650	1553	1945	779	484	430	670	287	234	151	100
Kollam	7561	2970	2843	2149	1210	919	755	479	342	263	120
Trivandrum	3074	1886	1725	1133	987	775	531	308	231	176	110

Source: Census Report, 2011

If we examine the indices of growth of population in the various districts of the State that happened over decades from 1901 onwards, it can be seen that considerable increase in index of urban population was witnessed during 1991-2001 in all the districts except Palakkad, Kottayam, and Pathanamthitta, whereas during 2001-2011, the urban index value increased all districts except Idukki. Malappuram district has the highest index value of growth during 2001-2011 with 17,198 followed by Kollam with 7,561, Thrissur with 6,698 and KasarAgod with 6,090. All other districts have an index of growth below 4,000. Wayanad district has the lowest index value (138). The other districts with lower index value below 2000 are Palakkad (1,158), Idukki(1,506), Pathanamthitta (1,650) and Kottayam (1,778). It is noted that the growth of urban population in the State/Districts during 1901- 2011 with base 1901 as base (1901=100) is presented.

Table: 4.6

Trends in Urbanization 1901-2011

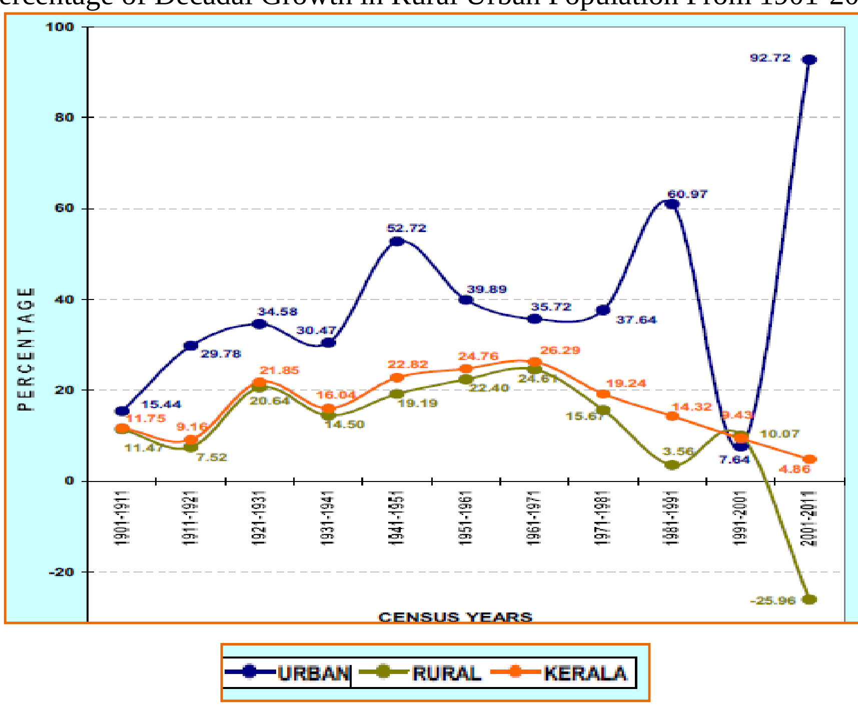
Year	Number of UAs	Number of Towns	Total Population	Total Urban Population	Percentage of Urban Population	Decennial Growth Urban		Annual Exponential Growth Rate
						Absolute	Percent	
1901	-	21	6396262	454499	7.11	-	-	-
1911	-	27	7147673	524661	7.34	70162	15.44	1.44
1921	-	44	7802127	680900	8.73	156239	29.78	2.61
1931	-	53	9507050	916330	9.64	235430	34.58	2.97
1941	-	62	11031541	1195550	10.84	279220	30.47	2.66
1951	-	94	13549118	1825832	13.48	630282	52.72	4.23
1961	-	92	16903715	2554141	15.11	728309	39.89	3.36
1971	-	88	21347375	3466449	16.24	912308	35.72	3.05
1981	9	106	25453680	4771275	18.74	1304826	37.64	3.19
1991	16	197	29098518	7680294	26.39	2909019	60.97	4.76
2001	17	159	31841374	8266925	25.96	586631	7.64	0.74
2011	19	520	33387677	15932171	47.72	7665246	92.72	6.56

Source: Census Report, 2011

The State Kerala consists of 14 districts, 63 Taluks, 520 Towns and 1018 Villages. More than one fourth of the total population of Kerala live in urban areas (25.96 percent) and this is little less than the national average. Compared to other States the urban- rural system in Kerala have many distinct and peculiar characteristics. The urbanization in Kerala is not limited to the designated cities and towns. Generally, increase in the growth rate of urban population is the result of over concentration in the existing cities especially in metropolitan cities. However, in Kerala, the main reason for the growth of urban population is the increase in the number of urban areas. Trends of urbanization in Kerala from 1901-2011 shown Table: 4.6. It shows that the number of urban agglomerations /towns has increased over the period from 1901 to 2011, but the change from 1991 to 2001 is only marginal. There were 197 Census urban towns (65 statutory towns and 132 Census towns) in the State in 1991 which decreased to 159 (60 statutory towns and 99 Census towns) in 2001, but now as per the 2011 census it is 520. The population of Kerala has increased from 255 lakh in 1981 to 291 lakh in 1991 and 338 lakh in 2011. The density of population was 747 persons per sq. km in 1991, which increased to 819 persons per sq. km in 2001. The density of population varies from the coastal plains to the highland regions, the highest in the coastal land and the lowest in the highland. The share of urban population in Kerala recorded steady growth from 7.11 percent in 1901 to 26.39 percent in 1991, but then declined to 25.96 percent in 2001 and then increased to 47.72 percent. In Kerala, it is very difficult to demarcate the urban and rural areas since the features in rural and urban areas are almost alike. Percentage of decadal growth in rural urban population is given in Figure: 4.2

Figure: 4.2

Percentage of Decadal Growth in Rural Urban Population From 1901-2011



Declassification of a few Census towns in 2001 as rural has also contributed to the lower proportion of urban population in the State. Among the districts, the percentage of urbanization has varied from 3.8 percent in Wayanad to 50.4 percent in Kannur. Ernakulam district follows Kannur with 47.6 percent urban population. In six districts of Kannur, Ernakulam, Kozhikode, Thiruvananthapuram, Alappuzha and Thrissur, the percentage of urban population is higher than the State average.

In Kerala the population has got settled all along the transportation routes in non-nucleated settlements with about 75 percent by the side of National Highway or the railway line, the average distance between these urban centers is about 15 Km. The overall development presents a rural urban continuum or 'rurban' character. This has led to the development of evenly spaced urban centers. Due to the nearness of the urban centers and the easy availability of infrastructure facilities even in rural areas, there is practically no push factor to urban areas from rural areas. The fast urbanization trend noticed in Kerala is not due to the rural to urban migration, but rather due to the transformation of the rural areas due to occupational shift. Another reason is the increase in the number of urban areas and urbanization of the peripheral areas of the existing major urban centers. This is quite clear from the study of the density patterns also. Kerala has the third highest overall density in 2011. Nevertheless, the density pattern in our major cities and towns shows that, the increase in density is due to the overall population increase over the entire spread of Kerala, which occasionally accentuated in the urban areas with nominal variations.

4.5 URBANIZATION IN ERNAKULAM DISTRICT: A COMPARISON WITH THE NATIONAL AND STATE SCENARIOS

Census 2001 recognizes 27.78 percent of the population of India as urban (Out of India's population of 102.70 crore, 28.54 crore live in urban areas). However, in 2011 census the rate increased to 51.51 percent with total population of 109.10.14 crore. During the last three decades, India has witnessed significant increase in the population of its metropolitan cities. There are 35 million plus cities in India as per the Census 2001. The State of Kerala accommodates only 2.90 percent of the urban population of India. However, the State has witnessed steady growth in the urbanization. The urban content of the State's population which was only 15.11 percent in 1961 has risen to 47.72 percent in 2011. The urban population of 159.32 lakh (2011) is accommodated in 520 urban areas comprising of 60 statutory towns and 99 census towns. A peculiar phenomenon of the urbanization trend in Kerala is that a major percentage of this urban population is within 17 urban agglomerations (UA). Kochi in Ernakulam district is one among the eleven cities, which have newly emerged as big cities in India having more than 10 lakh populations (2011 Census).

A remarkable feature of urbanization is that though the urban content of the State's population is only 25.97 percent, Ernakulam is the most urbanized district in the State in terms of absolute number of urban population (14.77 lakhs) and the percentage of urban to total district population (47.56 percent) as per 2001 census. The distribution of towns by size, class and population in the State shows that there are 7 Class 1towns with a population over 100,000 (one lakh). Kochi UA has the most number of constituent units (25) with Kannur in the second place with 16 constituent units and Kozhikode in the third position with 14 constituent units. All the other UAs have only 10 or less than ten constituent units. A comparison of urbanization trend and growth rate in Ernakulum with Kerala and India are given in Tables :4.7 ; 4.8)

Table: 4.7

Comparison of Urbanization Trend between India, Kerala and Ernakulum District

Year	India			Kerala		Ernakulum		
	Total	Urban	Percent Urban	Total	Urban	Total	Urban	Percent Urban
	Population (In Lakhs)			Population (In Lakhs)		Population (In Lakhs)		
1971	5481.6	1091.1	19.91	213.5	34.7	23.83	6.36	26.69
1981	6833.3	1594.6	23.34	254.5	47.7	25.35	10.03	26.69
1991	8463.1	2176.1	25.71	290.9	76.8	28.17	13.7.3	48.74
2001	10270.2	2853.6	27.78	318.4	82.7	31.06	14.77	47.56
2011	10910.1	5619.8	51.51	333.9	47.7	32.82	22.32	50.37

Source: Census Report, 2011

Table: 4.8

Comparison of Growth-India, Kerala and Ernakulam

Geographical Unit	1971-81 percent		1981-1991 percent		1991-2001 percent		2001-2011 percent
	Total	Urban	Total	Urban	Total	Urban	Total
India	24.7	46.1	23.9	36.5	21.3	31.1	17
Kerala	19.2	37.6	14.3	60.9	9.4	7.6	4.9
Eranamkulam	17.2	36.6	11.1	36.9	9.1	7.6	5.7

Source: Census Report, 2011

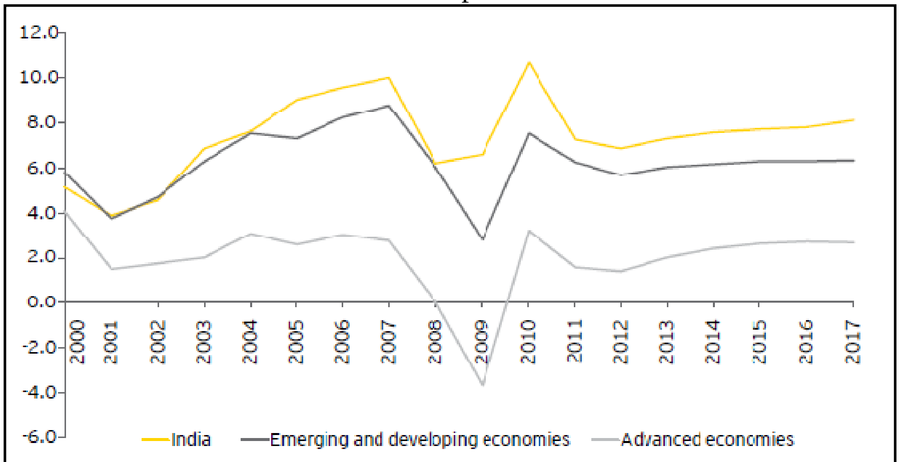
In the state of Kerala, there are 461census town and 59 statutory towns for the census 2011. District with highest number of statutory towns is Ernakulam (9), and it has 16 census towns, thus 25 towns. This district has the highest urban population of 22, 32,564. Ranking of district by percentage of urban population during 2001 and 2011 census shows that Ernakulam ranked as 1 among the 14 districts of Kerala. From the Tables: 4.7, 4.8, it is clear that the percentage of urban population to total population is greater in Ernakulam district than that in any other district in Kerala or in the State as a whole or in India. Ernakulam district is the most urbanized district in Kerala, with Kochi Urban Agglomeration acting as a magnet attracting economic investments in many sectors.

The growth of urban areas in the Country has resulted imbalanced development in the Country. The dispensed settlement pattern, a result of historical trends, a linking for homestead type of development, comparatively less developed infrastructure in urban areas, geographical reasons etc. can be considered as both a prospect and problem in this context. In terms of investment in infrastructure development, we spend a good share of budgetary resources. However, if the existing spatial pattern of urbanization allowed to continue, urban growth would further get concentrated in the areas and cities which are already bursting to the seams and which may not be able to support such large urban population with reasonable level of urban infrastructure.

4.6 INFRASTRUCTURE INVESTMENT IN INDIA

The global economy is currently facing several issues. Developed as well as emerging economies are expected to witness a slowdown in growth in the next five years. India is also likely to slow down from the high GDP growth trajectory of 8.1 percent (on an average), it witnessed in 2006–2011. A comparison of growth rate in India with those of the other advanced and developing economies shown by the figure below (Figure: 4.3). Most estimates peg the Country’s GDP growth to be less than 7.0 percent for 2012. IMF estimates that India’s GDP growth will be 6.9 percent during 2011–12 and ADB forecasts that it will be 6.5 percent during this period. This has raised doubts on the sustainability of the Country’s growth story.

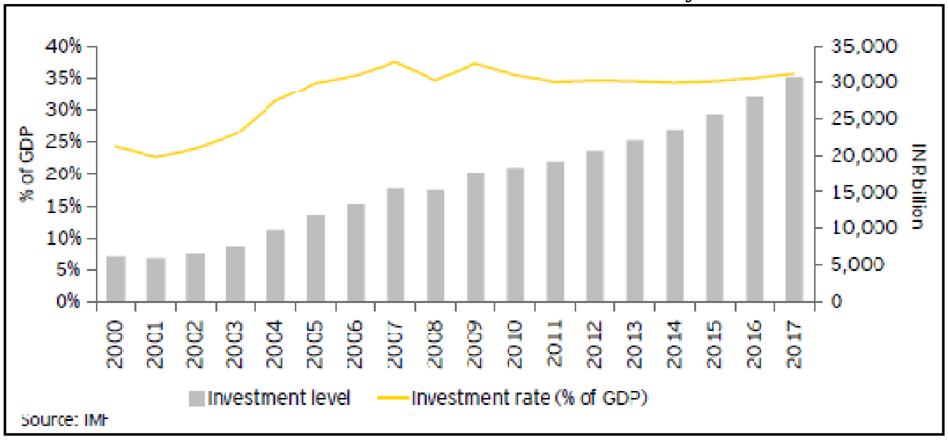
Figure: 4.3
Growth Rates: Comparison with India



Source: World Economic Outlook Database, IMF

There are many reasons put forward for the decline in India’s growth. It was thought that the primary reason for this is decreased investment in the Country. The investment trend in Indian economy depicted graphically (Figure: 4.4). Investment in absolute terms has increased, but its rate of growth has declined drastically in the last two or three years. This is partly attributed to cyclical and global factors, but more importantly, to slow reforms and delays in implementation of projects.

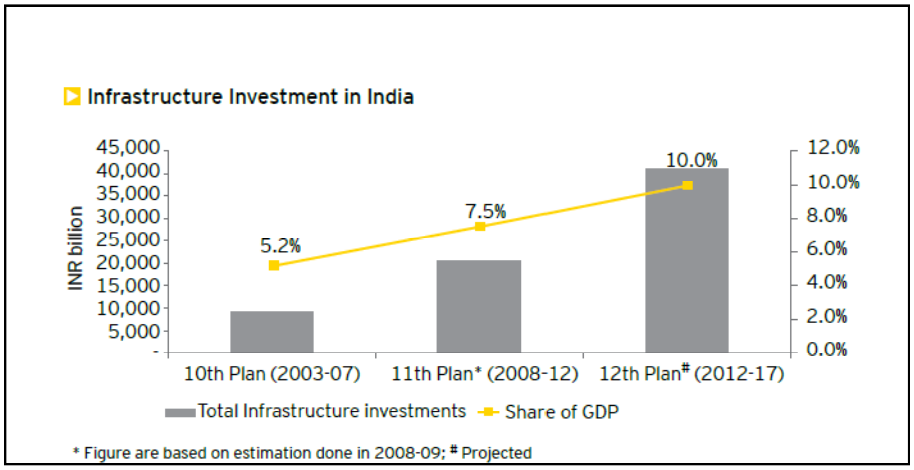
Figure: 4.4
Investment Trend in Indian Economy



To put India on track to achieve its previous growth trajectory, there is a need to provide an impetus to investments.. In this scenario, infrastructure investments will assume more importance than before to sustain economic growth. Infrastructure both economic and social plays a crucial role in determining the prosperity of an economy by enhancing the productive capacity in a self-accelerating process of economic development. Dr. V.K.R.V. Rao has rightly pointed out that, '*the link between infrastructure and development is not a once for all affairs, and if proper attention is not paid to the development of infrastructure, it is likely to act as a severe constraint on the economic development processes in the Country. Economic infrastructure is a sign of social, political, and cultural progress and it comprised of all those services or inputs which influences the production, consumption and distribution process directly, hence receive paramount importance in the county's developmental context*'.

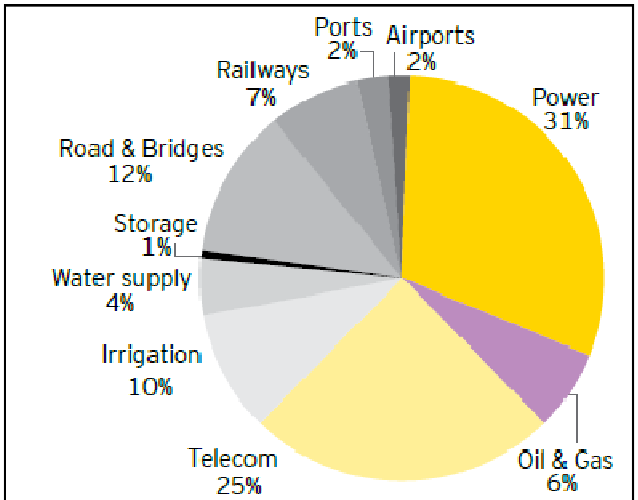
The Government of India realizes the importance of accelerating the investments in infrastructure to boost the Country's slowing economy. Therefore, it has set a massive target for doubling investment in infrastructure from INR 20.5 trillion to INR 40.9 trillion during the Twelfth Plan period, i.e., 2012–2017 (Figure: 4.5). The Twelfth Plan increased the share of total investment in infrastructure, including roads, railways, ports, airports, electricity, telecommunications, oil gas pipelines and irrigation to more than 10.5 percent by the end of the Plan period. This planned investment, if it is realized, can propel the Country's economic growth to a higher trajectory.

Figure: 4.5
Infrastructure Investment in India



Source: Twelfth Five-Year Plan, Planning Commission.

Figure: 4.6
Sectoral Investment Planned in 12th Five Year Plan



Source: 12th Five-Year Plan Approach Paper

In general, India has performed impressively by achieving its planned investment targets in infrastructure, which were set in the Eleventh Plan (Table: 4.9). It's clear from Table: 4.9 that percentage of investment in infrastructure for roads and bridges is 15.3 percent (original) and 13.56 percent (actual). However, a closer analysis reveals that it is likely that overall investment targets have achieved due to the strong performance of the Telecom and Oil & Gas sectors. It is to be note that the critical segments of infrastructure, i.e. roads, railways and ports, have under-achieved their investment targets by 22 percent in the Eleventh Plan.

Achieving physical targets in key infrastructure sectors is the primary measure of success of infrastructure plans and inspires confidence about the positive growth of the economy. However, most infrastructure projects commissioned during the last two Plan periods witnessed time and cost overruns: around 42 percent of the total number of 564 infrastructure projects in India costing more than INR 1.5 billion, are delayed and around 31 percent were sanctioned without any fixed commissioning date. This has resulted in an average escalation of 16.9 percent, amounting to an incremental cost of INR 1,207 billion. Therefore, while these delays have partially bridged investment shortfalls, they have increased the gaps in the achievement of actual physical targets, resulting in a huge backlog. Clearing the backlog along with the targets set for Twelfth Plan appears to be a challenging task, given the delays witnessed in execution of projects.

Table: 4.9

Investments in infrastructure in the Eleventh Plan

Category	Original	Actual	Percent of Target
Electricity	666525	658630	-1
Telecommunications	258439	345134	34
Roads and Bridges	314152	278658	-11
Irrigation	253301	246234	-3
Railways	261808	200802	-23
Water Supply	143730	111689	-22
Ports	87995	40647	-54
Airports	30968	36138	17
Storage	22378	8966	-60
Oil & Gas	16855	127306	655
Total	2056150	2054205	-

Source: Appraisal of Eleventh Five Year Plan

Typically, infrastructure comprises power, ports, airports, roads, railways, irrigation, oil and gas, telecom and urban infrastructure. Among these, transport plays a crucial role as it is vital to the economic development and social integration of the Country. Economic development of a Country is very much dependent on an efficient transport system, which is an important economic infrastructure in the Country context. The need for transport increasingly felt with the replacement of independent village economy by national or international economy. A well–knit and coordinated system of transport plays an important role in the sustained economic growth of a Country. Let us discuss with the development of transport in the globe from prehistoric period onwards.

4.7 DEVELOPMENT OF TRANSPORT: GLOBAL SCENARIO

The history of this mobility or transport is the history of civilization. Early Paleolithic and Neolithic man couldn't transport more than he was able to carry on his back. In the late Neolithic, Beasts of Burden began to be used and could be loaded or tied to animal's backs. After sometimes, early man invented the log roller for this task. Wooden sledges are first known by at least 7000 BC, among communities in northern Europe, on the fringes of the Arctic. In southern Russia and Mesopotamia Ox-drawn, sledges are in use by the fourth millennium BC. A wagon used more than 5000 years ago, near what is now Zurich. It is now one of the earliest known examples of wheeled transport. The horse is available in Mesopotamia by about 2000 BC. Not much later a two-wheeled chariot is developed. The main improvement in classical times derives from the construction of roads, first in the Persian and then in the Roman Empire.

Between about 520 and 510 BC the Persian emperor, Darius I (The Great Canal of Darius I: 6th Century BC), builds a canal linking the Nile and the Red Sea. It later becomes the terminus of the Suez Canal. The great network of Roman roads (2nd Century BC - 2nd Century AD) was the arterial system of the then empire. The Grand Canal: 3rd Century BC- 13th Century AD was one of the achievements of Chinese, the greatest early builders of canals. Chinese were improving the design of the Junks and Caravels during 12th -15th Century AD. The caravel is much smaller than the junk, but it is better suited to sailing in violent oceans. A caravel takes Magellan's crew on the first circum navigation of the globe in 1519-1922. The Inca roads, 15th Century AD, the arteries of an empire, amount in all too more than 14,000 miles. European Canals: 12th - 17th Century AD is an integral part of economic development. Britain constructs the first integrated system of waterborne traffic. Carriages are available for hire in the streets of London from 1605. The Bridgewater canal (AD 1759-176) is the first in Britain, which was the start of the Country's inland waterway system. In 1775 the first major effort is made by British colonists to build a road west through the Appalachians, so as to enable settlement of the land won from France in the French and Indian War. The Wilderness Road is the first example of American settlers blazing a trail. The first mail coach runs from Bristol to London in 1784. By 1797, there are forty-two routes in operation. In Britain, with the introduction of the mail coach in 1784, Improvement in the speed of coaches has seen. The settlement of the Ohio valley, and the admission of Ohio to the Union in 1803, prompts the construction of the USA's first great federal road project (The National Road: AD 1811-1852).

In the mid 19th century, railways revolutionized travel. The first major railway opened in 1930 from Liverpool to Manchester. The first underground railway in Britain was built in London in 1863. First electric underground trains began running in London in 1890. From 1829 horse, drawn omnibuses began running in London. In the 1860s and

1870s horse, drawn trams began running in many towns. The steam ship revolutionized sea travel. By 1815, steamships were crossing the English Channel. Then in 1838, a steam ship called the Sirius made the journey in 19 days. In 1897, Charles Parsons invented the steam turbine.

Karl Benz and Gottlieb Daimler made the first cars in 1885 and 1986. In 1934, a speed limit of 30 MPH in built-up areas introduced. The first traffic lights were installed in London in 1926. A driving test introduced in 1934. The parking meter invented by Carlton Magee installed in the USA in 1935. In 1983, wearing a seat belt made compulsory. In 1936, Belisha Beacons introduced to make road crossing safer. The first zebra crossing introduced in 1951. In 1931, an American called Rolla N. Harger invented the first breathalyzer. It was first used in Indianapolis USA in 1939. A Swede named Nils Bohlin developed the three-point seat belt in 1959. Meanwhile in the late 19th century horse drawn trams ran in many towns. At the beginning of the 20th century, they were electrified. At the end of the 20th century, some cities re-introduced light railways. In the mid-20th century, there was a large network of branch railways. The first hovercraft launched in 1959. The first hovercraft passenger service began in 1962. In 1919, Airplanes began carrying passengers between London and Paris. Jet passenger aircraft introduced in 1949. The Boeing 747, the first 'Jumbo jet' introduced in 1970. The Channel Tunnel opened in 1994.

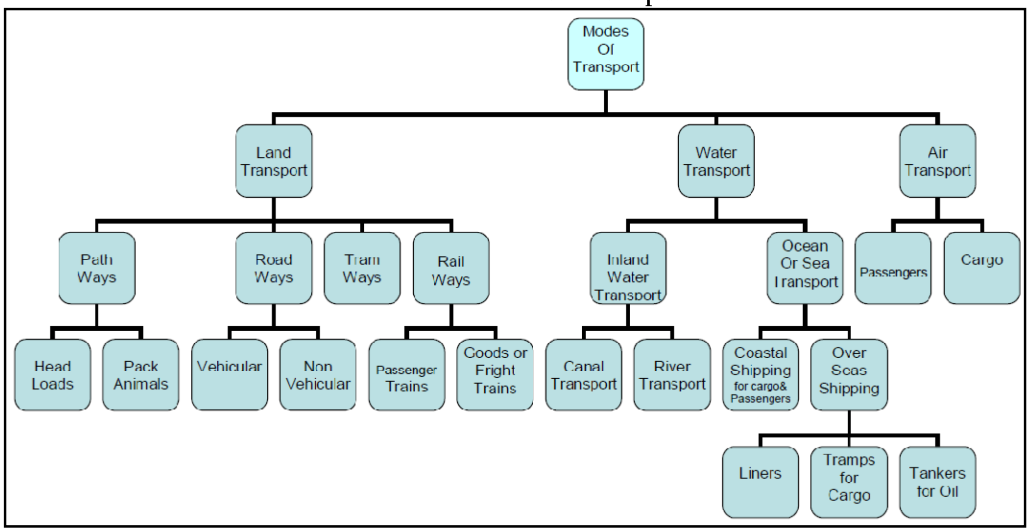
From the above analysis, it is very clear that transportation occurred mainly through three means. A brief explanation of these given below:

4.8 MEANS OF TRANSPORT

The means of transport classified based on the way, the vehicle, the motive power used and terminals. A detailed classification shown in figure below (Figure: 4.7). It shows that there are mainly three modes of transport: air, water and land transport. Land Transport classified as pathways, roadways, tramways and railways. In remote villages, forest and hilly areas, pathways are still an important amongst the different modes of transport. The animals like horse, pony, donkey, ass, buffaloes, camel, elephant, yak, sheep etc. used for this purpose.

Road Transport is one of the most important modes of transport. It further subdivided into Vehicular Transport (Cars, Trucks, Buses, Lorries, Autoricksaws, Bullock Carts, Tongas, Tumtums, and Hand Carts etc.) and Non-vehicular Transport (Hamals, Animals like Camel, Dogs, Elephant, Horse, Mules etc.). Tramway is suitable in large cities. Railway has been the pioneer of modern mechanical transport. Until the introduction of Motor Transport, Railway had the monopoly as the Land Transport. Water transport is the cheapest and the oldest form of transport for heavy goods and bulk cargoes. It may be classified Inland Waterways through river transport and canal transport and Sea transport through coastal shipping and Overseas Shipping. Air Transport subdivided into passenger and cargo.

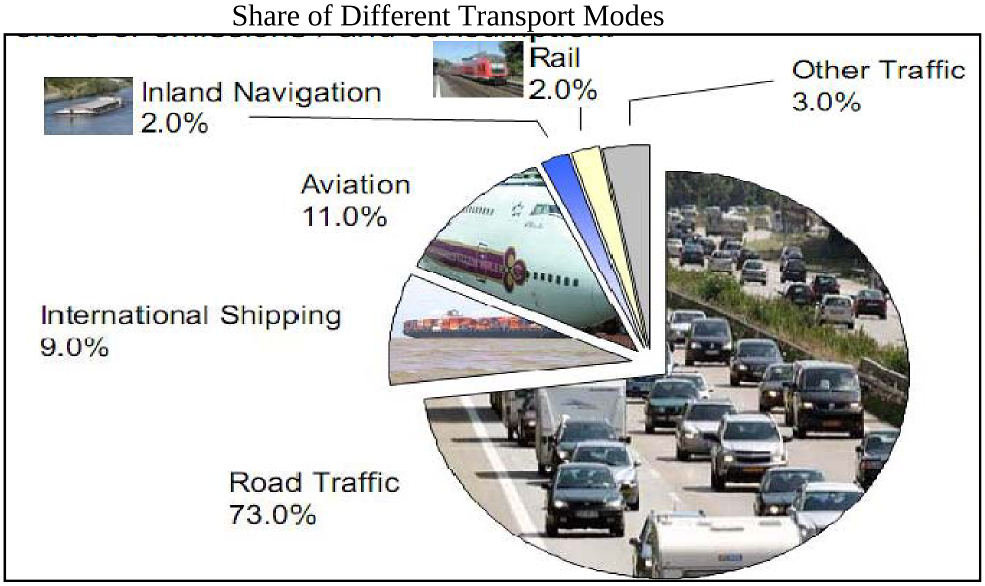
Figure: 4.7
Different Means of Transport



4.9 TRANSPORT SYSTEM IN INDIA

India has a large and extensive transportation system. The transport system in India comprises a number of distinct modes and services, notably railways, roads, road transport, ports, inland water transport, coastal shipping, airports, and airlines.

Figure: 4.8
Share of Different Transport Modes



Railways and roads are the dominant means of transport carrying more than 95% of total traffic generated in the Country. Although other modes such as coastal shipping and inland water transport would play a greater role, the railways and roads would continue to dominate the transport landscape in the near future. Share of different transport mode in India given in Figure: 4.8.

4.9.1 Budgetary Provision for Transport

Transport is the core component of infrastructure, which plays an important role in conveyance of goods and passengers and linking the centers of production, consumption and distribution. It is also a key factor for promoting socio-economic development in terms of social, regional and national integration. Over the years, the budget share of transport infrastructure has been increasing. The budget share on the transport sector in India given in Table: 4.10.

Table: 4.10

Budget Share on The Transport Sector in India (in percent)

Five Year Plan	Railways	Roads	Ports, Light House, Etc	Shipping	Civil Aviation	Total
I	11.07	7.5	1.43	0.97	1.17	22.14
II	15.57	5.18	0.71	1.13	1.1	23.69
III	15.46	5.26	1.13	0.47	0.47	22.79
IV	5.91	6.27	1.62	0.98	1.12	15.9
V	5.23	5.59	1.26	1.19	0.75	14.02
VI	6.03	4.77	0.66	0.43	0.88	12.77
VII	7.56	3.8	0.69	0.33	0.8	13.18
VIII	6.65	4.05	0.48	0.62	1.5	13.3
IX	5.64	3.1	1.44	0.46	1.04	11.68
X	8.65	8.24	0.43	0.6	0.94	18.86

Source: Infrastructure, CMIE, May (2006).

Though the overall budget share of the transport sector has decreased over the years, in the Tenth Plan, the budget share has increased significantly. One of the important aims of the Tenth Plan would be modernization and technological improvements of the railways. Similarly, road development with private participation to improve the quantity to meet the increasing demand is also a concern under this plan. From Table: 4.10 it is very clearly seen infrastructure was increased considerably from 11.73 percent in the Ninth Plan to 19.12 percent in the Tenth Plan.

Sustained economic growth has brought about expansion of the transport sector. The transport sector in India comprises both the public works and the transport sectors. The public works facilitates such as roads, dams, canals, and irrigation drainage facilities. This sector includes urban and inter urban railways, urban road transport, waterways, sea ports and air ports. India's transport sector is large and diverse. Transport sector caters to the needs of 1.1 billion people. Since the early 1990s, India's growing economy had witnessed a rise in the demand for transport infrastructure and services by around 10 percent a year.

Table: 4.11
Share of Different Modes of Transport in GDP

Sector	1999-2000	2000-01	2001-02	2002-03	2003-04	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
Transport Sector	5.9	6.0	6.0	6.2	6.3	6.7	6.7	6.7	6.6	6.5	6.5
Railway Transport	1.3	1.3	1.2	1.2	1.2	1.0	1.0	1.0	1.0	1.0	1.0
Road Transport	3.8	3.9	3.9	4.1	4.3	4.8	4.8	4.7	4.8	4.7	4.7
Water Transport	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Air Transport	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3
Services	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3

Source: Central Statistical Organization

The share of transport sector in Gross Domestic Product (GDP) of India has increased from 6.0 percent in 2001-02 to 6.5 percent in 2010-11. In particular, the contribution of road transport sector in GDP has increased from 3.9 percent in 2001-02 to 4.7 percent in 2010-11. However, the sector has not been able to keep pace with the rising demand and is providing to be a drag on the economy. The share of various subsectors of the transport sector in the GDP since 2001-02 given in Table: 4.11. In each year, the share of road transport sector is very high as compared to other modes. Each of the different modes of transport briefly described below:

4.9.2 Rail Transport in India

Indian Railways, a historical legacy, are a vital force in our economy. It was only in 1851, when the first train ran in the Country for hauling construction material in Roorkee and by 16th April 1853 the first passenger train service became operational running between Bori Bunder, Bombay and Thane. Since then there has been no looking back. Railways played an important role in unifying the Country. Indian railways consist of a vast network of 7031 stations spread over a route length of 63221 km, of this 13,000 km is electrified, with a fleet of 7817 locomotives, 5321 passenger service vehicles, 4904 other coaching vehicles and 228170 wagons 300 yards, 2300 good sheds, 700 repair shops, and 1.54 million work force. It is the largest rail network in Asia and the world's second largest under one management also credited with having a multi gauge and multi traction system. The track kilometers in broad gauge (1676 mm) are 86526 kms, meter gauge (1000 mm) are 18529 kms and narrow gauge (762/610mm) are 3651 kms. Indian Railway has the distinction of being one of the biggest and busiest rail networks in the world carrying more than 16 million passengers and 11 lakh tones of goods on a daily basis. In terms of headcount, again Indian Railway scores as it employs more than 1.6 million employees.

4.9.3 Water Transport in India

India has a long coastline; about 90% of sea borne trade handled via major ports. It has an extensive network of inland waterways and seaports. Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. The total navigable length of inland waterways is 14,500 km. There are three National Waterways in India: Allahabad Haldia stretch of the Ganga Bhagirathi Hooghly River (1620 km), Sadiya Dhubri stretch of the Brahmaputra river system (891km) and Kollam Kottapuram stretch of West Coast Canal along with Champakara canal and Udyogmandal Canal(205 km). There are 12 major ports and about 180 minor and intermediate ports in India. With the ports handling more than 95% of the trade in India, they act as the major gateway for trade. The major ports in India are Calcutta, Haldia, Paradip, Visakhapatanam, Ennore, Chennai, Tuticorin, Cochin, New Mangalore, Mormugao, JNPT, Mumbai and Kandla.

4.9.4 Air Transport in India

Air travel is a fastest means to reach in any part of the world. Indian Airlines operates to 57 domestic stations (including Alliance Air operations) and 17 international stations in 14 countries, including Alliance Air cover 76 destinations including 16 abroad. The Airlines owns a fleet of Eleven A-300, Thirty A-320, Twelve B- 737 and Three Dornier -228 aircraft. India had bilateral air services agreements with 93 countries. Air India Limited is the major international carrier of the Country. It owns a fleet of 26 aircraft consisting of six B-747-200, two B747-300 (Combi), seven B747-400, three A 300-B4 and eight A 310-300 aircraft. Domestic air services are looked after by Indian airlines and private airlines while the international airport service is looked after by Air India. Mumbai, Chennai, Kolkata and Delhi are the four major international airports of India. Pawan Hans Helicopters Limited has been providing helicopter support services to the petroleum sector including ONGC, Oil India Limited and Hardy Exploration at Chennai. An International green field airport has developed in Cochin, Kerala.

4.9.5 Road Transport in India

Road transport occupies a primary place in to-day's world as it provides a reach unparallel by any other contemporary mode of transport. Where roads are considered as veins and arteries of a nation, passenger and goods transported are likened to blood in circulation. Passenger Road Transport Service (PRTS) is an essential connected to the economic development. The freight traffic generally owned and operated by private sector whereas both the private and public sectors share the passenger services. Let us look into the growth of roadways in India.

Roadways in India have come a long way. Starting from the pug dandies (a small path created naturally due to frequent walks) of earlier times to the present-day Rajpath of Delhi, the Country has crossed many spheres of road travel. The ‘thread that binds the nation together’ is truly a deserving metaphor for a road network that is one of the largest in the World. Harappan and Mohenjodaro civilization, which dates back circa fourth millennium BC, provides ample understanding of roads. Mauryan rule in the 4th century constructed Rajpath (high roads) and Banikpaths (merchant roads). Megasthenes, the Greek traveler recorded a Rajamarga or the king’s highways which was also a trade route and precursor to the Modern Grand Trunk Road. During the Gupta era there was also a road connection with South India. There are also evidences of a route facilitating trade with Iran and China.The Mughal era was the golden era for roads. Thus, one can see that since ancient times roads were stressed upon.

But the British Government did not take much interest in the development of the roads and road transport. The interests of the railways loomed large and roads were treated subsidiary of these. However, they realized that an integrated transport plan is an essential prerequisite for a planned programme of balanced growth of the different sectors of the Country’s economy and thus appointed a number of committees and study groups for having recommendations for quick development of motor transport in the Country. These includes Jayakar Committee (1927), Mitchell-kinkness Committee (1932-33), Wedgewood Committee (1936), Transport Advisory Committee (1935), Motor Vehicles Act (1939), Post War Policy Committee (1943), Nagpur Plan (1943), Code of Principles and Practices (1945),), Nationalization of Road Transport (1947), Motor Vehicles Taxation Enquiry Committee (1950), Study Group of Transport Planning (1953), Taxation Enquiry Committee (1953-54), Motor Vehicles Amendment (1956),Other Co-ordination Institutions (1958), Hyderabad Plan (1959), Massuri committee report(1959-60), Neogy Committee (1959), Motor Vehicles Taxation Enquiry Committee (1966-67) etc.

The Government accepted most of the recommendations of these committee's. Transport departments, State, and Regional Transport Authorities have been set up in all the State and Union Territories of India. Enforcement Wing has been set up to ensure the enforcement of the motor vehicles Act and Rules. Nagpur Plan classified roads into four types as NHs, SHs, District Roads and Village Roads for the purpose of administration and enforcement of Motor Vehicles Act and Rules. Motor Vehicles Taxation Enquiry Committee (1950) must be regarded as the first favorable action by the Government of India towards the protection of motor transport in the Country. However, the Government took no notice of its recommendations. It was under the chair of John Mathai, observed the heavy tax burden on motor vehicles and laid emphasis on implementing the recommendations of the Motor Vehicles Taxation Enquiry Committee, 1950. As the existing services found inadequate and few of them ill organized, Government considered Nationalization of Bus Transport services as a means to ensure efficient, economical, and adequate and properly co-ordinate services. With these objectives in view, the Road Transport Corporation Act passed in 1950. In 1958, the Government established Transport Development Council, Road and Inland Water Advisory Committee, and Central Transport Advisory Committee to remove the competitions between rail and road. While most of committees and commission find fault in the railroad coordination, the Government has been vigilant enough to develop the road transport in the Country.

In the late 2000‘s, cycle rickshaws were banned in several cities for causing traffic congestion. Nevertheless, environmentalists have supported the retention of cycle rickshaws as a nonpolluting and inexpensive mode of transport. Intermediate public transport modes like tempos and cycle rickshaws assume importance in medium size cities. Autoricksaws now banned in Mumbai and Kolkata. Two-wheelers are the most popular mode of transport in terms of number of vehicles. Buses take up over 90 percent of public transport in Indian cities. The oldest Indian transport undertaking is North Bengal State Transport Corporation in 1945. Bangalore was the first Indian city to introduce Volvo B7 RLE intra city buses in India in January 2006. Double Decker Buses (funded in cities like Mumbai, Chennai, and Trivandrum), Semi Floor Buses (first bus started serve in Trivandrum), Propour Bus Service called Atal Sarige, buses with two coaches (APSRTC introduced first) etc are also servicing in our country.

Infrastructure development especially in the road transport sector reorganized in the planned economic regime of the Country. Hence, it received special attention right from the Five -Year Plan onwards. Let us examine the growth of road transport infrastructure under various Five-Year Plans period.

4.9.6 Road Transport Development over the Five - Year Plans

In concurrence with the policy to encourage growth of road transport in the public sector, various schemes implemented in the Five-Year Plans. The following Table: 4.12 summarized the outlay provided for the development of transport in each plan periods. First Five-Year Plan proposed to increase the fleet length of State Transport Undertakings. During this period a sum of 12.5 crore was spent on road transport. At the ends of the plan nearly 25 percent of passenger services were in the nationalized sector. Under the Second Five-Year Plan a provision of Rs. 246 crores for the road development in addition to Rs. 25 crores from the Central Road Fund. At the end of the plan the mettalled roads increased to 144,000 miles and the unmetalled roads to 25,000 miles.

Table: 4.12
Outlay for Road Development

Five Year Plan	Outlay for development of road (in crores)
I (1951-1956)	12.5
II (1956-61)	246
III (1961-66)	324
IV (1969-74)	876
V (1974-79)	1774
VI (1980-85)	830
VII (1985-90)	1729
VIII (1992-97)	1600
XI (2007-2012)	1131
XII (2012-2017)	11.4 Lakh

Source: Economic Survey

The Third Five-Year Plan provided for an outlay of Rs. 324 crores, of which it was proposed to make an outlay of Rs. 244 crores on the road development progrmme in the State and Rs. 80 crores in the Central sector. The Annual Plans (1966-69) proposed to reduce disparities existing in the various States in respect to of road development programmes and infinite efforts to argument services on the existing routes of the State Transport Undertakings. During Fourth Five- Year Planthe volume of goods traffic on road was estimated to increase by 8.2 percent. Completion of the 400 kilometers missing road links, increase the length of surfaced road to about 385,000 kilometers, trucks would need to be increased about 470,000 at the end of 1973-74 etc are the other focus of this plan . The proposed out lay for road development in the Fifth Five-YearPlan was Rs. 1,774 crores. The Plan gave top priority to the completion of works spilling over from the Fourth Plan, construction of bypasses around congested towns, the widening to two lanes of certain single land sectors etc. The Annual Plan (1979-80) aimed towards the completion of spill over schemes.

The Sixth Five Year Plan (1980-85) proposed to evolve a rational pricing structure for the State Transport Undertakings. The introduction of new generation of fuel-efficient motor vehicles is the main technological advances during this period. In the Sixth Plan 2,687 kms of roads were upgraded as National Highways and 5.77 lakh kms of different type of roads were added to the road grid. The major thrust of the programmes in the Seventh Five Year Plan (1985-90) should be to consolidate the gains so far as achieved, properly maintain existing assets and initiate step for up gradation and revitalizing the passenger road transport. The growth of passenger traffic would be restrained to 2 percent per annum. The total road network in the Country increased 20.7 percent from 16.9 lakh in 1985, 20.4 lakh km at the end of Annual Plans (1990-92). All weather accessibility of villages had improved significantly over the years. During 1990-91 and 1991-92, 93,000 villages connected with all-weather roads.

During the Eight Five Year Plan (1992-97) the capital base of National Highway Authority of India expanded substantially to Rs.500 crore. About 56 percent of the total length of two lane roads had to be strengthened, 44 percent of the National Highway network would have to be widened to four lanes. An out lay of Rs.2600 crore had been approved by the Planning Commission for the Eight Plan. The initiated reforms made by Government in road sector during the Eight Plan are as follows: (i) Pathkar abolished by all State Governments and Octroi by many of them,(ii) Road sector had declared as an industry (iii) MRTP provision had revealed to enable large forms to enter the Highway Sector, (iv) National highway Act amended to enable levy of a fee on National Highways, bridges, and tunnels.

During the Ninth Five Year Plan the National Integrated Highway Project merging Golden Quadrilateral connecting Delhi, Mumbai, Calcutta with the East-West (Silchar to Sourashtra) and North–South (Kashmir to Kanyakumari) corridors has been launched. The total length to be covered in this project is 13,000 km work on four lining of the Golden Quadrilateral connecting Delhi, Mumbai, Chennai and Calcutta is already in progress. The National Highway Authority of India has been mandated to implement 4 and 6 lining 13,252 km of National High ways with an estimate cost of Rs. 54000 crore. Out of these 588 km in Golden Quadrilateral and 628 km in East West Corridors have been four lined.

The road and construction sector is the engine of growth during the Tenth Five-Year Plan period (2002-2007). Balanced development of total network is the main objective relating to the road sector for the Tenth Plan. The out lay for construction Central Sector Roads for this Plan is Rs. 59,490 crore. The Eleventh Five Year Plan (2007-2012) envisages a major programme of road development covering the National Highways, based on a combination of public investment and PPP. An expanded National Highways Development Programme is currently under way, involving a total investment of Rs 227258 crore. It includes four lining of the Golden Quadrilateral and the North-South, East-West Corridors covering 14488 km, four or six lining of 10000 km of National Highways, six lining of 6500 km of selected National Highways, development of 1000 km of expressways and construction of ring roads around major towns and bypasses, flyovers, etc.

4.9.7 Road Transport: Present Scenario

Today, India has a huge network of roads comprising of National Highways, State Highways, Major District Roads and Village and other roads. India has one of the largest road networks in the world, of 41.09 lakh km, consisting of (i) National Highways (NHs), (Ii) State Highways (SHs), (Iii) Major District Roads (MDRs), and (iv) Rural Roads that include other district roads and village roads. National Highway network of about 71,772 km comprises only 2 percent of the total length of roads, but carries over 40 percent of the total traffic across the length and breadth of the Country. Table: 4.13 depicts the length of different category of roads. State Highways (SHs) and Major District Roads (MDRs) constitute the secondary system of road transportation carries about 40% of the total road traffic, although it constitutes about 13% of the total road length. The State Highways connect National Highways, district headquarters, important towns, tourist locations and minor ports. The aggregate length of roads, which was 0.4 million km in 1950-51, has increased more than 10 fold to 4.24 million km by 2009-10. The transport demand for freight and passenger movement within the Country met mainly through road transport and railways. Between these two modes, road transport has steadily expanded its scope of operation and is now not merely a mode for the last haul but is also handling freight over long distances.

Table: 4.13
Length of Road Networks

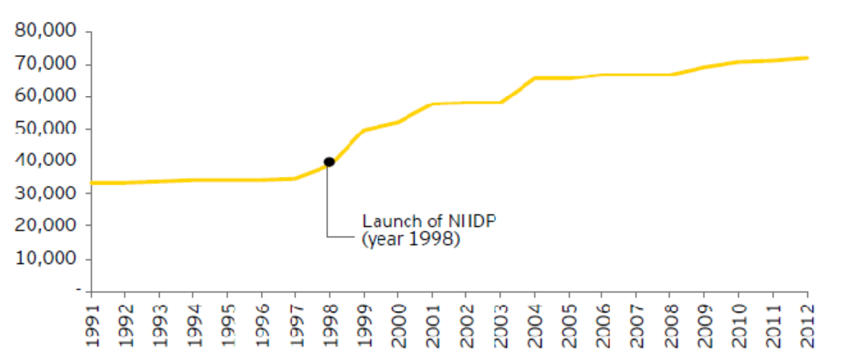
Types of Roads	Length
National Highways	71,772 KM
State Highways	1,54,522 KM
District Roads	2,66,058 KM
Village Roads	36, 17, 240 KM
Total	41,09,592KM

Source: Ministry of Road Transport and Highways

Road infrastructure is of prime importance for the growth of the economy, since around 60 percent of freight and 85 percent of passenger traffic moves by road in India, while the railway handle only 40 percent of the freight and 20 percent of the passengers of the passenger load. Thus there had been a substantial shift in the mode of transportation from railways towards the road sector The density of India's Highway Network at 0.66 km of Highway per square kilometer of land is similar to that of the United States (0.65) and much greater than China's (0.16) or Brazil's (0.20).

The National Highways have been classified based on carriageway width of the Highway. Generally, a lane has a width of 3.75 m in case of single lane and 3.5 m per lane in case of multi-lane National Highways. Out of the total length of National Highways 21 percent 15,536 km) is single lane or intermediate lane where as 54 percent (38,536 km) is double lane standard and the rest 14 percent(17,700 km) is four or six or eight lane standard. The National Highways constituted only around 1.7 percent of the road network, but carry 40percent of the total road traffic. For a Country aspiring to grow at 8.0 percent, India needs extensive highways and expressways to prevent roads from becoming bottlenecks in its growth. The (NHDP) is the largest and foremost infrastructural program undertaken in the Country for this purpose.

Figure: 4.9
Growth of National Highway Network in India



Source: World Road Statistics 2009 published by International Road Federation, Geneva

National Highway Development Programme envisaged upgrading or strengthening of around 54,000 km of the National Highways in several phases with an investment of around INR 3,000 billion. The National Highway network has grown at CAGR of 5.7 percent after the launch of the NHDP in 1998 (Figure: 4.9). It was growing at a mere 1.9 percent before initiation of the NHDP. In 2009-10, the National Highways Authority of India was able to build highways at an average of 13.72 km per day. This dropped further to an average of 10.39 km per day in 2011-12, against the much higher and seemingly formidable target of 20 kms a day.

However, there is a disconcerting side to the progress of work carried out by the National Highway Development Programme, which is harassed by delays in execution and the huge backlog of pending work -NHDP II and IIIA projects are still awaiting completion. The progress of NHDP is given below (Table: 4.14; Figure: 4.10). The two flagships projects under the NHDP- (I) the Golden Quadrilateral (GQ) and (II) the North-South-East-West (NSEW) Corridor- are typical examples of the degree of delays in NHDP projects. The Tenth Plan envisaged on top priority the completion of the GQ and the NSEW Corridor, but targets were delayed. This project target has revised to 2015 in the Twelfth Five Year Plan. The progress of the Pradhan Mantri Gram Sadak Yojana (PMGSY) is also slow, with only 328,208 km of rural roads being upgraded or newly built against targeted connectivity of 591,673 km by June 2011 due to significant constraints in the sector. Achievements of National Highways Development projects during 2010-11 given below:

Table: 4.14

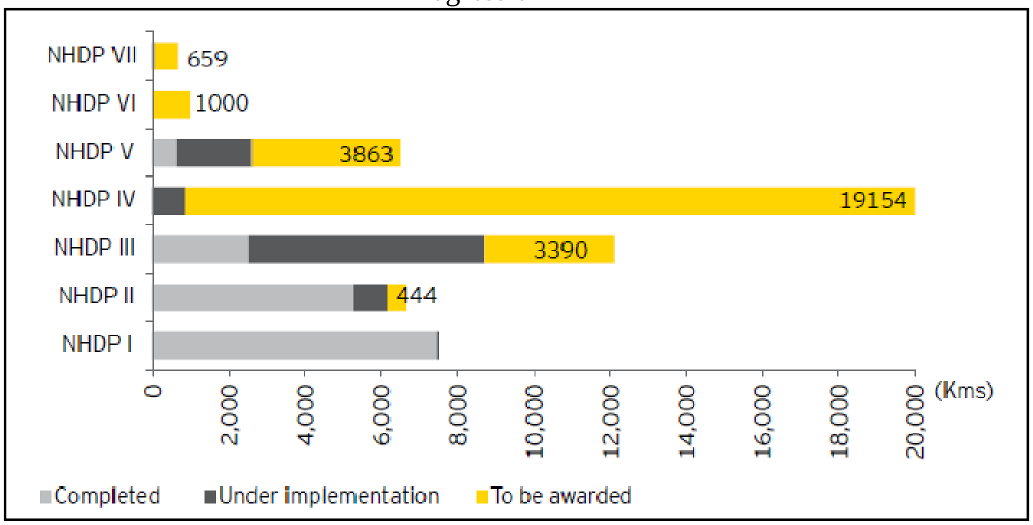
Achievements of National Highways Development Projects (2010-11)

NHDP components	Total Length (KM)	Competed 4/6 Lane (KM)	Under implementation		Balance for Award of Civil Work (KM)
			Length (KM)	No. of Contracts	
GQ	5846	5809	37	10	..
NS-EW	7142	5385	1332	106	425
Port Connectivity	380	291	83	6	6
Other NHs	1383	926	437	7	20
SARDP-NE	388	..	112	2	276
NHDP Phase III	12109	1922	5207	73	4980
NHDP Phase IV	20000	..	486	4	19514
NHDP Phase V	6500	407	1893	16	4200
NHDP Phase VI	1000	..	..	..	1000
NHDP Phase VII	700	..	41	2	659
Total	55448	14740	9628	226	31080

Source: Ministry of Road Transport and Highways, 2012

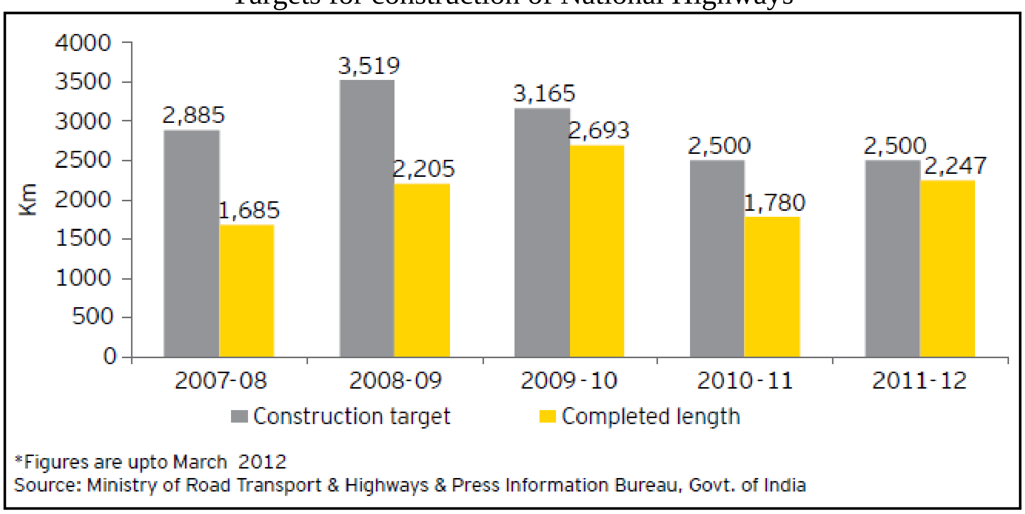
From Table: 4.14, it is very clear that the Golden Quadrilateral (GQ), and North South-East West corridors (NS-EW) showed remarkable Progress of construction by NHDP. NHDP completed a length of 55448 KM of road project until 2011. Out of the planned 5846 km of road length in under Golden Quadrilateral project, till November 2010, constructed road length totaling to 5809 km has been completed which is more than 99 percent of the planned target the rest 37 km of road length is under implementation. In the case of North South-East West corridors and of the planned 7142 km of road length, until Nov 2010, construction of road length of 5385 km that is more than 75 percent of the planned road length has completed. The rest of the work is under construction.

Figure: 4.10
Progress of NHDP



Source: Ministry of Road Transport and Highways

Figure: 4.11
Targets for construction of National Highways



The last five years have been particularly rough years for highway development, with physical achievement falling short of its intended target and being further delayed with time. In 2009-10, the NHAI was able to build highways at an average of 13.72 km per day. This dropped further to an average of 10.39 km per day in 2011-1216 against the much higher and seemingly formidable target of 20 km a day. Figure: 4.11 shows targets and completed length for construction of National Highways during 11th plan.

The target for roads has increased by 18.7 percent over the previous year to 9,500 km. Furthermore, projects for existing roads awarded through a new model Operate, Maintain and Transfer (OMT) model. An estimated length of 4360 km of roads maintained through the OMT model. The Plan wise addition to the NH network given in Table: 4.15. The table presents a glimpse of the development of roads since independence particularly during the various Five-Year Plan periods. It is clear that more than three times increase in the length of roads has witnessed during 1951 to 2012.

Table: 4.15
Plan-Wise Addition to NH Length

Period	Length Added (in KMs)	Total Length (in KMs)
As on 01.04.0947	Na	21440
Pre First Plan (1947-1951)	815	22255
First Plan(1951-56)	Na	22255
Second Plan(1956-61)	1514	23769
Third Plan (1961-66)	179	23948
Interregnum Period(1966-69)	52	24000
Fourth Plan(1969-74)	4819	28819
Fifth Plan (1974-78)	158	28977
Interregnum Period(1978-780)	46	29023
Sixth Plan(1980-85)	2687	31710
Seventh Plan (1985-90)	1902	33612
Interregnum Period(1990-92)	77	33689
Eight Plan (1992-97)	609	34298
Ninth Plan(1997-2002)	23814	58112
Tenth Plan (2002-2007)	9008	66590
Eleventh Plan (2007-2012)	10228	76818

Source: Various Five -Year Plans

Major cities of the States and Capital of the State are connected by State Highways. While District Roads are connecting with major Village Roads, Village Roads provide linkages to other roads in order to meet their daily needs and access to nearby markets. The strain on the network is increasing day by day. The number of vehicles has grown at rapid pace of 10.16 percent per annum. The road transport sector in India has expanded manifold in more than fifty years after independence, both in terms of spread (total road length & road density) and capacity (No. of registered vehicles on road and the volume of passenger and freight traffic handled). The total road length has increased from 4.0 lakh km. as on 31.03.1951 to about 46.9 lakh km as on 31.03.2011, an increase of more than 10 times (Table: 4.16). The total length of National highways has increased from 22.2 Th. Km to 79.12 Th. km, an increase of about 3 times only, during this period. During the year 2013, length of road is 46.89 lakh. Km.

Table: 4.16

Trends in Road Characteristics in India

Year	Length of Roads (‘00000 km)	Length of NHs (‘000 km)	Length of SHs (‘000 km)	Share of Surfaced Roads to Total Percent
1951	4.00	22.2	NA	39.25
1961	5.25	23.8	NA	50.10
1971	9.15	24.0	056.8	43.50
1981	14.86	31.7	094.4	46.00
1991	19.98	33.7	127.3	51.30
2000	33.26	52.0	132.8	47.32
2001	33.74	57.7	132.1	47.48
2002	34.27	58.1	137.7	48.49
2003	35.29	58.1	134.8	48.21
2004	36.22	65.6	133.2	48.62
2005	39.30	65.6	144.4	46.99
2006	40.04	66.6	148.1	47.72
2007	41.41	66.6	152.8	48.24
2008	42.36	66.8	154.5	49.34
2009	45.82	70.9	158.49	51.98
2010	46.90	70.9	160.17	53.09
2011	46.90	79.12	163.89	53.89

Source: Ministry of Road Transport and Highways, Year Book, 2011-2012

The rapid expansion and strengthening of the road network therefore is imperative, both to provide for present and future traffic and to provide for improved accessibility to the hinterland. In addition, road transport needs to be regulated for better energy efficiency, lesser pollution and enhanced road safety.

4.10 VEHICULAR MOBILITY IN INDIA

India has experienced a tremendous increase in the total number of registered motor vehicles. It increased from about 0.3 million as on 31st March, 1951 to about 142 million as on 31st March, 2011(Table: 4.17). The total registered vehicles in the Country grew at a Compound Annual Growth Rate (CAGR) of 9.9 percent between 2001 and 2011, while the road network increased at a CAGR of 3.4 percent. The growth of road network has not kept pace with the growth in the number of registered vehicles (Table: 4.18). While the number of registered motor vehicles has grown at a CAGR of 10.6 percent between 1951 to 2011, the growth in the road network during the same period was 4.2 percent. The share of two wheelers was about 72 percent of the total registered motor vehicles in India as on 31st Marc 2011, having increased from 8.8 percent as on 31st March 1951. Concomitantly, the share of number of registered cars, jeeps and taxis in the total number of registered vehicles stood at 13.6 percent as on 31st March, 2011, marking a steep decline from 52 percent as on 31st March 1951. The share of buses, including Omni buses, in total registered vehicles declined from 11.1 percent as on 31st March 1951 to 1.1 percent as on 31st March 2011. The number of registered goods vehicles, which had accounted for 26.8 percent as on 31st March, 1951 constituted 5.0 percent of the total vehicles in the Country as on 31st March, 2011. In terms of share in total, ‘other vehicles’, which include tractors, trailers, three wheelers (passenger)/Light Motor Vehicles (LMVs) and other miscellaneous vehicles, increased sharply from 1.3 percent as on 31st March, 1951 to 8.5 percent as on 31st March, 2011.

Table: 4.17
India: Composition of Vehicle Population
(As % of Total Vehicle Population)

Year	Two Wheelers	Cars, & Jeeps	Buses	Goods Vehicles	Others	Total (Million)
1951	8.8	52.0	11.1	26.8	1.3	0.3
1961	13.2	46.6	8.6	25.3	6.3	0.7
1971	30.9	36.6	5.0	18.4	9.1	1.9
1981	48.6	21.5	3.0	10.3	16.6	5.4
1991	66.4	13.8	1.5	6.3	11.9	21.4
2001	70.1	12.8	1.2	5.4	10.5	55.0
2002	70.6	12.9	1.1	5.0	10.4	58.9
2003	70.9	12.8	1.1	5.2	10.0	67.0
2004	71.4	13.0	1.1	5.2	9.4	72.7
2005	72.1	12.7	1.1	4.9	9.1	81.5
2006	72.2	12.9	1.1	4.9	8.8	89.6
2007	71.5	13.1	1.4	5.3	8.7	96.7
2008	71.5	13.2	1.4	5.3	8.6	105.3
2009	71.7	13.3	1.3	5.3	8.4	115.0
2010	71.7	13.5	1.2	5.0	8.6	127.7
2011	71.8	13.6	1.1	5.0	8.5	141.8

Source: MoRTH, Basic Road Statistics, 2012

During 2001-2011, the growth rate of registered motor vehicles was almost three times the growth rate of the road network. Amongst the various categories of vehicles, the highest CAGR during 2001-2011 was recorded by cars, jeeps and taxis (10.5 percent), followed by two-wheelers (10.2 percent). Two-wheelers accounted for the largest share of 72 percent, followed by cars, jeeps and taxis (14 percent), other vehicles (8 percent), goods vehicles (5 percent) and buses, including Omni buses (1 percent). The total number of registered two wheelers increased at a rate of 11.2 percent during 2010-11 to reach the figure of 1,018.6 lakh as on 31st March, 2011. The number of registered cars, jeeps and taxis rose by 12.4 percent during the financial year 2010-11. The total number of cars, jeeps and taxis stood at 192.3 lakh as on 31st March 2011. The number of registered buses, including Omni buses, posted an increase of 5 percent during 2010-11. There were 16 lakh buses, including Omni buses, as on 31st March 2011.

Table: 4.18

Compound Annual Growth Rate (in percent) of Vehicles and Road Length

Period	Vehicles						Roads				
	Two Wheelers	Cars, & Jeeps	Buses	Goods Vehicles	Others	Total	NHs	SHs	Rural	Urban	Total
2011-1951	14.5	8.1	6.0	7.6	14.1	10.6	2.1	3.2	4.4	-	4.2
1951-1961	12.5	6.9	5.3	7.4	26.5	8.1	1.9	4.0	-0.5	-	2.7
1961-1971	20.7	8.2	5.1	7.4	15.0	10.9	0.0	2.6	6.0	4.5	5.7
1971-1981	16.3	5.4	5.6	4.9	18.1	11.2	2.9	4.5	5.9	5.5	5.0
1981-1991	18.4	9.8	7.4	9.4	10.9	14.8	0.6	2.1	4.0	4.3	3.0
1991-2001	10.5	9.1	6.7	8.1	8.6	9.9	5.5	3.1	1.4	3.0	2.1
2001-2011	10.2	10.5	6.9	9.1	8.0	9.9	2.1	3.0	4.4	5.0	3.4

Source: Basic Road Statistics, 2010-11

The number of registered goods vehicles recorded a growth rate of 9.8 percent during 2010-11. As on 31st March 2011, there were 70.6 lakh goods vehicles. Other vehicles include tractors, trailers, three-wheelers (passenger vehicles/LMVs) and other miscellaneous vehicles, which are not classified separately. The combined growth of these vehicles together during 2010-11 was 9.2 percent. There were 121 lakh other vehicles as on 31st March 2011.

Vehicle population per thousand populations and per hundred kms shown in the Table: 4.19 below. The Compound Annual Growth Rate of Population in India from 1970 to 2011 shows 5.54 percent and that of registered motor vehicles shows 34.52 percent. Road length shows 9.58 percent of CAGR and that of total registered motor vehicles per thousand population shows 27.66 percent. Total registered motor vehicle per 100 Kms of road length during 2011 year is 388 and it was 221 during 1970.

Table: 4.19

Vehicular Population Per 1000 Population and Per 100 Kms

Year	Population in India (In '000)	Total Number of Registered Motor Vehicles (In '000)	Road Length (In Kms)	Total Registered Motor Vehicles Per Thousand Population	Total Registered Motor Vehicle Per 100 Kms of Road Length
1970	539000	1658	1188728	3	221
1980	673000	4521	1491873	7	222
1990	835000	19152	1983867	23	238
2000	1014825	48857	3325765	48	328
2001	1028610	54991	3373520	53	328
2002	1045547	58924	3426600	56	328
2003	1062388	67007	3528654	63	332
2004	1079117	72718	3621507	67	336
2005	1095722	81499	3809156	74	348
2006	1112186	89618	3880651	81	349
2007	1128521	96707	4016401	86	356
2008	1144734	105353	4109592	92	359
2009	1160813	114951	4471510	99	385
2010	1176742	127746	4582439	109	389
2011	1210193	141866	4690342	117	388
CAGR	5.54%	34.52%	9.58%	27.66%	3.83%

Source: Motor Vehicles Statistics in India

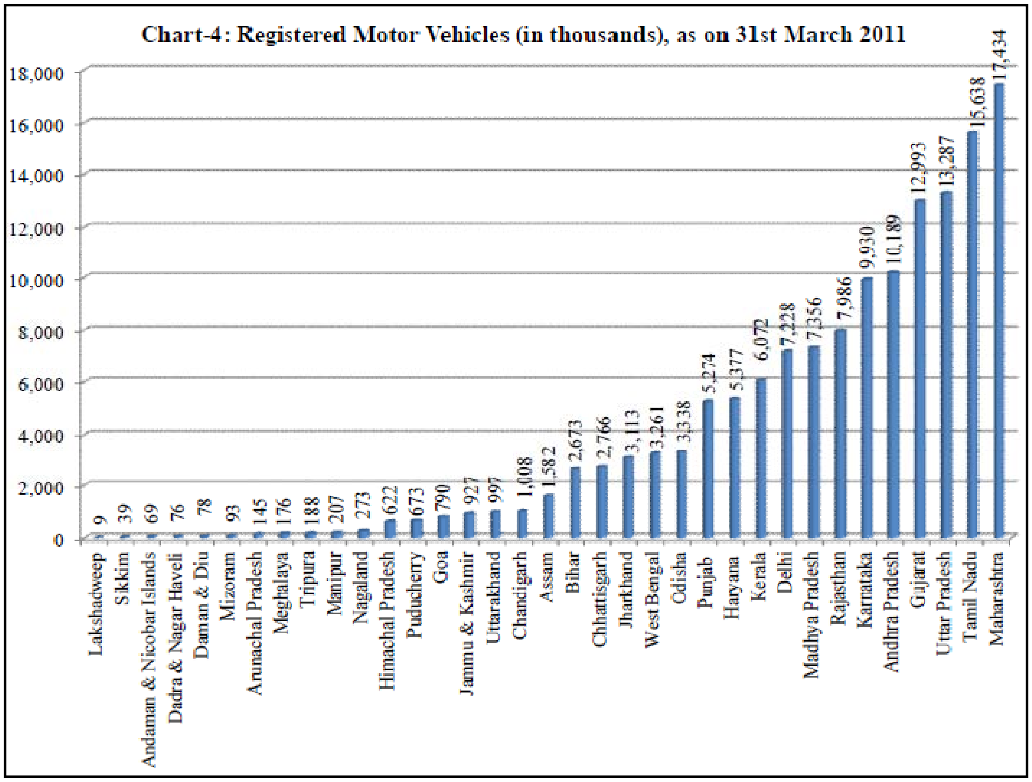
4.11 STATE -WISE DISTRIBUTION OF VEHICLE POPULATION

With a registered motor vehicle population of 174 lakh, the State of Maharashtra accounted for the largest share (12.3 percent) of the total registered motor vehicles in the Country. Tamil Nadu recorded the second highest share (11.0 percent) of registered motor vehicles, followed by Uttar Pradesh (9.4 percent), Gujarat (9.2 percent) and Andhra Pradesh (7.2 percent). These five States together accounted for about 49 percent of the total vehicles registered up to 31st March, 2011. The lowest number of motor vehicles (0.09 lakh) registered in the UT of Lakshadweep (0.01 percent). Among the States, Sikkim reported the lowest number of the total registered vehicles of 0.39 lakh (0.03 percent). The State-wise share of registered motor vehicles in India shown in Figure: 4.12 below.

Growth in terms of Compound Annual Growth Rate of registered vehicles amongst the States/UTs shows wide variations. While the highest CAGR for registered vehicles during 2001-2011 was recorded by Arunachal Pradesh (21.3 percent), followed by Dadra & Nagar Haveli (19.4 percent) and Tripura (14.1 percent), the lowest CAGRs were recorded by Nagaland (5.5 percent), Punjab (6.1 percent) and West Bengal (6.8 percent). Kerala (11.1 percent) exceed the national rate. As many as 26 States/UTs had CAGRs equal to or more than the all India growth rate of 9.9 percent during 2001-2011.

Figure: 4.12

Registered Motor Vehicles in Thousands, As on 31st March 2011



Source: Ministry of Transport and Highways, Basic Road Statistics, 2010-2011

In spite of the tremendous increase in the volume of road traffic, both passengers and freight, the main road network compromising of the National and State Highways has not matched this traffic growth. Much of the expansion of the road network has been through building the rural roads to provide connectivity to rural masses although 50 percent of the villages are still to be connected with all weather roads. Inadequate networks have led to higher transportation costs, which have also severely eroded international competitiveness of the Indian economy.

4.12 ROAD TRANSPORT DEVELOPMENT IN KERALA

Kerala, southernmost State of India, has a good network of roads. It has eight National Highways, number of State highways and many district roads. National Highway authority of India maintains 444.9 km and Kerala PWD (NH) section maintains rest of the National Highways from direction of Ministry of road Transport and Highways (MoRTH).

Table: 4.20

Agency Wise Distribution of Road Length during 2009-10

Name of Department/Agency	Length (KM)	Percentage
Panchayaths	104257	68.748
PWD (R&B)	23242	15.32
Municipalities	8917	5.88
Corporation	6644	4.381
Forests	4075	2.689
Irrigation	2664	1.757
National Highways†	1525	1.006
Others (Railways, KSEB)	328	0.216
Total	151652	100

Source: Basic Road Statistics, 2010-11

The district wise and category wise length of roads maintained by Public Works Department as on 31st March 2010 are given in the following table (Table: 4.21). From this, it is clear that Kottayam district have the highest total roads road length of 3016.75 km, when we take into account both State Highways and Major District Roads. In the case of State Highways, Idukki district have the highest road length of 998.37 followed by Kottayam (406.53 km). Least road length in Wayanad district (766.35 km)

Table: 4.21

District-wise and Category-wise Length of Roads

Maintained by PWD (R&B) as on 31-3-2010

Sl.No	Name of District	State Highways	Major District Roads	Total
1	Thiruvananthapuram	180.36	1471.942	1652.302
2	Kollam	123.79	1748.734	1872.524
3	Alappuzha	170.841	1032.485	1203.326
4	Pathanamthitta	249.194	1044.856	1294.05
5	Kottayam	406.531	2610.234	3016.765
6	Idukki	998.372	1402.688	2401.06
7	Ernakulam	325.206	1744.788	2069.994
8	Thrissur	374.033	1291.58	1665.613
9	Palakkad	245.987	1338.263	1584.25
10	Malappuram	374.764	1421.446	1796.21
11	Kozhikode	377.173	928.677	1305.85
12	Wayanad	128.955	637.397	766.352
13	Kannur	244.665	1453.196	1697.861
14	Kasaragode	141.78	773.772	915.552
	Total	4341.651	18900.058	23241.709

Source: Basic Road Statistics, 2010-11

4.12.1 National Highways in Kerala

Kerala has a well-connected road network. In Kerala, there are 8 National Highways that connects all the major cities and towns within Kerala and outside Kerala. There are about 50 State highways, which connect every corner of our state. The condition and quality of each road differs from one another. Normally the National Highways are of good quality and the roads are wider and maintained well. Some of the state highways are also in good condition. The condition of the roads of Kerala becomes worse due to the climate in our state. The monsoon season is long in Kerala and the rains trouble the roads. Another reason for the bad situation of the roads is the usage of heavy vehicles.

National Highways in Kerala runs about 1457 km. The Palakkad-Thrissur-Kochi stretch of NH 47 is a part of North-South and East-West Corridors of the Indian highway system. There was a proposal for construction of standalone ring road/bypasses around Tiruvananthapuram City under NHDP Phase VII. National Highway Authority of India stopped the feasibility study due to the present land acquisition crisis to the oncoming project under NHDP Phase-III scheme in the stretch of NH-47. A list NH that passes through Kerala is given (Table: 4.22) below:

Table: 4.22
National Highways in Kerala

Name of NH	Source-Destination	Length (Km)	Single/ Intermediate Lane(Km)	Two Lane (Km)	Four Lane (Km)
NH 47	Walayar-Kaliyikkavila	416.8	-	380.8	36.0
NH 17	Thalappaddy-Edappally	420.8	395.8	25	-
NH 49	Kundanoor-Bodimettu	167.6	167.6	-	-
NH 47 A	Kundanoor-Willington Island	5.9	-	5.9	-
NH 208	Kollam-Aryankavu	81.3	81	-	-
NH 212	Kozhikode-Muthanga	117	117	-	-
NH 213	Palakkd-Kozhikode	125.3	125.3	-	
NH 220	Kollam-Kumily	189.3	189.3	-	-
Total		1523.9	1076.0	411.7	36.0

Source: Basic Road Statistics, 2010-11

4.12.2 State Highways in Kerala

There are 77 State Highways in Kerala. Of them, MC Road (Main-Central Road), proposed Hill Highway (Kerala) and Main Eastern Highway are the largest. The respective State Highway number displayed on the top of all milestones (black in colour in green background) on the respective road. The Kerala State Transport Project, costing 336 million US dollars (Rs 1612 crores) - of which World Bank financing is US $ 255 million (Rs 1224 crores) and State's contribution is US $ 79.00 million (Rs 388 crores), aims to improve traffic flow and road safety on Kerala State's primary road network, and to strengthen the institutional and financial capacity of Kerala's key transport sector agencies.

4.13 MOTOR VEHICLES MOBILITY IN KERALA

There are about 1.6 lakh kilometers of roads in the state, of which only 20 percent are motorable. The rest are mostly narrow or single lane pathways intended for residential or street connectivity. 80 percent of motorable traffic uses the arterial and sub-arterial roads consisting of National Highways, State Highways and Major District Roads, which are under the supervision of Public Works Department. The maintenance and upkeep of these highways are far from satisfactory and devoid of any scientific pavement or bridge management system.

The motor vehicle population in Kerala, which was around 2 lakhs in 1980, has almost doubled every 5 to 6 years. There are about 60 lakhs-registered motor vehicles in the state, of which 25,000 are stage carriages (bus services), 63 percent of the vehicles are two wheelers. Around 5 lakhs vehicles now added on the state roads every year. A major chunk of this vehicle stock found in urban region causing traffic congestion. The category wise vehicle population in each district as on 31.03.2009 and the corresponding percent share are shown in the Table 4.23 and 4.24 respectively. From these tables it is very clear that out of the total 4678559 vehicles in the State Kerala, the highest vehicle population accounted in Ernakulam district during the year 2009.

Table: 4.23

Category Wise Vehicle Population in Kerala as on March 2009

Name of Districts	Four wheelrs	Buses	Three Wheelers	Cars/Taxis & Jeeps	Scooter/ Motorcycles	Tractors/ Trailers	Total
Trivandrum	1989	24750	51273	130465	433320	3859	645656
Kollam	1624	7252	38270	79316	220314	2048	348824
Pathanamthitta	9489	5295	19657	56936	111868	734	203979
Alappuzha	1562	6982	27069	56674	232094	1201	325582
Kottayam	1869	13873	41477	100907	194612	1638	354376
Idukki	4909	3064	13128	22520	34028	1250	78899
Eranamkulam	5069	24002	61907	158516	511857	8883	770234
Thrissur	2395	20597	50111	85899	336734	3114	498850
Palakkad	1858	11255	33885	41851	199430	7539	295818
Malappuram	2392	14264	78435	81257	186141	2994	365483
Kozhikode	1996	8552	41511	75607	249863	2659	380188
Wayanad	3413	1744	8770	13519	26630	2166	56242
Kannur	1627	9489	37827	54024	135047	4718	242732
Kasargod	4995	1712	20565	26016	57305	1103	111696
Total	45187	152831	523885	983507	2929243	43906	4678559

Source: Kerala Motor vehicle Statistics, 2011

Table: 4.24

Percentage Share of Category Wise Vehicle Population in Kerala as on March 2009

Name of Districts	Four wheelrs	Buses	Three Wheelers	Cars/Taxis & Jeeps	Scooter/ Motorcycles	Trctors/ Trailers
Trivandrum	0.31	3.83	7.94	20.21	67.11	0.60
Kollam	0.47	2.08	10.97	22.74	63.16	0.59
Pathanamthitta	4.65	2.60	9.64	27.91	54.84	0.36
Alappuzha	0.48	2.14	8.31	17.41	71.29	0.37
Kottayam	0.53	3.91	11.70	28.47	54.92	0.46
Idukki	6.22	3.88	16.64	28.54	43.13	1.58
Eranamkulam	0.66	3.12	8.04	20.58	66.45	1.15
Thrissur	0.48	4.13	10.05	17.22	67.50	0.62
Palakkad	0.63	3.80	11.45	14.15	67.42	2.55
Malappuram	0.65	3.90	21.46	22.23	50.93	0.82
Kozhikode	0.53	2.25	10.92	19.89	65.72	0.70
Wayanad	6.07	3.10	15.59	24.04	47.35	3.85
Kannur	0.67	3.91	15.58	22.26	55.64	1.94
Kasargod	4.47	1.53	18.41	23.29	51.30	0.99
Total	0.97	3.27	11.20	21.02	62.61	0.94

Source: Kerala Motor vehicle Statistics, 2011

Table: 4.25

Number of Registered Motor Vehicles in Kerala (in numbers)

Type of Vehicles	Newly Registered as on 31st March		Total Registered as on 31st March	
	2009-10	2010-11	2009-2010	2010-11
Multi Axled	182	277	16993	17270
Trucks/lorries	1727	3480	51784	55264
Light Motor(Goods)	21413	36976	251471	288447
Buses	5247	7201	383229	390430
Taxis	9479	11874	84792	96666
Light Motor(Passengers)	43230	52612	491879	544491
Others	378	459	114014	114473
Total Transport	81656	112879	1394162	1507041
Two Wheelers	287897	394715	2889123	3283838
Cars	133910	159198	826538	985736
Jeeps	0	0	137547	137547
Omni buses	36	50	3748	3798
Tractors	24	544	10665	11209
Trailers	0	3	3653	3656
others	34211	6978	132216	139194
Non-Transport	456078	561488	4003490	4564978
Grand Total	537734	674367	5397652	6072019

Source: Basic Road Statistics, 2010-11

While analyzing the percentage share of each mode we can observe that percentage share of Scooter/Motorcycles shows highest in all the district of Kerala. The vehicle population in the state is growing at an average rate of more than 10 percent every year. With the motor vehicles entering the roads doubling every eight years, the number of motor vehicles registered in the State is likely to exceed the number of households by 2015. The number of motor vehicles registered in the State was 5.81 lakh in 1990, 48.80 lakhs in 2009 and had crossed 52 lakh in 2010. The road length in the State is 1.74 lakh km and the road density about 1417 km / 100 sq km, which is higher than the national average. table 4:25 gives the district wise break up of registered vehicles in the state as on 31.03.2011. Out of the 6072019 vehicles in the State, two wheelers accounted the highest share, (3283838), and total Non-Transport vehicles accounted 4564978 vehicles. The number of cars registered has almost crossed more than one lakh in Thiruvananthapuram, Kottayam and Ernakulam. This means around 20 percent of the households in this districts own cars.

The present transportation system in the state was evolved by piece-meal process, which remains under connected and uncoordinated. It is characterized by high operating cost, inefficiency and high accident risk. The situation is likely to worsen in future due to increase in population, urbanization and demand for personalized transport resulting from economic growth and higher income. The daily transport demand is expected to grow from present 135 lakh trips to over 180 lakh passenger trips by 2025.

4.14 CONCLUSION

There is a huge investment target for the infrastructure sector that needs to be achieved during the current Plan period. This target is achievable, provided prompt actions and active monitoring is carried out. The Twelfth Plan period has already begun and action needs to be taken now. This needs to be supported by initiating policy measures and other reforms that create a conducive environment for private investment in infrastructure and thus influence infrastructure development in long-run.

There is also a need to change the way we approach infrastructure development. The change required needed across planning, bidding and execution of infrastructure projects. More thorough and forward-looking project preparation and a sound land-acquisition process can go a long way in facilitating successful implementation of projects. Similarly, enhanced dispute resolution and regular monitoring will increase the confidence of the private sector to invest in infrastructure projects in the Country. With the Twelfth Plan focusing on attracting private sector to fund about 50 percent of the total infrastructure investment target, there is need to start both short term actions and long-term measures at the earliest.

There is need to prioritize action and reforms under the present conditions to facilitate increased private sector investments and faster execution of projects across the infrastructure sectors. We believe that infrastructure dream can be realized and can place India's economy on a high growth trajectory.

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CHAPTER - 5

ROAD TRANSPORT IN ERNAKULAM DISTRICT

5.1 INTRODUCTION

The district Ernakulam situated at the middle of the State of Kerala in south India. Ernakulam district is the highest revenue-yielding district in the State and known as the Commercial Capital of Kerala. The district became India's first fully literate district in 1990 and the Country's first district having hundred percent banking or full meaning of financial inclusion in 2012. It is one of the fastest growing places in Kerala, bestowed with all the geographical factors, which help the development of industry and it is in the vanguard of all other districts in Kerala in the field of industry.

5.2 PROFILE OF ERNAKULAM DISTRICT

5.2.1 Location and Regional Setting

Ernakulam District is situate almost at the middle of the State of Kerala in southern India, covers an area of 3068 Sq Km located on the Western Coastal Plains. . Geographically Ernakulam district is situated between Northern Latitude 9^0 47'and 10^0 17' and Eastern longitude 76^0 9' and 76^0 47'. Located on the coast of the Arabian Sea with Kottayam and Alappuzha districts in the south, Idukki in the east and Thrissur in the north, Ernakulam is a booming business metropolis. This district was formed in 1958 by carving out regions from Thrissur and Kottayam district. The district is bounded by a 46.2 km. coastline of the Arabian Sea (Lakshadweep) on the west.

5.2.2 Demographic Features

According to the 2011 Census Ernakulam district has a population of 3,279,860. This gives it a ranking of 104^{th} in India (out of a total of 640). It is the third most populous district in Kerala, after Malappuram and Thiruvananthapuram out of the 14 districts. The district has a population density of 1,069 inhabitants per square kilometer (2,770 /sq mi). The area constituted based on Census data 2011, consists of Corporation of Kochi, 8 municipalities, 14 Panchayaths and parts of 4 Panchayaths. Its population growth rate over the decade 2001-2011 was 5.6 Percent. Ernakulam has a sex ratio of 1028 females for every 1000 males, and a literacy rate of 95.68 Percent. This district is listed as the most advanced district in Kerala. It had a resident population of 3,105,798, excluding the huge commuter traffic from neighboring districts. It is urbanized 68.07 Percent. Also, Ernakulam district has the highest number of Christian Population in India (More than 12 Lakhs).

5.2.3 Economic Commercial Activities

While analyzing the district wise State Gross Domestic Product, we known that Ernakulam district continues to have the highest income. The district contributes the highest portion, 14.47 Percent, of the State's Gross Domestic Product. Compared to the industrial sector, agriculture development and productivity trends shown a diminishing turn in this district. Ernakulum district has the highest number Medium and Large scale industry units (255) out of the 729 units in Kerala. Of these 255 units, 226 are in private sector and 12 are in central sector. The district stood at the highest position in terms of the number of working Small Scale Industrial units (26254), employment provided (114434) and investment (124366.09 Rs. Lakh).

A Special Economic Zone is coming at Kakkanad by a joint venture of Kochi Port Trust, Kochi International Airport Limited and Kochi Special Economic Zone. Kochi is the only city in India to have three SEZs. These include the Electronic Park at Kalamassery, Kochi SEZ and a port based SEZ. Eleven new SEZs have been approved in the State. In nine out of 11 approved SEZs, the State and Central Governments are the developers. Of the 11 SEZs, six are IT/ITE based SEZs, one each in food processing, biotechnology and electronics and two are port based SEZs. While the Vallarpadam SEZ port based consists mainly of the Container Transshipment Terminal and related infrastructure, the Puthuvypeen SEZ port based will comprise an LNG Terminal. Two SEZs have been approved in principle, for development by Smart City Infrastructure Pvt. Ltd. and Sutherland Global Service Pvt. Ltd.

Kochi special economic zone (CSEZ) established in 1984 spread over an area of 103 acres located at Kakkanad is one of the seven Special Economic Zones of Central Government. The CSEZ is multi product zone with 98 working units and four under implementation units in varied sectors such as software and hardware engineering, readymade garments, food processing, rubber products, manufacturing and with more than 7800 employees making it the single largest employment destination in the State. When analyzing the trade scenario, we had known that Ernakulam has a rich history as it was an important trade center of South India. It is perhaps the biggest commercial center. Its M.G. Road is the location of some of the biggest businesses in Kerala. Ernakulam district is the highest revenue yielding district in the State and is called and known as the ‘Commercial Capital of Kerala’. The district includes the largest metropolitan region of the State, Greater Kochi.

5.3 HISTORY AND EVOLUTION OF KOCHI

Kochi, renowned as the *‘Queen of the Arabian Sea’* is located in the district of Ernakulam in the State of Kerala. The port city Kochi, formerly known as Cochin, gained its reputation of being a port city only after the collapse of the Kulashekhara kingdom. Etymologically, Kochi derived its name from Malayalam words, ‘Koch azhi’, meaning 'small lagoon'. The earliest account of Kochi is derived from the records made by the Chinese traveler, Ma Huan. These accounts also State that Kochi was invaded by foreigners and colonized many times. Kochi prospered under the Dutch rule by shipping pepper, cardamom and other spices, coir, coconut, and copper.

The development of Kochi as a prime city of Kerala is closely linked with the political and administrative history of the Malabar Coast. Kerala was an important maritime country in the dawn of the Christian era, had their capital at Tiruvanchikulam located about 18 km north of Kochi. The ancient port of Muziris served as an international centre of trade and the main emporium of transit of goods between China and Rome. When Kodungalloor was destroyed by floods from Periyar in 1341, Kochi came to be recognized as the biggest natural port and centre of trade on the Western Coast. The old merchants of Muziris shifted to Kochi as soon as the new outlet became more or less stable. As the harbour gained prominence, the then ruler of the region shifted his capital also to Kochi, giving impetus to the growth of the town.

5.3.1 Mattancherry Market Town

The early settlement of Kochi was at Mattancherry, facing the protected lagoons in the east, which provided safe anchorage to country crafts in all seasons. Mattancherry was linked to the entire coastal stretch of Kerala through these inland waters. Thus gradually it grew into a busy settlement. Trading communities from Gujarat and the emigrants from Goa also established trading centres in Mattancherry along with the native Hindus and the early settlers. Mattancherry grew into a market town with cosmopolitan character attracting foreign traders. However developments in the adjoining Fort Kochi were strengthened by the foreign traders.

5.3.2. Development of Fort Kochi

From the 16th century, Kochi witnessed rapid changes through the trading and colonizing attempts of European powers. Portuguese were the first to arrive at Kochi. They founded Fort Kochi, established factories and warehouses, schools and hospitals and extended their domain in the political and religious fronts. The fall of the Portuguese in Kochi came with takeover of the Fort by the Dutch in 1663. The Dutch East India Company tried to persuade the local rulers into giving them monopoly in pepper trade. For the next hundred years, Kochi became the centre of political and commercial battles. In 1795 the British took over Kochi from the Dutch. Fort Kochi thus became British Kochi. It became a Municipality in 1866.

5.3.3 Development of Ernakulam

By 1840, Mattancherry was so much crowded that the activities spread to the eastern side of the backwaters to the Ernakulam side. Public buildings and educational institutions were setup in Ernakulam befitting the splendor of the Maharajas. Roads were laid out, markets were established and temples were renovated. Regional connectivity was improved with the commissioning of the railways in 1905. Ernakulam thus gradually started developing as an administrative town. Mattancherry rose to the status of Municipality in 1912 and was followed by Ernakulam in 1913. However it was to a large extent the Port that catapulted the importance of Kochi.

5.3.4 Development of Kochi Port

In the early nineties the existence of a sand bar in the sea mouth prevented large ships from entering safely into the backwaters of Kochi. The opening of Suez Canal in 1869 further emphasized the importance of the Port at Kochi as a coaling station for this route. The idea of making it a great harbour, out of the unique lagoons in Kochi was mooted as early as in 1870. Though Kochi had proposed for a dredged channel leading to the inland harbour, due to the non-availability of adequate technology for dredging at that time, it was only in 1920 that the port works were initiated. Under the direction of Sir Robert Bristow, the sand bar at sea mouth was cut open and a deep shipping channel was dredged to the backwaters. The spoils of the dredging were used to reclaim Wellington Island from the backwaters. Road and rail connectivity to the west Kochi and the island from the main land on the east were completed in 1940 when Government of India declared Kochi as a Major Port. Wellington Island developed with its wharfs, quays and other infrastructure as a transport terminal complex. Kochi port gradually became the focus of the city also coincided with the commissioning of the Pallivasal Hydro Electric Project supplying ample power, heralding a new era of industrial growth in the region. In this wake, a number of major propulsive industries established in the region.

5.4 BACKGROUND TO KOCHI CORPORATION

Kochi, the commercial capital of Kerala, is one of the fastest growing two-tier metropolitan cities in India. The city has an area of 94.88 sq. km. surrounded by the Western Ghats on the east and the Arabian Sea on the west. Kochi is the largest urban agglomeration in Kerala, located about 220 km north of the State capital Thiruvananthapuram. Though the Municipal Governments of Fort Kochi, Mattancherry and Ernakulam were able to exercise their powers and evolve schemes in their respective areas of jurisdiction, they were not in a position to perceive the problems of urban growth as a whole and to plan for it. In order to streamline the municipal administration, the Kochi Municipal Corporation was formed in 1967, incorporating the three municipalities (Fort Kochi, Mattancherry and Ernakulam), Wellington Island and a few surrounding areas in the suburbs.

Kochi is the nerve center of all commercial and economic activities in the state of Kerala. The coastal areas are densely populated with a density of 6300 persons per sq.km. in the city compared to the average density of 819 persons per sq.km. in the State. Urban expansion during the past few decades out grew the limits of Kochi. Kochi is ranked 7th in the list of the top ten most affluent cities in India by 2009 study by Nielsen Company. The city was ranked 10th among Indian cities in terms of house-cost and availability, urban household crowding and household incomes. The Kochi Urban Agglomeration comprises of Kochi Municipal Corporation, five municipalities, 15 Panchayats and a part of three Panchayats. Immediate hinterland of Kochi Port has delineated as the Greater Kochi Region, which covers 731 sq. km, which is almost 8 times the area of the city.

Kochi emerged as a major port city in 1939 had become highly developed during the time of the British rule in India. Later, this city became the first princely State to join the Indian Union willingly after India achieved Independence from the British rule. Its strategic location has always made it stand out as a significant commercial and industrial hub of Kerala. Kochi gained a reputation of being an important spice-trading center. Today, this port city of Kerala is a growing centre of information technology, health services, ship building, International trade and tourism and thus, is regarded one of the fastest growing second-tier metros in India.

It is believed to be the oldest church built by the Europeans in India is the St. Francis Church, located in Kochi. This church also happens to be the original burial site of the legendary seafarer, Vasco-da-Gama before his remains were finally shipped to Lisbon in Portugal. Santa Cruz Basilica, a Roman Catholic cathedral, built in 1557, is another historic edifice located here. The city hosts the highest number of international and domestic tourists in Kerala State. Thus, Kochi can unarguably be the most ideal point if you wish to see the unfathomable beauty of the State of Kerala. The importance of Kochi in the region is evident from its population size and growth. Kochi Urban Agglomeration is the most economically forward looking growth region in the State. Let us examine it in briefly.

5.4.1 Profile of Kochi: Demographic Features

The city of Kochi is the most densely populated city in the State with a population of 601,574 as of 2011 and the city has Kerala's highest population density parameter with 6340 people per km^2, housing about 40 Percent of the district's urban population. The population in the study area has been growing at a rate of 1.4 Percent per annum. As of 2011, Kochi had a metropolitan area population of 2,117,990. Projected population based on natural growth trend is estimated to be 13.69 lakhs in 2021 and 14.29 lakhs in 2026.The city does not exert a pulling effect compared to other Metropolitan cities probably due to the rural urban continuum character of Kerala which provides services and amenities in outlying areas as well. There is definitely a large Percentage of floating population who commute daily to the city from a radius of about 100 kms. The total population including the expected migration and the floating population is estimated to be 17.69 lakhs in 2021 and 21.69 lakhs in 2026 in the Corporation area.

The city has grown rapidly over the past century. 49 per cent of Kochi's population follows Hinduism, and Kochi has the largest Christian population in India at 40.8 per cent. The city's literacy rate is 97.5 per cent and female literacy lags behind that of males by just 1.1 per cent, amongst the lowest such gaps in India. In spite of this, unemployment in Kochi is high at 45.9 per cent due to the lower rate of industrialization compared with other Indian cities. 34 per cent of the population of the City Development Plan area is below the poverty line and in approximately 8,000 people were living in the slums of Kochi.

5.4.2 Economic Base of Kochi

The economy of the area of Kochi is dependent on the activities of the Kochi Port. It is a major coastal city which acts a gateway to goods in India. Over the years, the city has witnessed rapid commercialization. The city is a part of Greater Cochin region and is classified as a B-1 grade city by the Government of India, making it the highest graded city in the State. Kochi was one of the 28 Indian cities found to be among the emerging 440 global cities that will contribute 50 Percent of the world GDP by the year 2025, in a study done by McKinsey Global Institute. A number of industries are located in this district and the proximity and development potential of Kochi Port attracts private and public investments in port related activities. Eloor, north of the city-centre, is the largest industrial belt in Kerala. Fertilisers and Chemicals Travancore Limited (FACT), one of the oldest fertilizers and chemical industry in Kerala is located in Kochi. Kochi

Refineries of (BPCL) at Ambalamugal is one of the largest oil refining facilities in South India. Petronet India has now almost completed Kochi LNG Terminal, for importing and storing natural gas, for energy and fueling needs. Central Government establishments like the Coconut Development Board, the Coir Board and the Marine Products Export Development Authority (MPEDA) have head offices located in the city.

Availability of electricity, fresh water, long coastline, backwaters, and good banking facilities, presence of a major port, container trans-shipment terminal, harbor terminal and an international air terminal are some of the factors which accelerated the industrial growth in the city and its adjoining district. In recent years the city has witnessed heavy investment, thus making it one of the fastest-growing second-tier metro cities in India. More than 60 Percent of the tax revenue of the State comes from Kochi and hence it is rightly called the 'Commercial Capital of Kerala'. Sales tax income generated in the Kochi metropolitan area contributes heavily to state revenue. Construction and manufacturing combined contributes 37 Percent, and trade, tourism and hospitality together provides another 20 Percent. Kochi is recognized as one of the seventeen major industrial cities of India by World Bank.

Since Kochi is a crucial center of commerce, trade and tourism in Kerala, it is well connected by air, rail and road. Urban expansion during the past few decades outgrew the limits of Kochi City. Also the economic activities and the population growth exert pressure on the available infrastructural facilities. This calls for the analysis of key sectors of infrastructural development to assess the extent of intervention needed to achieve the desired living and working condition in the area. Transport is one among them as good transport infrastructure is critical for the city's economy.

5.5 URBAN TRANSPORTS IN ERNAKULAM DISTRICT

The availability of all types of transport facilities is a factor which is unique to this the overall development of any region. The district is well connected to other places with all means of transport facilities like railways, waterways, airways and more importantly roadways. But the current road network and public transport which cannot even handle the present travel demand has to be developed to handle the future traffic demand. The present chapter is an attempt to address this burning issue.

5.5.1 Rail Transport

There are two railway routes from Ernakulam Junction to Kollam, one is the route through Kottayam and another is through Alappuzha route. There are three broad guage lines lying across the district i.e., Shornur-Kochi harbour Terminus line, Ernakulam-Trivandrum line (via) Kottayam and Ernakulam-Alappuzha-Trivandrum line. There is 105 km of rail track in the district. Short link lines to Wellingdon Island and Irumpanam industrial area also exist. The Intercity Rail transport system in the city is administered by the Southern Railway Zone of the Indian Railways. Ernakulam Junction and Ernakulam Town are the two major stations (locally known as the 'South' and 'North' railway stations respectively) are the two major stations in the district. Of these two stations Ernakulam South is the most frequently used, as maximum number of trains touch this Station. Ernakulam South station handles about 65 Percent of traffic generated in the district and the rest is handled by Ernakulam North station.

The South Railway Station is one of the busiest railway stations in South India, with more than 128 scheduled train services daily. The Junction Railway station currently has six platforms with two terminal gates. The main terminal located on the western side is the older structure, constructed in 1932. The East terminal is a new structure, constructed by Greater Cochin Development Authority, as a counter-measure to reduce traffic congestion on the South Rail-Over Bridge, by allowing passengers from the eastern side to access the east gate. The North Railway Station mainly catering to long-distance services that bypass the Eranakulam Junction, and as an additional halt station for many trains. A larger terminal in north has opened to the public as of 27 November 2010. Kochi Harbour Terminus located in the Willingdon Island, constructed by the British in 1946 is the third railway station in the city, provides connectivity to the Kochi port, used mainly for the transportation of goods.

There is a historic station named as Ernakulam Terminus (Station Code: ERG) situated behind the High Court. Great personalities like Mahatma Gandhi and The Viceroy have visited Kochi through this old majestic railway station. Ernakulam Terminus was the first station to serve the city but had abandoned in the early 60's. Now, Southern Railway plans to convert it into a hub for proposed suburban railway system for the city. A Metro rapid transit service, intended to considerably ease congestion, is currently sanctioned of the Central Government. In addition, the Southern Railway started a suburban railway system in Ernakulam, connecting nearby towns and cities by introducing MEMU services. Table: 5.1 summarizes the distance from Kochi to major cities. The longest distance is to Delhi, 2594 km, second is Kolkata, 2360 km from Kochi, and second is to Varanasi, a distance of 2312 km among the 35 cities listed in the table. From Kochi to Mumbai, there is only 1384 km distance. The same is depicted below:

Table: 5.1
Rail Distance (in KM) from Kochi to Major Cities

City	Distance	City	Distance	City	Distance
Ahmedabad	1881	Kollam	150	Panaji (Goa)	842
Alapuzha	63	Kottayam	63	Sabarimala	211
Bangalore	533	Kozhikode	196	Salem	358
Chennai	684	Kumarakom	77	Thekkady	190
Coimbatore	193	Madurai	270	Trivandrum	221
Delhi	2594	Malampuzha	153	Thrissur	79
Guruvayoor	100	Mangalore	439	Trichy	395
Hyderabad	1095	Mumbai	1384	Thirunelveli	256
Kanyakumari	307	Munnar	130	Tirupati	730
Kannur	290	Mysore	397	Tuticorin	304
Kodaikanal	330	Ooty	281	Varanasi	2312
Kolkata	2360	Palakkad	163		

Source: Kochi City Development Plan, 2010

5.5.2 Air Transport

There are two Airports in the District one is Naval Airport in Wellington Island and other is Kochi International Airport. Naval Airport is the old Cochin Airport. This has operated by the Indian Navy, whose southern headquarters is located in Kochi. This airport is however not open to the public, and is solely used by the navy and by important government dignitaries visiting the city. Kochi International Airport at Nedumbassery (near Angamali town), 28 km from the city, is the largest airport in Kerala in terms of passengers and number of flights and the 4th largest airport in India, owned by a public limited company. It is the first international airport in India built without Central Government funds. Having a 3,400-metre runway, one of the largest in Asia, the airport is equipped to operate any type of aircraft. Currently it is the fourth busiest International airport in India. There are international flights from Kochi to foreign countries. Currently in expansion mode, the airport has made ready to accommodate the super jumbo Airbus 380. The Airport is connected with most of the cities in the Middle-East and South East Asia with nearly sixteen International flight carriers operating to the city. Apart from this, the city is well connected to major metros and cities of India with seven domestic carriers operating nationwide air services.

5.5.3 Water Transport

Kochi has a good network of inland waterway system consisting of backwaters, canals and lagoons. The rivers and lagoons here have enabled water transport in this district. The two main boat terminals are Mattancherry and Ernakulam High Court Jetty. The National Waterway No.3 connecting Kollam and Kottappuram passes through the district through the Vembanad Backwaters. Inland waterways are also providing connectivity to different parts of the district and to other districts. Domestic ferry and cruises operate in Kochi. Regular inter-island boat services operated from the High Court Jetty and the Ernakulam Central Jetty at Park Avenue to various places. The Junkar ferry for the transshipment of vehicles and passengers between the various islands is operated between Ernakulam and Vypin, and between Vypin and Fort Kochi. However, construction of the Goshree Bridges (which links Kochi's various islands) has made ferry transport less important. Backwaters cruises are one of the most important tourist activities here.

Being one of the safest harbours in the Arabian Sea, Kochi ranks among India's major seaports. The Port regularly handles various international passenger cruisers. ‘Queen Mary 2’ was the largest passenger cruiser at Kochi. Kochi is also the only home port in India for international cruises operated by Louis Cruises with regular trips to Maldives and Sri Lanka. Kerala Shipping and Inland Navigation Corporation operates large luxury cruise vessel called Sagar-Rani for high seas cruise parties. Also, numerous of private operators provide private cruise vessels for short leisure trips across the backwaters.

5.5.4 Road Transport

The State has total road length of 1.6 lakh km including National and State Highways. Out of the total road length, Ernakulam district ranks top with a total road length of 2172 km. Many roads in the city follow a North-South direction with two East-West corridors. The three major National Highways passing through Ernakulam District are the Kochi -Mumbai Highway (NH 17), Salem-Kanyakumari (NH 47 part of NSEW corridor) and Kochi-Dhanushkodi Highway (NH 49). The district has two small National Highways namely NH 47A for Cochin Port connectivity (Smallest Indian National Highway) starting from Kundannur to Willingdon Island and NH 47C as part of the Inter National Container Transshipment Terminal connectivity (Vallarpadam) starting from Kalamassery. The city is also connected with several State Highways like SH - 15, SH - 16, SH - 41, SH - 63, and SH - 66. The State government has constructed an expressway called Airport-Seaport Road running parallel to NH 47 bypass road at Maradu junction to Kalamasserry junction.

5.6 KOCHI CITY ROADS

Mahatma Gandhi Road is a 4-kilometre-long (2.5 mi) arterial road and commercial high street in Kochi. The 8.2-kilometre-long (5.1 mi) Chittoor Road is the oldest arterial road that connects the city to northern suburbs like Chittoor, Panchalam and Vaduthala. Another major arterial road is the 1.5-kilometre-long (0.93 mi) Marine Drive Road, which extends southward as Park Avenue and Foreshore Roads and northward as the Marine drive bay road. The youngest arterial road is the 3.2-kilometre-long (2.0 mi) Kaloor-Kadavanthra Road, constructed in 2002 as an effort to reduce congestion at MG Road and Chitoor Road and provide an alternative for commuters to reach the major southern junction of Kadavanthara from the northern junction of Kaloor.

The following table (Table: 5.2) shows functional classification road networks in Kochi. The share of arterial roads in the total road net work in the city is only 2.75 Percent, whereas the sub arterial roads are about 9 Percent. Local streets forms the major part of the road network. 63.96 Percent of the roads are local streets and Collector streets have 151.4 km length.

Table: 5.2
Functional Classification of Roads in Kochi

Type of Road	Length (KM)	Percentage
Arterial Road	16.9	2.75
Sub Arterial Road	53	8.63
Collector Street	151.4	24.66
Local Streets	392.66	63.96
Total	613.96	100

Source: Road Transport Statistics, 2011

Out of the total length, 72.1(11.74 Percent) is owned by PWD and 541.865 (88.26 Percent) by Corporation. 64 Percent of the total roads in Kochi are of local street category having a right of way of less than 5m. 35 Percent of roads in study area are of collector road category and have a right of way of ranging and 5 to 10. 8 Percent of the roads are of sub arterial category. Table: 5.3 presented the category wise road network in Kochi.

Table: 5.3
Category wise Road Network in Kochi

Type of Road	Length (KM)	Percent
PWD Road	72.1	11.74
Corporation Road	541.86	88.26
Total	613.96	100

Source: Road Transport Statistics, 2011

Carriageway width and corresponding road length is given in the following table (Table: 5.4). 56.6 Percent of total road length is single lane, only 7 Percent is three laned, less than single lane is 16.3 Percent, 28.46 km of road length is four laned ones.

Table: 5.4

Carriage Width and Road length in Kochi

Carriage Width	Road Length	Percentage
Less than Single Lane	100.125	16.3
Single Lane	347.68	56.6
Intermediate Lane	81.295	13.2
Two Lane	52.355	8.5
Three Lane	4.05	0.7
Four Lane	28.46	4.7
Total	613.965	100

Source: Kochi City Development Plan, 2010

The city has only two east-west corridors, creating one of the most congested traffic at the stretch. The 4-kilometre-long (2.5 mi) Sahodharan Ayyappan Road connects MG Road to Kochi Bypass Road at Vytilla Junction at the southern side and the 5-kilometre-long (3.1 mi) Kaloor Road connects Banerjee Road to NH 47 at Edappally Junction. The 17 km (11 mi) stretch of Edapally - Aroor bypass road has turned out to be the most important arterial road in Kochi. A third east–west corridor is planned connecting MG Road with NH 47 known as Pullepady-Thammanam road, for which first phase has started with construction of Pullepady Rail-Over Bridge. Fort Kochi has the maximum number of roads, mostly narrow in nature, due to presence of several heritage properties and thickly populated areas. Indira Gandhi Road is the main arterial road in Willington Island that runs parallel to western coastal side of the island connecting Ernakulam Wharf with NH 47A.

5.7 PUBLIC TRANSPORT IN KOCHI

Public transport in Kochi basically comprises of auto rickshaws, taxis, buses and ferry rides. Pedal bikes, used as taxis in Kochi during colonial times. Non-mechanized forms of transport, except bicycles, are now obsolete on Kochi roads. The city has a very fast and efficient bus transport system, mainly dominated by private operators, known as Red-Buses. The red buses offer no-frills travel within the city, forming a major backbone of public transport. However the reckless driving and competitive tendency among red-buses has been heavily criticized by the public. Despite its mounting public criticism on reckless driving, the punctuality and reliability of services often silence the critics to a great extent.

In 2010, the State public transport company, KSRTC started city services due to frequent complaints against red-buses, which has been praised for its efficient and controlled services. KSRTC bus stations provide buses to all major places within the

State. The main Bus Stations in Ernakulam district are Aluva, Angamaly, Ernakulam Central, Muvattupuzha, Kothamangalam, Kaloor, High Court Junction, Railway Station Junction and Perumbavoor. KSRTC operates two classes of service: a basic no-frills service known as Thiru-Kochi which has the same fare system as the red-buses. These buses are distinguishable by their blue-white livery and are JNNURM funded transport services. The JNNURM transport services operated by KSRTC offer premium air-conditioned low-floor bus services known as Orange Buses and non-air conditioned semi low floor buses known as Yellow Buses. Both the buses connect the central business district areas of Kochi with the nearby suburbs. Currently these premium bus services are available as per the schedule published by Kerala State Road Transport Corporation. At present, 630 intra-buses are authorized to operate inside the city. The city also caters to nearly 2100 long-distance private buses, which include 466 inter-city State buses.

Most of the buses run primarily on four major routes, known as the Big 4 routes, though there are 160 official authorized routes to operate connecting 60 destinations in the city and nearby suburbs. The most popular route is the Aluva-Fort Kochi Route, which covers almost all the city areas. The city has primarily four major bus stations: (1) Kaloor Bus station: A major terminus used by privately operated long-distance buses and local red-buses, (2) KSRTC Central Bus Station in the south: Exclusively operated by KSRTC Inter-State/inter-city buses. Buses of neighbouring State Transport Corporations also operate their services from this bus station, (3) KSRTC Jetty Station: Located near Central Boat Jetty in Park Avenue, is used by KSRTC city and short distance services, (4) Fort Kochi Bus Terminus: Located near Fort Kochi Beach, is a major bus station for both private and KSRTC City services. A total of 160 routes originating from 60 locations scattered all over the city. The buses contribute about 14 Percent of the vehicular traffic and carry 73 Percent passenger traffic. The share of cars in terms of vehicular trips is about 38 Percent carrying 15 Percent of the passenger. Two wheelers contribute 35 Percent of vehicular traffic and 8 Percent of passenger traffic. Autorikshaws contribute about 13 Percent of vehicular traffic and 4 Percent of passenger traffic.

To ease congestion within the city limits, a large integrated public transport terminus is planned to be constructed at Vytilla Junction, known as Integrated Mobility Hub, which provides commuters multi-modal transport options. The Mobility Hub plans to provide space for 170 buses, 2000 car bays, 50 Inter-State buses parking bays, 5,000 two- and three-wheeler parking bays and a boat jetty with 3 piers for providing water ferry transport. A shopping mall and commercial towers are planned in the second phase to sustain with additional revenues. On-street Taxi cabs are rare and can be hired from taxi stands located all over the city. Major taxi stands are located outside both the city railway stations, Woodlands Junction, BTH Rounds, Thevara bus station, Kaloor bus station, Thoppumpady and Fort Kochi terminuses. Most of the on-street taxis are HM Ambassadors and Tata Indica and as per law, they have to be in White colour with yellow plates without any taxi sign on top. Call taxis are more popular and can be hired on an hourly basis and on a distance travelled basis, by prior telephonic booking. The most common on-street hire options are Auto rickshaws autos, which are economical. Private rent-a-cars, rented bikes companies also operate, for self and chauffeur driven options.

Like many other cities, two-wheeler vehicles like motor bikes, scooters, cycles contribute major share of the vehicle population in the city, which is extremely popular among the locals. As Kochi is being a major financial and commercial center, there is a sharp rise in private vehicles plying on the city roads. This necessitated the attention of authorities to allocate a good share of budget to this sector.

5.8 FINANCIAL OUTLAY OF TRAFFIC AND TRANSPORT IN KOCHI

A consolidated statement of the year wise expenditure outlay under traffic and transport sector and for Roads and Pavements in Kochi Corporation are given below (Table: 5.5, 5.6).

Table: 5.5

Year Wise Outlay for Traffic and Transport Sector (Rs. Crores)

Year Wise Outlay	Outlay for Traffic & Transport	Total Outlay	Percent Share
2006-07	692	1214.9	56.96
2007-08	1041	1992.24	52.25
2008-09	1093	2503.24	43.66
2009-10	847	2700.09	31.37
2010-11	519	1537.27	33.76
2011-12	60	1035.14	5.8
AAG	-18.85	4.35	-25.61
EG	-41.6	-4.3	-37.3

Source: Kochi Development Report (in various years)

From Table: 5.5, it is clear that out of the total 1214.9 crores of outlay, 692 crores were allocated for traffic and transport in the year 2006-07. The percentage share of outlay allocated for traffic and transport in the city are showing a diminishing trend from 2007-08 to 2011-12. The Average Annual Growth Rate of outlay for traffic and transport in Kochi is -18.85 and that of Exponential Growth Rate is -41.6. Total outlay shows an Average Annual Growth of 4.35 and Exponential Growth of -4.3. During 2012, the share of outlay for traffic and transport is only 5.8 percent of the total outlay.

Table: 5.6

Operation and Maintenance Expenditure for Roads and Pavements in Kochi

Years	Total Budget	Lorry, Taxi, Auto and other Vehicle Tax	Percentage Share	Transportation Expenditure(Gas ,Diesel, Petrol)	Percentage Share	Fund Allocated for Road Transport (Repairs and	Percentage Share
2006-07	144483146	20000000	13.84	44116116	30.53	20583159	14.25
2007-08	120197210	65066000	54.13	20583159	17.12	21205648	17.64
2008-09	115303798	26000	0.02	2800000	2.43	9500000	8.24
2009-10	150303270	6035280	4.02	20701824	13.77	54068192	35.97
2010-11	139639600	2250000	1.61	4756750	3.41	59200000	42.39
2011-12	224455230	110000	0.05	10105184	4.50	57661882	25.69
2012-13	152236929	110000	0.07	12300000	8.08	87102077	57.21
AAG	5.16	3846.69		92.79		79.15	
EG	5.71	-85.4		-16.9		29.14	

Source: Kochi Development Plan (Various Years issues)

Table: 5.6 shows that out of the total budget share for the operation and maintenance expenditure for roads and pavements in Kochi during the year 2012-13, 57.21 percent utilized for the repairs and maintenance of roads. The Average Annual Growth Rate of total budget in the Erankulam district shows a percent of 5.16 and exponential growth of 5.71. Average Annual Growth Rate of Lorries, Taxi, Auto and other vehicle tax is 3846.69 and that of Exponential Growth Rate is -85.4. 92.79 is the AAG of transportation expenditure for diesel, petrol and gas and its Exponential Growth Rate is -16.9. fund allocated for road transport shows an Annual Growth Rate of 79.15 and Exponential Growth of 29.14. For bridges, secondary roads and metro rail, huge amount of investments spend. About 53 Percent of the total investment spends for this three areas development. For secondary roads 661 crores is the estimated investments during 2012-13.

From Table: 5.5(A) we can see the future values of outlay for traffic and transport sector in the district. The future value shows a negative trend in the case of outlay for traffic and transport and total outlay also. In the year 2019-20, future values for the outlay for traffic and transport sector is -782.93 and total outlay is 1210.42. Future values of the operation and maintenance expenditure for roads and pavements in Kochi for the year 2019-2020 is 240986022.93. Vehicle tax and transportation expenditure shows a diminishing trend. 159249144.71 is the future value for the fund allocated for the repairs and maintenance of road transport during 2019-2020. The same we can see in Table: 5.6(A).

Table: 5.5 (A)
Future Values- Outlay for Traffic and Transport Sector (Rs. Crores)

Year Wise Outlay	Outlay for Traffic & Transport	Total Outlay
2012-13	211.47	1623.79
2013-14	69.41	1564.74
2014-15	-72.65	1505.69
2015-16	-214.70	1446.63
2016-17	-356.76	1387.58
2017-18	-498.82	1328.53
2018-19	-640.88	1269.48
2019-20	-782.93	1210.42

Table: 5.6 (A)
Future Values - Operation and Maintenance Expenditure for Roads and Pavements in Kochi

Years	Total Budget	Lorry, Taxi, Auto and other Vehicle Tax	Transportation Expenditure	Fund Allocated for Road Transport
			(Diesel, Petrol, Gas)	(Repairs and Maintenance)
2013-14	186104624.86	-13394388.57	130783.57	90212882.86
2014-15	195251524.54	-20085745.71	-3956628.86	101718926.50
2015-16	204398424.21	-26777102.86	-8044041.29	113224970.14
2016-17	213545323.89	-33468460.00	-12131453.71	124731013.79
2017-18	222692223.57	-40159817.14	-16218866.14	136237057.43
2018-19	231839123.25	-46851174.29	-20306278.57	147743101.07
2019-20	240986022.93	-53542531.43	-24393691.00	159249144.71

5.9 VEHICULAR MOBILITY IN ERNAKULAM AND KOCHI

In Ernakulam district there are 9 Regional Transport Offices which is the highest number in the State. They are Ernakulam - KL 07, Muvattupuzha - KL 17, Thripunithura - KL 39, Perumbavoor - KL 40, Aluva - KL 41, North Paravur - KL 42, Mattancherry - KL 43, Kothamangalam - KL 44, Angamaly - KL 63. These Sub RT offices were formed in 1985, upto that there were only one RT office located at Kakkanad, Civil Station. Only two RT offices come under the Kochi Corporation namely Ernakulam

Regional Transport office and Regional Transport office Mattancherry. The district, Ernakulam which has got the maximum number of vehicles in the State. Let us now look into traffic and vehicular growth in Kochi Corporation with a comparison to those of the district.

The following Table: 5.7, illustrates the total registered motor vehicles in Ernakulam district as on 31st March of year. As we know that the average life of a vehicle is 15 years, last 15 years of data (from 1997 onwards) provides the exact picture of vehicle growth trend. This statistics shows that there have been increases in the number of registered vehicles in each year throughout the district. Each year an average of 50,000 new vehicles is registered in the district. At the end of 2012, there were 1136226 registered vehicles in the district. From 2011 April to 2012 March, an increase of 100723 vehicles reported in the district.

Table: 5.7

Total Number Registered Motor Vehicles in Ernakulam District

Year	Newly Vehicles (End of Financial Year)	Total Registered Vehicles (Starting of Financial Year)	Percentage of Newly Registered vehicles to Total Registered	Total Number of Motor Vehicles (End of Financial Year*
1997-98	42109	418179	10.07	460288
1998-99	41753	459932	9.07	502592
1999-00	42308	502240	8.42	546640
2000-01	43619	545859	7.99	592536
2001-02	40449	586308	6.89	633565
2002-03	42416	628724	6.74	679813
2003-04	44376	673100	6.53	723465
2004-05	49528	722628	6.85	772051
2005-06	45246	767874	5.89	816540
2006-07	67156	835030	8.04	890325
2007-08	59852	894882	6.68	951375
2008-09	53208	948090	5.61	995,598
2009-10	57135	1005225	5.68	1,050,607
2010-11	67643	1072868	6.30	1,130,681
2011-12	88321	1136226	7.77	1,231,404
CAGR	5.06	6.89	- 1.71	6.78
AAG	6.54	7.41	-0.81	7.29
EG	4.46	7.04	-2.6	7

Source: Annual Administration Report, Motor Vehicles Department, Ernakulam

Total number of motor vehicles at the end of the financial year includes vehicles transferred in the district, excludes the number of vehicle transferred out from the district and registration-cancelled vehicles. The Compound Annual Growth Rate of newly registered vehicles in the district from 1997 to 2012 is 5.06 and that of total registered vehicles are 6.89 percent. Average Annual Growth of newly registered vehicles in Ernakulum district is 6.54 percent and that of Exponential Growth Rate is 4.46 percent. The future values of the number of newly registered motor vehicles in the district calculated and it is 89834.51667 as on 2019-20,and that of total registered vehicles are 1510454.56, the same is shown in Table: 5.7 (A).

Table: 5.7(A)

Future Values -Total Number Registered Motor Vehicles in Ernakulam District

Year	Newly Vehicles (End of Financial Year)	Total Registered Vehicles (Starting of Financial Year)	Total Number of Motor Vehicles (End of Financial Year*
2012-13	72337.66667	1153932.01	1220383.181
2013-14	74837.21667	1204863.802	1273118.745
2014-15	77336.76667	1255795.595	1325854.31
2015-16	79836.31667	1306727.388	1378589.874
2016-17	82335.86667	1357659.181	1431325.438
2017-18	84835.41667	1408590.974	1484061.002
2018-19	87334.96667	1459522.767	1536796.567
2019-20	89834.51667	1510454.56	1589532.131

Table: 5.8, shows that total registered motor vehicles in the Kochi Corporation, as on 2000 March, is 254491(for the district it is 502240), it is 51 Percent of the total registered vehicles in the district. Before the formation of Kerala State, there were only 2603 motor vehicles in Kochi (The data collected by checking the Registration and ownership of vehicle). Kochi Corporation shows the Compound Annual Growth Rate of newly registered motor vehicles at 7.04 percent and that of total motor vehicles at 17.97 percent. The Average Annual Growth Rate of newly registered vehicles in the district is 16.53 percent and that of total motor vehicles is 24.58 percent. Exponential Growth Rate of newly registered vehicles in the district is 4.68 percent and that of total motor vehicles is 12 percent. Table: 5.8(A) shows the future values of the total registered motor vehicles in Kochi. During the year 2019-20, the newly registered vehicles estimated to be as 44881.36308, total motor vehicles would be 788016.9692 and that of growth percent calculated as -17.79.

The statistics in Table: 5.9 clearly indicate the unstable and fluctuating number of registered vehicles. It shows that in the Corporation, the number of newly registered motor vehicles shows an Average Annual growth of 6.55 Percent (1997-2012).

Table: 5.8

Total Registered Motor Vehicles in Kochi

Year	Newly Registered	Total Motor Vehicles	Growth Percent
1960-1970	7727	10330	-
1970-1980	24342	34672	70.21
1980-1990	48024	82696	58.07
1990-1991	10124	92820	10.91
1991-1992	9756	102576	9.51
1992-1993	11360	113936	9.97
1993-1994	15238	129174	11.80
1994-1995	19352	148526	13.03
1995-1996	20363	168889	12.06
1996-1997	20963	189852	11.04
1997-1998	18749	208601	8.99
1998-1999	20510	229111	8.95
1999-2000	25380	254491	9.97
2000-2001	24071	278562	8.64
2001-2002	22929	301491	7.61
2002-2003	27548	329039	8.37
2003-2004	30892	359931	8.58
2004-2005	32641	392572	8.31
2005-2006	37261	429833	8.67
2006-2007	36195	466028	7.77
2007-2008	31173	497201	6.27
2008-2009	29957	527158	5.68
2009-2010	35453	562611	6.30
2010-2011	39190	601801	6.51
2011-2012	42358	644159	6.58
CAGR	7.04	17.97	- 9.39
AAG	16.53	24.58	
EG	4.68	12	

Source: Annual Administration Report, Motor Vehicles Department (Kakkanad and Mattancherry RT Offices).

Table: 5.8(A)

Future Values - Total Registered Motor Vehicles in Kochi

Year	Newly Registered	Total Motor Vehicles	Growth Percent
2012-13	38154.67	612395.87	-5.9841002
2013-14	39115.62615	637484.5985	-7.670877138
2014-15	40076.58231	662573.3269	-9.357654077
2015-16	41037.53846	687662.0554	-11.04443102
2016-17	41998.49462	712750.7838	-12.73120795
2017-18	42959.45077	737839.5123	-14.41798489
2018-19	43920.40692	762928.2408	-16.10476183
2019-20	44881.36308	788016.9692	-17.79153877

The Exponential Growth of newly registered vehicles is 4.93 percent from 1997 to 2012. As on 2012, a total of 1231404 vehicles registered in Ernakulam, of which 644159 registered in Kochi (52.31 Percent). In 2012, the newly registered vehicles case is 88321 and 42358 respectively (47.96 Percent of the district total). The CAGR of newly registered vehicle in the Corporation is 5.58 percent and that of the district is 5.06 percent. In the case of total registered vehicles in Kochi, CAGR is 7.81 percent and that of the district is 6.78 percent. The Exponential Growth Rate of the newly registered vehicles in the district is 4.46 percent and that of the Corporation is 4.93 percent.

Table: 5.9

Comparison of Registered Motor Vehicles in Ernakulam District and Kochi

Year	Newly Registered in Kochi	Newly Registered in District	% of Newly Registered in Kochi out of District	Total Vehicles in Kochi	Total Vehicles in District	% of Total Registered out of District
1997-98	18749	42109	44.52	208601	460288	45.32
1998-99	20510	41753	49.12	229111	502592	45.59
1999-00	25380	42308	59.99	254491	546640	46.56
2000-01	24071	43619	55.18	278562	592536	47.01
2001-02	22929	40449	56.69	301491	633565	47.59
2002-03	27548	42416	64.95	329039	679813	48.40
2003-04	30892	44376	69.61	359931	723465	49.75
2004-05	32641	49528	65.90	392572	772051	50.85
2005-06	37261	45246	82.35	429833	816540	52.64
2006-07	36195	67156	53.90	466028	890325	52.34
2007-08	31173	59852	52.08	497201	951375	52.26
2008-09	29957	53208	56.30	527158	995,598	52.95
2009-10	35453	57135	62.05	562611	1,050,607	53.55
2010-11	39190	67643	57.94	601801	1,130,681	53.22
2011-12	42358	88321	47.96	644159	1,231,404	52.31
CAGR	5.58	5.06	0.49	7.81	6.78	0.96
AAG	6.55	6.54		8.4	7.29	
EG	4.93	4.46		8.06	6.78	

Source: Annual Administration Report, Ernakulam District.

Compound Annual Growth Rate of newly registered motor vehicles in Kochi during 1999 to 2012 shows 5.58 percent while that of the district, shows 5.06 percent during the same period. Total motor vehicles, as on 2012March, are 1231404, but the total number of registered motor vehicles is 1,219,002. Table: 5.9 (A), shows the future values of the newly registered and total registered motor vehicles in the district and Corporation. At the year of 2019-20, the newly registered vehicles in Kochi would be

51696.79 and 89834.52 that of the district Ernakulam. In the case off total registered vehicles, it is 874311.65 and 1589532.13 respectively.

Table: 5.9 (A)
Future Values: Comparison of Registered Motor Vehicles in Ernakulam District and Kochi

Year	Newly registered in Kochi	Newly registered in District	Total vehicles in Kochi	Total vehicles in the District
2012-13	41705.62	72337.67	655535.65	1220383.18
2013-14	43132.93	74837.22	686789.36	1273118.75
2014-15	44560.24	77336.77	718043.08	1325854.31
2015-16	45987.55	79836.32	749296.79	1378589.87
2016-17	47414.86	82335.87	780550.50	1431325.44
2017-18	48842.17	84835.42	811804.22	1484061.00
2018-19	50269.48	87334.97	843057.93	1536796.57
2019-20	51696.79	89834.52	874311.65	1589532.13

Table: 5.10
Inflows and Outflows of Motor Vehicles in Ernakulam District

Year	Vehicles transferred in the District	% Vehicles Transferred in the District Out of Total	Registration Cancelled Vehicles	Vehicles Transferred Out from the District	Net Extra Growth in vehicles	% Net Extra Growth
1997-1998	11469	2.49	16	10596	857	0.19
1998-1999	11761	2.34	25	11185	551	0.12
1999-2000	12220	2.24	57	10423	1740	0.34
2000-2001	12346	2.08	63	10006	2277	0.41
2001-2002	10135	1.6	23	9532	580	0.10
2002-2003	13982	2.06	47	10103	3832	0.58
2003-2004	11997	1.66	88	12633	-724	-0.08
2004-2005	12484	1.62	37	13389	-942	-0.11
2005-2006	12263	1.5	106	12914	-757	-0.07
2006-2007	16425	1.84	102	9694	6629	0.77
2007-2008	13287	1.4	112	11886	1289	0.16
2008-2009	13042	1.31	246	14656	-1860	-0.14
2009-2010	12871	1.23	550	14447	-2126	-0.10
2010-2011	26990	2.39	584	13975	12431	1.20
2011-2012	20052	1.63	155	13040	6857	0.56
AAG	7.95		45.24	2.36	-101.94	
EG	3.76		20.74	2.34		

Source: Annual Administration Report, Ernakulam District

One point to be noted here is that the total registered motor vehicles and total numbers of vehicles are different one in the case of district data while the difference not measured in Corporation area. This slight variation is due to vehicles transferred in the district, out from the district and the number of registration cancelled vehicles. That is, total number motor vehicles in the district can be calculated by adding newly registered motor vehicle with number vehicles transferred in the district and from these subtract the number of vehicles whose registration is either cancelled or it is transferred out from the district. The same depicted in Table: 5.10.

From the table, it is clear that as on 2012 March, the number of vehicles transferred in the district is 20052 (1.63 Percent of total), 13040 vehicles are transferred out from the district and 155 vehicle's registration cancelled. Therefore, the net growth of vehicles is 6857, which is 0.56 Percent of the total vehicles. Annual Average Growth rate of vehicles transferred in the district is 7.95 percent and that of the Exponential Growth Rate id 3.76 percent. In the case of registration cancelled, the AAG is 45.24 percent and EG is 20.74 percent. The AAG of vehicles transferred from the district is 2.36 percent and that of EG is 2.34 percent. Table: 5.10(A) provides the future values of the inflows and outflows of motor vehicles in the district from 2012-13 to 2019-20. It is predicted that vehicles transferred in the district would be 23308.02 during 2019-20, 571.63 registration cancelled vehicle and the number of vehicles transferred out from the district would be 16135.73.

Table: 5.10(A)
Future Values - Inflows and Outflows of Motor Vehicles in the District

Year	Regression - Vehicles Transferred in the District	Regression - Registration Cancelled Vehicles	Regression - Transferred Out from the District	Regression - Net Extra Growth in vehicles
2012-13	19005.47	373.66	14158.40	4473.41
2013-14	19620.12	401.94	14440.88	4777.30
2014-15	20234.77	430.22	14723.35	5081.20
2015-16	20849.42	458.50	15005.83	5385.09
2016-17	21464.07	486.79	15288.30	5688.98
2017-18	22078.72	515.07	15570.78	5992.87
2018-19	22693.37	543.35	15853.25	6296.77
2019-20	23308.02	571.63	16135.73	6600.66

Road vehicles are categorized into two: Transport and Non-Transport, based on the purpose it served. The following Table: 5.11 explains the share of Transport and Non-Transport vehicles in total vehicles as on 31st March of every year. Table: 5.11(A) shows the future values of total transport and Non –transport vehicles growth in the district.

Table: 5.11
Total Transport and Non -Transport Vehicles Growth in Ernakulam District

Year	Newly Registered Transport	Total Transport	Percentage of Transport	Newly Registered Non-Transport	Total Non -Transport	Percentage of Non-Transport	Grand Total (Transport + Non-Transport)	Ration Between Transport and Non Transport
1997-98	6098	72943	15.85	36462	387345	84.15	460288	0.19
1998-99	6258	79714	15.86	35495	422878	84.14	502592	0.19
1999-00	5968	86620	15.85	36340	460020	84.15	546640	0.19
2000-01	6070	93300	15.75	37549	499236	84.25	592536	0.19
2001-02	7347	100809	15.91	33102	532756	84.09	633565	0.19
2002-03	5670	107514	15.82	36746	572299	84.18	679813	0.19
2003-04	6006	113936	15.75	38370	609529	84.25	723465	0.19
2004-05	7004	121392	15.72	42524	650659	84.28	772051	0.19
2005-06	6103	127906	15.66	39143	688634	84.34	816540	0.19
2006-07	8843	139391	15.66	58313	750934	84.34	890325	0.19
2007-08	8229	148561	15.62	51623	802814	84.38	951375	0.19
2008-09	6962	147966	14.86	46246	847632	85.14	995598	0.17
2009-10	9298	156420	14.89	47837	894187	85.11	1050607	0.17
2010-11	9252	167760	14.84	58391	962921	85.16	1130681	0.17
2011-12	13256	293583	23.84	75065	937821	76.16	1231404	0.31
AAG	7.61	11.53	3.87	6.48	6.56	-0.67	7.29	
EG	4.21	7.43	0.65	4.47	6.59	-0.2	6.78	
CAGR	5.29	9.72		4.93	6.07		6.78	

Source: Annual Administration Report, Motor Vehicles Department, Kochi

From this table it is very clear that out of the total 1231404 number of vehicles, (Total registered Vehicles is not the same) 293583 are Transport Vehicles and 937821 are Non-Transport Vehicles. Total Transport vehicles grow at 23.84 Percent of total vehicles in 2011-12 year, and that of Non-Transport is 76.16 Percent of total vehicles. During 2011-12, newly registered (both Transport and Non-Transport) vehicle’s are 88321, of which Transport vehicles account 13256 and that of Non-Transport Vehicles 75065. The percent of transport vehicles to total motor vehicle in the district during the year 2011-12 is 23.84 and that of non- transport vehicles is 76.16 percent. The ratio between transport to non-transport from 1997 to 2011shows a decrease trend from 0.19 percent to 0.17 percent. But during 2011-12 it is 0.31percent. The Average Annual Growth Rate of newly registered transport vehicles is 7.61 percent from 1997-2012 and that of Compound Annual Growth Rate is 5.29 percent. Total transport vehicles grow at an Average Growth Rate of 11.53 percent and that of Non-Transport vehicles is 6.56 percent. Table: 5.11(A) predicts the future values of total transport and non-transport vehicles growth from 2012-2010. The estimated value of total transport vehicles is 283810.29 and that of non-transport vehicles is 1305721.85. That is, 1589532.13 for the total transport and non-transport vehicles during the year 2019-20.

Table: 5.11(A)
Future Values - Total Transport and Non -Transport Vehicles Growth

Year	Newly Registered Transport	Total Transport	Newly Registered Non-Transport	Total Non-Transport	Grand Total (Transport+ Non -Transport)
2012-13	10273.1	212275.3	62004.4	1008107.9	1220383.2
2013-14	10620.9	222494.6	64144.9	1050624.2	1273118.8
2014-15	10968.7	232713.9	66285.4	1093140.5	1325854.3
2015-16	11316.5	242933.1	68425.9	1135656.7	1378589.9
2016-17	11664.2	253152.4	70566.4	1178173.0	1431325.4
2017-18	12012.0	263371.7	72706.9	1220689.3	1484061.0
2018-19	12359.8	273591.0	74847.4	1263205.6	1536796.6
2019-20	12707.6	283810.3	76987.9	1305721.9	1589532.1

Table: 5.12 explains the growth share of Transport and Non-Transport vehicles in Kochi Corporation. As on the year 1960, there are only 696 registered Transport Vehicles and 1907 registered Non-Transport Vehicles in the Corporation area (Total of 2603 Vehicles). When we analyze the growth of vehicles from 1960 onwards, we realize that, Newly Registered Transport vehicles grow at an average of 3571 in every year, while those of Non- Transport are 22091. The growth of Newly Registered Non-Transport Vehicles is six fold of the growth of Transport Vehicles. As such, total Transport vehicles increases at an average of 15.8 Percent of Total Vehicles (Total of Transport and Non-Transport Vehicles) from 1960 onwards. However, the shares of Non-Transport to Total Vehicles add to at an average of 84.16 Percent, about 5.5 times of Transport Vehicles growth. From the last decade onwards (After 2000), we can see a sharp increase in the number of registered Transport vehicle; it expands at an average of 4327 each year. In the same period, Registered Non- Transport Vehicles inflate at an average of 28146 numbers in each year. As on 2012, there are 89966 Transport Vehicles, 554193 Non -Transport Vehicles out of a total of 644159 vehicles.

The Annual Average Growth Rate of newly registered transport vehicles in Kochi from 1960-2012 shows a figure of 0.17 percent and that of non-transport vehicles shows a percent of 0.16. In the case of total transport vehicles, it is 0.23 and that of total non-transport vehicles, the figure is 0.25. The Compound Annul Growth Rate of grand total of both transport and non-transport vehicles estimated as 17.98 percent. Table: 5.12(A) shows the future values of total transport and non -transport vehicles growth in Kochi.

Table: 5.12

Growth of Transport and Non -Transport Vehicles in Kochi

Year	Newly Registered Transport	Total Registered Transport	% of Total Transport	Newly Registered Non Transport	Total Registered Non-Transport	% of Total Non-Transport	Grand Total (Transport + Non-Transport)
1960-1970	1290	1986	19.23	6437	8344	80.77	10330
1970-1980	4720	6706	19.34	19622	27966	80.66	34672
1980-1990	8789	15495	18.74	39235	67201	81.26	82696
1990-1991	1489	16984	18.30	8635	75836	81.70	92820
1991-1992	1657	18641	18.17	8099	83935	81.83	102576
1992-1993	1837	20478	17.97	9523	93458	82.03	113936
1993-1994	2316	22794	17.65	12922	106380	82.35	129174
1994-1995	2696	25490	17.16	16656	123036	82.84	148526
1995-1996	2846	28336	16.78	17517	140553	83.22	168889
1996-1997	2836	31172	16.42	18127	158680	83.58	189852
1997-1998	2089	33261	15.94	16660	175340	84.06	208601
1998-1999	2076	35337	15.42	18434	193774	84.58	229111
1999-2000	2710	38047	14.95	22670	216444	85.05	254491
2000-2001	2726	40773	14.64	21345	237789	85.36	278562
2001-2002	2841	43614	14.47	20088	257877	85.53	301491
2002-2003	3646	47260	14.36	23902	281779	85.64	329039
2003-2004	3914	51174	14.22	26978	308757	85.78	359931
2004-2005	4232	55406	14.11	28409	337166	85.89	392572
2005-2006	4765	60171	14.00	32496	369662	86.00	429833
2006-2007	4862	65033	13.95	31333	400995	86.05	466028
2007-2008	4642	69675	14.01	26531	427526	85.99	497201
2008-2009	4223	73898	14.02	25734	453260	85.98	527158
2009-2010	5192	79090	14.06	30261	483521	85.94	562611
2010-2011	5467	84557	14.05	33723	517244	85.95	601801
2011-2012	5409	89966	13.97	36949	554193	86.03	644159
AAG	0.17	0.23		0.16	0.25		0.25
EG	3.65	10.45		4.87	12.3		12
CAGR	5.9	16.48	-1.27	7.24	18.27	0.25	17.98

Source: Annual Administration Report, Motor Vehicles Department, Kochi

During the year 2019-20, the newly registered transport vehicles increase to 5456.43 and that of total transport vehicles in the Corporation increase as108676.13. In the case of newly registred non-transport vehicles, the future value estimated as 39424.93 and that of non-transport vehicles is 679340.84 during the same period. In the case of grand total that is, total of transport and non-transport vehicles the figure is estimate as 788016.97 at the period of 2019-20.

Table: 5.12(A)
Future Values: Total Transport and
Non -Transport Vehicles Growth in Kochi

Year	Newly registered transport	Total transport	Newly registered Non-transport	Total Non-transport	Grand total (Transport+ Non - transport)
2012-13	4796.46	85414.30	33358.21	526981.57	612395.87
2013-14	4890.74	88737.42	34224.88	548747.18	637484.60
2014-15	4985.02	92060.54	35091.56	570512.79	662573.33
2015-16	5079.30	95383.66	35958.23	592278.40	687662.06
2016-17	5173.59	98706.77	36824.91	614044.01	712750.78
2017-18	5267.87	102029.89	37691.58	635809.62	737839.51
2018-19	5362.15	105353.01	38558.26	657575.23	762928.24
2019-20	5456.43	108676.13	39424.93	679340.84	788016.97

Table: 5.13
A comparison of Newly Registered
Transport and Non -Transport Vehicles Growth

Year	Ernakulam District		Kochi Corporation			
	Newly Registered Transport Vehicles	Newly Registered Non-Transport	Newly Registered Transport Vehicles	Percentage of Newly Registered to Total Newly Registered	Newly Registered Non-Transport Vehicles	Percentage of Newly Registered to Total Newly Registered
1997-1998	6098	36462	2089	34.25	16660	45.69
1998-1999	6258	35495	2076	33.17	18434	51.93
1999-2000	5968	36340	2710	45.40	22670	62.38
2000-2001	6070	37549	2726	44.90	21345	56.85
2001-2002	7347	33102	2841	38.66	20088	60.69
2002-2003	5670	36746	3646	64.30	23902	65.05
2003-2004	6006	38370	3914	65.16	26978	70.31
2004-2005	7004	42524	4232	60.42	28409	66.81
2005-2006	6103	39143	4765	78.07	32496	83.02
2006-2007	8843	58313	4862	54.98	31333	53.73
2007-2008	8229	51623	4642	56.41	26531	51.39
2008-2009	6962	46246	4223	60.65	25734	55.65
2009-2010	9298	47837	5192	55.83	30261	63.26
2010-2011	9252	58391	5467	59.08	33723	57.75
2011-2012	13256	75065	5409	40.81	36949	49.22
AAG	7.61	6.48	7.63	3.99	6.44	1.79
EG	4.21	4.47	7.04	2.83	4.63	0.15

Source: Annual Administration Report, Motor Vehicles Department

A comparison of the Newly Registered Transport and Non-Transport Vehicles Growth both in Ernakulam District and that of Kochi Corporation are given below (Table 5.13). From the table, we can point out that Newly Registered Transport Vehicles in the District grow at an average of 14.29 Percent from the last 15 years onwards. While, in the case of Kochi, it is 12.74 Percent. The increase of Non-Transport Vehicles in Ernakulam District is 85.72, and in Kochi, it is 87.26. Out of the district total, in each year, an average of 50.6 Percent of Newly Registered Transport Vehicles is registered under Kochi Corporation limit. Likewise 56.3 Percent of the total district's Non-Transport Vehicles comes under the Corporation area. In the year 2012, the total newly registered transport vehicles in the district is 13256, which is 15 Percent of the total registered vehicles and that of Non-Transport vehicles is 75065 (84.99 percent of the total motor vehicles the district). For the Kochi Corporation, the registered transport vehicles are estimated at 5409, 40.81 percent of the total transport vehicles in the district as on 2012 and of Non-Transport are 36949 (49.22 percent of the Non-Transport Vehicles in the district).

The Annual Average Growth of newly registered transport vehicles in the district from 1997-2012 is calculated as 7.61 percent and that of Kochi Corporation is 7.63 percent. Table: 5.13(A) shows the future values of transport and non-transport vehicles growth in the district and Corporation. In the district Ernakulam, the future value of newly registered transport vehicles at the year 2019-20 estimated as 12707.56 and that of Kochi Corporation is 7705.49. In the case of non-transport vehicles, the estimated figures are 76987.90 and 43991.30 respectively.

Table: 5.13(A)
Future Values - A Comparison of Newly
Registered Transport and Non-Transport Vehicles Growth

Year	Ernakulam District		Kochi Corporation	
	Newly Registered Transport vehicles	Newly Registered Non-Transport Vehicles	Newly Registered Transport Vehicles	Newly Registered Non-Transport Vehicles
2013-14	10620.91	64144.90	6191.14	36941.79
2014-15	10968.68	66285.40	6443.53	38116.71
2015-16	11316.46	68425.90	6695.92	39291.63
2016-17	11664.23	70566.40	6948.31	40466.55
2017-18	12012.01	72706.90	7200.71	41641.47
2018-19	12359.78	74847.40	7453.10	42816.38
2019-20	12707.56	76987.90	7705.49	43991.30

Transport Vehicles includes Passenger Vehicles like Autorickshaw 3 in all, Autorickshaw 4 in all, Motor Cab (Ordinary, Tourist), Motor Car (Jeep-Taxi), Contract Carriage 7-12 Seated, 13-20 Seated, Above 20Seated, Contract Carriage All India Permit, Stage Carriage (Ordinary) LMV, Stage Carriage (Ordinary) LMV, Stage Carriage (Ordinary) MPV, Stage Carriage (Ordinary) HMPV, Stage Carriage (FP/Express), Educational Institution Bus LMV, Educational Institution Bus MPV, Educational Institution Bus HMPV, Private Service Vehicle LMV, MPV, HPMV; Goods Vehicles like 3 Wheeler Goods Vehicle, LMV <4000 kgs, LMV 4001<6000, LGV (NP), MGV (NP), MGV (SP), HGV (NP), HGV (SP), Multi-Axled Vehicle (NP), Multi-Axled Vehicle (SP), Tipper (LGV), Tipper (MGV), Tipper (HGV), Tanker (SP), Tanker(NP); Tractors and Tailors like Articulated vehicles, Tiller Trailer, Tractor, Tiller, Trailer, Road Roller, Fire Fighter. Non- Transport Vehicles includes Two Wheelers like Motor Cycle, Scooter, Moped, Motorized Vehicle; Non Transport Passenger Vehicles like Three Wheeler, Cycle Rickshaw, Invalid Carriage, Motor Car, Jeeps, Ambulance, Omni Bus for Private Use.

Table: 5.14

Category wise Vehicles Growth in Ernakulam District

Year	Two Wheelers	Passenger Transport Vehicles	Non-Transport Vehicles	Goods Vehicles	Tractors/ Trailers	All Other vehicles	Total Vehicles
1997-98	278308	109037	41220	27712	2027	1984	460288
1998-99	302778	120100	45012	30256	2109	2337	502592
1999-00	328234	131786	49141	32577	2216	2686	546640
2000-01	355603	143633	53167	34750	2344	3039	592536
2001-02	378946	153810	56142	36440	2472	5755	633565
2002-03	406854	165445	60027	38767	2564	6156	679813
2003-04	433747	175782	63612	41258	2631	6435	723465
2004-05	463365	187294	67887	43984	2774	6747	772051
2005-06	490795	197839	71543	46528	2803	7032	816540
2006-07	535153	215781	77583	51533	2910	7365	890325
2007-08	573027	229787	82621	55249	2944	7747	951375
2008-09	603292	244340	86523	50474	2928	8041	995598
2009-10	634330	259857	90784	53060	2925	9651	1050607
2010-11	680984	281937	96180	56211	3027	12342	1130681
2011-12	628905	103120	308916	139017	1336	50110	1231404
CAGR	5.58	-0.37	14.37	11.35	-2.74	24.02	6.78
AAG	6.08	2.52	22.06	15.81	-1.06	37.39	7.29
EG	6.39	4.32	9.09	7.46	0.85	15.79	6.78

Source: Annual Administration Report, Kerala Motor Vehicles Department.

Table: 5.14 illustrates the category wise list of motor vehicles in the district since the last fifteen years. From this, we know that two wheelers growth is very high as compared to other category of vehicles. Its growth rate on an average in each year is 60.14 Percent of the total vehicles growth. Highest Compound Annual Growth Rate shown by goods vehicles in the District (14.37 percent), even though all other vehicles category shows a percent of 24.02. The Compound Annual Growth Rate of two wheelers estimated as 5.58 percent. Passenger transport vehicles grow at 24.28 Percent. Non-Transport vehicles except two-wheelers increase at 8.5 Percent per annuam on an average. 5.65 Percent is goods vehicles growth. Average Annual Growth Rate of Goods vehicles are, 15.81 percent and its Exponential Growth Rate is 7.46 percent. Future Values of the category wise growth of motor vehicles in Ernakulam district presented in Table: 5.14(A). During the year 2019-20, it is predicted that, in the district 909055 two wheelers, 305774 passenger transport vehicles, 225054 non- transport vehicles, 112799 goods vehicles, 3007tractors and trailers and 33844 all other category of vehicles. Thus accounted 1589532 vehicles in the district.

Table: 5.14(A)
Future Values - Category wise Vehicles Growth in Ernakulam District

Year	Two Wheelers	Passenger Transport vehicles	Non Transport Vehicles	Goods vehicles	Tractors/ Trailors	All other vehicles	Total vehicles
2012-13	705542	247687	158929	83114	2786	22326	1220383
2013-14	734615	255985	168375	87354	2818	23971	1273119
2014-15	763688	264283	177821	91595	2849	25617	1325854
2015-16	792762	272581	187268	95836	2881	27262	1378590
2016-17	821835	280879	196714	100077	2913	28908	1431325
2017-18	850908	289177	206161	104317	2944	30553	1484061
2018-19	879982	297476	215607	108558	2976	32199	1536797
2019-20	909055	305774	225054	112799	3007	33844	1589532

Tables: 5.15, 5.16 provide a more detailed classification of the growth of different types of vehicles and its growth Percentage. Table: 5.15 illustrates the total number of each category of vehicles as on 31st March of every year. Compound Annual Growth Rate is very highest among goods and Muti Axle vehicles (11.35 percent), followed by Motor car and Motor Cab (7.23 percent). As on 2012, out of the total 1231404 vehicles, two wheelers account for 628905 (51.07 Percent), 284920 Motor Cars (23.14 Percent), other Non-Transport vehicles (includes Jeeps, Omni buses etc) numbered as 23996 (1.95Percent). Out of the 680984 number of two wheelers, 192414are Motor Cycles below 100 CC, 335550 are in between 100CC to 250CC and 100941 are above 250 CC vehicles. Transport vehicles like Autorickshaw accounted for 50927 (4.14 Percent), 30213Motor Car/ Motor Cab (2.45 Percent), 55770 vehicles includes Goods, Contract/ Stage Carriages, Multi Axle Vehicles, constituted (13.07) Tractors / composed a total of 139017vehicles (13.07 Percent of total vehicles).

Table: 5.15

Category wise Total Motor Vehicle Growth in Ernakulam District

Year	Non- Transport Vehicles					Transport Vehicles			
	Two Wheeler	Motor Car	Jeeps & Omni Bus	Others	Auto Rickshaw	Motor Car/ Motor Cab	Contract/ Stage Carriage	Goods & Multi Axle Vehicles	All Others
1997-98	278308	100108	8107	822	20943	10610	9667	27712	4011
1998-99	302778	110601	8503	996	22482	11914	10616	30256	4446
1999-00	328234	121617	8991	1178	24268	13287	11586	32577	4902
2000-01	355603	132773	9510	1350	25950	14632	12585	34750	5383
2001-02	378946	142219	10054	1537	27137	15637	13368	36440	8227
2002-03	406854	153099	10625	1721	28541	17175	14311	38767	8720
2003-04	433747	162656	11258	1868	29959	18502	15151	41258	9066
2004-05	463365	173164	12018	2112	32109	19877	15901	43984	9521
2005-06	490795	182911	12663	2265	33554	21231	16758	46528	9835
2006-07	535153	199611	13663	2507	36389	23274	17920	51533	10275
2007-08	573027	212749	14315	2723	38592	25083	18946	55249	10691
2008-09	603292	226811	14738	2791	40212	26501	19810	50474	10969
2009-10	634330	242028	14927	2902	42798	27656	20330	53060	12576
2010-11	680984	261828	15419	4690	46487	28650	21043	56211	15369
2011-12	628905	284920	15662	8334	50927	30213	21980	139017	51446
CAGR	5.59	7.22	4.49	16.69	6.1	7.23	5.63	11.35	18.54
AAG	6.08	7.77	4.83	19.56	6.57	7.79	6.06	15.81	27.48
EG	6.39	7.12	5.05	12.71	6.01	7.43	5.74	7.46	12.16

Source: Annual Administration Report, Ernakulam District

Table: 5.15(A)

Future Values - Category wise Total Motor Vehicle Growth in Ernakulam District

Year	Non- Transport Vehicles					Transport Vehicles			
	Two Wheeler	Motor Car	Jeeps & Omni Buses	Others	Auto Rickshaw	Motor car/ Motor cab	Contract/ Stage Carriage	Goods & Multi Axle Vehicles	All Others
2012-13	705542	280591	16751	5224	49279	31718	23053	83114	25112
2013-14	734615	293105	17341	5562	51269	33147	23935	87354	26789
2014-15	763688	305620	17932	5900	53259	34576	24817	91595	28466
2015-16	792762	318135	18522	6238	55249	36006	25699	95836	30143
2016-17	821835	330650	19112	6577	57240	37435	26581	100077	31820
2017-18	850908	343164	19702	6915	59230	38865	27463	104317	33497
2018-19	879982	355679	20292	7253	61220	40294	28345	108558	35174
2019-20	909055	368194	20882	7591	63210	41723	29227	112799	36851

Table: 5.15(A) depicts the future values of category wise total motor vehicles growth in Ernakulam district. The future values shows that Two Wheelers in non-transport vehicles category increased as 909055, Motor Cab increased to 368194, Jeeps and other Omni Buses increased as 20882 during the period of 2019-20. At the same period of time, transport vehicles like Goods and Multi Axle vehicles shows a growth of 112799 and that of Stage Carriages and Contract Carriages shows a figure of 29227.

Table: 5.16
Category wise Total Motor Vehicle Growth Percent in Ernakulam District

Year	Non- Transport Vehicles(In Percent)					Transport Vehicles(In Percent)			
	Two Wheeler	Motor Car	Jeeps & Omni Bus	Others	Auto Rickshaw	Motor Car/ Motor Cab	Contract/ Stage Carriage	Goods & Multi Axle Vehicles	All Others
1997-98	60.46	21.75	1.76	0.18	4.55	2.31	2.10	6.02	0.87
1998-99	60.24	22.01	1.69	0.20	4.47	2.37	2.11	6.02	0.88
1999-00	60.05	22.25	1.64	0.22	4.44	2.43	2.12	5.96	0.90
2000-01	60.01	22.41	1.60	0.23	4.38	2.47	2.12	5.86	0.91
2001-02	59.81	22.45	1.59	0.24	4.28	2.47	2.11	5.75	1.30
2002-03	59.85	22.52	1.56	0.25	4.20	2.53	2.11	5.70	1.28
2003-04	59.95	22.48	1.56	0.26	4.14	2.56	2.09	5.70	1.25
2004-05	60.02	22.43	1.56	0.27	4.16	2.57	2.06	5.70	1.23
2005-06	60.11	22.40	1.55	0.28	4.11	2.60	2.05	5.70	1.20
2006-07	60.11	22.42	1.53	0.28	4.09	2.61	2.01	5.79	1.15
2007-08	60.23	22.36	1.50	0.29	4.06	2.64	1.99	5.81	1.12
2008-09	60.60	22.78	1.48	0.28	4.04	2.66	1.99	5.07	1.10
2009-10	60.38	23.04	1.42	0.28	4.07	2.63	1.94	5.05	1.20
2010-11	60.23	23.16	1.36	0.41	4.11	2.53	1.86	4.97	1.36
2011-12	51.07	23.14	1.27	0.68	4.14	2.45	1.78	11.29	4.18

Source: Annual Administration Report, Ernakulam District

The number of motor cycles in the district are mushrooming day by day. Each year by an average of 27582 Motor Cycles are Newly Registered in the district.1626 Scooters and 1087 Mopeds are also newly registered in every year. That is 30295 new Two-wheelers are added to total vehicles in each year with in the district alone. Of the total 962921 Non-Transport vehicles, Two-wheelers accounts 70.72 Percent as on 2011.

On an average 60.14 Percent of the growth of the total vehicles contributed by Two wheelers, 22.46 Percent by Motor Car, jeeps contributed 0.14 Percent, 1.4 Percent contribution made by Omni Buses, and other private purposes vehicles have a share of 0.26 Percent. Thus, a total of 84.4 Percent of the vehicles that plying on the road is exclusively for private purposes in each year. While we analyzing the share of Transport vehicles Autorickshaw contributed 4.2 Percent, Motor Cab and Motor Car contributed 2.5 Percent, Contract or Stage Carriage contributes 2.04 Percent. 5.58 Percent of vehicles belong to the category of goods vehicles which includes light, heavy and medium type goods vehicles. The share of Multi Axled, Tractor/ Trilors is 0.93 Percent and 0.35 Percent respectively. Thus Transport vehicles as a whole contributed 15.6 Percent of the total vehicles in each year.

Next, we look into the category wise growth of Transport vehicles in Kochi and the same explained in Table: 5.17 and 5.18 below: Only 13.43 Percentage of vehicles belongs to transport vehicles, the rest is Non-Transport Vehicles.

Table: 5.17

Category wise Newly Registered Transport Vehicles in Kochi

Year	Multi- Axled / Articulated Vehicles	Trucks/ Lorries	Four Wheeler	Three Wheeler	Total Buses	Total Taxis	Light Motor Vehicles	Other Vehicles	Total of Newly Registered Transport Vehicles
1960-1970	6	281	400	52	189	296	51	15	1290
1970-1980	83	689	1394	588	554	397	975	40	4720
1980-1990	846	1020	1673	759	923	642	2854	72	8789
1991-1992	60	249	381	113	242	224	328	60	1657
1993-1994	121	239	567	204	328	316	487	54	2316
1995-1996	69	334	619	245	316	302	877	84	2846
1997-1998	72	172	440	193	228	168	749	67	2089
1999-2000	70	245	632	260	398	226	778	101	2710
2000-2001	65	183	516	311	501	274	765	111	2726
2001-2002	31	102	486	443	606	417	662	94	2841
2002-2003	96	213	609	613	645	435	859	176	3646
2003-2004	44	200	697	819	622	461	875	196	3914
2004-2005	46	145	973	885	423	698	798	264	4232
2005-2006	28	135	1168	947	540	607	1069	271	4765
2006-2007	33	132	1165	746	491	801	1235	259	4862
2007-2008	24	100	1089	373	431	788	1590	247	4642
2008-2009	15	86	1014	317	295	601	1686	209	4223
2009-2010	23	74	1291	258	452	755	2056	283	5192
2010-2011	59	125	1179	222	328	675	2439	440	5467
2011-2012	35	118	1480	213	304	740	2240	279	5409
AAG	123.9	8.2	19.5	58.7	14.5	11.1	113.6	24.6	21.8
EG	-5.8	-9.0	4.1	3.4	0.5	5.8	9.3	13.3	4.2

Source: Annual Administration Report, Motor Vehicles Department, Kochi

From Table: 5.17, it is understandable that Multi-Axled Vehicles grows at an average of 2.8 Percent per year from 1960 onwards to the total Transport Vehicles. In the

Transport vehicle category, the share of other Transport modes like Trucks/ Lorries is 7.9 Percent, Four Wheelers contribute 22.76 of the transport vehicle, 10.31 Percent is from Three Wheelers, 12.39 Percent contributed by different categories of Buses, share of Total Taxis is 12.24 Percent and that of Light Motor Vehicle is 27.75 Percent. 3.79 is the contribution given by other category of vehicles. Annual Average Growth of Multi Axled and Articulated vehicles shows a percent of 123.88 while that of Light Motor Vehicles (LMV) shows a figure of 113.59 percent. In the case of Three Wheeler, calculated AAG shows a percent of 58.69, while that of Four Wheelers is 19.5 percent. The Exponential Growth rate of other vehicles shows a figure of 13.3 percent. The future values of the category wise newly registered transport vehicles in Kochi explained Table: 5.17(A) below:

Table: 5.17(A)

Future Values - Category wise Newly Registered Transport Vehicles in Kochi

Year	Multi- Axled / Articulated Vehicles	Trucks/ Lorries	Four Wheeler	Three Wheeler	Total Buses	Total Taxis	Light Motor Vehicles	Other Vehicles	Total
2012-13	-24	-18	1185	495	420	771	1882	349	5060
2013-14	-35	-43	1213	501	418	798	1950	367	5169
2014-15	-46	-67	1241	507	416	824	2018	384	5278
2015-16	-57	-92	1269	514	414	851	2086	402	5387
2016-17	-68	-117	1297	520	412	878	2154	419	5495
2017-18	-79	-142	1326	526	410	904	2222	436	5604
2018-19	-90	-167	1354	533	408	931	2290	454	5713
2019-20	-101	-191	1382	539	406	958	2358	471	5822

From Table:5.17(A), it is clear that the predicted value of the Multi Axled vehicles during the year 2019-20 is -101, while that of Trucks and Lorries is -191. In the case of Four Wheelers, it is 1382 and 2358 for Light Motor Vehicles. Annual growth of Non-Transport vehicles in Kochi, is given as category wise in the below Table: 5.18. As on 2012, there were 652 Mopeds, 23584 Motor Cycles, 10357 Cars, 52 Omni Buses and 2296 Other Vehicles registered in the Corporation as Non-Transport vehicle category. During the same period, 36949 Non-Transport vehicles registered in Kochi. Table: 5.18(A) describes the future values of Non-Transport vehicles in Kochi. From this, it is clear that, the future values predicted during the year 2019-20 for the growth of Non-

Transport Vehicles in Kochi, is 27537 for Motor Cycles, 12392 for Cars, 3031 for other vehicles, thus 42109 Non-Transport vehicles.

Table: 5.18

Category wise Newly Registered Non Transport Vehicles in Kochi

Year	Mopeds	Motor Cycles	Cars	Omni Buses	Tractors	Trailers	Other Vehicles	Total
1960-1970	570	1849	3941	10	21	4	42	6437
1970-1980	3027	10105	6112	83	57	1	237	19622
1980-1990	6762	21807	9978	96	60	3	529	39235
1990-1991	794	5838	1828	28	9	1	137	8635
1992-1993	2602	4519	2252	46	13	0	91	9523
1994-1995	3012	8979	4365	68	25	0	207	16656
1996-1997	3355	9521	4408	459	7	0	377	18127
1998-1999	2875	9247	5158	598	13	0	543	18434
2000-2001	2227	12202	5614	561	10	1	730	21345
2001-2002	1464	12608	4979	369	11	1	656	20088
2002-2003	1200	15098	6102	322	19	1	1160	23902
2003-2004	1149	17715	6235	253	9	0	1617	26978
2004-2005	866	18800	6780	179	9	0	1775	28409
2005-2006	813	21281	8371	199	15	1	1816	32496
2006-2007	823	19607	8810	130	32	0	1931	31333
2007-2008	530	15864	8362	99	35	0	1641	26531
2008-2009	447	14611	9109	90	12	0	1465	25734
2009-2010	530	17485	10673	111	13	0	1449	30261
2010-2011	769	21256	9789	96	11	0	1802	33723
2011-2012	652	23584	10357	52	8	0	2296	36949

Source: Annual Administration Report, Motor Vehicles Department, Kochi

Table: 5.18 (A)

Future Values - Category wise Newly Registered Non Transport Vehicles in Kochi

Year	Mopeds	Motor Cycles	Cars	Omni Buses	Tractors	Trailers	Other Vehicles	Total
2012-13	76	22162	10100	179	9	-1	2229	34754
2013-14	-81	22930	10427	178	8	-1	2343	35804
2014-15	-238	23698	10755	177	7	-1	2458	36855
2015-16	-395	24466	11082	175	6	-1	2573	37906
2016-17	-551	25233	11410	174	5	-1	2687	38957
2017-18	-708	26001	11737	173	4	-1	2802	40007
2018-19	-865	26769	12065	171	3	-1	2916	41058
2019-20	-1022	27537	12392	170	2	-1	3031	42109

While analyzing the rate of growth of Motor Cycle, we can see that, out of the total Motor Cycle growth in the district, 57.57 Percent of growth contributed by Kochi Corporation only. 58.94 Percent is the annual average growth rate of Motor Cycles registration in Kochi. The rate of growth of Mopeds to Total Non-Transport vehicles increase at 9.4 Percent per annum in the Corporation. The contribution of Car to Total Non-Transport vehicles in Kochi is 26.78 Percentages. Table: 5.19 summarize the newly registered motor vehicles in Ernakulam district and Kochi Corporation to understand clearly the share of vehicles of Kochi out of the total.

Table: 5.19
A Comparison of Registered Motor Vehicles in Ernakulam District and Kochi

Year	Newly Registered Vehicles in Kochi	Newly Registered Vehicles in District	Percentage of New Registration with that of District	Total Registered Vehicles in Kochi	Total Registered Vehicles in District	Percentage of Total Registration with that of District
1997-1998	18749	42109	44.52	208601	418179	49.88
1998-1999	20510	41753	49.12	229111	459932	49.81
1999-2000	25380	42308	59.99	254491	502240	50.67
2000-2001	24071	43619	55.18	278562	545859	51.03
2001-2002	22929	40449	56.69	301491	586308	51.42
2002-2003	27548	42416	64.95	329039	628724	52.33
2003-2004	30892	44376	69.61	359931	673100	53.47
2004-2005	32641	49528	65.90	392572	722628	54.33
2005-2006	37261	45246	82.35	429833	767874	55.98
2006-2007	36195	67156	53.90	466028	835030	55.81
2007-2008	31173	59852	52.08	497201	894882	55.56
2008-2009	29957	53208	56.30	527158	948090	55.60
2009-2010	35453	57135	62.05	562611	1005225	55.97
2010-2011	39190	67643	57.94	601801	1072868	56.09
2011-2012	42358	88321	47.96	644159	1231404	52.31
AAG	6.55	6.54	1.79	8.4	8.04	0.37
EG	4.93	4.46	0.46	8.06	7.25	0.82

Source: Annual Administration Report, Motor Vehicles Department.

From the above table, it is clear that during the year 2011-12, 47.96 percent of the newly registered motor vehicles in the district is from Kochi that shows the mobility in the centre of the district. Also 52.31 percent of the total vehicles in the district were come under the Kochi regional transport office (Mattanchery and Ernakulam Road Transport Offices). Annual Average Growth of Vehicles in the case of newly registered vehicles in Kochi is 6.55percent and that of the district is 6.54 while in the case of AAG of the total registered vehicles in the Corporation is 8.4 percent, in the district it is 8.04. This shows no significant deviation between the growth rate of motor vehicle in the Corporation and the district. Table: 5.19(A) depicts the future values of motor vehicles in Ernakulam and Kochi Corporation. Future values of the newly registered vehicles in Kochi, is 51696.79 and that of Ernakulam is 89834.52.

Table: 5.19(A)

Future Values of Registered Motor Vehicles in Ernakulam District and Kochi

Year	Newly Registered Vehicles in Kochi	Newly Registered Vehicles in District	Percentage of New Registration With that of District	Total Registered Vehicles in Kochi	Total Registered Vehicles in District	Percentage of Total Registration With that of District
2012-13	41705.62	72337.67	60.53	655535.65	1179312.81	56.82
2013-14	43132.93	74837.22	60.77	686789.36	1232624.05	57.25
2014-15	44560.24	77336.77	61.02	718043.08	1285935.30	57.68
2015-16	45987.55	79836.32	61.26	749296.79	1339246.54	58.12
2016-17	47414.86	82335.87	61.51	780550.50	1392557.78	58.55
2017-18	48842.17	84835.42	61.75	811804.22	1445869.02	58.99
2018-19	50269.48	87334.97	62.00	843057.93	1499180.27	59.42
2019-20	51696.79	89834.52	62.24	874311.65	1552491.51	59.85

Table: 5.20

Category Wise Number of Newly Registered Passenger Vehicle

Year	Auto Rickshaw	Motor Cab (Ordinary)	Motor Cab Tourist	Contract and Stage Carriages	Educational Institution Bus	Private Service Vehicle	Total
1997-1998	2087	893	111	479	44	58	3672
1998-1999	2145	888	95	466	43	54	3691
1999-2000	2026	897	130	475	42	55	3625
2000-2001	2092	895	107	496	46	65	3701
2001-2002	1765	843	113	467	38	70	3286
2002-2003	1801	1026	121	534	23	62	3567
2003-2004	1845	968	130	515	37	58	3533
2004-2005	2392	898	212	506	38	55	4101
2005-2006	1882	988	133	528	40	61	3632
2006-2007	2594	1148	377	610	107	60	4896
2007-2008	2215	1416	109	620	95	63	4518
2008-2009	2203	1269	253	498	131	26	4380
2009-2010	3186	1321	13	259	138	52	4969
2010-2011	3317	1405	112	513	88	71	5506

Source: Annual Administration Report, Motor Vehicles Department.

Table: 5.20 examines category wise newly registered Passenger Vehicles that is Transport Vehicle, in Ernakulam district. Every year on an average 4077 Passenger vehicles added to total vehicles in the district. Out of these, 816 are Autorickshaw 3 in all (12.53 Percent of total Passenger Vehicles) and 1438 number of Autorickshaw 4 in all, which constitutes 35.44 Percent of Passenger Vehicles in the District. Motor Cab is also registered in the district, which is on an average 1205 numbers per year that have a share of 28.74 Percent. Contract Carriage and Stage Carriage raises on an average by 497 numbers.

Table: 5.21

Category Wise Number of Goods Vehicle in Ernakulam District

Vehicle Category	2008-09	2009-10	2010-11	2011-12
Three Wheelers Goods Vehicle	10819	11169	11689	12205
Light Motor Vehicle 4001< 4000 Kgs	7218	8720	9673	1301
Light Motor Vehicle 4001< 6000 Kgs	26018	26371	27483	75146
Medium Goods Vehicle NP	5979	6358	6925	50077
Multi Axle Vehicle NP	259	258	260	237
Multi Axle Vehicle NP	181	184	181	51
Grand Total	50474	53060	56211	139017

Source: Annual Administration Report, Motor Vehicles Department, Eranakulam

Table: 5.21(A)

Future Values: Category Wise Number of Goods Vehicle in Ernakulam District

Year	Three Wheelers Goods Vehicle	Light Motor Vehicle 4001< 4000 Kgs	Light Motor Vehicle 4001< 6000 Kgs	Medium Goods Vehicle NP	Multi Axle Vehicle NP	Multi Axle Vehicle NP
2012-13	12640.00	2528.50	75878.50	50550.00	237.50	51.00
2013-14	13107.80	848.70	90728.10	63836.10	231.10	11.70
2014-15	13575.60	-831.10	105577.70	77122.20	224.70	-27.60
2015-16	14043.40	-2510.90	120427.30	90408.30	218.30	-66.90
2016-17	14511.20	-4190.70	135276.90	103694.40	211.90	-106.20
2017-18	14979.00	-5870.50	150126.50	116980.50	205.50	-145.50
2018-19	15446.80	-7550.30	164976.10	130266.60	199.10	-184.80
2019-20	15914.60	-9230.10	179825.70	143552.70	192.70	-224.10

From 1997-98 to 2007-08 the number of Goods Vehicles more than doubled. Among the various categories, Light Motor Vehicles 4001<6000 Kgs, had grown tremendously (from 9146 to 23552), and now it is 27483 numbers. The category which shows second high growth in Goods Vehicles is Three Wheeler Goods Vehicles, it is 11689 numbers. The total number of goods vehicles in the district was 56211 as on 2011 and 139017 as on March 2012. This is mainly due to the medium and light motor vehicles growth. The category wise goods vehicles in the district from 2008 onwards shown in Table: 5.21. The growths of Tractor and Trailers in Motor vehicles growth also require mentioning. It is to be noted that there are 7 categories of Tractors and Trailers but it constitute a share of only .1or .2 percent.

Table: 5.22
Annual growth of Permits Issued for Different Kinds of Vehicle

Year	Goods Vehicles	Auto Rickshaw	Motor Cab	Tourist Taxi	Omni Bus	Others	Total
Upto 1997-1998	19963	19086	4011	2641	417	1520	47638
1998-1999	23154	21630	4929	3577	652	2313	56255
1999-2000	26132	24431	5884	4532	1213	3291	65483
2000-2001	29264	27407	6898	5523	1924	4248	75264
2001-2002	32559	30755	8013	6513	2337	5317	85494
2002-2003	36127	34287	9511	7535	2720	6342	96522
2003-2004	39650	37880	10752	8550	3136	7468	107436
2004-2005	43170	41807	12119	9615	3574	8518	118803
2005-2006	47397	45826	13800	10819	4149	9593	131584
2006-2007	51911	50462	15845	11974	4610	10777	145579
2007-2008	56934	55659	18398	13202	4963	11985	161141
2008-2009	67391	62413	21744	13827	4979	12280	182634
2009-2010	78775	69631	25649	14303	4995	12596	205949
2010-2011	90487	77444	29651	14738	5017	12930	230267
2011-2012	101871	84662	33556	15214	5033	13246	253582

Source: Annual Administration Report, Motor Vehicles Department

Table (5.22) shows annual growth of permits issued to different kinds of vehicles, of these goods vehicles shows highest share. During the year 2012, out of the total 205949 vehicles permitted, goods vehicles account 101871, a share of 40.17 percent. The share of Auto rickshaw out of the total permitted vehicles during the same period is 33.38 percent. From the above discussion of vehicular mobility, it is clear that each year, the number of registered motor vehicles increases in the district, of these lion share is from Kochi area. The vehicular growth in Kochi is very high compared to the district.

5.10 CONCLUSION

The economic activities and the population growth exert pressure on the available infrastructural facilities. Development of road infrastructure not keeping pace with the increase in traffic is a major problem faced by Ernakulam district, like most other parts of Kerala. The road infrastructure in the district has not been able to meet the growing traffic demand and hence traffic congestion is a major problem in the city. The city roads are over-crowed with road-based public and private vehicles. Kochi has around 630 city buses, 3,000 auto-rickshaws, 6,500 taxis and countless cars and motorcycles. The city of the district is reeling under traffic congestion, increased accidents, air and noise pollution and sluggish traffic movement. The public transport system is not adequately catering to the growing transport and connectivity needs of the city. While certain areas are well connected and serviced, others ignored, even though there is a demand and need in those areas. Adding to the woes, there are around 2,766 long - distance private and Government buses, originating and terminating from the two major bus terminals in the city, creating chaos on the roads that they play on.

A transportation study conducted by NATPAC has shown that nearly 2.5 lakh persons commute to the core city daily thereby increasing the pressure on civic amenities and congestion on major traffic corridors. Records say that about 2,000 vehicles registered in the city limits in a month; 85 per cent of which are private ones. A rapid system called the Kochi Metro is under construction and expected to complete by 2016. A Suburban Railway system, intended considerably to ease congestion, is also to be built in the near future. The main aim of Kochi Development Plan is ‘to attain an integrated transport system which leads to efficient, speedy, smooth, comfortable, and safe traffic flow with high priority to public transport which is environment friendly and accessible to the disabled’. However, it is quite difficult to achieve as is evident from the experience of the City and the district. The widening gap between the growing number of vehicles, the lack of infrastructure and unscientific plans has turned life worse. Like other fast-growing cities in the developing world, the district suffers from major urbanization problems, poor sanitation, vector problem, heavy pollution etc. The next Chapter attempt to analyze the issue of gaseous emission and the air pollution from road vehicles in the district.

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CHAPTER - 6

VEHICULAR EMISSION:

THE CASE OF ERNAKULAM DISTRICT

6.1 INTRODUCTION

Air is the most important natural source for sustenance of life and activities in the biosphere. Due to natural sources and manmade activities, it contains many impurities. It is known as air pollution. Air pollution is defined as, 'the presence in ambient atmosphere of substances, generally resulting from the activities of man, in sufficient concentration, present for a sufficient time and under circumstances such as to interfere with comfort health or welfare of persons or with reasonable or enjoyment of property (Bureau of Indian Standards)'. Urban air pollution poses a significant threat to the environment and human health throughout both the developed and developing world. The issue of urban air quality is receiving more attention as an increasing share of the world's population are now living in urban centres and are demanding a cleaner urban environment. The United Nations estimated 4.9 billion inhabitants out of 8.1 billion will be living in cities throughout the world by 2030 (UNCSD, 2011). High levels of urbanization sharp increasing traffic, trajectory growth, rapid economic development and industrialization, and higher levels of energy consumption has resulted an increase of pollution load in the urban environment. Vehicle numbers have grown greatly, especially in the past decade in most of the cities and urban areas throughout the world. It is accepted that automobiles have emerged as a critical source of urban air pollution especially in the developing world. The present chapter focuses on road transport emissions (CO_2, CH_4, CO, NO_X, N_2O, SO_2, PM, HC etc.), using region specific mass emission factors of each type of vehicles, in order to provide an overview of the link between urban air pollution and motorization in Ernakulam District and to provide the same in the context of Kochi Corporation in national background.

6.2 AIR POLLUTION FROM MOTOR VEHICLES IN INDIA

With the increase in economic activities, number of transport is increasing in metropolitan cities. It increases the transport emission load of Indian cities. It is assumed that, diesel is used as fuel in Buses, Omni Buses, Taxi, Trucks, Lorries, Light Motor Vehicles (goods), Trailers and Tractors, while Two Wheelers, Light Motor Vehicles (Passenger), car and jeeps use gasoline. In Delhi, most of the buses and Omni buses and 5% of total Cars and Jeeps also use Compressed Natural Gas (Das and Parikh, 2004). CO, HC, NO_x, and PM emissions from CNG based buses were 1.77, 0.88, 2.81 and 0.032 g km^{-1} and for cars and jeeps were 0.78, 1.55, 0.92 and 0.02 g km^{-1}, respectively (Central Pollution Control Board,2007).

Emissions from road were quantifies based on the number of vehicles and distance travelled in a year per different vehicle type, which is given by:

$$\mathbf{Ei = \sum(Vehj \times Dj) \times Eij\ km}$$

Where; Ei = Emission of compound;

Vehj = Number of vehicles per type;

Dj = Distance travelled in a year per different vehicle type;

Eij km = Emission of compound (i) from vehicle type (j) per driven KM

The region specific emission coefficients for emission estimate and Net Calorific Values (NCV) of different type of fuels (ALGAS, 1998; IPCC, 1996; Singh et al., 2008) are listed below (Table: 6. 1):

Table: 6.1
Net Calorific Values and Emission Coefficients

Category	NCV	CO_2	CH_4	CO	NO_X	NMVOC	N_2O
	($TJ/10^3$ Tonnes)	(Ton ton^{-1})	(Kg TJ^{-1})	(Kg TJ^{-1})	(Kg TJ^{-1})	(Kg TJ^{-1})	(Kg TJ^{-1})
High Speed Diesel	43.33	3.18	5	1000	800	200	0.6
Light Diesel Oil	43.33	3.18	5	1000	800	200	0.6
Fuel Oil	40.19	3.13	5	1000	800	200	0.6
Coal	-	1.76	-	5.51g kg^{-1}	4.02g kg^{-1}	-	-
Aviation Turbine Fuel	-	2.94	2.64g kg^{-1}	1034g kg^{-1}	3.52g kg^{-1}	-	-

Source: ALGAS, 1998; IPCC, 1996; Chakraborty et al., 2008; Singh et al., 2008

Region specific emission factors of road transport, based on the type of vehicles compiled are listed in the following Table: 6.2. Based on this factors, the emissions calculated (Ramachandra, T.V, Shwetmala, 2009), for different type of road transport vehicles in India that are summarized in Table: 6.3. Among different type of vehicles, trucks and Lorries contribute 28.8% CO_2 (70.29 Tg), 39% NO_x (0.86 Tg), 27.3% SO_2

(0.19 Tg), and 25% PM (0.03 Tg), which constitute 25% of the total vehicular emission of India. Similarly two wheelers are major source of CO (0.72 Tg; 23.7%), CH_4 (0.06 Tg; 46.4%), and HC (0.46 Tg; 64.2%) and buses are emitting NO_x (0.68 Tg; 30.7%) and PM (0.03 Tg; 20.5%).

Table: 6.2
Emission Factors for Road Vehicles (g/ Km^{-1})

Pollutants	Buses	Omni Buses	Two Wheelers	LM V (Passenger)	Cars and Jeeps	Taxi	Trucks & Lorries	LMV (Goods)	Trailers and Tractors	Others**
CO_2	515.2	515.2	26.6	60.3	223.6	208.3	515.2	515.2	515.2	343.8
CO	3.6	3.6	2.2	5.1	1.98	0.9	3.6	5.1	5.1	3.86
NO_X	12	12	0.19	1.28	0.2	0.5	6.3	1.28	1.28	3.89
CH_4	0.09	0.09	0.18	0.18	0.17	0.01	0.09	0.09	0.09	0.11
SO_2	1.42	1.42	0.013	0.029	0.053	10.3	1.42	1.42	1.42	1.94
PM	0.56	0.56	0.05	0.2	0.03	0.07	0.28	0.2	0.2	0.24
HC	0.87	0.87	1.42	0.14	0.25	0.13	0.87	0.14	0.14	0.54

Source: Mittal and Sharma, 2003; EEA, 2001; CPCB, 2007; Kandikar and Ramchandran, 2000; UNEP, 1999. **= Average of above value are used for Others

Table: 6.3
Emission from Different Types Vehicle in India, 2009 (Gg)

Categories	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus	28748.16	207.26	679.73	5.02	79.24	31.36	51.72
Omni Bus	8508.42	60.94	200.53	1.49	23.45	9.28	15.11
Two Wheelers	8701.08	719.64	62.15	58.88	4.25	16.36	464.49
LMV Passengers	4378.1	370.29	92.93	13.07	2.11	14.52	10.16
Cars and Jeeps	23901.22	212.30	22.14	18.17	5.67	3.22	28.01
Taxi	2367.08	10.23	5.68	0.11	117.05	0.8	1.48
Trucks and Lorries	70288.92	491.15	859.51	12.28	193.73	38.2	118.69
Light M V (Goods)	44654.58	442.04	110.94	7.8	123.08	17.33	12.13
Trailers and Tractors	46563.85	460.94	115.69	8.13	128.34	18.08	12.65
Others	5705.22	57.41	64.54	1.83	32.19	3.98	8.96

Source: Ramachandra, T.V, Shwetmala,(2009),Emissions from India's transport sector :State wise synthesis, Atmospheric Environment, Vehicular emissions vary with type, efficiency and type of fuel used. Emission analysis based on the vehicle type reveal that bus and Omni buses contribute higher CO_2 (CO_2: 96.5%, NO_x: 2.28%) compared to two wheelers (CO_2: 86.8%, CO: 7.18%, HC: 4.6%), passenger light motor vehicles (CO_2: 86.8%, CO: 7.6%, NOx: 1.9%), cars and jeeps (CO_2: 98.8%), taxi (CO_2: 94.6%, SO_2: 4.68%), trucks and lorries (CO_2: 97.6%, NO_x: 1.2%), goods light motor vehicles (CO_2: 98.4%), and trailers and tractors (CO_2: 98.4%) are different.

Bottom-up approach (Gurjar,2004) was adopted for estimation of Gaseous and Particulate emission based on annual average utilization for different vehicle category, number of registered vehicles and the corresponding emission factors. Annual utilization of Buses, Omni Buses, Two Wheelers, Light Motor Vehicles (Passenger), Car and Jeeps and Taxi were assumed to be 100000,100000,63000,33500,12600 and 12600 km, respectively (Buses, Two-Wheelers, Cars and Autorickshaw). Similarly for Trucks and Lorries, Light Motor Vehicles (Goods), and Trailers and Tractors were assumed as 25000 to 90000, 63000 and 21000 km/ year respectively. These values were assumed based on Five Year Planning reports of India. For other section of vehicles, annual utilization was calculated on average of all above values.

Indian road transport contributes a significant quantities of 243.82 Tg CO_2 (94.5%) and smaller quantities of CO, CH_4, NO_x, SO_2, HC and PM. Industrially and economically advanced states (Maharashtra, Gujarat, Tamil Nadu) contribute maximum compared to other states and average emission for the country is 6.97 Tg. Among the states and UT, Maharashtra’s contribution is the largest, 28.85 Tg (11.8%) of CO_2, followed by Tamil Nadu 26.41 Tg (10.8%), Gujarat 23.31 Tg (9.6%), Uttar Pradesh 17.42 Tg (7.1%), Rajasthan 15.17 Tg (6.22%) and Karnataka 15.09 Tg (6.19%). The these six states accounts for 51.8% of the CO_2 emissions from road transport. Total CO_2 emission from road transport in year 2003–2004 is approximately 2.3 times more than in comparison to year 2000 emission. This shows average State wise emission of CO, CH_4, NOx, SO_2, HC and PM are 3.62, 63.25, 20.26, 20.67 and 4.37 Gg, respectively. The result further confirms that Gujarat, Maharashtra and Tamil Nadu have higher proportion of emissions of CO, CH_4, NO_x, SO_2, HC and PM. In Maharashtra, there is significant increase in state GDP from 2478 to 4380 billion Rs. during 1999 and 2005 (CMIE, 2008). This has also contributed to higher number of private vehicles resulting in higher emissions. With the increase in city size, the traveling distance has become longer; the relative importance of walking and cycling has come down significantly.

Total Indian transport emission of CO_2, CO, NO_x, CH_4, SO_2, PM, HC, N_2O and NMVOC are summarized in Table: 6.4. During 2003-2004, total transport emission of CO_2 was 258.10 Tg CO_2 contribution of road sector, aviation, railways and shipping was 243.82 Tg (94.5%), 7.60 Tg (2.9%), 5.22 Tg (2%) and 1.45 Tg (0.6%), respectively. Road sector contribute 3.03 Tg (53.3%) of CO. Among all type of transport, road are the major contributor of air pollution.

Table: 6.4
Emission from Vehicular Transport of Metropolitan Cities in India

Metropolitan City	CO2 (Mg KM^{-2})	CO (Mg KM^{-2})	CH4 (Mg KM^{-2})	HC (Mg KM^{-2})	NOX (Mg KM^{-2})	PM (Mg KM^{-2})	SO2 (Mg KM^{-2})
Hyderabad	18258.9	281.5	13.3	78.1	197.1	13.9	55.9
Visakhapatnam	5034.0	77.6	3.7	21.5	54.4	3.8	15.4
Patna	18244.8	189.2	5.9	32.9	149.0	10.4	55.6
Delhi	20843.8	284.4	15.6	87.7	130.0	9.1	42.4
Ahmadabad	12438.7	165.5	6.7	35.5	93.2	7.5	33.0
Surat	10967.7	145.9	5.9	31.3	82.2	6.6	29.1
Vadodara	2481.4	21.3	0.8	5.5	29.2	1.5	8.7
Bangalore	32013.3	405.3	16.1	86.0	323.8	22.2	93.3
Bhopal	3786.2	47.6	1.9	11.6	27.3	2.2	12.3
Indore	11973.8	150.5	6.1	36.7	86.3	6.9	38.8
Mumbai	8562.0	118.9	5.0	24.7	67.8	5.4	23.7
Nagpur	7955.7	110.5	4.6	22.9	63.0	5.0	22.0
Pune	5367.0	74.5	3.1	15.5	42.5	3.4	14.8
Ludhiana	14847.9	183.9	7.5	43.4	98.3	8.1	38.7
Jaipur	6571.5	72.8	2.8	17.6	65.6	4.1	18.4
Chennai	34903.5	429.1	19.0	119.0	353.7	23.0	108.0
Kanpur	4570.5	59.9	2.6	15.1	32.0	2.7	12.3
Lucknow	5616.3	73.6	3.2	18.5	39.3	3.3	15.1
Varanasi	11370.8	148.9	6.4	37.5	79.6	6.6	30.6
Kolkata	22402.2	213.9	9.1	59.7	273.6	14.2	72.1
Total	258209.8	3254.7	139.1	800.7	2287.8	160.0	740.1

Source: MoUD, 2008 & MoSRTH, 2007

Emission per unit area for metropolitan cities is summarized in Table: 6.4. Chennai, Bangalore, Kolkata, Delhi and Hyderabad are the five major metropolitan cities of India that play a vital role in Indian economy. In the case of Mumbai, GDP has increased from 90.2 to 149.9 billion Rs. During 1997–2005, while human population has increased from 10.8 to 11.9 million (Das and Parikh, 2004). These increases have also increased the total passenger travel demand from 32 to 61 billion passenger km. Similar situation prevails in other major metropolitan cities in India.

Number of vehicles in important Indian cities is 20 million, with a share of 28% of total vehicles of India. Chennai, Bangalore, Kolkata, Delhi and Mumbai with 10.2 million vehicles constitute 51.1% of total vehicles of important Indian cities and 14% of total vehicles of India. Total emission per unit area of metropolitan cities is 0.25 Tg km^{-2} of CO_2. Chennai has the largest contribution of 0.034 Tg km^{-2} (13.5%) followed by Bangalore with 0.032 Tg km^{-2} (12.4%), Kolkata with 0.022 Tg km^{-2} (8.7%), Delhi with 0.02 Tg km^{-2} (8%) and Hyderabad with 0.018 Tg km^{-2} (7.1%).

Kochi is the most promising growth oriented development region in the State of Kerala. Developments in the city and surrounding area have taken a fast stride in the last two decades. These are exerting tremendous stress on the infrastructure components. The most apparent issues in Kochi City are then increasing traffic congestion and the degradation of urban environment.

6.3 TREND OF AMBIENT AIR QUALITY STATUS OF DIFFERENT STATIONS IN ERNAKULAM DISTRICT

Generally air constitutes 80 percent of man's daily intake of materials by weight. We breathe 22,000 times a day on the average, inhaling 16 kg of air each day which is nearly 12-15 times higher than the food we take. This is why even the small concentration of pollutants in the air becomes more significant in comparison to the similar levels present on the food.

Earth's present atmosphere consists of several layers. Most of the ultraviolet radiation from the sun is absorbed by Ozone (O_3) in the atmosphere, which is found primarily in the so called ozone layer located 17-26 km above the sea level. The lower atmosphere, i.e. the troposphere contains about 70 percent mass of the atmosphere. It has mainly three categories of gaseous components major, minor, and trace. For major gases, like N_2 and O_2, concentrations vary but to a very little extent with time, while for trace gases, the values tend to converge as the averaging time lengthens. Nitrogen forms the main bulk of volumes of the air with a concentration of nearly 78 percent together with oxygen (21 percent).

Today air pollution has emerged as one of the most threatening problems. The concentration of air pollution varies spatially and temporarily causing the pattern of air pollution to change with different locations and time due to changes in meteorological factors and topographical features. The Kerala State Pollution Control Board is measuring the ambient air quality in Ernakulam district along with a total of 24 stations in the State of Kerala, which monitored by Central Pollution Control Board. National Ambient Air Quality is the levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property. This is conducting in order to check whether the air quality is above or below the standard level. The National Ambient Air Quality Standards (2011) is given below (Table: 6.5):

Table: 6.5
National Ambient Air Quality Standards

Pollutants	Time Weighted Average	Concentration in Ambient Air	
		Industrial Residential, Rural & Other Areas	Ecologically Sensitive Area
Sulphur Dioxide (SO_2) Mg/m^3	Annual*	50	20
	24 Hours**	80	80
Oxides of Nitrogen (NO_2) Mg/m^3	Annual*	40	30
	24 Hours**	80	80
Particulate Matter PM_{10} Mg/m^3	Annual*	60	60
	24 Hours**	100	100
Particulate Matter $PM_{2.5}$ Mg/m^3	Annual*	40	40
	24 Hours**	60	60
Ozone (O3) Mg/m^3	8 Hours*	100	100
	1 Hour*	180	180
Lead (Pb) Mg/m^3	24 Hours**	0.5	0.5
	24 Hours**	1.0	1.0
Carbon Monoxide (CO) Mg/m^3	8 Hours**	02	02
	1 Hour*	04	04
Ammonia (NH_3) Mg/m^3	Annual*	100	100
	24 Hours**	400	400
Benzene (C_6H_6) Mg/m^3	Annual*	05	05
Arsenic (As) Mg/m^3	Annual*	06	06
Nickel (Ni), Mg/m3	Annual*	20	20

Source: Central Pollution Control Board, 2011

Ambient Air Quality monitoring is required to determine the existing quality of air, evaluation of the effectiveness of control programme and to identify areas in need of restoration and their prioritization. The areas selected for monitoring are based on high traffic density, industrial growth, human population and its distribution, emission source, the land use pattern etc. The pollutants included for measurement are Carbon Monoxide (CO), Respirable Suspended Particulate Matter (RSPM/PM_{10}), Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_X) and Oxides of Sulphur (SO_2) . High Volume

Sampler (Model: Respirable Dust Sampler APM 460BL $ Gaseous Sampling APM 411) and CO Analyzer (Model: Gazguard TX CO) are the equipments deployed to measure the concentration of pollutants. High Volume Sampler used to locate at a height between 5m and 12m depends on the locally available buildings as well as fulfilling other criteria such as obstruction, canopy etc. At any case, the height of the instrument is not exceeded beyond 15m from the ground level. The CO analyzer is located at traffic volume count station. i.e. maximum vehicle passing station.

The concentration of air pollution varies spatially and temporarily causing the air pollution pattern to change with different locations and time due to changes in meteorological factors and topographical features. The monitoring authority measuring meteorological parameters like wind speed, wind direction, solar radiation, atmospheric stability and precipitation because those factors have a direct and significant effects on the distribution of air pollutants in the atmosphere. While the speed of the wind determines how the pollution is diluted and blown away, the direction of the wind decides the line along with those dilution takes place. Wind speed determines the travel time of a pollutant from source to the receptor. As wind speed increases, the volume of air moving by a source in a period of time also increases. If emission rate is relatively constant, a doubling of wind speed halves the pollutant concentration, as the concentration is an inverse function of the wind speed. Pollutant dispersion is affected by the variability in wind direction also. If the wind direction is relatively constant, the same area is continuously exposed to high pollutant levels. If the wind direction is constantly shifting pollutants are dispersed over a large area, and concentrations over any exposed area are lower. Wind Logger is the equipment, which measures the wind speed, and wind direction, the hourly average of the parameter observed.

The ambient air monitoring in Ernakulam commenced with the establishment of a station in town hall premises in 1984. Monitoring stations in Ernakulam district are: KWA Building M.G. Road, Near South Over Bridge, FCN OEN Connectors Building Vytila, Irumpanam, Carborandum Universal Company Kalamassery, Eloor-Methanam, and FACT Quarters Udyogamandal Eloor. The following Table: 6.6 shows the same recorded in 2009, seven different stations in the district. Air characteristics monitored include Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM). The monitoring of pollutants is carried out for 24 hours (8 - hourly sampling for $SO_{2,}$ NO_X, SPM and RSPM /PM_{10}).

Table: 6.6
Ambient Air Quality Status in Ernakulam (2009)

Stations	Annual Average of				
	Limit	SO_2 Mg/m^3	NO_X Mg/m^3	RSPM Mg/m^3	SPM Mg/m^3
KWA Building M.G. Road	Mean	3.83	15.69	37.50	62.75
	Max	11.24	29.58	75.00	131.83
	Min	2.00	8.63	20.75	27.58
Near South Over Bridge	Mean	4.10	18.51	41.00	77.50
	Max	10.85	36.01	79.08	155.9
	Min	2.00	9.73	17.90	32.25
FCN OEN Connectors Building Vytila	Mean	4.34	14.33	40.5	60.5
	Max	12.3	29.37	72.0	103.83
	Min	2.00	9.00	21.5	34.5
Irumpanam	Mean	3.58	10.65	36.75	55.08
	Max	9.13	20.93	71.25	110.58
	Min	2.00	8.25	15.5	22.75
Carborandum Universal Kalamassery	Mean	4.58	12.50	39.75	61.33
	Max	10.33	25.45	98.17	132.17
	Min	2.00	7.13	16.0	25.83
Eloor-Methanam	Mean	2.02	6.58	50.42	104.33
	Max	2.65	13.51	173.58	282.25
	Min	2.00	4.5	14.33	41.92
FACT Quarters Udyogamandal Eloor	Mean	2.00	6.48	49.17	118.83
	Max	2.00	12.03	166.83	344.33
	Min	2.00	4.5	11.25	37.75

Source: Central Pollution Control Board, 2009

The emission rate of each of the pollutant is measured by a nine days monitoring at each station in every month and finding out the mean value for getting, the Annual Average. The maximum emission limit of SO_2, NO_X, RSPM and SPM of first three monitoring stations, i.e,. M.G. Road, South Over Bridge and Vytila are 80 Mg/m^3, 80 Mg/m^3, 100 Mg/m^3 and 200 Mg/m^3 respectively. It is 24-hour average. Moreover, the corresponding Annual Average was 60 Mg/m^3, 60 Mg/m^3, 60 Mg/m^3, 140 Mg/m^3 respectively. But at Irumpanam, Kalamassery, Udyogamandal and Eloor-Methanam maximum emission limit of 24 hour average of SO_2, NO_X, RSPM and SPM are 120 Mg/m^3, 120 Mg/m^3, 150 Mg/m^3 and 500 Mg/m^3, and the corresponding Annual Average is 80 Mg/m^3, 80 Mg/m^3, 120 Mg/m^3, 360 Mg/m^3. The calculated maximum rate is 11.24 Mg/m^3 for SO_2 Mg/m^3 , 29.58 Mg/m^3 for NO_X, 75.00 Mg/m^3 for RSPM, and 131.83 Mg/m^3 for SPM at M. G. Road. The corresponding minimum values are 2.00 Mg/m^{3,} 8.63 Mg/m^3, 20.75 Mg/m^3, 27.58 Mg/m^3 respectively. From table: 6.6 it is very clear that during the year 2009, the highest mean value, of SO_2 recorded at Kalamassery (4.58 Mg/m^3), of NO_X at South Over Bridge monitoring station (18.51 Mg/m^3), of RSPM at

Eloor-Methanam (50.42 Mg/m^3), and of SPM at Udyogamandal monitoring station (118.83 Mg/m^3). The ambient air quality during 2010 scheduled below (Table: 6.7). It shows that during the year 2010, the highest mean value, of SO_2, NO_X and RSPM are recorded at Kalamassery (5.67 Mg/m^3, 17.04 Mg/m^3 and 45.93 Mg/m^3). The highest SPM value recorded at Udyogamandal monitoring station (76.85 Mg/m^3).The standard deviation value is also given in the table for each pollutant in different stations.

Table: 6.7
Ambient Air Quality Status in Ernakulam (2010)

Stations	Annual Average of				
	Limit	SO_2 Mg/m^3	NO_X Mg/m^3	RSPM Mg/m^3	SPM Mg/m^3
KWA Building M.G. Road	Mean	4.15	13.09	34.40	51.26
	St Dev	3.14	4.77	13.41	18.23
	Max	16.65	29.44	67.25	100
	Min	2.00	5.25	12.42	22.50
Near South Over Bridge	Mean	3.71	15.68	35.77	49.04
	St Dev	3.77	6.38	17.02	17.88
	Max	19.93	33.46	66.58	93.25
	Min	2.00	6.38	11.75	22.0
FCN OEN Connectors Building Vytila	Mean	4.47	13.69	40.55	56.67
	St Dev	3.01	5.35	13.43	17.22
	Max	15.55	29.43	73.67	99.0
	Min	2.00	5.62	16.42	27.33
Irumpanam	Mean	4.06	11.10	37.71	51.97
	St Dev	2.35	4.05	13.34	16.13
	Max	10.69	23.45	70.92	90.58
	Min	2.0	4.5	13.92	23.12
Carborandum Universal Kalamassery	Mean	5.67	17.04	45.93	61.63
	St Dev	4.48	6.69	21.95	25.00
	Max	22.35	31.46	104.92	127.58
	Min	2.0	6.96	15.42	26
Eloor-Methanam	Mean	2.14	5.69	29.38	76.84
	St Dev	4.98	3.61	20.27	31.87
	Max	4.15	12.24	87.43	168.92
	Min	2.00	4.5	10.08	38.08
FACT Quarters Udyogamandal Eloor	Mean	2.22	5.75	29.36	76.85
	St Dev	0.54	2.26	20.33	31.87
	Max	4.15	12.22	97.33	168.92
	Min	2.00	4.5	10.08	38.08

Source: Central Pollution Control Board, 2010

During the year 2011, the highest mean value of SO_2 and NO_X are recorded at M.G. Road (4.28 Mg/m^3 and 19.03 Mg/m^3), of RSPM recorded at Kalamassery (58.67 Mg/m^3), the same is given in Table: 6.8.

Table: 6.8
Ambient Air Quality Status in Ernakulam (2011)

Stations	Annual Average of				
	Limit	SO2 Mg/m3	NOX Mg/m3	RSPM Mg/m3	SPM Mg/m^3
KWA Building M.G. Road	Mean	4.28	19.03	39.36	51.26
	St Dev	3.60	6.47	16.23	18.23
	Max	16.61	36.43	115.17	100
	Min	2.00	6.42	13.67	22.50
Near South Over Bridge	Mean	3.56	17.23	52.495	49.04
	St Dev	2.96	6.82	19.78	17.88
	Max	14.19	33.95	95.25	93.25
	Min	2.00	4.5	18.5	22.0
FCN OEN Connectors Building Vytila	Mean	3.92	15.33	46.46	56.67
	St Dev	3.54	5.89	18.21	17.22
	Max	16.64	30.68	86	99.0
	Min	2.00	5.5	15.92	27.33
Irumpanam	Mean	3.18	12.04	37.42	51.97
	St Dev	2.43	5.27	16.15	16.13
	Max	12.49	24.29	74.42	90.58
	Min	2.00	4.50	12.08	23.12
Carborandum Universal Kalamassery	Mean	3.80	15.28	58.67	61.63
	St Dev	2.995	6.69	30.46	25.00
	Max	13.68	32.20	199.33	127.58
	Min	2.00	5.08	15.75	26
Eloor-Methanam	Mean	2.21	5.04	16.73	76.84
	St Dev	0.704	1.6	1.95	31.87
	Max	4.74	10.05	20.0	168.92
	Min	2.00	4.5	13.33	38.08
FACT Quarters Udyogamandal Eloor	Mean	2.34	5.18	18.29	76.85
	St Dev	0.81	1.67	2.64	31.87
	Max	4.71	10.02	23.33	168.92
	Min	2.00	4.50	13.67	38.08

Source: Central Pollution Control Board, 2011

6.4 MEASUREMENT OF AIR POLLUTION INDEX (API)

The National Ambient Air Quality Standards (2011) was used to construct the Air Pollution Index in seven monitoring stations of Ernakulam district. Air Pollution Index is a scheme that transforms the (weighted) values of individual air pollution related parameters into single number or set of numbers. The Air Pollution Index can be determined by the following equation. From Air Pollution Index, the sampling station can be categorized in to clean, light moderate, heavy and severe pollution levels. The Table: 6.9 shows the API value of each category.

$$\textbf{Air Pollution Index} = \frac{1}{4}\left(\frac{\textbf{SO2}}{S_{SO2}} + \frac{\textbf{NOx}}{S_{NOx}} + \frac{\textbf{RSPM}}{S_{RSPM}} + \frac{\textbf{SPM}}{S_{SPM}}\right) \times 100$$

Where:

SO_2, NO_x. RSPM, SPM represent the measured values

S_{SO2}, S_{NOx}, S_{RSPM}, S_{SPM} represent the Annual Average Quality standard values prescribed by Central Pollution Control Board.

Table: 6.9

Standard Air Pollution Index Values

Air Pollution Index Values	Air Pollution Index
0-25	Clean Air
25-50	Light Air Pollution
50-75	Moderate Air Pollution
75-100	Heavy Air Pollution
>100	Severe Air Pollution

From the above parameters described in table, we can determine the Air Pollution values in each station and it is scheduled below (Table: 6.10). Here we take into account the Revised National Ambient Air Quality Standard of CPCB as the AAQ values of each pollutant.

Table: 6.10

Air Pollution Values & Index at Different Stations in Ernakulam

Stations	2009	2010	2011	Air Pollution Index
KWA Building M.G. Road	66.57	56.63	62.47	Moderate
Near South Over Bridge	79.14	57.21	65.07	Moderate
FCN OEN Connectors Building Vytila	65.81	63.11	66.32	Moderate
Irumpanam	58.18	57.16	57.19	Moderate
Carborandum Universal Kalamassery	65.00	71.14	74.51	Moderate
Eloor-Methanam	91.34	64.89	59.25	Moderate
FACT Quarters Udyogamandal Eloor	99.81	64.97	60.06	Moderate

From Table: 6.10 it is clear that seven monitoring stations in Ernakulam district show moderate air pollution during the year 2011. The Air Pollution Index of Kalamassery during 2011 was 74.51, touches the heavy air pollution level. During 2009, Eloor Methanam and FACT Udyogamandal Eloor, showed heavy air pollution.

The next section of this chapter deals with the emission of pollution from motor vehicles by two ways. One is Registered Motor Vehicles Emission and two, In-Use Vehicle Emission. The method used for measuring emission in both cases is Bottom Up

Approach based on Annual Average Utilisation for different vehicles categories and the corresponding emission factors established by the Automotive Research Association of India(ARAI), Pune.

6.5 REGISTERED MOTOR VEHICLES EMISSION IN ERNAKULAM DISTRICT

The main drawback of this Air Pollution Index (API) is it doesn't takes into account the emission of other pollutants especially Carbon Dioxide and Carbon Monoxide etc. Thus by using this type of analysis, we cannot get a clear picture of the exact pollution level in the district. Here, the study primarily focuses on the vehicles related pollution, and hence let us go through an analysis of the emission levels of road transport vehicles. For this, we have to categorize the total number of vehicles in the district and the same is given below (Table: 6.11).

Table: 6.11
Category wise Registered Motor Vehicles
in Ernakulam District (as on March 2013)

Vehicles Category	Total Number of Registered Vehicles	Percentage Share of Each Vehicles
Bus	17461	1.32
Auto Rickshaw	54956	4.16
Two Wheelers	679587	51.49
Light Motor Vehicles (Passenger)	13248	1.00
Cars & Jeeps	320037	24.25
Taxi	36825	2.79
Trucks & Lorries	78020	5.91
Light Motor Vehicles (Goods)	64084	4.86
Trailers &Tractors	1547	0.12
Others	53960	4.09
Total	1319725	100.00

Source: Annual Administration Report, Motor Vehicle Department,

As per the Annual Administration Report, prepared by Motor Vehicles Department, there were 1319725 vehicles in Ernakulam district. Of these, 51.49 percent of vehicles are two wheelers, 24.25 percent of vehicles Cars and Jeeps, all others constitute only minor percentages. These accounts are for registered motor vehicles only, that is those, which are, registered under the seven sub- regional transport offices at Ernakulam district. But this data take into account the number of vehicles transferred into the district as well as excluded registration cancelled as well as those vehicles which are transferred out from the district. The emission factors according to fuel types, category of vehicles for Indian vehicles established by the Automotive Research Association of India

(ARAI) can be used to estimate emission of vehicles, and the same is depicted in Table: 6.12 below. From the table, it is very clear that among the various pollutants from vehicles, the intensity of CO_2 is very high while compared to other pollutants. It is to be also noted that vehicles like Buses, Trucks, Lorries, Tractors and Trailers and Goods Vehicles emit more CO_2 when compared to other category of vehicles. This is mainly because of high engine capacity of these types of vehicles.

Table: 6.12
Emission Factor for Different Category of Vehicles (g/KM)

Pollutant	Bus	Auto Rickshaw	Two Wheelers	L M V (Passenger)	Cars & Jeeps	Taxi	Trucks & Lorries	L M V (Goods)	Trailers & Tractors	Others
CO_2	515.2	62.41	26.6	60.3	223.6	208.3	515.2	515.2	515.2	343.9
CO	3.6	1.37	2.2	5.1	1.98	0.9	3.6	5.1	5.1	3.9
NO_X	12	0.20	0.19	1.28	0.2	0.5	6.3	1.3	1.3	3.9
CH_4	0.09	0.02	0.2	0.2	0.2	0.01	0.09	0.09	0.09	0.1
SO_2	1.4	0.03	.013	0.03	0.05	10.3	1.4	1.4	1.4	1.9
PM	0.6	0.45	0.05	0.2	0.03	0.07	0.3	0.2	0.2	0.2
HC	0.9	2.53	1.42	0.14	0.25	0.13	0.87	0.14	0.14	0.5

Source: Emission Factor Development for Indian Vehicles, ARAI, 2013

From the different category of vehicles, we can estimate the different pollutant emission to the atmosphere by multiplying each category of vehicles with the corresponding emission factor. The result is depicted below in Table: 6.13.

Table: 6.13
Category wise Emission for Registered Vehicles In Ernakulam District(KG/KM)

Pollutant	CO2	CO	NOX	CH4	SO2	PM	HC
Bus& Omni Bus	8995.9	62.9	209.5	1.6	24.4	10.5	15.7
Auto Rickshaw	3429.8	75.3	11	1.1	1.6	24.7	139
Two Wheelers	18077	1495.1	129.1	135.9	8.8	34	965
L M V (Passenger)	798.9	67.6	17	2.6	0.4	2.6	1.9
Cars & Jeeps	71560.3	633.7	64	64	16	9.6	80
Taxi& Motor Cab	7670.6	33.1	18.4	0.4	379.3	2.6	4.8
Trucks & Lorries	40195.9	280.9	491.5	7	109.2	23.4	67.9
L M V (Goods)	33016.1	326.8	83.3	5.8	89.7	12.8	9
Trailers&Tractors	797	7.9	2	0.1	2.2	0.3	0.2
Others	18556.8	210.4	210.4	5.4	102.5	10.8	27

Source: Primary Data

From Table: 6.13, emissions of different category of vehicles are shown in Kg per Km. the emission factor is given in grams so we just convert it into kilogram by dividing each by thousand. From these values it is clear that, the Cars and Jeeps category emit more Carbon Dioxide (71560.3 Kg/Km) to the atmosphere even though Two Wheelers exceed in its number. The CO_2 of Two Wheelers is 18077 Kg/ Km. Trailors and Tractors emit less as these are less in number. Carbon Monoxide emission of Two Wheelers is very high (1495.1 Kg/Km) when compared to other category of vehicles. Trucks and Lorries emit more Nitrous Oxide (135.9), Taxi and Motor Cab emit 379.3 Kg/Km Sulphur Dioxide, Hydro Carbon emitted by Two Wheelers are 695.0 Kg/Km.

Table: 6.14

Total Emission of Registered Vehicles (as on 31st March, 2013

Pollutants	Emission (KG/KM)	Percentage share of Each Pollutant
CO_2	203098.34	96.75
CO	3193.66	1.52
NO_X	1236.31	0.59
CH_4	223.94	0.11
SO_2	734.26	0.35
PM	131.34	0.06
HC	1310.46	0.62
Total	209928.31	100.00

Source: Primary Data

Table: 6.14 give the consolidated emission details. The total emission of CO_2 from various categories of vehicles for one kilometre is 203093.34 kg, which is 96.75 percent of the road transport vehicles emission. For Carbon Monoxide it is 3193.66 that constitute only 1.52 percent of the total emission. It is to be note that, here we take into account only one kilometre distance emission. That is if the vehicle travel one kilometre what the emission of pollutants in the atmosphere is. To get more clear emission of pollutants, we have to consider the Vehicle Kilometre Distance Travelled (VKT) by each and every vehicle in the district. But one limitation of that method is, the same vehicle plying on the road may need not be the one which is registered in the district, or if it is registered within the district, may be passes to out of stations. So in order to overcome this limitation, it is better to take the average annual distance travelled by Indian vehicles, laid down in the Five-Year Planning Reports of India. So here we take into account the same from there.

Annual utilization of buses, minibuses, two-wheelers, light motor vehicles (passenger), cars and jeeps, and taxi estimated as 100000, 100000, 6300, 33500, 12600 and 12600 km, respectively. Similarly, for trucks and Lorries, light motor vehicles (goods), trailers, and tractors 25000 to 90000, 63000 and 21000 km per year. For other category of vehicle an average of the above figures are taken into account. Therefore, the corresponding emission details are as follows (Table: 6.15):

Table: 6.15

Category wise Annual Emission for Registered Vehicles In Ernakulam District (Tonne)

Pollutant	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus& Omni Bus	899590.0	6290.0	20950.0	160.0	2440.0	1050.0	1570.0
Auto Rickshaw	21607.7	474.4	69.3	6.9	10.1	155.6	875.7
Two Wheelers	113885.1	9419.1	813.3	856.2	55.4	214.2	6079.5
L M V (Passenger)	26763.2	2264.6	569.5	87.1	13.4	87.1	63.7
Cars & Jeeps	901659.8	7984.6	806.4	806.4	201.6	121.0	1008.0
Taxi, Motor Cab	96649.6	417.1	231.8	5.0	4779.2	32.8	60.5
Trucks & Lorries	2311264.3	16151.8	28261.3	402.5	6279.0	1345.5	3904.3
L M V (Goods)	2080014.3	20588.4	5247.9	365.4	5651.1	806.4	567.0
Trailer&Tractors	16737.0	165.9	42.0	2.1	46.2	6.3	4.2
Others	644941.6	7312.5	7312.5	187.7	3562.4	375.4	938.4

Source: Primary Data

The annual emission are calculated and depicted in Table: 6.15 above. The emission expressed in tonne (1000 Kg) by considering the travel distance of each category of vehicles. From this table, it is clear that, Trucks and Lorries emit more Carbon Dioxide emission, 2311264.3 tonne in a year. It constitutes 32.49 percent of the total carbon dioxide emission in the district. The next highest emitter of CO_2 is light motor vehicles goods, 29.24 percent of total CO_2 emission in the district. The percentage wise details are given below in Table: 6.16. Highest CH_4 emitter is two wheeler 856.17 tonne for an average distance of 6300 km in a year (here we take 2013 as the year).

Table: 6.16

Category wise Annual Emission for Registered Vehicles in Ernakulam District (Percentage)

Pollutant	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus& Omni Bus	12.65	8.85	32.58	5.56	10.59	25.03	10.42
Auto Rickshaw	0.30	0.67	0.11	0.24	0.04	3.71	5.81
Two Wheelers	1.60	13.25	1.26	29.74	0.24	5.11	40.34
L M V (Passenger)	0.38	3.19	0.89	3.03	0.06	2.08	0.42
Cars & Jeeps	12.68	11.24	1.25	28.01	0.88	2.88	6.69
Taxi, Motor Cab	1.36	0.59	0.36	0.18	20.74	0.78	0.40
Trucks & Lorries	32.49	22.73	43.95	13.98	27.25	32.08	25.91
L M V (Goods)	29.24	28.97	8.16	12.69	24.53	19.23	3.76
Trailers&Tractors	0.24	0.23	0.07	0.07	0.20	0.15	0.03
Others	9.07	10.29	11.37	6.52	15.46	8.95	6.23

Source: Primary Data

The total emissions of pollutants from various categories of vehicles as on 31st March 2013 are given in Table: 6.17 below. It is seen that Carbon Dioxide constitutes 97.52 percent of the total emission in the year 2013. 7113113 tonne is the emission of

Carbon Dioxide in the district. Other pollutants values are negligible when compared to this value. Carbon Monoxide emission is only 71068.3 tonne. Hydro Carbons emit 15.71.17 tonne into the atmosphere.

Table: 6.17

Annual Emission of Registered Vehicles

Pollutants	Emission (Tonne)	%share of Each Pollutant
CO_2	7113113	97.52
CO	71068.3	0.97
NO_X	64303.97	0.88
CH_4	2879.317	0.04
SO_2	23038.39	0.32
PM	4194.184	0.06
HC	15071.17	0.21
Total	7293668	100

Source: Primary Data

Let us examine the emission of Kochi in the same manner and it is explained below:

6.6 REGISTERED MOTOR VEHICLES EMISSION IN KOCHI

The consolidated report of total registered motor vehicles in Kochi Corporation prepared by combining the data obtained from Kakkanad and Kochi Regional Transport Offices and the same is table out below (Table: 6.18). Out of the total 525397 vehicles, Cars & Jeeps accounted 228478 vehicles (43.49%), 168112 are Two Wheelers (32%). 71.3 % of Cars & Jeeps and 24.73% of Two Wheelers in the district are registered under Kochi Corporation. It meant that this area is the core RT office functioned under Regional Transport Office Ernakulam.

Table: 6.18

Category wise Registered Motor Vehicles in Kochi Corporation (31st March2013)

Vehicles Category	Total Number of Registered Vehicles	Percentage Share of Each Vehicles
Bus	15376	2.93
Auto Rickshaw	32500	6.19
Two Wheelers	168112	32.00
LMV (Passenger)	5544	1.06
Cars & Jeeps	228478	43.49
Taxi	18143	3.45
Trucks & Lorries	32921	6.27
LMV (Goods)	10681	2.03
Trailers &Tractors	478	0.09
Others	13164	2.51
Total	525397	100.00

Source: Annual Administration Report, RT Office, EKLM

Table: 6.19
Category wise Emission for Registered Vehicles (KG/KM) in Kochi

Pollutant	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus& Omni Bus	7921.7	55.4	184.5	1.4	21.5	9.2	13.8
Auto Rickshaw	2028.3	44.5	6.5	0.7	1.0	14.6	82.2
Two Wheelers	4471.8	369.8	31.9	33.6	2.2	8.4	238.7
L M V (Passenger)	334.3	28.3	7.1	1.1	0.2	1.1	0.8
Cars & Jeeps	51087.7	452.4	45.7	45.7	11.4	6.9	57.1
Taxi, Motor Cab	3779.2	16.3	9.1	0.2	186.9	1.3	2.4
Trucks & Lorries	16960.9	118.5	207.4	3.0	46.1	9.9	28.6
L M V (Goods)	5502.9	54.5	13.9	1.0	15.0	2.1	1.5
Trailers&Tractors	246.3	2.4	0.6	0.0	0.7	0.1	0.1
Others	4527.1	51.3	51.3	1.3	25.0	2.6	6.6

Source: Primary Data

As per the data obtained, we calculated the emission of pollutants and the same is depicted above in Table: 6.19. 452.4 Kg Carbon Monoxide and 51087.7 Kg CO_2 are contributed by Cars and Jeeps for one kilometre travel. Trucks and Lorries emit 16960.9 Kg/KM CO_2 even though they are 32921 in number. These categories of vehicles emit Hydro Carbon (28.6 Kg/Km). Table: 6.20 presented the total emission of registered vehicles in Kochi.

Table: 6.20
Total Emission of Registered Vehicles in Kochi (KG/KM)

Pollutants	Emission (KG/KM)	Percentage share of Each Pollutant
CO_2	96860.11	97.35
CO	1193.48	1.20
NO_X	558.07	0.56
CH_4	87.93	0.09
SO_2	309.87	0.31
PM	56.23	0.06
HC	431.82	0.43
Total	99497.50	100.00

Source: Primary Data

From Table: 6.20, it is seen that, out of the total Carbon Dioxide emission in the district, 47.69% contribute ted Kochi Corporation Registered Vehicles. The Corporation only contributed 69860.11 Kg/Km CO_2 Emission. That is 97.35 percent of the total transport emission in the district. These figures are only for the emission per one kilometre. Let us examine the annual emission of each pollutant in the Kochi area.

Table: 6.21

Category wise Annual Emission for Registered Vehicles in Kochi (Tonne)

Pollutant	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus& Omni Bus	792170.0	5540.0	18450.0	140.0	2150.0	920.0	1380.0
Auto Rickshaw	12778.3	280.4	41.0	4.4	6.3	92.0	517.9
Two Wheelers	28172.3	2329.7	201.0	211.7	13.9	52.9	1503.8
L M V (Passenger)	11199.1	948.1	237.9	36.9	6.7	36.9	26.8
Cars & Jeeps	643705.0	5700.2	575.8	575.8	143.6	86.9	719.5
Taxi, Motor Cab	47617.9	205.4	114.7	2.5	2354.9	16.4	30.2
Trucks & Lorries	975251.8	6813.8	11925.5	172.5	2650.8	569.3	1644.5
L M V (Goods)	346682.7	3433.5	875.7	63.0	945.0	132.3	94.5
Trailers&Tractors	5172.3	50.4	12.6	0.0	14.7	2.1	2.1
Others	157339.4	1782.9	1782.9	45.2	868.9	90.4	229.4

Source: Primary Data

The category wise annual emission in Kochi are calculated and depicted in the Table: 6.21 above in Tonne, and the corresponding percentages are expressed below Table: 6.22. From this table it is clear that Trucks and Lorries emit more Carbon Dioxide emission, 975251.8 tonne in 2013 year. It constitutes 32.29 percent of the total carbon dioxide emission in Kochi Corporation. The highest Carbon Monoxide and Nitrous Oxides, Hydro Carbon emitter is also the trucks and Lorries category. The next highest emitter of CO_2 is bus and Omni buses 26.23 percent of total CO_2 emission in Kochi.

Table: 6.22

Category wise Annual Emission for Registered Vehicles in Ernakulam District (Percentage)

Pollutant	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Bus& Omni Bus	26.23	20.45	53.92	11.18	23.48	46.02	22.44
Auto Rickshaw	0.42	1.04	0.12	0.35	0.07	4.60	8.42
Two Wheelers	0.93	8.60	0.59	16.91	0.15	2.65	24.46
L M V (Passenger)	0.37	3.50	0.70	2.95	0.07	1.85	0.44
Cars & Jeeps	21.31	21.05	1.68	45.99	1.57	4.35	11.70
Taxi, Motor Cab	1.58	0.76	0.34	0.20	25.72	0.82	0.49
Trucks & Lorries	32.29	25.16	34.85	13.78	28.96	28.48	26.75
L M V (Goods)	11.48	12.68	2.56	5.03	10.32	6.62	1.54
Trailers&Tractors	0.17	0.19	0.04	0.00	0.16	0.11	0.03
Others	5.21	6.58	5.21	3.61	9.49	4.52	3.73

Source: Primary Data.

The percentage wise details are given above (Table: 6.22). Highest CH_4 emitter is Cars and Jeeps category, 57.5.8 tonne for an average distance of 12600 km in the year.

The total annual emissions of pollutants from various categories of vehicles in 2013 in Kochi Corporation are as follows (Table: 6.23). It is seen that Carbon Dioxide constitutes 97.14 percent of the total emission in the year 2013. 3020088.8 tonne is the emission of Carbon Dioxide in the district. Other pollutants values are negligible when compared to this value. Carbon Monoxide emission is only 27084.4 tonne constitute 0.9 percent of the total emission in Kochi.

Table: 6.23
Annual Emission of Registered Vehicles In Kochi
(as on 31st March, 2013

Pollutants	Emission (Tonne)	%share of Each Pollutant
CO_2	3020088.8	97.14
CO	27084.4	0.9
NO_X	34217.1	1.1
CH_4	1252.0	0.0
SO_2	9154.8	0.3
PM	9154.8	0.3
HC	1999.2	0.1
Total	6148.7	0.2

Source: Primary Data

It is keeping in mind that the above values are only for one kilometre distance travel. Actual kilometre distance travel determines the intensity of pollution level. For example the average distanced travelled per month by a road freight carrier is depend on the age of the vehicle also. Vehicle age 0-6 years average distance travelled per month 8000 Km; Vehicle age 6-10 years average distance travelled per month 7000 Km; Vehicle age 10-15 years average distance travelled per month 4000 Km and; Vehicle age more than 15 years average distance travelled per month 2000e Km. For getting somewhat accurate level of pollution estimation, we have to calculate the in-use vehicles emission.

6.7 IN-USE MOTOR VEHICLES EMISSION IN SELECTED LOCATIONS

It is to be note that the above discussion of vehicular emission is only registered motor vehicles emission. But exact emission data somewhat different from this. In order to get the exact emission from motor vehicles, we have to count the in–use vehicle on the road. We know that the same vehicle plying on the road more than one time per day, Out-of-State and Out-of-district vehicles may come into or pass through this Ernakulam district, etc, are a constraint to measure the exact emission. We exclude such category, when we take into account the registered motor vehicles only. Therefore, for better results, we have to count the in-use vehicles on the road (known as Traffic Volume Analysis) and measure the pollution level.

Traffic Volume Analysis help in determining the traffic flow pattern, total number of vehicles and their distribution based on category, type etc. The same serves as the basic input for capacity analysis and design of facility for developing a maintenance strategy. The continuous counts of vehicles for both directions will serve as the basic input for forecasting the vehicular population. A survey of Traffic Volume count being conducted at the monitoring junction nearby air quality monitoring stations to get the number of in-use vehicles. The collected data is categorized into sub categories like Two Wheeler, Three Wheelers, Car/ Jeep, Light Commercial Vehicle, Multi Utility Vehicle, Buses, Trucks and Tractor.

To find the in-use vehicles, three outer area of Ernakulam district selected, i.e, Angamaly, Aluva, Kothamangalam so that we can get the number of vehicles enter and exit into the district. Angamaly is fast developing suburb of Kochi. It is situated 33 KM north of Ernakulam. This town lies at the intersection of Main Central Road popularly known as MC road and NH47. Aluva is the second largest town in Kochi city and an important commercial town in Ernakulam district, situated 28 KM north of Ernakulam. It is located 12 KM away from the Cochin International Airport. Kothamangalam is a town located in the eastern part of Ernakulam district and situated 45 KM north east of Kochi city. The NH 49 (Ernakulam-Madurai-Rameshwaram) passes through this town. In–use vehicles in Kochi also counted as Kochi is Kerala’s second largest city and is a part of an extended metropolitan region, which is the largest urban agglomeration in Kerala. It lies about 220 KM north of the State capital and about 180 K M south of Kozhikode, the third largest city of Kerala.

Traffic Volume Study for Seven days was conducted as per the Indian Road Congress Guidelines (04-05-2013 to 10-05-2013) at both upward and downward direction of each location in order to get the total number of in–use vehicles at each location (to measure the existing vehicle population). The categorized survey was carried out for a period of seven days of 24 hours at the four stations and the summarized vehicle population (In-use vehicles in category wise at the selected areas) is given from Table 6.24 to 6.27. At Angamaly location, 8 AM to 9 AM is the peak hour, were an average of 1502 Vehicles counted (During the survey), those passed to Thrissur direction. But to Ernakulam direction, an average of 1766 vehicles passed at the peak hour, evening 5-6 PM.

Table: 6.24

Category wise In-Use Vehicle in Angamaly

Category	To Ernakulam	To Thrissur	Total
Two Wheelers	43064	34531	77595
Auto Rickshaws	10983	7945	18928
Pick Up Auto	3367	3689	7056
Car and Jeeps	45171	38661	83832
Light Commercial	10752	6874	17626
Bus	5474	5145	10619
Truck/Tractor	18508	20664	39172
Others	16877	12761	29638
Total	154196	130270	284466

Source: Traffic Volume Survey

Table: 6.25

Category wise In-Use Vehicle in Aluva

Category	To Ernakulam	To Aluva	Total
Two Wheelers	58646	31934	90580
Auto Rickshaws	30247	15043	45290
Pick Up Auto	6377	4263	10640
Car and Jeeps	58380	19047	77427
Light Commercial	2184	1897	4081
Bus	24759	581	25340
Truck/Tractor	13153	5390	18543
Others	6741	3388	10129
Total	200487	81543	282030

Source: Traffic Volume Survey

Table: 6.26

Category wise In-Use Vehicle in Kothamangalam

Category	To Ernakulam	To Perumbavoor	Total
Two Wheelers	45192	36904	82096
Auto Rickshaws	28007	29281	57288
Pick Up Auto	2009	2009	4018
Car and Jeeps	21588	17192	38780
Light Commercial	1519	1855	3374
Bus	6412	6251	12663
Truck/Tractor	1323	1785	3108
Others	4732	5201	9933
Total	110782	100478	211260

Source: Traffic Volume Survey

At Aluva station, during the survey time, the peak hour of traffic towards Aluva was 4 PM to 5 PM (969 vehicles counted) and that towards Ernakulam direction was 3 PM to 4 PM (2545 vehicles counted). An average of 1288 vehicles passes through to

Perumbavoor during 12 PM to 1 PM at Kothamangalam station and that to backward direction was an average of 1279 during 11 AM to 12 PM. In the case to Kochi to Vytila direction the peak hour is 7 PM to 8 PM, an average of 8863 vehicles passed, and to Ernakulam town direction 9217 vehicles counted. Thus we came to known that the peak hour of each and every station is different from one another depending upon the density of population, density of vehicles, road characteristics, weather conditions etc.

Table: 6.27

Category wise In-Use Vehicle in Kochi

Category	To Ernakulam	To Vytila	Total
Two Wheelers	292418	319256	611674
Auto Rickshaws	58989	55958	114947
Pick Up Auto	8169	9387	17556
Car and Jeeps	174944	113932	288876
Light Commercial	4662	4907	9569
Bus	25949	33600	59549
Truck/Tractor	5600	5145	10745
Others	136647	89131	225778
Total	707378	631316	1338694

Source: Traffic Volume Survey

From the traffic volume survey, it is observed that personalized vehicles such as two wheelers, Cars and Multi Utility Vehicles are the leading vehicles on the roads. At Angamaly station, a total of 284466 vehicles counted both upward and downward direction during the survey time, where 83832 are Cars, 77595 are Two Wheelers and 39172 are trucks and tractors. In the case of Aluva 282030 vehicles counted where Two Wheelers (90580) exceeded Cars (77427) in traffic volume. In the case of Kothamangalam, 211260 vehicles counted, out of this 82096 are Two Wheelers and 57288 are Auto Rickshaws which exceeded the traffic count of Cars which is 38780. In the case of Kochi, 1338694 vehicles counted where Two Wheelers counted as 611674. The number of cars adds up as 288876 and Multi Utility Vehicles Counted as 225778 in Kochi location both upward and downward direction. The estimated vehicle emissions for all the four location are given in the following four tables (Table: 6.28 to 6.31). In the case of Angamaly station, 2064.03 kg per km is the Carbon Dioxide emission by Two-wheelers. Carbon Dioxide shows the highest amount of emission among all the categories of pollutant. Two wheelers is the biggest emitter among all categories of the vehicles. The total Carbon Dioxide emission of the station during the survey time is 67844.55 kg per kilometre. 779.63 kg per km is the Carbon Monoxide emission. Particulate Matter shows a least figure of 41.17 kg per km.

Table: 6.28

Category wise In-Use Vehicles Emission in Angamaly (KG/KM/Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	2064.03	170.71	14.74	15.52	1.01	3.88	110.18
Auto Rickshaws	1181.30	25.93	3.79	0.38	0.57	8.52	47.89
Pick Up Autos	928.64	2.89	3.60	0.14	0.21	0.64	0.99
Car and Jeeps	18744.84	165.99	16.77	16.77	4.19	2.51	20.96
Light Commercial	9080.92	89.89	22.91	1.59	24.68	3.53	2.47
Buses	5470.91	38.23	127.43	0.96	14.87	6.37	9.56
Truck/Lorries	20181.41	170.40	148.85	3.53	54.84	9.79	19.78
Others	10192.51	115.59	115.59	2.96	56.31	5.93	14.82
Total	67844.55	779.63	453.68	41.84	156.68	41.17	226.64

Source: Primary Data

Table: 6.29

Category wise In-Use Vehicles Emission in Aluva (KG/KM/Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	2409.43	199.28	17.21	18.12	1.18	4.53	128.62
Auto Rickshaws	2826.55	62.05	9.06	0.91	1.36	20.38	114.58
Pick Up Autos	1400.33	4.36	5.43	0.21	0.32	0.97	1.49
Car and Jeeps	17312.68	153.31	15.49	15.49	3.87	2.32	19.36
Light Commercial	2102.53	20.81	5.31	0.37	5.71	0.82	0.57
Buses	13055.17	91.22	304.08	2.28	35.48	15.20	22.81
Truck/Lorries	9553.35	80.66	70.46	1.67	25.96	4.64	9.36
Others	3483.36	39.50	39.50	1.01	19.25	2.03	5.06
Total	52143.40	651.19	466.53	40.05	93.12	50.88	301.86

Source: Primary Data

Table: 6.30

Category wise In-Use Vehicles Emission in Kothamangalam (KG/KM/Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	2183.75	180.61	15.60	16.42	1.07	4.10	116.58
Auto Rickshaws	3575.34	78.48	11.46	1.15	1.72	25.78	144.94
Pick Up Autos	528.81	1.65	2.05	0.08	0.12	0.37	0.56
Car and Jeeps	8671.21	76.78	7.76	7.76	1.94	1.16	9.70
Light Commercial	1738.28	17.21	4.39	0.30	4.72	0.67	0.47
Buses	6523.98	45.59	151.96	1.14	17.73	7.60	11.40
Truck/Lorries	1601.24	13.52	11.81	0.28	4.35	0.78	1.57
Others	3415.96	38.74	38.74	0.99	18.87	1.99	4.97
Total	28238.58	452.58	243.75	28.12	50.52	42.45	290.18

Source: Primary Data

In the case of Aluva, Kothamangalam and Kochi station, the biggest emitter of air pollutant from motor vehicles is Carbon Dioxide, 52143.40 kg/ km, 28238.58 kg/km and 209138.06 kg per km respectively. In the case of Aluva and Kothamangalam, the least emitter is Methane, and in the case of Kochi, it is Particulate Matter (178.06 kg/km).

Table: 6.31

Category wise In-Use Vehicles Emission in Kochi (KG/KM/Week)

Category	CO_2	CO	NOX	CH4	SO2	PM	HC
Two Wheelers	16270.5	1345.7	116.2	122.3	8.0	30.6	868.6
AutoRickshaw	7173.8	157.5	23.0	2.3	3.5	51.7	290.8
Pick Up Autos	2310.6	7.2	9.0	0.4	0.5	1.6	2.5
Car and Jeeps	64592.7	572.0	57.8	57.8	14.4	8.7	72.2
Light Goods	4930.0	48.8	12.4	0.9	13.4	1.9	1.3
Buses	30679.6	214.4	714.6	5.4	83.4	35.7	53.6
Truck/Lorries	5535.8	46.7	40.8	1.0	15.0	2.7	5.4
Others	77645.1	880.5	880.5	22.6	429.0	45.2	112.9
Total	209138.1	3272.8	1854.3	212.5	567.2	178.1	1407.3

Source: Primary Data

From the classified vehicle population, the vehicular emission can be estimated using the emission factors of Automotive Research Association of India. The vehicular emission at all sampling locations has evaluated based on the total vehicle of each category and the corresponding emission factors (Table: 6.32). It represented in KG/ KM/ Week.

Table: 6.32

Estimated vehicular emission of In-Use Vehicles (KG/KM/Week)

Stations	Pollutants Concentration in Kg/KM/Week						
	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Angamaly	67844.6	779.6	453.7	41.8	156.7	41.2	226.6
Aluva	52143.4	651.2	466.5	40.1	93.1	50.9	301.9
Kothamangalam	28238.6	452.6	243.8	28.1	50.5	42.5	290.2
Kochi	209138.1	3272.8	1854.3	212.5	567.2	178.1	1407.3
Total	357364.6	5156.2	3018.3	322.5	867.5	312.6	2226.0

Source: Primary Data

When we analyzed the emission quantity among the four selected places, it has to be noted that, Kochi surpass all other three locations in all pollutants emission. The in-use vehicles as a total of these four locations emit 357364.59 Kg Carbon Dioxide, 5156.19 Kg Carbon Monoxide, 3018.29 Kg Oxides of Nitrogen, 2226.0 Kg Hydro Carbon, 322.54 Kg Methane, 867.48 Kg Sulphur Dioxide and 312.56 Kg Particulate Matter. It is the emission per week and also per kilometre during the survey period. In all the four locations the emission of Carbon Dioxide exceeds other pollutants rate of emission. It is also to be note that while calculating the emission of Truck/Lorries category, the average of trucks/lorries and trailers/ Lorriess taken into account.

These four stations in Ernakulam district constituted the main centres of the district. But we have to keep in mind one point that the sum part is not equal to total. The total in the above table (Table: 6.32) shows only the total of four stations not the entire district. It we take into account the whole major centres emission, still it doesn't constitute the district emission as the emission may spread depending upon the wind speed, climatic conditions, etc. Here from the table (Table: 6.32), we know that, the emission of Carbon Dioxide in Kochi city only estimated as 209138.06 Kg, and that of CO is 3272.79 Kg/km/week. This is only for one kilometre travelling emission. Actually the Vehicle Kilometre Travelled (VKT) of different vehicles are different, thus the emission rate is far exceed the above measured one. These are explaned below: Here the average annual distance covered by each vehicles are taken for seven days as an average figure. (The figure of Average Annual Distance divided by 365 and multiplied by seven, thus calculated the in use vehicles emission). The kilometre distance covered by two wheelers is 121 kilometre, Autorickshaw 121, Cars and Jeeps 242 km, Light Goods 403 km, buses 1918 km, Trucks and Lorries 1208 km , and Others taken as an average of 669 kilometre as per the guidelines of Five-Year Plan reports of India. The estimated emission is shown from Table: 6.33 to 6.37.

Table: 6.33

Category wise In-Use Vehicles Emission in Angamaly (Tonne/ Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	249.7	20.7	1.8	1.9	0.1	0.5	13.3
Auto Rickshaw	142.9	3.1	0.5	0.0	0.1	1.0	5.8
Pick Up Autos	224.7	0.7	0.9	0.0	0.1	0.2	0.2
Car and Jeeps	4536.3	40.2	4.1	4.1	1.0	0.6	5.1
Light Goods	3659.6	36.2	9.2	0.6	9.9	1.4	1.0
Buses	10493.2	73.3	244.4	1.8	28.5	12.2	18.3
Truck/Lorries	22260.1	188.0	164.2	3.9	60.5	10.8	21.8
Others	6818.8	77.3	77.3	2.0	37.7	4.0	9.9
Total	48385.3	439.5	502.4	14.3	137.9	30.7	75.4

Source: Primary Data

From Table: 6.33, it is clear that, at Angamaly station, after incorporating the weekly utilisation, the emission rate of Carbon Dioxide is 48385.3 tonne. From these Trucks and Lorries accounted 22260.1 tonne, Others (road roller, tractors, tillers etc) category shared 6818.8 tonnes of Carbon Dioxide. In the case of Carbon Monoxide total emission rate is 439.5 tonne, of these Trucks and Lorries have 188.0 tonne emission, buses and other category contributed 77.3 tonnes each. NOx, emission of the in-use vehicles accounted 502.4 tonne, of these buses contributed the major share (244.4 tonne). In the case of Hydro Carbon, SO_2 and CH_4 Trucks and Lorries category emit more percent.

At Aluva station, total Carbon Dioxide emission is 43916.9 tonnes, of these 10537.3 contributed by the Trucks and Lorries Category. Total Carbon Monoxide emission is 368.6 tonne, of these Buses contributed the major share (175 tonne).Total NOx emission is 697.6 tonne, total CH_4 emission is 13.1 tonne, total Hydro carbon emission is 92.2 tonne, of these three, buses category contribute the more share. Here Buses is the villain of emission not Trucks and Lorries category. The same is depicted in Table: 6.34 below:

Table: 6.34

Category wise In-Use Vehicles Emission in Aluva (Tonne/ Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	291.5	24.1	2.1	2.2	0.1	0.5	15.6
Auto Rickshaw	342.0	7.5	1.1	0.1	0.2	2.5	13.9
Pick Up Autos	338.9	1.1	1.3	0.1	0.1	0.2	0.4
Car and Jeeps	4189.7	37.1	3.7	3.7	0.9	0.6	4.7
Light Goods	847.3	8.4	2.1	0.1	2.3	0.3	0.2
Buses	25039.8	175.0	583.2	4.4	68.1	29.2	43.7
Truck/Lorries	10537.3	89.0	77.7	1.8	28.6	5.1	10.3
Others	2330.4	26.4	26.4	0.7	12.9	1.4	3.4
Total	43916.9	368.6	697.6	13.1	113.2	39.8	92.2

Source: Primary Data

Table: 6.35

Category wise In-Use Vehicles Emission in Kothamangalam (Tonne/ Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	264.2	21.9	1.9	2.0	0.1	0.5	14.1
Auto Rickshaw	432.6	9.5	1.4	0.1	0.2	3.1	17.5
Pick Up Autos	128.0	0.4	0.5	0.0	0.0	0.1	0.1
Car and Jeeps	2098.4	18.6	1.9	1.9	0.5	0.3	2.3
Light Goods	700.5	6.9	1.8	0.1	1.9	0.3	0.2
Buses	12513.0	87.4	291.5	2.2	34.0	14.6	21.9
Truck/Lorries	1766.2	14.9	13.0	0.3	4.8	0.9	1.7
Others	2285.3	25.9	25.9	0.7	12.6	1.3	3.3
Total	20188.2	185.5	337.9	7.3	54.1	21.1	61.1

Source: Primary Data

Tble (6.35) shows the in-use vehicle emission at Kothamangalam. At this station, the total Carbon Dioxide emission estimated as 20188.2 tonne. Of these buses category contributed 12513.0 tonne. Total Carbon Monoxide emission is 185.5 tonne, NOx emission is 337.9 tonne, CH_4 emission is 7.3 tonne, SO_2 emission is 54.1 tonne, Particulate Matter emission is 21.1 tonne, and Hydro Carbon emission is 61.1 tonne. Of all these category of emission, buses contributed the largest share. One important point to be note here is that the annual utilization of the buses category is high and also the number of buses plying on the roads is high as compared to all other category that contributed the highest emission of buses as compared to other category of vehicles. The in-use vehicle emission of Kochi Corporation is given in the following Table: 6.36.

Table: 6.36

Category wise In-Use Vehicles Emission in Kochi (Tonne/ Week)

Category	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Two Wheelers	1968.7	162.8	14.1	14.8	1.0	3.7	105.1
Auto Rickshaw	868.0	19.1	2.8	0.3	0.4	6.3	35.2
Pick Up Autos	559.2	1.7	2.2	0.1	0.1	0.4	0.6
Car and Jeeps	15631.4	138.4	14.0	14.0	3.5	2.1	17.5
Light Goods	1986.8	19.7	5.0	0.3	5.4	0.8	0.5
Buses	58843.5	411.2	1370.6	10.3	159.9	68.5	102.8
Truck/Lorries	6106.0	51.6	45.0	1.1	16.6	3.0	6.0
Others	51944.5	589.1	589.1	15.1	287.0	30.2	75.5
Total	137908.1	1393.6	2042.8	56	473.9	115	343.2

Source: Primary Data

In the case of Kochi Corporation station, the highest emission of carbon dioxide estimated (137908.1 tonne). Of these Cars and Jeeps category contributed, 15631.4 tonne, trucks and loriies contributed 61.06 tonne, buses have a share of 58843.5 tonne. 1393.6 tonne is the Carbon Monoxide emission in the corporation area. Of these 411.2 tonne contributed by buses category, out of the 2042.8 tonne Nitrous Oxides emission 1370.6 tonne contributed by buses. CH_4 emission is 56 tonne, SO_2 emission is 473.9 tonne, PM emission is 115 tonne, HC emission is 343.2 tonne, of these too buses category emit more pollution as compared to other category of vehicles..

Table: 6.37

Estimated vehicular emission of In-Use Vehicles (Tonne/Week)

Stations	Pollutants Concentration in Tonne/KM/Week						
	CO_2	CO	NO_X	CH_4	SO_2	PM	HC
Angamaly	48385.3	439.5	502.4	14.3	137.9	30.7	75.4
Aluva	43916.9	368.6	697.6	13.1	113.2	39.8	92.2
Kothamangalam	20188.2	185.5	337.9	7.3	54.1	21.1	61.1
Kochi	137908.1	1393.6	2042.8	56	473.9	115	343.2

From Table: 6.37 we can get a consolidated picture of the in-use vehicle emission at the four selected stations. Of these Kochi Corporation Station account 137908.1 tonne of Carbon Dioxide, 1393.6 tonne of Carbon Monoxide, 2042.8 tonne of Nitrous Oxide, 56 tonne of Methane, 115 tonne of Particulate Matter 343.2 tonne of Hydro Carbons. Of all the four station Kochi station exceed others in the case of overall emission of each category of vehicles. But it is to be remembered that once the vehicles emitted the pollutants, it diluted in the atmosphere, and while it is contaminated in the air, it badly affect to the surrounding environment depending upon the wind direction.

The drastic increase in number of vehicles has resulted in a significant increase in the emission load of various pollutants. Type of pollutants emitted by vehicles varies significantly by the category of vehicles and the type of fuel used for propulsion, say petrol driven or diesel run vehicles. the vehicular emission depends upon the type, age and condition of vehicle, congested traffic condition of pavement, acceleration, idle or deceleration of vehicle, capability of driver an traffic management systems. Some of the specific factors caused for high emission rate in Ernakulam district are as follows:

- High emission from two and three wheelers
- Adulteration of fuel
- Violation of emission norms
- Lack of vehicle maintenance
- Poor maintenance of roads
- Older engine technologies
- Inadequate traffic management
- Large number of old vehicles in use
- Increase in population of vehicles and erratic traffic behaviour
- Inadequate road space preventing better mobility of traffic

Unless we understand the basic nature of problems faced by these cities, the adverse impact of growing mobility on the environment will continue to multiply in the future. The automobile industry has to address the following issues at all the stages of vehicle manufacture:

- Environmental Imperatives
- Safety Requirements
- Competitive Pressures and
- Customer Expectations

There is a strong interlinking amongst all these forces of change, influencing the automobile industry. These have to be addressed consistently and strategically to ensure competitiveness. Since pollution is caused by various sources, it requires an integrated, multidisciplinary approach. The different sources of pollution have to be addressed simultaneously in order to stall widespread damage. Parameters Determining Emission from Vehicles are: (i) Vehicular Technology (ii) Fuel Quality (iii) Inspection & Maintenance of In-Use Vehicles (iv) Road and Traffic Management. While each one of the four factors mentioned above have direct environmental implications, the vehicle and fuel systems have to be addressed as a whole and jointly optimized in order to achieve significant reduction in emission.

6.8 CONCLUSION

Urbanization and motorization have proceeded with inadequate government and technological support for sustainable development plans. As the economy is growing rapidly, high economic growth accompanied by deteriorated air quality because of soaring emission of pollutants from ever-increasing growth of vehicles. Vehicular emission generally includes Oxides of Nitrogen, Carbon Monoxide, Carbon Dioxide, Hydrocarbon, Mercury, and Lead. These toxic and carcinogenic air pollutants from motor vehicles are of concern because they are known or suspected of causing cancer in human, and pose a threat to existence. The estimated vehicular emission indicates that the ground level concentration is increasing rapidly due to personalized vehicles and it leads the significant values of Green House Gases emission such as CO_2 and NO_X. Other pollutants such as CO, HC, PM concentrations are also showing crucial values. The prior attention is mandatory for preventive and control measures of vehicular pollution. Fuel standards as an environmental policy could be introduced to mitigate this problem. The introduction of vehicles with stricter emission control may decrease the overall emissions, but the vehicle population growth rate might neutralize that impact in overall emissions.

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CHAPTER - 7

MOTOR VEHICLES FUEL CONSUMPTION IN ERNAMKULAM DISTRICT

7.1 INTRODUCTION

The economic life of the country depends largely on the resources bestowed up on it by nature. It is upon these resources that people apply labour and capital and produce commodities that ultimately satisfy their wants. This natural resource includes land and soil resources, water resources, forests, mineral resources and energy resources. Of all these, the availability of energy is the most important single factor which affect the economic growth of a Country. Energy has universally recognized as one of the most important inputs for economic growth and human development. There is a strong two-way relationship between economic development and energy consumption. On one hand, growth of an economy, with its global competitiveness, hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development has observed to be reliant on the energy demand. Energy is the basic requirement for increasing labour productivity in agriculture, industry and services. There is a direct correlation between the degree of economic growth and the Percapita consumption of energy. Among the various types of energy resources, Oil (Petroleum) is one of the chief sources of power in modern times. As a non-renewable resource of the country, consumption of Petroleum and its related products make the sustainability yield concept an irrelevant one. The reason is the distinctive feature of non-renewable resource as they are fixed in quantity and therefore the more we extract, the less will be available for future generation. These resources will exploit as long as the user rate is positive. The present chapter provides a glimpse of the consumption of Petroleum products (Figures are taken from the suppliers of Petroleum products and hence there is no gap between supply and demand) specifically by road transport sector in Ernakulam district with in a State level background.

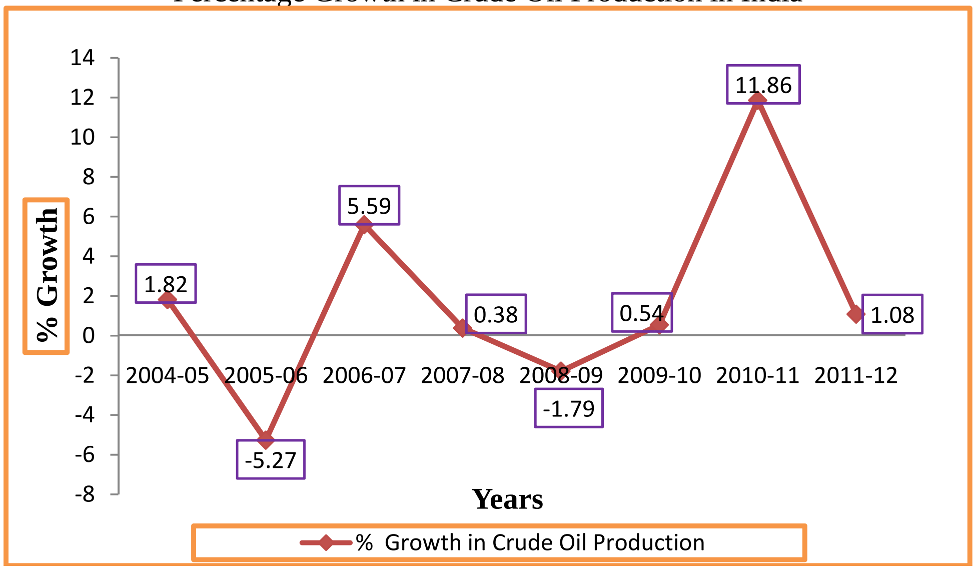
Oil is formed from the remains of marine microorganisms (microscopic animals and plants) deposited on the sea floor. As they accumulate over millions of year's they gradually infiltrate the microscopic cavities of the sea floor sediment and rock where they decay. A fossil fuel is formed when large quantities of dead organisms, usually zooplankton and Algae, are buried underneath sedimentary rock and undergo intense heat and pressure. The resulting of oil remains trapped in these spaces, forming oil reserves, which, can be extracted through large drilling platforms. To obtain many fossil fuel oils, crude oil pumped from the ground and is shipped via oil tanker to an oil refinery. Therefore, it is converted from crude oil to diesel fuel (Petro Diesel), Ethane, fuel oils (heaviest of commercial fuels, used in ships and furnaces), gasoline (Petrol), Jet fuel, Kerosene, Bitumen (tar) Benzene and Gas. A huge percent of Petroleum products consumed by motor vehicles and hence increased motor vehicles is a threat to the sustainability of these non-renewable energy resources. Depletion of resources considered as an environmental cost of transport and in this perspective, the present discussion is essential. Let us start with an overview of Petroleum consumption in India before going to the discussion at local context.

7.2 PETROLEUM CONSUMPTION IN INDIA

The Petroleum industry in India has made headway only after independence. In 1950-51 the production of Petroleum amounted to only 0.25 million tonnes. It increased to only 0.5 million tonnes in 1960-61. The reserves of Crude Oil, simply described as 'Liquid Gold', are located in Assam, Gujarat, Mumbai High, Arunachal Pradesh and Tamil Nadu areas. Mumbai High offshore accounting for about 70 percent of the Country's total oil production has emerged as the leading centre. Off shore, oil also produced at Cambay basin, Krishna-Godavari and Cauvery basin. Oil has discovered at few others off shore places. Because of these successes, production of crude oil in India recorded a marked improvement, from 0.25 million in 1950-51 to 37.5 million during 1995-96. With Progressive industrialisation of the country and growth in GDP, the consumption of Petroleum products in the country has also been steadily increasing at more than 7 percent during the 8th plan and the growth in Petroleum products in 9th Plan is around 7 percent assuming a GDP growth of 6-7 percent. However, from the last decade onwards the demand for oil and its domestic production has widened and resulted in growing reliance on imports of oil and oil products, that has created a serious disequilibrium in the balance of payments of the Country. The other segment of oil industry, that is refining, has also developed considerably during the last five decades.

India has total reserves of 760 million metric tonnes of crude oil and 1330 billion cubic metres of natural gas as on 1.4.2012. Crude oil production during 2011-12 at 38.09 million metric tonnes is .08 percent higher than 37.68 million metric tonnes produced during 2010-11. During the financial year 2011-12, crude oil production was about 38.09 million metric tonne, with share of national oil companies at 72.4 percent. Crude oil production in 2012-13 is about 41.12 MMT which is about 8 percent higher than the previous year crude oil production. The increase in crude oil production is mainly due to higher crude oil production from Barmer Fields, Rajasthan. Figure: 7.1 depicted the trend in the production of crude oil during the period 2004-05 to 2011-12. During the year 2011-12, production for crude oil is 38.09 MMT, which is about 1.08 percent higher than the actual crude oil production of 37.684 MMT during 2010-11. The percentage growth rate in crude oil production in India is very high during 2010-11, it is 11.86 percent. During 2011-12, 1.08 percent is the growth rate.

Figure: 7.1
Percentage Growth in Crude Oil Production in India



Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

The Refinery production (Crude Throughput) achievement was 211.424 MMT during 2011-12, which is 2.63 percent higher than that produced during 2010-11 (206.03 MMT). At present, the marketing of Petroleum products in India is being done by three major public sector oil companies, namely, Indian Oil Corporation Limited, Hindustan Petroleum Corporation Limited and Bharat Petroleum Corporation Ltd. The vast expanse of the country and a population of 940 million served through an elaborate and extensive network of retail distribution by these companies. There are 42138 retail outlets in India as on April 2012, of which Indian Oil Corporation has the largest number and it is the major player. IOC accounted 20575 number of retail outlets, a share of 48.8 percent. The second largest player in the field of oil marketing is Bharat Petroleum, which has 10310 retail outlets all over India. Hindustan Petroleum accounted 11253 retail outlets. Apart from these, there are some private players in the same field but they accounted only a minute percent of business in oil marketing as compared to the public sector companies.

India accounted only 1 percent of world crude oil production as on 2011. Nevertheless, oil consumption of our nation is increasing over the years. During 2004, India's oil consumption was 192.8 million tonnes, but during the year 2011, it accounted

319.7 million tonnes. There was an increase by 3.37 percent in production of total Petroleum products, including fractionise, during 2011-12 compared to the year 2010-11. The indigenous consumption of Petroleum products increased by 4.93 percent during 2011-12 at 147.995 MMT compared to the previous year (2010-11) at 141.04 MMT. Year-wise production and consumption of Petroleum products during 2004-05 to 2011-12 are depicted in Table: 7.1 and Figure: 7.2 below.

Table: 7.1

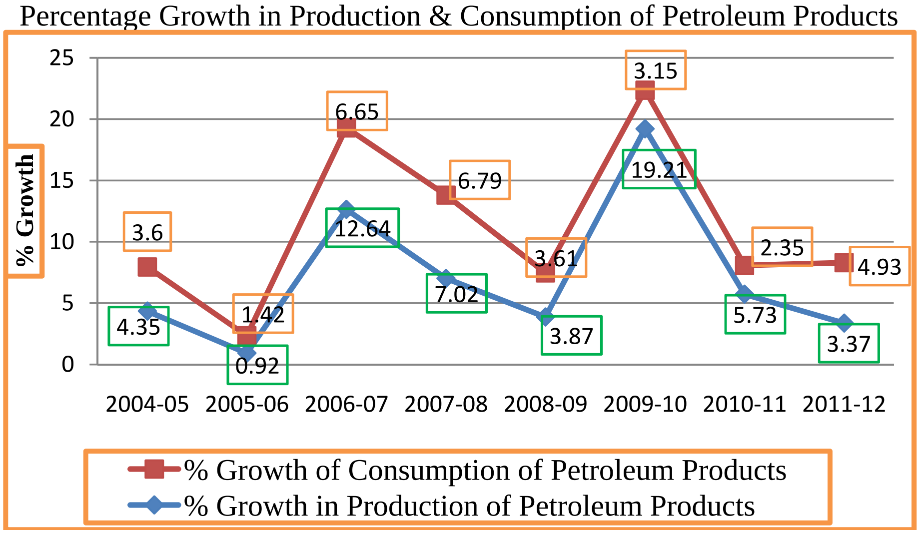
Production and Consumption of Petroleum Products in India

Year	Production of Petroleum Products (MMT)	Percentage Growth	Consumption of Petroleum Products (MMT)	Percentage Growth
2004-05	120.82	-	111.63	-
2005-06	121.94	0.92	113.21	1.42
2006-07	137.35	12.64	120.75	6.65
2007-08	146.99	7.02	128.95	6.79
2008-09	152.68	3.87	133.59	3.61
2009-10	182.01	19.21	137.81	3.15
2010-11	192.43	5.73	141.04	2.35
2011-12	198.92	3.37	147.99	4.93

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

Figure: 7.2

Percentage Growth in Production & Consumption of Petroleum Products



Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

It is evident that production and consumption (both) of Petroleum products have a marked upward trend since 2004-05. The production of Petroleum products during 2011-12 was 196.707 million metric tonnes (excluding 2.213 million metric tonnes of LPG production from natural gas), against the last year's production at 190.316 million metric tonnes (excluding 2.168 million metric tonnes of LPG production from natural gas). Consumption of Petroleum products during 2011-12 was 147.995 million metric tonnes (including sales through private imports) which is 4.93 percent higher than that of 141.040 million metric tonnes during 2010-11.

Despite the discovery of new sources of unconventional energy, Petroleum remains the primary energy source in India, and even more so, all over the world. The consumption of Petroleum in the world, which started as a few tonnes a year around 140 years ago, has reached over 3000 Million metric tonnes (MMT) per year. Following Tables: 7.2, 7.3 shows year wise and product wise consumption of Petroleum products during 2004-05 to 2011-12.

Table: 7.2

Product wise Production of Petroleum Products in India ('000'Tonnes**)**

Products	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
LPG	5570	5525	6315	6732	6996	8091	7538	8333
Naphtha	14100	14509	16660	16440	14826	17105	17531	14724
Kerosene	9238	9078	8491	7794	8223	8545	7702	5564
HSD	45903	47572	53465	58361	62889	73281	78053	61131
LDO	1546	923	803	671	606	472	578	356
Lube Oils	646	677	825	881	874	950	737	482
Furnace Oil	10560	10320	12325	12638	14749	15828	18659	13360
Bitumen	3349	3576	3891	4507	4713	4889	4478	3145
ATF	5201	6196	7805	9107	8071	9296	9570	7774

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

Table: 7.3

Consumption of Petroleum Products in India

Products	2004-05	2005-06	2007-08	2008-09	2009-10	2010-11	2011-12	CAGR (In %)
LPG	10245	10456	12165	12344	13121	14328	11338	1.28
Naphtha	13993	12194	13294	13911	10239	10691	8537	-5.99
Kerosene	9395	9541	9365	9303	9304	8929	6204	-5.06
HSD	39651	40191	47669	51710	56320	59990	47894	2.39
LDO	1476	883	667	552	457	455	325	-17.2
Lubes/Greases	1347	2081	2290	2000	2657	2508	1784	3.57
Furnace Oil	9136	8921	9469	9419	9105	8896	6862	-3.52
Bitumen	3337	3508	4506	4747	4919	4566	3106	-0.89
ATF	2811	3296	4543	4423	4627	5079	4120	4.89

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

It is evident from the data that the production and consumption of Petroleum products shows upward trend since 2004-05. From Table: 7.2, we came to know that 78053 Metric tonnes of diesel produced in India but the figure declined to 61131 thousand tonnes during 2011-12. At the same period, the consumption of Diesel was 59990 thousand tonnes and 47894 thousand tonnes respectively. The growth rate of India's Petrol consumption is set to fall below 5 percent in the current fiscal, the first time in five years. Meanwhile, the consumption of diesel continues to grow at 7 percent, adding to the losses of the oil marketing companies because of subsidies. In India, diesel subsidized, while Petrol is not, and the price difference has led to more buyers opting for vehicles driven by the cheaper fuel. The Compound Annual Growth Rate of High Speed Diesel during 2004-05 to 2011-12 is 2.39 percent and that of ATF is 4.89 percent. In the case of Lubes and Greases, CAGR is 3.57 percent and Naphtha shows -5.99 percent. According to the data provided by the Petroleum Planning and Analysis Cell, Petrol consumption in India in 2012 April-January was 12.35 million tonnes. India is expect to end up consuming 14.82 million tonnes of Petrol in the year 2013, registering growth of 4.41 percent in financial year 2012. Consumption of diesel is expect to be 63.91 million tonnes, registering growth of 6.4 percent. The Compound Annual Growth Rate of Petrol quantity from 2006-12 is 8.11 percent and that of Diesel quantity is 6.8 percent. The same shown below in Table: 7.4.

Table: 7.4

Year Wise Growth of Petrol and Diesel (000' Tonnes)

Year	Petrol Quantity	Year- On-Year Growth	Diesel Quantity	Year- on-Year Growth
2006-07	9286	7.40%	42897	6.70%
2007-08	10332	11.30%	47669	11.10%
2008-09	11258	9.10%	51710	8.50%
2009-10	12818	13.90%	56242	8.80%
2010-11	14192	10.70%	60071	6.80%
2011-12	14822	4.41%	63913	6.40%
CAGR	8.11%	-	6.87%	-

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

It is to be note that there are varieties of Petroleum products extracted from the process of crude oil refinering. Mainly it includes Liquefied Petroleum Gases (LPG), Motor Spirit (MS or Petrol), Naphtha (Mainly used for Industrial Purpose), Aviation Turbine Fuel (ATF), Superior Kerosene Oil (SKO or Kerosene), Furnace Oil (FO), Bitumen (Tar), Lubricating Oil (Lubes) etc. The estimated demand and consumption of

Petroleum products during the 12th Five-Year Plan period are given below in Tables: 7.5, 7.6. The figures are expressed in Million Metric Ton (MMT same as Million Tonnes). The total demand for LPG during 2012-13 to 2016-17 estimated as 250.59 million tonnes and that of diesel was 364.78 million tonnes. The demands for Motor Spirit during the current Five-Year Plan estimated as 240.88 Million tonnes and that of High Speed diesel were 364.78 MT.

Table: 7.5

Estimated Demand for Petroleum Products in 12th Plan (Fig.In MMT)

Products	2012-13	2013-14	2014-15	2015-16	2016-17	Total
LPG	169.86	18.36	19.68	20.86	21.83	250.59
MS	160.91	17.53	19.08	20.77	22.59	240.88
Naphtha	12.35	11.42	11.42	11.02	11.02	57.23
ATF	6.01	6.59	7.2	7.85	8.54	36.19
SKO	7.95	7.63	7.33	7.03	6.75	36.69
HSD	65.04	68.65	72.59	76.9	81.6	364.78
LDO	0.4	0.4	0.4	0.4	0.4	2.00
Lubes	2.69	2.77	2.86	2.95	3.04	14.31
FO/LSHS	7.95	7.9	7.9	7.87	7.87	39.49
Bitumen	5.25	5.54	5.73	5.97	6.11	28.6
Pet Coke	6.77	7.51	8.35	9.27	10.29	42.19
Others	5.45	6.13	6.11	6.09	6.16	29.94

Source: Report of Petroleum Planning and Analysing Cell, 2012

Table: 7.6

Estimated Production for Petroleum Products in 12th Plan (Fig.In MMT**)**

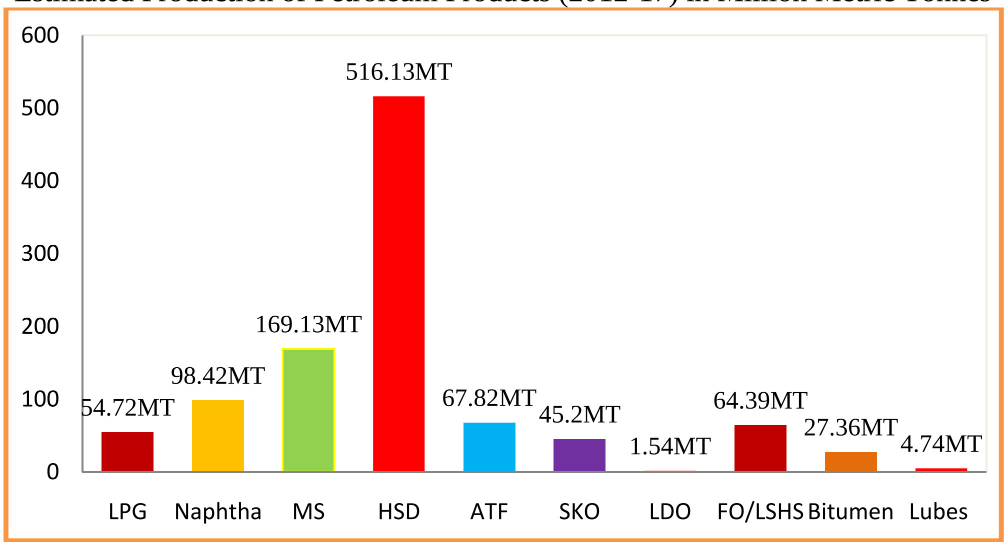
Products	2012-13	2013-14	2014-15	2015-16	2016-17	Total
LPG	9.26	10.35	10.66	11.36	13.09	54.72
Naphtha	18.15	18.77	18.7	20.09	22.71	98.42
MS	30.07	31.62	32.68	36	38.76	169.13
HSD	95.64	97.57	100.18	106.22	116.52	516.13
ATF	11.98	12.64	12.84	14.32	16.04	67.82
SKO	8.38	8.7	8.98	9.4	9.74	45.2
LDO	0.48	0.34	0.34	0.16	0.22	1.54
FO/LSHS	16.15	15.56	11.41	11.19	10.08	64.39
Bitumen	5.21	5.48	5.6	5.45	5.62	27.36
Lubes /Greases	0.79	0.87	0.88	0.9	1.3	4.74
Others	25.49	28.03	29.54	31.7	35.53	150.29

Source: Report of Petroleum Planning and Analysing Cell, 2012

Table: 7.6 depicted the estimated production of Petroleum products for the 12th Plan period, i.e., 2012-17 year. Estimated productions of motor spirit for the coming five years were 169.13 Metric tonne, where as for diesel it is estimated at 516.13 metric tonne. Aviation Turbine Fuel, Naphta and Furnace Oil were estimated 67.82, 98.42 and 64.39 Million Metric Tonnes (MMT, same as Million tonnes) of production for the 12th Plan period. During the12th Plan period the highest production of these Petroleum products estimated as on 2016-17. Superior Kerosene Oil accounted 45.2 million tonnes during 2012-17. Figure: 7.3 exhibit the estimated production of Petroleum products during the 12th plan periods. From the figure, we have known that the share HSD exceeds all other categories far above.

Figure: 7.3

Estimated Production of Petroleum Products (2012-17) in Million Metric Tonnes



Source: Report of Petroleum Planning and Analysing Cell, 2012

Table: 7.7

Oil Company Wise Consumption of Petroleum Products (Fig.In MMT)

Year	Public Sector Companies				Private	Total
	IOC	BPCL	HPCL	Others		
2003-04	50940	20297	18577	2316	15621	107751
2004-05	52612	20697	19091	2193	17041	111634
2005-06	50476	20477	18309	2440	21511	113213
2006-07	53425	22661	19698	2156	22809	120749
2007-08	57956	24866	22056	2264	21804	128946
2008-09	61363	26324	23712	2094	20106	133599
2009-10	63570	27015	24246	1946	21419	138196
2010-11	66727	28461	25578	1728	18546	141040
2011-12	70084	30228	27581	1639	18463	147995

Source: Report of Petroleum Planning and Analysing Cell, 2012

Table: 7.7 depicted oil company wise consumption of Petroleum products from 2003-04 to 2011-12. During the period, the consumption of Indian Oil Company Petroleum Products had shown a remarkable progress. In 2033-04, out of the 107751 million metric tonne consumption, IOC has a share of 50940 million tonne. That is 43.4 percent of the total consumption. This company is the leading market player in oil distribution both in private and public sector companies.

As on 2011-12, the market shares of IOC were 47.4 percent. During the year 2007, IBP (India Burma Petroleum) amalgamated with IOC thus we can see a slight improvement in IOC company market share. The share of Bharat Petroleum Corporation also showed a minute progress in its market share of Petroleum consumption. During 2003-04, it was 18.8 percent but it increased over the last nine years and now as on 2011-12 BPCL has 20.4 percent of total oil market share. During the same period, HPCL accounted an increase of 17.2 percent from 2003-04 to 18.6 percent in 2011-12. These three public players (IOC, BPC, and HPC) accounted 86.4 percent of the market share of oil distribution. The rest accounted by other private companies like Reliance, Essar, MSAPL etc. 147995 MT was the total Petroleum product consumption in India during 2011-12, of these 70084 MT by IOC, 30228 by BPC, 27581 by HPC the rest 20102 MT by Private ones marketed.

Table: 7.8
Percentage Share of
Oil Company Wise Consumption of Petroleum Products

Year	Public Sector Companies				Private
	IOC	BPCL	HPCL	Others	
2003-04	47.28	18.84	17.24	2.15	14.50
2004-05	47.13	18.54	17.10	1.96	15.27
2005-06	44.58	18.09	16.17	2.16	19.00
2006-07	44.24	18.77	16.31	1.79	18.89
2007-08	44.95	19.28	17.10	1.76	16.91
2008-09	45.93	19.70	17.75	1.57	15.05
2009-10	46.00	19.55	17.54	1.41	15.50
2010-11	47.31	20.18	18.14	1.23	13.15
2011-12	47.36	20.43	18.64	1.11	12.48

Source: Report of Petroleum Planning and Analysing Cell, 2012

Table: 7.8 shows the percentage share of oil company wise consumption of Petroleum products. During the year 2003-04, IOC has 47.28 percentage of total market share, it shows a slight improvement of 0.06 percentage after the financial year 2011-12. During the same period, BPCL share increased from18.84 percent to 20.43 percent and that fo HPCL increased to 18.64 percent from 17.24 percent. Table: 7.9 explained the product wise Petroleum energy availability in India from 2004 to 2012. As on 2004-05 financial year, the total Petroleum products accounted 94.45 million metric tonnes. Of these, High Speed Diesel accounted 39.75 MT. However, during the year 2011-12 129.84 MT was the Petroleum energy availability in India. Product wise, Percentage share of Petroleum energy in India shown below in Table: 7.10.

Table: 7.9

Petroleum Energy in India (Million Tonnes)

Products	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Kerosene	9.5	9.84	9.76	10.15	9.57	9.48	9.05	08.01
ATF	2.78	3.42	4.16	4.62	4.37	4.71	5.09	05.50
HSD	39.75	39.84	43.06	46.99	50.99	57.36	59.78	62.46
LDO	1.55	0.92	0.8	0.67	0.61	0.43	0.49	00.50
Fuel Oils	13.76	13.29	14.92	9.16	13.2	14.09	14.71	12.69
Others	27.1	26.03	28.75	19.73	32.15	38.41	42.02	40.69
Total	94.45	93.34	101.45	91.32	110.89	124.48	131.15	129.84

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

Table: 7.10

Percentage Share of Petroleum Energy in India (Million Tonnes)

Products	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Kerosene	10.06	10.54	9.62	11.11	8.63	7.62	6.90	06.17
ATF	2.94	3.66	4.10	5.06	3.94	3.78	3.88	04.24
HSD	42.09	42.68	42.44	51.46	45.98	46.08	45.58	48.11
LDO	1.64	0.99	0.79	0.73	0.55	0.35	0.37	00.39
Fuel Oils	14.57	14.24	14.71	10.03	11.90	11.32	11.22	09.77
Others	28.69	27.89	28.34	21.61	28.99	30.86	32.04	31.34

Source: Basic Statistics on Indian Petroleum & Natural Gas, 2011-12

Percentage share of Petroleum energy in India shows that, during the year 2004-05 to 2011-12, Kerosene shows a marked decline from 10.06 to 6.17 percent. HSD shows an increase of 42.09 percent to 48.11 percent. Others like LPG, Naphtha, Bitumen, FO/Greases, etc., show an increase from28.69 percent to 31.34 percent with slight variations during the same period.

7.3 CONSUMPTION OF PETROLEUM PRODUCTS IN KERALA

Let us now focus our analysis towards the case of Kerala as our study area Ernakulam district belongs to this State. In Kerala, there are three major public sector oil companies, functioning in excellent mode. Apart from IOC, BPC and HPC, Reliance and Essar have also functioned in Kerala. However, as per the latest accounts (as on 2013 March), 98.5 percent of the oil marketing vested with the major three public sector companies. These companies have a huge distribution network. In Kerala, there is only one refinery situated at Kochi, run by the Government until 2002. Afterwards it was taken over by BPCL. Six terminals located in Kerala, of these three of IOC, one of BPC and the remaining two of HPC.

The main terminals of all the three players located side by side at Irumpanam, Kochi. These terminals are the places were refined products pumped to a storage point. There are five Bulk depots in Kerala, of these IOC have two (Calicut and Trivandrum), BPC have two (Kochi, and Kannur) and one of HPCL. There are seven LPG bottling plants in our State. Total number of retail outlets in Kerala is 1766, which supplied various Petroleum products like LPG, Naphtha, Motor spirit, Kerosene, High Speed Diesel (HSD), Furnace Oil, Bitumen, Lubes, and Aviation Fuel (ATF). Out of these, IOC has 795, BPC have 425 and HPC have 546 retail outlets. SKO or Superior Kerosene Oil used for household and industry purposes, which have 195 dealerships in Kerala including Light Diesel Oil (LDO).

Table: 7.11 explicate the consumption of Petroleum Products in Kerala. As on 2003-04, the total consumption of all Petroleum products accounted as 3789962 MT in Kerala. Out of these, 1347604 MT was High Speed Diesel and 430763 MT was Petrol consumption. From 2003-04 to 2004-05, we can observe a huge decline in the consumption of Naphtha (703540 MT declined to 279334 MT). With only slight changes both in upward and downward direction, each category of Petroleum products shows growth in its consumption from the last ten year onwards (Table: 7.11).

Table: 7.11

Consumption of Petroleum Products in Kerala (in Million Metric Tonnes)

Year	LPG	Naphtha	Petrol	HSD	SKO	LDO	FO/ LSHS	Bitumen	Lubes & ATF	All Products
2003-04	412.3	703.5	430.8	1347.6	225.2	3.3	420.8	122.3	124.0	3790.0
2004-05	481.9	279.3	443.5	1420.4	228.0	1.4	358.0	135.2	154.1	3501.6
2005-06	456.1	243.4	468.7	1470.5	228.0	2.4	317.2	132.9	174.3	3493.6
2006-07	479.7	403.4	507.5	1516.9	226.9	1.5	347.9	131.4	207.7	3823.0
2007-08	517.5	397.9	556.0	1578.1	224.1	0.6	297.7	111.7	244.1	3927.6
2008-09	525.3	609.3	619.1	1747.9	219.8	2.0	380.1	143.3	266.5	4513.1
2009-10	574.7	646.7	705.8	1850.5	226.1	1.4	408.0	148.5	315.7	4877.4
2010-11	640.0	487.8	757.7	2015.8	184.4	0.5	347.5	178.7	340.4	4952.8
2011-12	659.6	272.7	800.4	2202.9	155.7	0.1	322.8	222.5	344.5	4981.1
2012-13	673.4	403.3	846.0	2427.1	99.0	0.1	338.7	170.9	355.5	5314.0

Source: Reports of Oil Industry in Kerala, Prepared by IOC

Table: 7.12

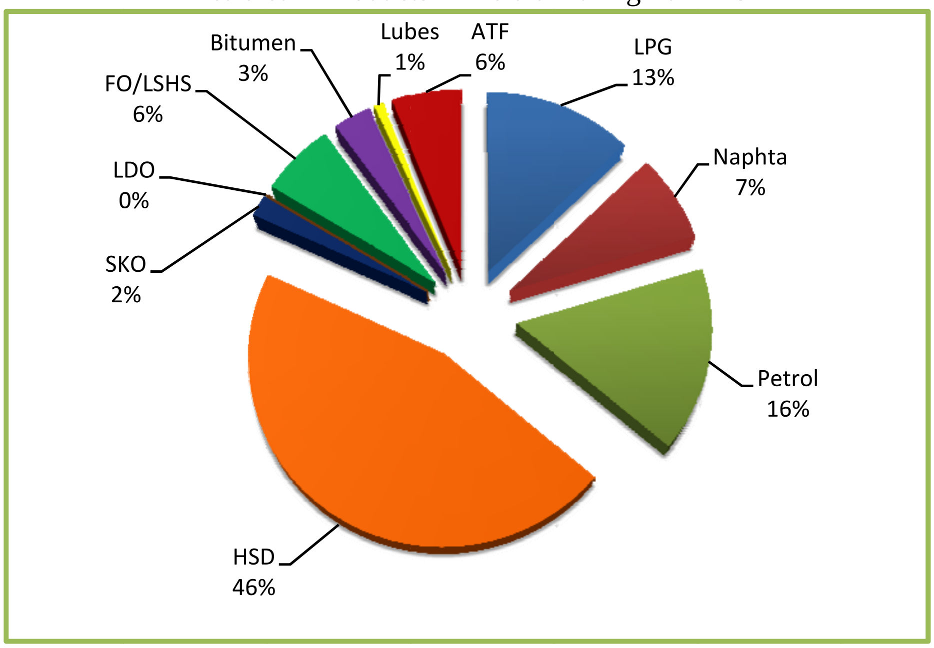
Percentage Share of Consumption of Petroleum Products in Kerala

Year	LPG	Naphtha	Petrol	HSD	SKO	LDO	FO/LSHS	Bitumen	Lubes & ATF
2003-04	10.88	18.56	11.37	35.56	5.94	0.09	11.10	3.23	3.27
2004-05	13.76	7.98	12.67	40.56	6.51	0.04	10.22	3.86	4.40
2005-06	13.06	6.97	13.42	42.09	6.53	0.07	9.08	3.80	4.99
2006-07	12.55	10.55	13.27	39.68	5.94	0.04	9.10	3.44	5.43
2007-08	13.18	10.13	14.16	40.18	5.71	0.02	7.58	2.84	6.21
2008-09	11.64	13.50	13.72	38.73	4.87	0.04	8.42	3.18	5.91
2009-10	11.78	13.26	14.47	37.94	4.64	0.03	8.37	3.04	6.47
2010-11	12.92	9.85	15.30	40.70	3.72	0.01	7.02	3.61	6.87
2011-12	13.24	5.47	16.07	44.23	3.13	0.00	6.48	4.47	6.92
2012-13	12.67	7.59	15.92	45.67	1.86	0.00	6.37	3.22	6.69

Source: Reports of Oil Industry in Kerala, Prepared by IOC

Figure: 7.4

Percentage Share of Consumption of Various Petroleum Products in Kerala During 2012-13



Source: Reports of Oil Industry in Kerala, Prepared by IOC

Table: 7.12 show the percentage share of consumption of Petroleum products in Kerala. High Speed Diesel is the most consumable Petroleum products in all years, it shows 45.67 percent during the year 2012-13. Figure: 7.4 shows the percentage share of consumption of various Petroleum products in Kerala during 2012-13. Consumption of

Naphtha is in least amount, only 7.59 percent. Petrol has only 15.92 percent during 2012-13. During the period 2012-13, the total consumption of Petroleum product was 5313959 MT, of these 673447MT of LPG, 403275MT Naphtha. 2427068 MT is the consumption of HSD during 2012-13 and that of Petrol was 846007 MT. High Speed Diesel accounted 46 percent of total Petroleum Products consumption, 16 percent are for Petrol consumption and 13 percent accounted for LPG consumption. Naphtha accounted only 7 percentages out of total.

Now we explain the district wise distribution of motor Spirit in Kerala for the last one-decade (2003-04 to 2012-13). This can be taken by adding the consumption of motor spirit distributed by the three companies. From the Table: 7.13, the last ten years data shown, which revealed the fact that, among the fourteen districts, the highest percent of motor spirit consumed by Ernakulam district.

Table: 7.13

District Wise Consumption of Petrol in Kerala (Fig. In KL)

Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	29687	35929	45791	60265	68193	72337	13.6
Trivandrum	61202	76419	102791	127988	147592	154728	14.2
Kollam	36398	46403	62678	80625	91880	94794	14.7
Pathanamthitta	25184	26586	33897	43001	47742	48994	9.9
Idukki	7887	9847	12233	17867	22085	25257	18.1
Kottayam	31575	37430	50944	66879	73516	77283	13.6
Ernakulam	79701	93127	120760	149029	160163	166585	11.1
Thrissur	47918	57498	77116	98674	108485	113114	13.1
Palakkad	27971	37452	49772	64061	72758	76950	15.6
Kozhikode	35268	42728	59823	79811	91489	99143	15.9
Malappuram	27487	38256	60987	87210	100278	110567	21.9
Wayanad	3610	5557	7776	12908	16020	18249	26.1
Kannur	18560	24675	36639	48702	56940	61387	18.7
Kasargode	13341	16008	22187	29284	33840	36786	15.6
Mahe	4526	6465	12964	18274	17625	17373	21.2
Kerala Total	450315	554380	756358	984578	1108606	1173547	14.7

Source: Annual Reports of IOC, BPC and HPC (1 KL= 1000 Litre)

During 2003-04, out of the 450315KL consumption of Petrol, 79701KL consumed by Ernakulam district, followed by Trivandrum (61202 KL) and then Thrissur (47918 KL). The same trend followed in the current year too. The total consumption is 1173547 KL during 2012-13, of these 166585KL consumed by Ernakulam district followed by Trivandrum 154728 KL. Ernakulam district Petrol consumption was 14 percent State's consumption. This is mainly due to the large demand for travel, luxury life style of metro city and the overall development of the city particularly sound industrial and business environments that compel the people to own and use vehicles. The least consumption of Petrol is in Wayanad district. Compound Annual Growth Rate of Petrol consumption in Kerala State during the year 2003-04 to 2012-13 is 14.66 percent. Among the various districts of the State, the highest growth rate recorded at Wayanad District (26.05 percent). The figures of Kerala include the consumption of Mahe area too as it included in the Kerala region as per the distribution network.

We know that, in Kerala these are mainly three oil companies, which fulfil the oil needs of the people at an affordable rate. Let us now explain the district wise consumption of Petrol distributed IOC in Kerala. Following Table: 7.14 explain the consumption of Petrol distributed by IOC in Kerala.

Table: 7.14
District Wise Consumption of Petrol
Distributed by Indian Oil Corporation in Kerala (Fig. In KL)

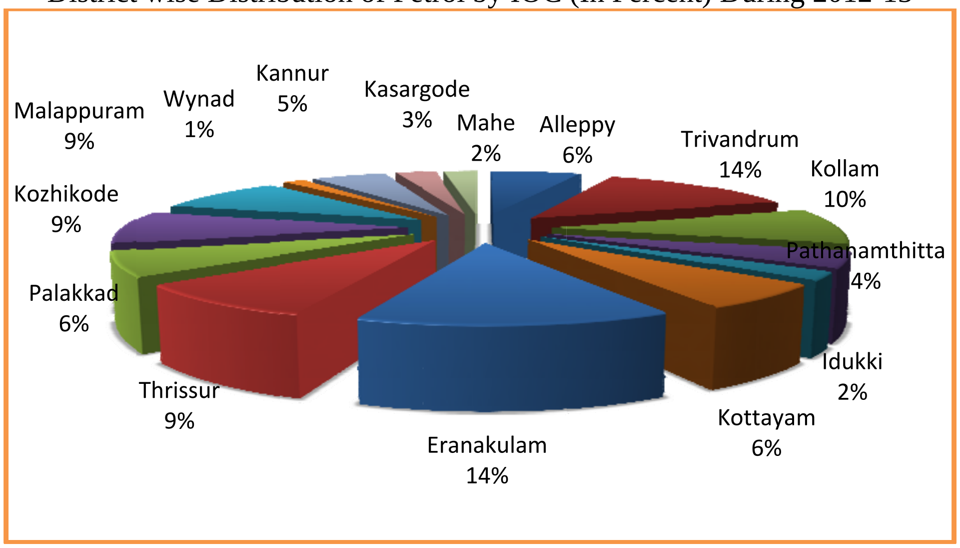
Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	13958	16170	23028	30766	33003	36023	14.5
Trivandrum	27388	34468	53428	64721	75379	78653	16.3
Kollam	14940	22244	37144	48982	53595	54764	20.1
Pathanamthitta	13660	12596	17424	22955	24632	24625	8.8
Idukki	4052	4508	6420	8469	10840	12160	17.0
Kottayam	11928	13528	23688	31338	33024	35648	17.3
Ernakulam	29003	33267	53375	68898	74525	77705	15.1
Thrissur	12901	17889	33514	46154	50125	51509	21.9
Palakkad	14180	18016	24866	31622	33887	36396	14.4
Kozhikode	13676	14932	26674	38836	47292	51002	20.7
Malappuram	11306	13786	29514	41323	45822	51088	24.1
Wayanad	2412	2788	3660	5756	7235	7990	18.7
Kannur	5952	8016	16440	23624	27987	29297	25.6
Kasargode	4804	5100	9272	12743	14667	15470	18.2
Mahe	2432	3332	9060	13737	12861	13019	27.1
Kerala Total	182592	220640	367507	489924	544874	575349	17.8

Source: Annual Reports, IOC

It shows that, Motor Spirit (Petrol) consumption distributed by IOC in Kerala is very high, has shown a marked performance from 2003-04 to 2012-13. During the period 2003-04, the total Kerala consumption was 182592 KL, of these Ernakulam district accounted 29003KL of Petrol consumption followed by Trivandrum district 27388 KL. The share of Ernakulam district to State's total consumption of Petrol was 15.88 percent. During 2012-13, it becomes 13.5 percent. That is 77705 KL out of the 575349 KL Petrol. District wise consumption of Petrol distributed by IOC in Kerala shows 17.82 percent of Compound Annual Growth Rate, of these the highest growth rate recorded in Kannur district (25.57 percent) and the least in Pathanamthitta district (8.78 percent only). Figure: 7.5 depicts the share of each district in the consumption of Petrol distributed by IOC in the State during 2012-13 financial year. From the figure, we can see that Ernakulam district accounted 14 percent of market share of Petrol distributed by IOC during 2012-13. Trivandrum district accounted 14 percent followed by Kollam (10 percent).

Figure: 7.5

District wise Distribution of Petrol by IOC (In Percent) During 2012-13



Source: Annual Reports, IOC

The district wise distribution of Petrol by BPCL given below in the following Table: 7.15. The share of BPCL Petrol consumption when comparing to IOC is low. During the year 2003-04, Bharat Petroleum Corporation distributed 131016 KL Petrol in the State Kerala. Of these, 25154 KL, that is 19.2 percent of the Petrol consumed by Ernakulam district. The least is by Wayanad, only 121 KL. The consumption of BPCL Petrol steadily increasing over the last ten years , and now that is 2012-13, it is almost doubled than what has been in 2003-04.During 2012-13, the total consumption of BPCL Petrol was 276345 KL, of these 48176 KL used by the Ernakulam district. The Petrol consumption of Wayanad is also increasing, now it is 4689 KL. Compound Annual

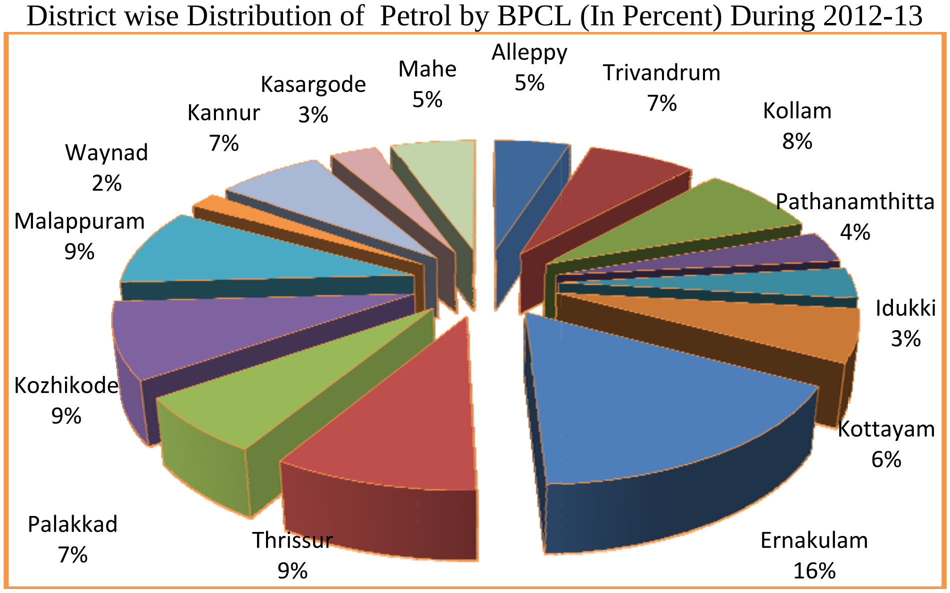
Growth Rate of district wise consumption of Petrol distributed by Bharat Petroleum Corporation in Kerala during the last ten years shows 11.25 percent. Among the various district cases Wayanad district recorded 68.62 percent Compound Annual Growth Rate.

Table: 7.15
District Wise Consumption of Petrol
Distributed by Bharat Petroleum Corporation in Kerala (Fig. In KL)

Districts	2003 -04	2005 -06	2007 -08	2009 -10	2011 -12	2012 -13	CAGR
Alleppy	7852	9394	10936	12355	15882	15901	10.6
Trivandrum	20473	25417	30360	37357	42171	44211	11.6
Kollam	8253	9123	9992	10792	12852	14311	8.2
Pathanamthitta	6208	7478	8749	10448	11059	11257	8.9
Idukki	1305	2043	2781	3659	4118	4532	19.5
Kottayam	10258	12238	14217	18012	18185	18582	8.9
Ernakulam	25154	30594	36035	43586	46710	48176	9.7
Thrissur	18933	20731	22529	25610	26539	28316	5.9
Palakkad	6844	8632	10420	12452	14095	15122	12.0
Kozhikode	8276	10376	12477	15998	17592	20178	13.6
Malappuram	3137	7299	11462	15902	19647	21449	31.6
Wynad	121	1105	2332	3828	4664	4689	68.6
Kannur	8835	11195	13555	16052	17020	18404	11.1
Kasargode	4898	6152	7407	9309	9476	10258	11.3
Mahe	469	779	1088	1532	1084	959	10.8
Kerala Total	131016	162556	194340	236892	261094	276345	11.3

Source: Annual Reports, BPCL

Figure: 7.6
District wise Distribution of Petrol by BPCL (In Percent) During 2012-13



Source: Annual Reports, BPCL

Figure: 7.6 depicted Petrol consumption of Kerala as district wise, distributed by BPCL during 2012-13 financial years. The Ernakulam district accounted 14 percent of the total consumption of Petrol, followed by Thrissur, Kozhikode and Malappuram district accounted 9 percent of the total consumption distributed by BPCL. Trivandrum district accounted only 7 percent. Wayanad, Kasargode and Idukki are consumed an average of 2.5 percent. The same shows by the above diagram.

Table: 7.16

District Wise Consumption of Petrol Distributed by HPCL in Kerala (Fig. In KL)

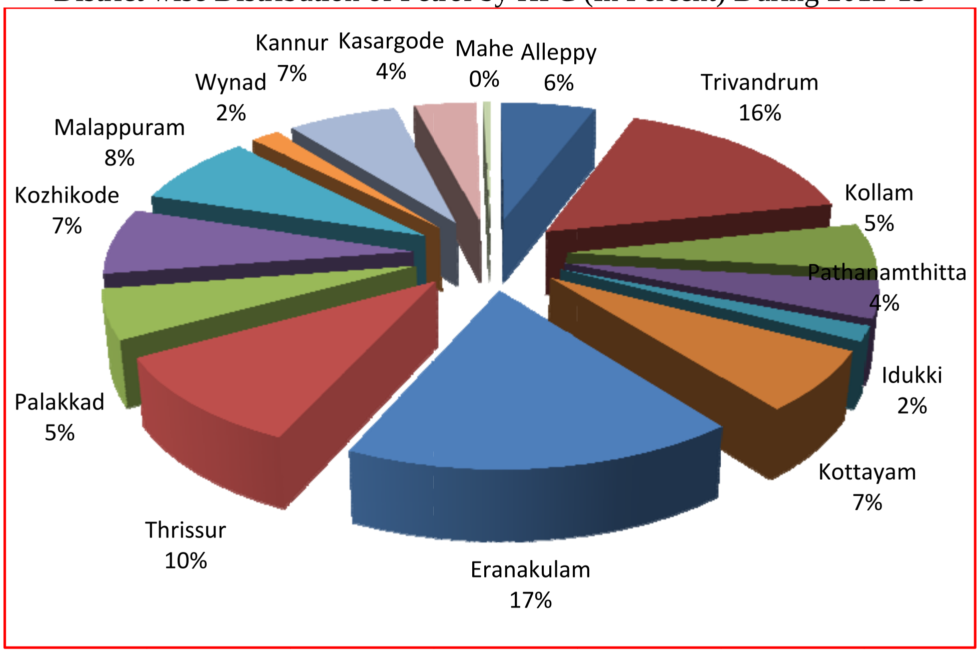
Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	7877	10365	11827	17144	19308	20413	14.6
Trivandrum	13341	16534	19003	25910	30042	31864	13.2
Kollam	13205	15036	15542	20851	25433	25719	9.9
Pathanamthitta	5316	6512	7724	9598	12051	13112	13.8
Idukki	2530	3296	3032	5739	7127	8565	19.0
Kottayam	9389	11664	13039	17529	22307	23053	13.7
Ernakulam	25544	29266	31350	36545	38928	40704	6.9
Thrissur	16084	18878	21073	26910	31821	33289	10.9
Palakkad	6947	10804	14486	19987	24776	25432	20.4
Kozhikode	13316	17420	20672	24977	26605	27963	11.2
Malappuram	13044	17171	20011	29985	34809	38030	16.5
Wayanad	1077	1664	1784	3324	4121	5570	26.5
Kannur	3773	5464	6644	9026	11933	13686	20.2
Kasargode	3639	4756	5508	7232	9697	11058	17.2
Mahe	1625	2354	2816	3005	3680	3395	11.1
Kerala Total	136707	171184	194511	257762	302638	321853	13.0

Source: Annual Reports, HPCL

Table: 7.16 explains the district wise distribution of Petrol byHindustan Petroleum Corporation. During the year 2003-04, the HPCL distributed 136707 KL Petrol in the State, of these, 25544 KL consumed by Ernakulam district. This case too, the least consumption is by Wayanad district (1077 KL IN 2003-04). During the Year 2003-13, we can see that the second largest distributor of Petrol is HPCL. We can also see a steady growth of total distribution of Petrol in the State from the last 10 years onwards. Compound Annual Growth Rate of district wise consumption of Petrol distributed by HPCL during the last ten years that is from 2003-04 to 2012-13 is 13.01 percent. The highest is at Wayanad district (26.45 percent) and the least is at Ernakulam district (6.7 percent). During the year 2012-13 the annual utilization of Petrol distributed by HPCL was 321853 KL, of these Ernakulam district consumed 40704KL. Least is by

Mahe, 3395 KL only. Figure: 7.7 below shows the percentage share of Petrol consumption distributed by HPCL during 2012-13. Out of the total HPCL distribution of Petrol in Kerala during 2012-13, 17 percent consumed by Ernakulam district, followed by Trivandrum, and consumed 16 percentages. Thrissur accounted 10 percentages only and that of Malappuram and Kozhikode are 8 and 7 percent respectively.

Figure: 7.7
District wise Distribution of Petrol by HPC (In Percent) During 2012-13



Source: Annual Reports, HPCL

Table: 7.17 shows district wise consumption of High Speed Diesel in Kerala. During the year 2003-04, the consumption of HSD of total Kerala was 1004075 KL. The highest consumer of HSD in the overall fourteen district were Ernakulam (177259 KL) followed by Thrissur (116321 KL). 17.65 percent of the total diesel consumption in the district vested with Ernakulam district. During the period 2012-13, the consumption of Kerala increased to 2553595 KL, of these 434601 KL consumed by Ernakulam district.

Compound Annual Growth rate of Diesel consumption in Kerala during 2003-04 to 2012-13 is 14.26 percent. Among the different district of our State, the highest growth rate recorded at Malappuram District (20.76 percent). Figure: 7.8 show the same in 2012-13. From the figure, it is clear that Ernakulam district consume 17.01 percent of the total Kerala diesel consumption during 2012-13. The second highest consumer is Thrissur (10.06 percent) and Malappuram district (10 percent). During 2012-13, 257006 KL is the final consumption of Thrissur district, 255487KL Malappuram district. The following table and figure shows the same.

Table: 7.17

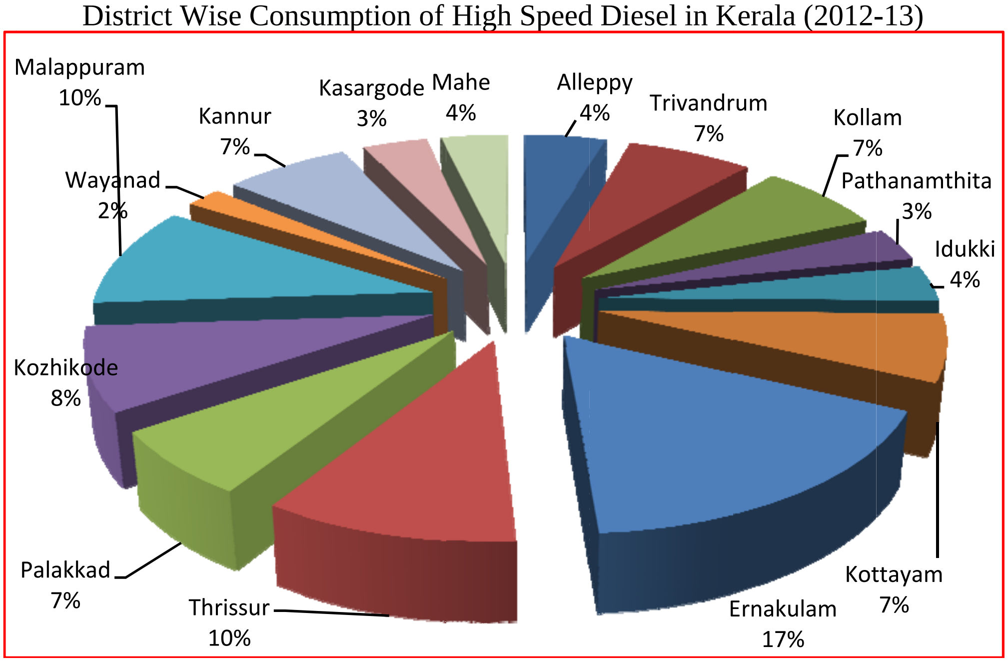
District Wise Consumption of High Speed Diesel in Kerala (Fig. In KL)

Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	51582	56465	68891	84217	104286	114789	12.1
Trivandrum	63540	79542	105015	121839	150854	176463	15.7
Kollam	80971	92675	107403	122666	152984	176770	11.8
Pathanamthita	40104	44260	52226	61629	74929	84328	11.2
Idukki	33726	41345	47565	62392	80059	92266	15.4
Kottayam	76347	86782	111236	126549	157810	171548	12.3
Ernakulam	177259	215747	271530	323725	384450	434601	13.7
Thrissur	116321	132259	169761	187401	226184	257006	11.9
Palakkad	62153	77389	102829	120711	148750	167205	15.2
Kozhikode	85078	102793	135259	157288	191349	213558	14.1
Malappuram	68232	94875	141029	175737	221909	255487	20.8
Wayanad	19008	23483	27828	35292	44492	50867	15.1
Kannur	70916	82377	109652	127742	157676	176163	13.9
Kasargode	31637	39801	52990	65445	82174	89941	16.2
Mahe	27201	43035	88028	97594	104371	92603	19.1
Kerala Total	1004075	1212828	1591242	1870227	2282277	2553595	14.3

Source: Annual Reports, IOC, BPCL and HPCL

Figure: 7.8

District Wise Consumption of High Speed Diesel in Kerala (2012-13)



Tables: 7.18; 7.19 and 7.20 depict the district wise consumption of High-Speed diesel distributed by IOC, BPC and HPC in Kerala. This categorisation is done to identify the figure share of each player in the market.

Table: 7.18
District Wise Consumption of High Speed Diesel
Distributed by Indian Oil Corporation in Kerala (Fig. In KL)

Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	25990	27386	38423	45642	53728	60995	12.9
Trivandrum	36517	37639	55040	60599	73865	86701	13.2
Kollam	44400	46888	64380	73817	86313	98272	12.0
Pathanamthita	25020	23860	29416	33489	40264	44887	8.7
Idukki	17360	17944	23108	29211	39976	44638	14.4
Kottayam	33472	34632	52128	58695	69152	75855	12.4
Ernakulam	81990	88382	131593	158682	183151	207854	14.2
Thrissur	38931	42631	76049	89752	105049	116453	16.9
Palakkad	35522	41078	54797	62585	71579	82750	12.8
Kozhikode	44278	47404	72782	83812	102676	110922	14.0
Malappuram	25034	30290	63979	78155	96930	111756	23.9
Wayanad	11572	11372	12984	14824	19565	22338	9.9
Kannur	25142	27842	50448	63500	78521	84727	18.9
Kasargode	12920	14120	23472	27857	34561	37226	16.3
Mahe	7444	22320	63840	74275	76079	68269	37.2
Kerala Total	465592	513788	812439	954895	1131409	1253643	15.2

Source: Annaual Reports, IOCL

Table: 7.19
District Wise Consumption of High Speed Diesel
Distributed by Bharat Petroleum Corporation in Kerala (Fig. In KL)

Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	14420	14420	14420	16816	23824	25306	8.4
Trivandrum	16373	23819	31264	39022	48225	56566	19.4
Kollam	17809	18583	19356	19824	24376	30913	8.2
Pathanamthitta	8338	10720	13102	15840	16945	18903	12.4
Idukki	5554	7922	10291	12911	14762	17295	17.6
Kottayam	24025	26957	29889	33629	39853	44466	9.2
Ernakulam	51035	62549	74062	86576	106490	121540	13.2
Thrissur	48967	50829	52692	53837	61311	70124	5.3
Palakkad	14379	18611	22844	24864	32577	37370	14.6
Kozhikode	14369	19137	23905	29073	36576	44491	17.5
Malappuram	9822	17872	25921	34004	46155	55659	28.1
Wayanad	3325	6299	9272	13236	15616	16207	25.4
Kannur	35443	39215	42988	45526	50584	55883	6.7
Kasargode	10801	14753	18706	22798	26492	28130	14.7
Mahe	7575	9441	11308	13156	12516	11161	5.7
Kerala Total	282235	341127	400020	461112	556302	634014	12.26

Source: Annual Reports, BPCL

Table: 7.20
District Wise Consumption of High Speed Diesel
Distributed by Hindustan Petroleum Corporation in Kerala (Fig. In KL)

Districts	2003-04	2005-06	2007-08	2009-10	2011-12	2012-13	CAGR
Alleppy	11172	14659	16048	21759	26734	28488	14.3
Trivandrum	10650	18084	18711	22218	28764	33196	17.6
Kollam	18762	27204	23667	29025	42295	47585	14.2
Pathanamthitta	6746	9680	9708	12300	17720	20538	17.2
Idukki	10812	15479	14166	20270	25321	30333	15.9
Kottayam	18850	25193	29219	34225	48805	51227	15.3
Ernakulam	44234	64816	65875	78467	94809	105207	13.2
Thrissur	28423	38799	41020	43812	59824	70429	13.8
Palakkad	12252	17700	25188	33262	44594	47085	21.2
Kozhikode	26431	36252	38572	44403	52097	58145	11.9
Malappuram	33376	46713	51129	63578	78824	88072	14.9
Wayanad	4111	5812	5572	7232	9311	12322	16.9
Kannur	10331	15320	16216	18716	28571	35553	19.3
Kasargode	7916	10928	10812	14790	21121	24585	17.6
Mahe	12182	11274	12880	10163	15776	13173	1.12
Kerala Total	256248	357913	378783	454220	594566	665938	14.6

Source: Annual Reports, HPCL

During the year 2003-04, Kerala consumed 465592 KL diesel distributed by Indian Oil Corporation. Of these 81990 KL supplied at Ernakulam district. That is 17.60 percent of the total state consumption supplied by IOC distributed in Ernakulam district. During the year 2012-13, 1253643 KL Diesel supplied by Indian Oil Corporation in Kerala, of these 207854 are in Ernakulam district, 116453 KL consumed in Thrissur district. The least is in Wayanad District, 22338 KL only.

The consumption of BPCL diesel has also shows a notable progress as the BPCL, in 2003-04 supplied only 282235 KL HSD in Kerala shown in Table: 7.20. Of these the largest consumer in district wise is Ernakulam district, consumed 51035 KL, which is 18.08 percent of the State's Total. This district still continued its superiority in the consumption of HSD distributed by BPCL. Currently BPCL's HSD supply (2012-13) is 634014 KL out of these, 121540 Consumed by the same district. Mahe have least consumption in the Kerala region regarding BPCL's HSD consumption.

The case of Hindustan Petroleum consumption in Kerala is not far differs. 665938 KL diesel consumed by the State during the year 2012-13. Of these, 105207 KL is supplied in Ernakulam district.70429 consumed in Thrissur district. Compound Annual Growth Rate of district wise consumption of HSD supplied by IOCL in Kerala is

15.19 percent, by BPCL is 12.26 percent and that of HPCL is 14.62 percent during the year 2003-04 to 2012-13.

Table: 7.21

Oil Company Wise Consumption of

Motor Spirit Distributed in Kerala State (Fig. In KL)

Years	IOC Petrol	BPC Petrol	HPC Petrol	Total Petrol
2003-04	182592	131016	136707	450315
2004-05	201616	146665	153945	502226
2005-06	220640	162556	171184	554380
2006-07	239664	178449	173797	591910
2007-08	367507	194340	194511	756358
2008-09	430637	213831	222900	867368
2009-10	489924	236892	257762	984578
2010-11	516563	242015	284441	1043019
2011-12	544874	261094	302638	1108606
2012-13	575349	276345	321853	1173547
CAGR	12.16	7.75	8.94	10.05

Source: Annual Reports of IOC, BPC and HPCL

Table: 7.22

Oil Company Wise Consumption of High Speed

Diesel Distributed in Kerala State (Fig. In KL)

Years	IOC Diesel	BPC Diesel	HPC Diesel	Total Diesel
2003-04	465592	282235	256248	1004075
2004-05	489690	311681	290139	1091510
2005-06	513788	341127	357913	1212828
2006-07	537886	370574	363824	1272284
2007-08	812439	400020	378783	1591242
2008-09	925877	444992	432045	1802914
2009-10	954895	461112	454220	1870227
2010-11	1021329	492682	518024	2032035
2011-12	1131409	556302	594566	2282277
2012-13	1253643	634014	665938	2553595
CAGR	10.41	8.43	10.03	9.78

Source: Annual Reports of IOC, BPC and HPCL

Oil company wise and year wise Petrol and diesel consumption in Kerala are depicted in Table: 7.21, 7.22. From these tables, it is clear that, IOC is the major player both in the supply of Petrol and diesel in the State. Over the years, we can see an obvious performance of both the three companies in the distribution of their products. Second largest company is HPCL and third is BPCL. During the year 2012-13, out of the 1173547 KL Petrol, 575349 KL supplied by IOC (49.02 percent), 276345 KL supplied by BPC (23.55 percent) and 321853 KL supplied by HPCL (27.43 percent). Of the 2553595 KL diesel supplied in the State, IOC supplied 1253643 KL (49.09 percent) diesel, 634014 KL by BPCL (24.82 percent of the State total) and 665938 KL by HPCL(26.07 percent of the State total). Compound Annual Growth Rate of total Petrol consumption in Kerala is 10.05 percent (here we taken into account ten year data, from 2003 to 2013) and that of High Speed Diesel is 9.78 percent.

Table: 7.23 explains oil company wise market share of motor spirit and diesel distributed in Kerala. From 2003-04, IOC percent market share of Petrol was 40.55, of HPCL was 30.36 percent and that of BPCL was 29.09 percent. During the same period diesel share of IOC, BPC, and HPC were 46.64, 27.69 and 25.67 percent respectively. Over the last ten years, the share of IOC on the market of both diesel and Petrol increases but the share of other two's decreases. At the financial year 2012-13, the share IOC has 49.03 percent for petro and 49.09 percent for diesel.

Table: 7.23
Oil Company Wise Market Share of Motor Spirit
and Diesel Distributed in Kerala State (Fig. in Percent)

Years	IOC - % Mkt. Share of Petrol	BPC - % Mkt. Share of Petrol	HPC - % Mkt. Share of Petrol	IOC - % Mkt. Share of Diesel	BPC - % Mkt. Share of Diesel	HPC - % Mkt. Share of Diesel
2003-04	40.55	29.09	30.36	46.64	27.69	25.67
2004-05	40.14	29.20	30.65	45.04	28.27	26.69
2005-06	39.80	29.32	30.88	42.46	27.96	29.58
2006-07	40.49	30.15	29.36	42.33	29.05	28.63
2007-08	48.59	25.69	25.72	51.06	25.14	23.80
2008-09	49.65	24.65	25.70	51.35	24.68	23.96
2009-10	49.76	24.06	26.18	51.06	24.66	24.29
2010-11	49.53	23.20	27.27	50.26	24.25	25.49
2011-12	49.15	23.55	27.30	49.57	24.37	26.05
2012-13	49.03	23.55	27.43	49.09	24.83	26.08
CAGR	1.92	-2.09	-1.00	0.51	-1.08	0.16

Source: Annual Reports of IOC, BPC and HPCL

7.4 PETROL AND DIESEL CONSUMPTION IN ERNAKULAM DISTRICT

In Kerala, Ernakulam district ranked highest in the consumption of Petrol and diesel from the last ten year onwards. (Last ten-years data only taken for the study). This is mainly because Ernakulam district is the highest vehicular mobility district in the State. However, it is to be note that, Out of State and Out of District vehicles also passes through this district, so we can't make a water tight compartmentalisation in this respect. That is, any vehicle can fuelled at anywhere. For example, many north Indian registered goods vehicles pass through Ernakulam district especially Maharashtra and Tamilnadu, and Karnataka registred vehicles. The case of Ernakulam district, in respect of consumption of MS and HSD also supported by 24 hours Petrol pumps in the district.

Table: 7.24
Oil Company Wise Consumption of Petrol
and Diesel Distributed in Ernakulam District (Fig. In KL)

Years	IOC Petrol	BPC Petrol	HPC Petrol	Total Petrol	IOC Diesel	BPC Diesel	HPC Diesel	Total Diesel
2003-04	29003	25154	25544	79701	81990	51035	44234	177259
2004-05	31135	27874	27405	86414	85186	56792	51095	193073
2005-06	33267	30594	29266	93127	88382	62549	64816	215747
2006-07	35399	33315	28918	97632	91578	68305	64205	224088
2007-08	53375	36035	31350	120760	131593	74062	65875	271530
2008-09	63724	38203	34849	136776	159202	83447	76694	319343
2009-10	68898	43586	36545	149029	158682	86576	78467	323725
2010-11	71142	44196	38903	154241	165657	91332	85326	342315
2011-12	74525	46710	38928	160163	183151	106490	94809	384450
2012-13	77705	48176	40704	166585	207854	121540	105207	434601
CAGR	10.36	6.71	4.78	7.67	9.74	9.06	9.05	9.37

Source: Annual Reports of IOC, BPC and HPCL

Table: 7.24 focused on the consumption pattern of Petrol and diesel in Ernakulam district only. During the period 2003-04, total Petrol consumption in the district was 79701 KL, out of these, 29003 KL were marketed by IOC, 25154 KL distributed by BPC, and 25544 KL supplied by HPC. During the same period, the diesel consumption of the district was 177259 KL. 81990 KL by IOC, 51035 KL by BPC and 44234 KL by HPC marketed. Petrol and diesel consumption of the district increases more than doubled with in the last ten years. As per the latest report, the district consumed 166585 KL Petrol and 434601KL diesel. Compound Annual Growth Rate of Petrol consumption in Ernakulam district is 7.66 percent and that of Diesel consumption is 9.37 percent.

Table: 7.25 convey a picture about the oil company wise market share of Motor Spirit and High Speed Diesel in the district Ernakulam. During the year 2003-04, the market share of Petrol for Indian Oil Corporation was36.39 percent, of BPC was 31.56

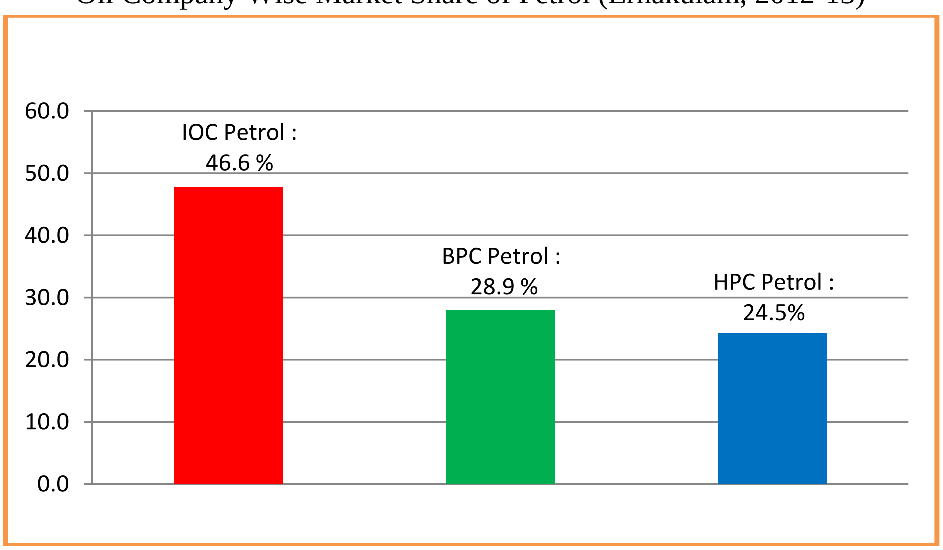
percent and of HPC was 32.05 percent. At the same period the market share of Diesel of IOC, BPC and HPC were, 46.25, 28.79 and 24.95 percent respectively.

Table: 7.25
Oil Company Wise Market Share of MS and HSD
Distributed in Ernakulam District (Fig. in Percent)

Years	IOC - % Mkt. Share of Petrol	BPC - % Mkt. Share of Petrol	HPC - % Mkt. Share of Petrol	IOC - % Mkt. Share of Diesel	BPC - % Mkt. Share of Diesel	HPC - % Mkt. Share of Diesel
2003-04	36.39	31.56	32.05	46.25	28.79	24.95
2004-05	36.03	32.26	31.71	44.12	29.41	26.46
2005-06	35.72	32.85	31.43	40.97	28.99	30.04
2006-07	36.26	34.12	29.62	40.87	30.48	28.65
2007-08	44.20	29.84	25.96	48.46	27.28	24.26
2008-09	46.59	27.93	25.48	49.85	26.13	24.02
2009-10	46.23	29.25	24.52	49.02	26.74	24.24
2010-11	46.12	28.65	25.22	48.39	26.68	24.93
2011-12	46.53	29.16	24.31	47.64	27.70	24.66
2012-13	46.65	28.92	24.43	47.83	27.97	24.21
CAGR	2.54	-0.87	-2.68	0.34	-0.28	-0.29

Source: Annual Reports of IOC, BPC and HPCL

Figure: 7.9
Oil Company Wise Market Share of Petrol (Ernakulam, 2012-13)

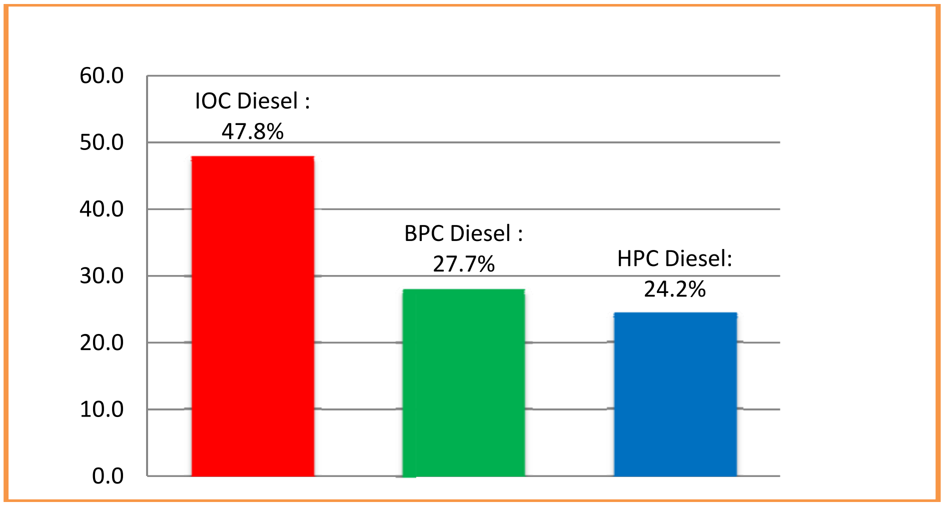


Source: Annual Reports of IOC, BPC and HPCL

The market share of each of the three players increases over the years and that of 2012-13 are depicted in the Figures: 7.9, 7.10 respectively. The market share of IOCL shows a growth rate of 2.54 percent of Compound Rate of Petrol and that of Diesel with a growth rate of 0.34 percent. All other companies share shows a declining growth rate during the last ten years.

Figure: 7.10

Oil Company Wise Market Share of Diesel (Ernakulam, 2012-13)



Source: Annual Reports of IOC, BPC and HPCL

Figure: 7.9 explain the oil company wise market share of Petrol distributed in the Ernakulam district during 2012-13. It shows that 46.6 percent of total Petrol marketed in the district was supplied by the Indian Oil Corporation. Bharat Petroleum has only 28.9 percent of market share and 24.5 percent supplied by Hindustan Corporation. Figure: 7.10 chart out the diesel distribution in the District by company wise during 2012-13 year. In the case of Diesel Consumption, during the period 2012-13, IOC have a share of 47.8 percent, BPC have a share of 28.0 percent and 24.2 percent share by HPCL. The figure shows that the consumption of Petrol and diesel distributed by Indian Oil Corporation is very high in Ernakulam district too.

Year wise and oil company wise growth volume and percentage share of Petrol distributed in Ernakulam district (fig. In KL) are shown in the Table: 7.26. During the year, 2003-04, the growth volume of Petrol of Indian Oil Corporation was 2053 KL out of a total growth volume of 5787 KL Petrol. BPC's Growth volume during the same period was 1945 KL and that of HPCL was 1789 KL. During the period, the Petrol percent growth of IOC WAS 7.62, OF BPC was8.38 and of HPC was 7.53 percent. Thus an average of 7.83 percentage of Petrol growth happened in 2003-04. However, during 2012-13, the growth volume of Petrol was 6422 KL, with a percent of 4.01. The same depicted graphically below (Figure: 7.11).

Table: 7.26

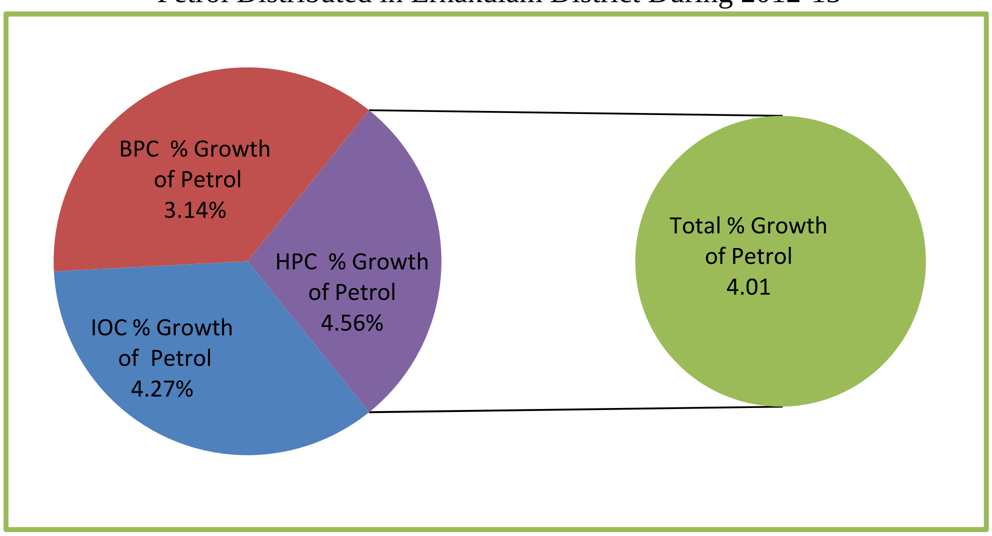
Year Wise and Oil Company Wise Growth Volume and Percentage Share of Petrol Distributed in Ernakulam District (Fig. In KL)

Years	IOC Petrol Growth Volume	BPC Petrol Growth Volume	HPC Petrol Growth Volume	Total Petrol Growth Volume	IOC Petrol Percent Growth	BPC Petrol Percent Growth	HPC Petrol Percent Growth	Total Petrol Percent Growth
2003-04	2053	1945	1789	5787	7.62	8.38	7.53	7.83
2004-05	2132	2720	1861	6713	7.35	10.81	7.29	8.42
2005-06	2132	2720	1861	6713	6.85	9.76	6.79	7.77
2006-07	2132	2721	-348	4505	6.41	8.89	-1.19	4.84
2007-08	17976	2720	2432	23128	50.78	8.16	8.41	23.69
2008-09	10349	2168	3499	16016	19.39	6.02	11.16	13.26
2009-10	5174	5383	1696	12253	8.12	14.09	4.87	8.96
2010-11	2244	610	2358	5212	3.26	1.40	6.45	3.50
2011-12	3383	2514	25	5922	4.76	5.69	0.06	3.84
2012-13	3180	1466	1776	6422	4.27	3.14	4.56	4.01
CAGR	4.48	-2.79	-0.01	1.05	-5.62	-9.34	-4.89	-6.47

Source: Annual Reports of IOC, BPC and HPCL

Figure: 7.11

Oil Company Wise Growth of Percentage Share of Petrol Distributed in Ernakulam District During 2012-13



Source: Annual Reports of IOC, BPC and HPCL

Table: 7.27 illustrated the year wise and oil company wise growth volume and percentage share of diesel distributed in Ernakulam district (fig. in KL). The Compound Annual Growth Rate related to the growth volume of Diesel in Ernakulam district is 5.41

percent. IOCL shows a marked growth rat of 20.62 percent of CAGR in relation to the growth volume of diesel in the district. High Speed Diesel growth volume during 2003-04 in Ernakulam district were recorded as 11968 KL, of these 3789 KL was the growth volume of IOC, 4416 KL was of BPCL and 3763 KL was the growth volume of HPCL.

Table: 7.27

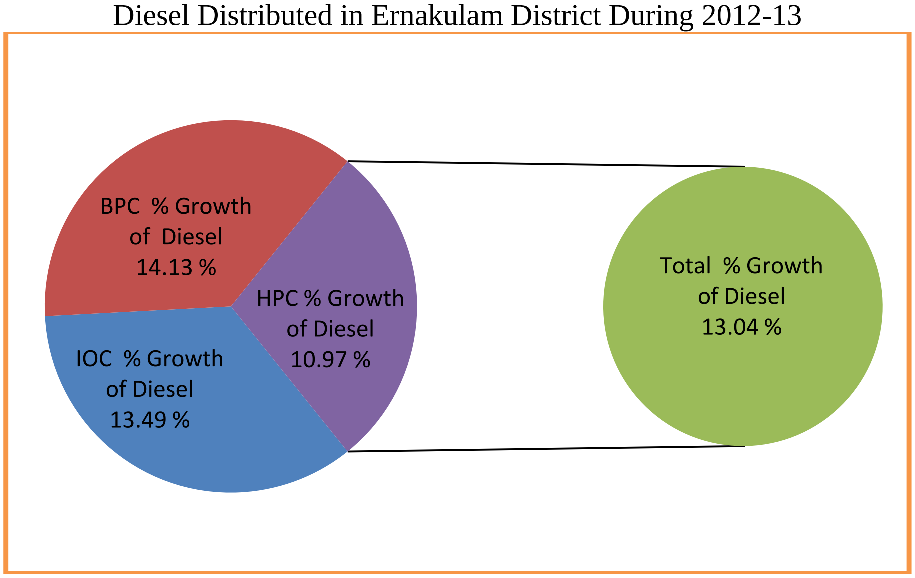
Year Wise and Oil Company Wise Growth Volume and Percentage Share of Diesel Distributed in Ernakulam District (Fig. In KL)

Years	IOC Diesel Growth Volume	BPC Diesel Growth Volume	HPC Diesel Growth Volume	Total Diesel Growth Volume	IOC Diesel Percent Growth	BPC Diesel Percent Growth	HPC Diesel Percent Growth	Total Diesel Percent Growth
2003-04	3789	4416	3763	11968	4.85	9.47	9.29	7.24
2004-05	3196	5757	6861	15814	3.90	11.28	15.51	8.92
2005-06	3196	5757	13721	22674	3.75	10.14	26.85	11.74
2006-07	3196	5756	-611	8341	3.62	9.20	-0.94	3.87
2007-08	40015	5757	1670	47442	43.69	8.43	2.60	21.17
2008-09	27609	9385	10819	47813	20.98	12.67	16.42	17.61
2009-10	-520	3129	1773	4382	-0.33	3.75	2.31	1.37
2010-11	6975	4756	6859	18590	4.40	5.49	8.74	5.74
2011-12	17494	15158	9483	42135	10.56	16.60	11.11	12.31
2012-13	24703	15050	10398	50151	13.49	14.13	10.97	13.04
CAGR	20.62	13.04	10.69	15.41	10.77	4.09	1.68	6.07

Source: Annual Reports of IOC, BPC and HPCL

Figure: 7.12

Oil Company Wise Growth of Percentage Share of Diesel Distributed in Ernakulam District During 2012-13



Source: Annual Reports of IOC, BPC and HPCL

The percent growth of total HSD supplied by these oil companies in the district during 2003-04 was an average of 7.24 percent. During the year 2012-13, the growth volume of diesel by IOC is 24703KL, of BPCL was 15050 KL and that of HPCL was 10398 KL. The total percentage growth of diesel in the Ernakulam district during 2012-13 is estimated at 13.04 percent. Percent growth of diesel of BPC is 14013 percent, that of HPCL was 10.97 percent and of IOC , it is 13.49 percent during 2012-13. The same illustrated in the Figure: 7.12.

Table (7.28) shows a comparison of the consumption of Petrol and diesel distributed in Kerala and Ernakulam district from 2003-04 onwards. The total Kerala consumption of Petrol during 2003-04 was 450315 KL (Kilo Litre) and that of diesel was 1004075 KL. Of these, 79701 KL Petrol and 177259 KL diesel consumed by Ernakulam district. That is 17.70 percent of the State's Petrol consumption and 17.65 percent of the State's Diesel consumption. The consumption of Petrol and diesel of both the State and district shows an increasing performance over the last years. The district shows an annual average of 15.35 percent of growth by Petrol and 17.35 percent growth by diesel during the period. During the period 2012-13, the total Petrol consumption of Kerala was 1173547 KL and that of diesel was 2553595 KL. The district Ernakulam consumed 14.20 percent of State's Petrol and 17.02 percent of the State's diesel consumption.

Table: 7.28

Consumption of Petrol and Diesel:

A Comparison of Kerala and Ernakulam District (KL)

Years	Kerala State		Ernakulam		% of Ernakulam Out of Kerala	
	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel
2003-04	450315	1004075	79701	177259	17.70	17.65
2004-05	502226	1091510	86414	193073	17.21	17.69
2005-06	554381	1212828	93127	215747	16.80	17.79
2006-07	591910	1272284	97632	224088	16.49	17.61
2007-08	756358	1591242	120760	271530	15.97	17.06
2008-09	867368	1802914	136776	319343	15.77	17.71
2009-10	984578	1870227	149029	323725	15.14	17.31
2010-11	1043019	2032035	154241	342315	14.79	16.85
2011-12	1108606	2282277	160163	384450	14.45	16.85
2012-13	1173547	2553595	166585	434601	14.20	17.02
CAGR	10.05	9.78	7.65	9.38	-2.18	-0.37
AAG	11.42	11.08	8.70	10.64		
EG	11.51	10.56	9.01	9.98		

Source: Annual Reports of IOC, BPC and HPCL

In order to predict the future trend of the Consumption of Petrol and Diesel, we fit the linear trend line (y=at+b) and based on the fitted line we predict the future values for next 8 years. The same presented in Table:7.28(A).

Table: 7.28(A)
Future Values: Consumption of Petrol and Diesel:
A Comparison of Kerala and Ernakulam District (KL)

Years	Kerala State		Ernakulam	
	Petrol	Diesel	Petrol	Diesel
2013-14	1286095.87	2617384.87	183575.33	443122.47
2014-15	1373889.52	2789400.53	194326.70	471215.08
2015-16	1461683.16	2961416.20	205078.07	499307.69
2016-17	1549476.81	3133431.87	215829.44	527400.30
2017-18	1637270.46	3305447.53	226580.81	555492.92
2018-19	1725064.11	3477463.20	237332.18	583585.53
2019-20	1812857.76	3649478.87	248083.55	611678.14

During the year 2019-20, in the State of Kerala, Petrol consumption increased to 1812857.76 and that of Diesel consumption is 3649478.87. However, in the case of the district Ernakulam, estimated Petrol figure is 248083.55 and that of Diesel is 611678.14.

7.5 CONCLUSION

Nowadays, energy is the lifeblood of modern civilization. The shortage of energy that can be one of the issues related to the economy of every country denotes the importance of energy in the world. Evidently, the natural energy reservoirs are limited and will no longer be capable to satisfy the intensive energy demand of the world. Therefore, the proper use of energy is a matter of concern to every nation. Efficient and reliable energy supplies are a precondition for accelerating the growth of the Indian economy. While the energy needs of the country are going to increase at a rapid rate in the coming decades, the energy resources that are indigenously available are limited and may not be sufficient in the long run to sustain the process of economic development.

From the analysis of the consumption of Petroleum products, we came to know that the consumption of Petroleum products by the State and District is not a trifling figure. If this is the habit of consumption of Petrol and Diesel, we will follow for a non renewable resource, just think, to what extent we can make the sustainability concept possible and practicable?

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CHAPTER - 8

ROAD ACCIDENTS IN INDIA: AN ACCOUNT

8.1 INTRODUCTION

Healthy and strengthen road network is essential for socio-economic development of a country. Inadequate, overcrowded and incomplete roads cannot be of much use for the development of a country and will create environmental, economical and social problems. The concept of sustainable transportation takes into account these three aspects of the problem. We know that every environmental impact ultimately affect the society. Transport sector is also not except from the fact. Development in transport increases environmental problems that resulted in accidents, health problems, which in turn resulted in heavy human loss, all these things badly, affect the productivity of the country, and the result is it adversely affects the prosperity of the country. In the context of road accident, term 'environment' was used to describe the effect of transport up on the surroundings. Even though accidental damage is the economic cost of transport, economic and environmental perspectives are interrelated. Thus, the study of environmental issues of road transport finds a scope for an analyzing traffic accidents and injuries. The present chapter looks into the same in Ernakulam District by comparing those with State level.

8.2 FACTORS CAUSING ROAD ACCIDENTS

An accident (collision, overturning, or slipping) which occurred or originated on a road open to public traffic resulting in either injury or loss of life or damage to property, in which at least one moving vehicle was involved. Accidents are rarely caused because of one single factor. Usually the interaction of a diverse set of factors causes the accidents though one factor can be responsible than the rest and can easily be identified. A car knocking down a school child - a very common occurrence in traffic accident statistics- can be considered as an example to illustrate. The car driver might have been speeding and drinking recklessly. He might have been even under the influence of liquor. The geometric on the road on which he was driving might be deficient. The street surface might have become slippery due to the use of very soft aggregates in the surfacing course, the driver on seeing the child might have suddenly applied the brakes and mechanical failure of the brakes and the slippery conditions of the surface might have rendered all his efforts of no avail. The sequence of events leading to the accident in this case is rather involved and interlinked and no single factor can be isolated and identified as the sole cause of accident. Broadly, the factors that cause accidents viewed from six dimensions. They are: a) Human factors like population density, driving habits, biological factors, attitude, cultural factor, and time factor, b)

Automobile factors like vehicle population, mix, vehicle design, size, stability, technology factors, vehicle maintenance, age, spareparts and components, c) Geographical factors like terrain, weather and geological factors, d) Infrastructure factors like availability, design, maintenance, fleet management or administrative factors, e) Information factors like availability, presentation, maintenance, and f) Legal factors like system, authorities, law violators.

The characteristic of the road has a great influence on the cause of accidents. Improvement to the conditions of the road can bring about a measurable change in the accidents. Therefore, the roads must be designed to proper standards, built to the correct specifications and maintained properly and adequately. The safe speed at which a vehicle can negotiate a curve depends on the radius of the curvature of the curve. Sharp curve permits low speeds and large radii curves cater to high designed speeds. As far as possible, a large radius must be provided. Deficiency in super elevation can cause serious accidents. The minimum carriage width for a two-way road should be 7 m to cater for two lanes of traffic. Unfortunately, due to limited financial resources, most of the roads in the country are single lane and this is a major cause of accidents because of the inherent danger on such roads during overtaking and crossing. An intermediate width of 5.5 m is advocated. If accidents are to be avoided the shoulders should be of adequate width and should be maintained in good condition. Properly designed and maintained road signs inform the driver of need for caution and can avert many an accident. Similarly road markings such as centre line marking, stop line marking and pedestrian marking can prevent accidents.

Any deficiency in the design of junction can cause accident. Elements of junction such as turning radius, width at entry and exist and channelizing islands should receive proper attention. Improved visibility and staggered crossroads can reduce the accidents. Pavement surface characteristics determine to a large extent safety of a vehicle, when negotiating a curve or when applying a brakes. The surface should have anti-skid properties even the pavement is wet. Also, note that when driving along curves or on high embankments, the driver needs to be guided about the direction of the road formation delineators with reflectors aid in this requirement. Guardrails prevent vehicles from the use of the roadway in the event of loss of control and are very useful in specific situations. Narrow bridges and culverts can cause very serious accidents especially when the road is wide. Widening of such narrow structures should be undertaken if accidents are frequently caused at the location. Posting proper warning signs save ugly accidents.

The vehicles play an important role in safety. Mechanical deficiencies cause five percent of all traffic accidents. For example without a good braking system, the driver loss the directional control of the vehicle. An efficient and reliable system of lighting the vehicle is desirable for averting accidents. The head light should perform the two functions of providing a main beam for enabling the driver to see the road ahead for sufficient long distance and provide a beam, which must avoid glare to the opposing traffic. Rear lamps give indication to the driver following a vehicle about the presence of a vehicle in front of him. Design of the vehicle is also a crucial factor determining accident. The factors that need to be considered are the shape and the dimensions of the driver's seat, arrangements of dials on the dashboard, positioning of controls in relation to the driver's seat, visibility of the driver from the seat, noise levels in the vehicle, concentration of Carbon Monoxide inside the vehicle etc. Frequent inspection of vehicle and testing determine the crashes. Unless at least, brakes, lighting, and steering mechanism checked, driving of vehicles invite human loss.

The driver is the key factor in most of the accidents. He is the human element in charge of the machine. He drives it, steers it, accelerates it, decelerates it, brakes it and stop it. His behavior influences and controls the vehicle, while his behavior itself is controlled by his personality, training and attitudes, alcohol and drugs affects his driving capability profoundly. Age and sex of drivers have also been found to be important factors in safety research.

8.3 COST OF ROAD ACCIDENTS

Accidents carry high economic and social costs, which are not easy to measure. The cost of road related injuries and accidents can be viewed in terms of medical costs, other cost related to administrative legal and police expenditure, collateral damage in terms of damage to property and motor vehicle and loss due to income foregone arising out of absence from work or impairment/disability. Besides accident, survivors often live poor quality of life and have to live with pain and suffering which are difficult to estimate. In economic terms, the cost of road crash injuries is estimated at roughly one percent of Gross National Product in Low-Income Countries, 1.5 percent in Middle-Income Countries and 2 percent in High Income Countries. For India, the socio-economic cost of road accidents was estimated as 3.2 percent of GDP.

8.4 ROAD ACCIDENTS IN INDIA

As India embraces globalization and making rapid strides in economic growth coupled with motorization, road infrastructure expansion and urbanization have become hall features of Country's growth and development. This phenomenon is reflected in all areas of society with change in value and life styles. Consequently, transport and mobility have become an integral part of human life and travel today as a necessity rather than luxury. After witnessing a decade of rapid motorization and infrastructure development efforts in the Country a question to be addressed at his stage is, has mobility and safety been integrated and go together or are we pushing only mobility without accompanying safety on Indian highways?

India is undergoing a major change in the causes of mortality accompanied by a rapid motorization and urbanization. High concentration of vehicles in cities and subsequent engendered traffic would generate a variety of social costs such as air pollution, accidents, and climate impacts. Increasing road related accidents is the negative externality associated with expansion in road network, motorization and urbanization in the country. Accompanying this change is a gradual decline in communicable and infectious diseases due to effective health policy interventions and programmes and emergence of road traffic injuries as a major public health concern. Today, Road Transport Injuries are one of the leading causes of deaths, disabilities and hospitalizations with severe socioeconomic costs.

Worldwide, more than 1.2 million people killed in road accident every year. 2 to 3 Percent of Gross National Product is the loss in road accident. Globally, one child is killed in road accident every three minutes. In India around 4.4 lakh road accidents - one road accident every minute - resulting in death of 130,000 persons - one road accident death every 6 minutes - took place.

Road accidents have earned India a dubious distinction. With over 130,000 deaths annually, the country has overtaken China and now has the worst road traffic accident rate worldwide. The World Health Organization in its first Ever-Global Status Report on Road Safety has revealed this. The report pointed out that speeding, drunk driving and low use of helmets, seat belts and child restraints in vehicles are the main contributing factors of road accidents. It is to be note that unsatisfactory conditions of Indian roads attributed to low axle-load bearing capacity and lack of maintenance. These coupled with frequent overloading result in road damage, increase in maintenance costs, equipment breakdown, loss of utilization time and accidents. Every hour, 40 people under the age of 25 die in road accidents around the globe. According to the WHO, road accident is the second most important cause of death for 5 to 29 year olds. In India alone, the death toll rose to 14 per hour in 2009 as opposed to 13 the previous year. The total number of deaths every year due to road accidents has now passed the 135,000 mark, according to the latest report of National Crime Records Bureau. While trucks and two-wheelers were responsible for over 40 per cent of deaths, peak traffic during the afternoon and evening rush hours is the most dangerous time to be on the roads.

National Crime Records Bureau states that drunken driving was a major factor for road accidents. Road deaths increased by nearly 40 per cent and the more progressive and developed states like Andhra Pradesh, Maharashtra and Tamil Nadu are the ones most affected. Road safety experts also warn that the real numbers of fatalities could be much higher since many cases are not even reported. There is no estimate as to how many people injured in road accidents with in a die a few hours or days after the accident. In addition, their deaths are then no longer linked to road traffic accidents.

8.4.1 Profile of Road Accidents in India

The problem of deaths and injury because of road crashes is now acknowledged as a global phenomenon. The Percentage change of accidental deaths in India presented in Table: 8.1 below.

Table: 8.1

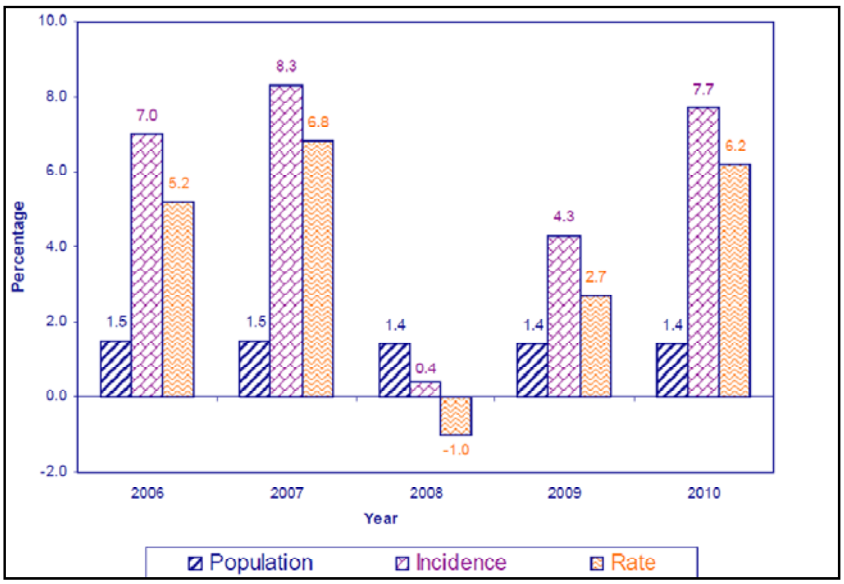
Percentage Change in Population, Incidence & Rate of Accidental Deaths During 1990 to 2010 (Over the Corresponding Previous Years)

Year	Percentage Change in Population	Percentage Change in Accidental Deaths	Percentage Change in Rate of Accidental Deaths
1990-91	2.3	7.8	5.3
1992-93	1.8	-1.0	-2.8
1994-95	1.7	-1.1	-2.8
1996-97	1.6	10.5	8.7
1998-99	1.6	5.2	3.5
1999-00	1.6	-5.9	-7.4
2000-01	2.5	5.9	3.4
2001-02	2.3	-4.0	-6.2
2002-03	1.7	-0.2	-1.9
2003-04	1.6	6.8	4.9
2004-05	1.6	6.1	4.7
2005-06	1.5	7.0	5.2
2006-07	1.5	8.3	6.8
2007-08	1.4	0.4	-1.0
2008-09	1.4	4.3	2.7
2009-10	1.4	7.7	6.2

Source: Motor Transport Statistics, Ministry of Transport and Highways

From Table: 8.1, it is clear that the incidence of accidental deaths has shown an increasing trend during the decade 2000-2010 with an increase of 50 Percent in the year 2010 as compared to 2000. The population growth during the corresponding period was 18.3 Percent whereas the increase in the rate of accidental deaths during the same period was 32.4 Percent. 384649 accidental deaths reported in the country during 2010 showing an increase of 7.7 Percent as compared to previous year. Correspondingly, 1.4 Percent increase in the population and 6.2 Percent increase in the rate of accidental deaths reported during this year as compared to previous year. The following Figure: 8.1 shows the same.

Figure: 8.1
Percentage Change in Population, Incidence &
Rate of Accidental Deaths During 2006 to 2010



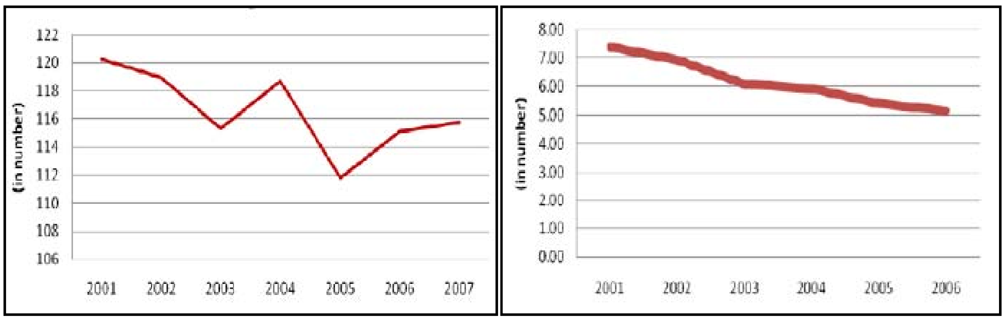
Source: Motor Transport Statistics, Ministry of Transport & Highways

The total number of road accidents has increased from about 4.1 lakh in 2001 to 4.8 lakh in 2007. The number of casualties from accidents has increased from 4.86 lakh to 6.28 lakh and share of fatality in the casualties has increased from 16.64 Percent to 18.23 Percent during the same period, which means that the accidents are becoming fatal over time. Road accidents per 1000 registered motor vehicles and per 1000 kilometer of road length show a negative average annual growth rate. The number of road accidents per 1000 registered motor vehicles decreased from seven in 2001 to five in 2006. Road accidents per thousand kilometer of road length decreased from 120 in 2001 to 116 in 2008. However, due to large increase in number of vehicles on roads, absolute number of accidents is increasing over the years. Figure: 8.2 provided a comparison of the accident in these two dimensions. Percentage share of major States in accidental deaths is shown below (Figure: 8.3) diagrammatically. Maharashtra has reported 64,204 accidental deaths out of 384649 such deaths in the country during the year and remained at the top with nearly one sixth (16.7 Percent) of total accidental deaths reported in the country.

Figure: 8.2

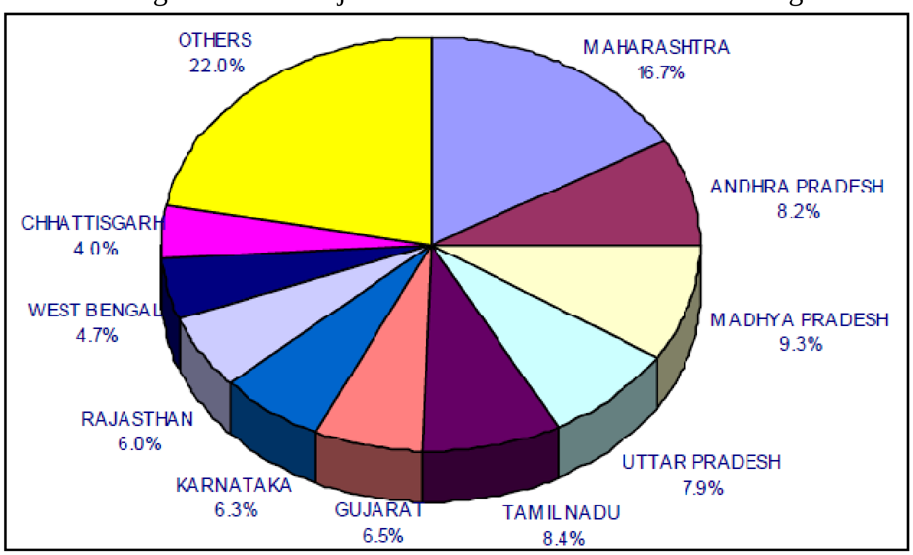
Road Accident
Per 1000 KM of Road Length

Road Accident
Per 1000 Registered Motor Vehicles



Source: Motor Transport Statistics, Ministry of Transport & Highways, India

Figure: 8.3
Percentage Share of Major States in Accidental Deaths During 2010



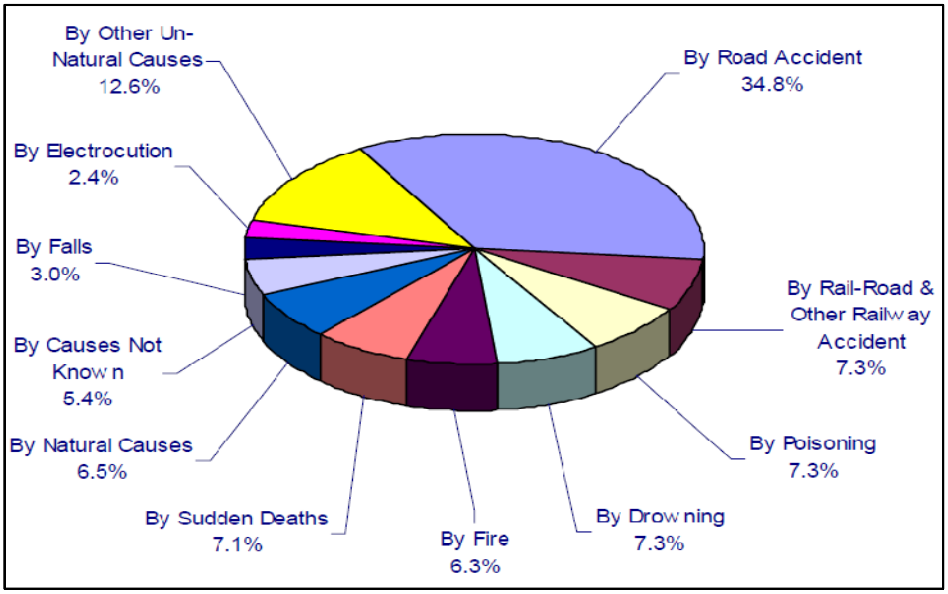
Source: Motor Transport Statistics, Ministry of Transport & Highways

The figure above shows that, Uttar Pradesh, the most populous State in the country with population share of 16.8 Percent, on the other hand, has accounted for 7.9 Percent of accidental deaths and stood at fifth position after Maharashtra (16.7 Percent), Madhya Pradesh (9.3 Percent), Tamil Nadu (8.4 Percent) and Andhra Pradesh (8.2 Percent). The States of Gujarat (6.5 Percent), Karnataka (6.3 Percent) and Rajasthan (6.0 Percent) have also reported significant shares of deaths due to accidents during 2010.

The Percentage of Accidental Deaths due to causes attributable to Nature and those due to Un-Natural Causes were 6.5 Percent and 93.5 Percent respectively (Figure: 8.4). The share of accidental deaths due to causes attributable to Nature has increased from 6.2 Percent in 2009 to 6.5 Percent in 2010. The average rate of Accidental Deaths has marginally increased from 30.5 in 2009 to 32.4 in 2010.

Figure: 8.4

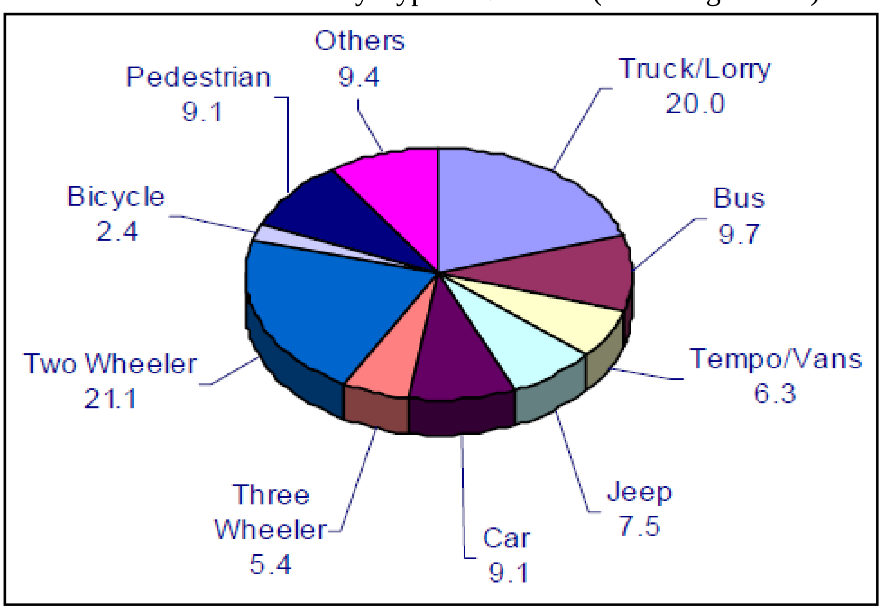
Percentage Share of Various Causes of Accidental Deaths During 2010 (Natural and Un-Natural Causes)



Source: Motor Transport Statistics, Ministry of Transport and Highways.

Figure: 8.5

Road Accident Deaths by Type of Vehicles (Percentage Share)



Source: Motor Transport Statistics, Ministry of Transport & Highways

Although break-up of total Government and Private vehicles are not available, it is pertinent to note that 97.3 Percent victims of Jeeps, 96.8 Percent victims of Truck or Lorry, 97.6 Percent victims of Cars, 97.7 Percent victims of Tempo and Vans and 67.6 Percent victims of Buses involved in accidents, were traveling in private vehicles. The total number of persons killed during 2010 were 133938, out of which 113935 males and 20,003 females, while traveling by various modes of transport on roads. 28,234 persons (20.1 Percent) of these were riding on Two-wheelers, 26,800 (20.0 Percent) were occupants of Truck or Lorry, 13,003 (9.7 Percent) were killed while traveling in buses and 12204 (9.1 Percent) were traveling in car. The diagram (Figure: 8.5) depicts the percentage share of accidents contributed by each category of vehicle.

8.5 ROAD ACCIDENTS IN KERALA

Traffic accidents are a major cause of death and injuries worldwide, but while they are declining in many parts of the developed world, fatalities are still on the rise in many developing States. In our State, more than half of the road accident victims are in the age group of 20 to 55, the key wage earning and child raising age group. The loss of the main breadwinner and head of household due to death or disability can be catastrophic, leading to lower living standards and poverty. When we analyses the State-wise distribution of road traffic deaths in India in 2005, we can see that the figure of Kerala exceeds the national average of 90 per million populations. In Kerala it is 96 per million populations.

8.5.1 Main Causes of Increasing Road Accident Death Rates in Kerala

The main causes of increasing death rate in road accidents in Kerala identified based on the study conducted by State Crime Records Bureau. The key causes are as follows:

1. Over speeding.
2. Drunken Driving
3. Driving without Helmet.
4. Driving without seat belt.
5. Rider's ignorance or violation of Traffic Rules.
6. Not knowing or not adopting correct driving habits.
7. Bad condition of Roads and absence of different lanes.
8. Increasing number of New generation vehicles especially Two wheelers.
9. Rider's ignorance of Road conditions, Road signs and the Environmental factors.

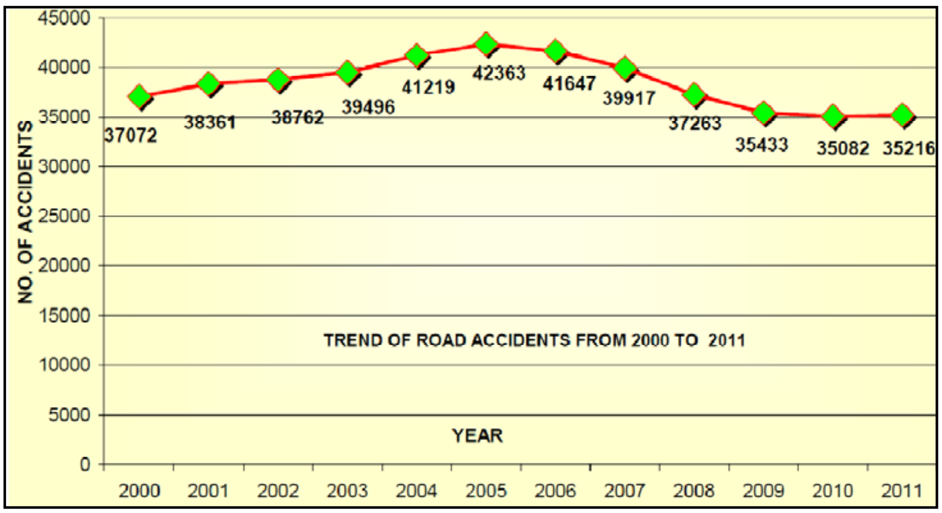
10. Aggressive driving behavior of Heavy vehicle drivers (Buses & Tipper Lorries).

11. Drivers sleeping while driving after midnight due to fatigue and other reasons.

8.5.2 Trend of Road Accidents in Kerala

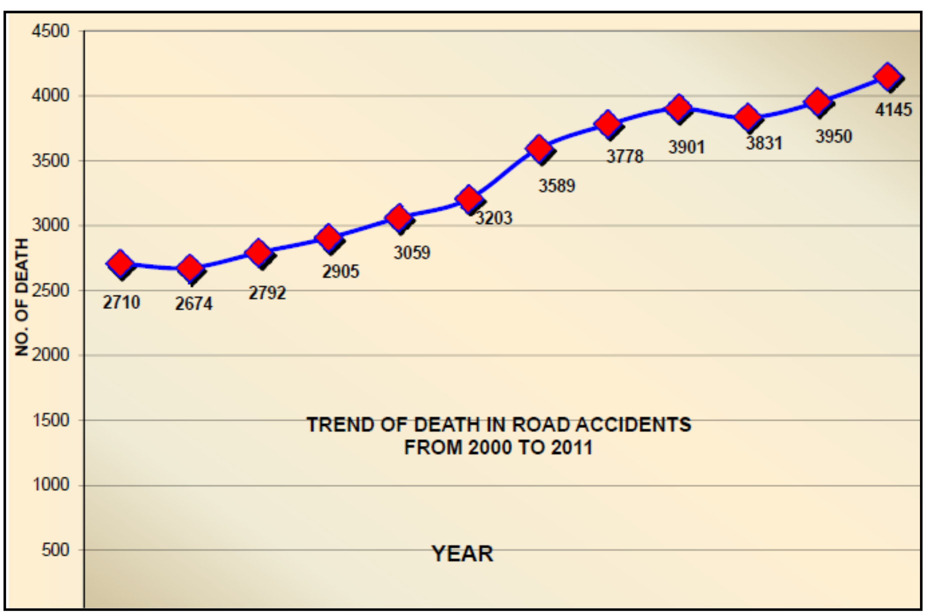
The graph below (Figure: 8.6) depicts the road accidents in Kerala from 2000 onwards. In 2000, the total number of road accidents was 37072; it goes on increasing until 2005. In 2005, it is 42363. After 2005 it begins to decline up to 2010, and in 2011, we can see a slight increase in the number of accidents.

Figure: 8.6
Road Accidents in Kerala (2000-2011)



Source: Annual Administration Report, Kerala Motor Vehicles Dept., 2011

Figure: 8.7
Year wise Death in Road accidents

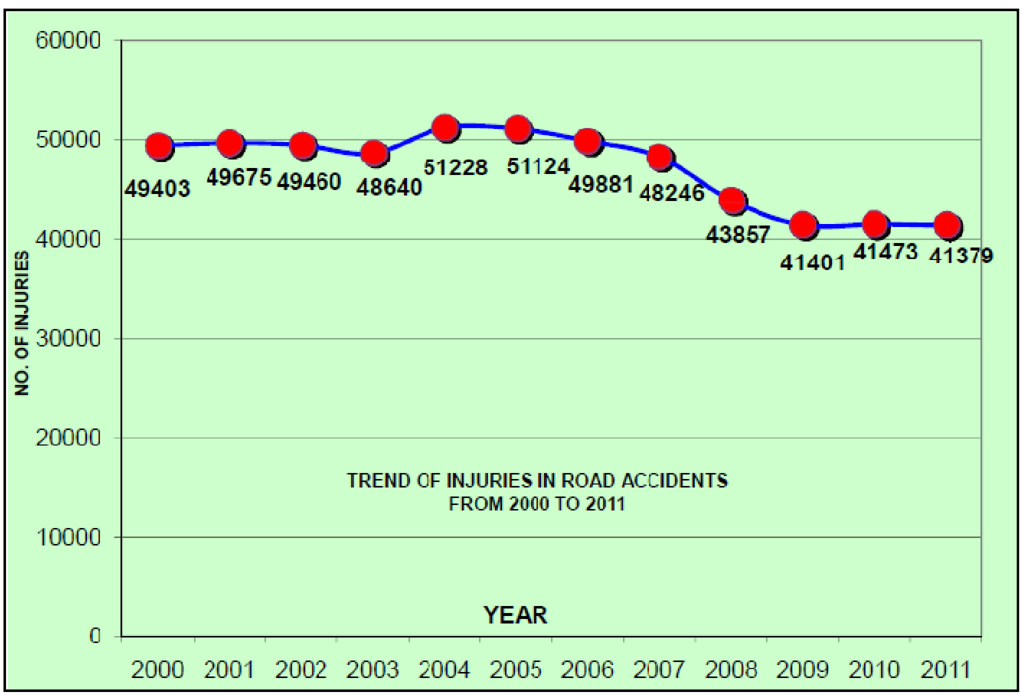


Source: Annual Administration Report, Kerala Motor Vehicles Dept, 2011

From Figure: 8.6, it is very clear that, the total number of accident cases during the year 2010 were 35082 which decreased to 35216 in the corresponding year 2011. While compared 2010, the total number of accident cases reported in 2011 shows an increase of 0.38Percent, which is an increase of 134 accidents cases. Out of the 35216 cases reported, 4145 were death cases, 25110 were grievously injured and minor injuries were 16269 cases. Figures: 8.7, 8.8 show the road accident death cases, the trend of injuries in Kerala from 2000 to 2011.

Figure: 8.7 shows that the trend of death in road accident goes on increasing from 2000 to 2011. In 2000, only 7.3 Percent of the total road accident cases met death, while in 2011, it is 11.8 percent of total accident cases. During the year 2000, 2710 road accident death reported, it increased to 4145 at the end of the year 2011. This shows a tremendous increase.

Figure: 8.8
Year wise Death in Road accidents



Source: Annual Administration Report, Kerala Motor Vehicles Dept., 2011

In the case of traffic injuries (Figure: 8.8) we can see a decline trend from 2005 onwards. In 2000, 49403 reported cases of injuries due to road accidents, but in 2004, it is 51228 and in 2010, it shows a declining trend (41379). There were 49403 road traffic injuries recorded at the year 2000, and it increased to 49460 within two years. During 2004, the highest accident injuries reported (51288). From 2005 onwards, it shows a declining trend, now road accidents injuries reported as 41379 at the year 2011.

The accident caused by different categories of vehicles, the contribution given by each category shown in below in Table: 8.2.

Table: 8.2

Road Accidents on Different Type of Vehicles in Kerala in 2011

Category of Vehicles	Cases	% of Cases	Persons Killed	% of Persons Killed	Persons Injured	% of Persons Injured
Truck	2635	7.48	550	13.27	2697	6.52
KSRTC Buses	1109	3.15	222	5.36	1167	2.82
Private & Mini Buses	4704	13.36	680	16.41	7593	18.35
Cars , Jeep & Taxis	8909	25.30	895	21.59	11188	27.04
Goods Vehicles	1515	4.30	222	5.36	1648	3.98
Three Wheelers	4546	12.91	283	6.83	5377	12.99
Two Wheelers	11303	32.10	1097	26.47	11329	27.38
Other Heavy Vehicles	39	0.11	10	0.24	52	0.13
Vehicles Not Known	303	0.86	152	3.67	158	0.38
Others	153	0.43	34	0.82	170	0.41
State Level	35216	100	4145	100	41379	100.00

Source: Annual Administration Report, Kerala Motor Vehicles Dept., 2011

Table: 8.2 revealed that during 2011, out of the total number of cases reported, two wheelers responsible for 11303 accident cases, (32 Percentage of State’s accident case), Car, Jeeps and Taxi responsible for 8909 cases of accidents. Highest total number of people killed during the year 2011 is due to two-wheeler accident, and there were 11329 persons injured due to the same reason. 11188 persons injured due to Car, Jeeps and Taxi. Two wheelers responsible for 32.10 of accident cases, 26.47 percent of person’s road traffic accident death, 27.38 percent persons accident injury during the year 2011. The category of Cars, Jeeps and Taxi caused the same scenario. Cars, Jeeps and Taxi account 25.30 percent accident cases, 21.59 people’s accident death, and 27.04 person’s injury.

Table: 8.3

Road Accidents on Different Type of Road in 2011

Category of Roads	Cases	% of Cases	Persons Killed	% of Persons Killed	Persons Injured	% of Persons Injured
National Highways	9519	27.03	1432	34.55	11201	27.07
State Highways	6401	18.18	836	20.17	7794	18.84
Other Roads	19296	54.79	1877	45.28	22384	54.10
State Total	35216	100.00	4145	100.00	41379	100.00

Source: Annual Administration Report, Kerala Motor Vehicles Dept., 2011

When we analyses the road accidents on different type of roads (Table: 8.3), we known that, 9519 cases of reported accidents occurred in National Highways (27.03 percent), 6401 cases in State Highways (18.18 percent). Other roads like Village and District roads account the major share of accident cases. 35216 cases of accident reported in this category (54.79 percent of the State's total). During 2011, 1432 persons killed, 11201 persons injured in the accidents occurred in National Highways (34.55 percent and 27.07 percent respectively). In the case of persons injured and killed too, the role of Village and District roads were very high during the year 2011, accounted 45.28 percent of traffic deaths and 54.10 person's injuries.

District wise road accident details shown below in Table: 8.4. It clearly shows that during 2011, the number of accident case is very high in Ernakulam district while comparing to other districts. There were 5251 cases (total of city and rural) reported in Ernakulam district. It is 15 percent of the State total. Out of these 5251 cases, Ernakulam Rural 3265, and in city 1986. This is very high both in terms of rural and in city accidents, while comparing to other Municipal corporations. The number of accident cases in Alappuzha was 3003 and in Thrissur rural 2759. The reporting of road accident among the five Municipal Corporations in Kerala revealed that the highest accident cases reported in Kochi Municipal Corporation (1986) and lowest in Thrissur Municipal Corporation (1262).

Table: 8.4

District Wise Details of Road Accidents in 2011

Districts	Cases	Died	Grievously Injured	Minor Injured
Trivandrum	4435	487	3595	1140
Kollam	2923	422	2382	827
Pathanamthitta	1425	161	1028	484
Alappuzha	3003	415	2005	1266
Kottayam	2458	226	2103	1070
Ernakulam	5251	537	3803	2059
Idukki	1031	69	706	759
Thrissur	4021	488	2925	1427
Palakkad	2174	392	1032	1608
Malappuram	2694	324	1979	1555
Kozhikode	2802	296	1936	1347
Wayanad	580	63	364	432
Kannur	1642	173	782	1619
Kasarkodu	777	92	470	676
State Total	35216	4145	25110	16269

Source: Annual Administration Report, KMV Dept., 2011

The number of death cases during accidents is very high in the districts of Alappuzha (415), and Palakkad (392) respectively. Among the Municipal Corporations, city accidents are very high in Kollam (222), and least in Trivandrum and Thrissur city (141). Other notable highest death cases are reported at Ernakulam Rural (355), Thrissur Rural (347), Trivandrum Rural (346) and Malappuram (324). The number of grievously injured road accident cases is very high in districts of Ernakulam Rural (2526) Thiruvananthapuram Rural (2230), Kottayam (2103) and Thrissur Rural (2072). The reporting of grievously injured road accident cases is highest in Ernakulam range (8617). Vehicles play an important role in the accident issues.

The category wise vehicles responsible for road accident in each district during 2011 shown in Table: 8.5 below. Out of the total road accidents in the State, Ernakulam district contributed 15 percentages. The same is the share of two wheelers accidents. The number of vehicle involved accidents by KSRTC buses is very high (total of city and rural) in districts of Trivandrum (306), (22.3 percent of State total), Ernakulam (202), Kollam (137), Alappuzha (125) and least in Idukki (23).

Table: 8.5

Types of Vehicles Involved in the Accidents in 2011

Districts	KSRTC	Private Bus	Lorry	Mini Bus	Car	Jeep	Auto	Two Wheeler	Others	Not Known
Trivandrum	306	178	141	261	1120	69	713	3523	153	29
Kollam	137	217	123	180	818	71	544	2169	181	20
Pathanamthitta	66	124	60	103	460	54	314	917	91	11
Alappuzha	125	152	161	170	865	29	489	2267	194	21
Kottayam	87	296	100	156	724	78	555	1496	104	43
Ernakulam	202	583	395	265	1602	67	770	3780	408	84
Idukki	23	109	49	43	234	149	344	476	36	3
Thrissur	121	522	258	224	1260	64	762	2785	295	35
Palakkad	48	289	193	125	457	68	512	1502	115	11
Malappuram	71	467	256	148	809	110	710	1463	108	18
Kozhikode	65	583	209	114	743	144	538	1737	97	23
Wayanad	28	68	36	29	156	60	133	283	16	5
Kannur	50	328	134	137	418	91	344	842	84	6
Kasarkodu	39	87	79	42	205	42	192	397	26	4
State Total	1368	4003	2194	1997	9871	1096	6920	23637	1908	313

Source: Annual Administration Report, Kerala Motor Vehicles Department, 2011

The number of vehicle involved accidents by private buses is very high in districts of Ernakulam and Kozhikode (583) followed by Thrissur (522), Malappuram (467). The reporting of accident cases by private buses is highest in Thrissur range (1278) and lowest in Trivandrum Range (519). The number of vehicle-involved accidents by Lorries is highest in districts of Ernakulam (583, total of city and rural) followed by Thrissur (258, total of city and Rural) Malappuram (256), Ernakulam Rural (206), and Palakkad (193). The reporting of accident cases by Lorries is highest in Thrissur Range (707) and lowest Thiruvananthapuram Range (324).

The number of vehicle involved accidents by Mini Lorries & Buses is highest in districts Ernakulam (265, total of city and rural), Trivandrum (261, total of city and rural), and Alappuzha (170). The number of vehicle involved accidents by Car is very high in district of Ernakulam (1602, total of city and rural) followed by Thrissur (1260, total of city and rural), Alappuzha (865) and Malappuram (809). The reporting of accident cases by Car is highest in Ernakulam range (3425) and lowest Kannur Range (1522). The number of vehicle-involved accidents by Jeeps is very high in districts of Idukki (149), Kozhikode (144, total of city and rural), Malappuram (110) and Kannur (91). The number of vehicle-involved accidents by Auto Rickshaws is very high in districts of Ernakulam (770, total of city and rural) and Thrissur (713, total of city and rural) and Malappuram (710).

Table: 8.6

Type of Road involved in Accidents in 2011

Districts	National Highways	State Highways	Other Types of Roads
Trivandrum	1024	576	7270
Kollam	1156	220	4470
Pathanamthitta	0	471	2379
Alappuzha	1247	265	4494
Kottayam	263	482	4171
Ernakulam	1349	815	8338
Idukki	192	343	1527
Thrissur	1104	784	6154
Palakkad	551	656	3141
Malappuram	785	605	3998
Kozhikode	986	476	4142
Wayanad	156	210	794
Kannur	433	361	2490
Kasarkodu	273	137	1144
State Total	9519	6401	54512

Source: Annual Administration Report, KMV Department, 2011

The reporting of accident cases by Auto Rickshaws is highest in Ernakulam range (2158) and lowest range in Kannur range (1207) among the ranges. The number of vehicle-involved accidents by two wheelers is very high in districts of Ernakulam (3780, total of city and rural) and Trivandrum Rural (3523, total of city and rural). The reporting of accident cases by two wheelers is highest in Ernakulam range (8019) and lowest range is Kannur range (3259). Accidents with not known the type of vehicles involved is also highest in Ernakulam (84).

Table: 8.6 shows that number of road accidents is very high on National Highways in the districts of Alappuzha (1247), Kollam City (948) and Thrissur Rural (921). The number of road accidents is very high on State Highways in the districts of Palakkad (656), Ernakulam Rural (631), Malappuram (605) and Thrissur Rural (503). While take into account the district as a whole (total of city and rural), the highest number of accidents on NH happened in Ernakulam (815) followed by Thrissur (784). The reporting of accident cases during the Night is highest in Ernakulam range (3045).

8.6 ROAD ACCIDENT IN ERNAKULAM DISTRICT

The number of metropolitan cities is increasing in India in tune with the day-by-day increased urban population. In Kerala, Kochi is the only metropolitan city, which ranks 20th rank among the 35 metropolitan cities in India, however, ranks sixth among all the Metropolitan Accident Risk Index (4.98). Studies indicated that from the globalized decade onwards, metropolitan cities grew by about 7 percent, but Kochi City registered the 3rd highest growth (9.68).

Table: 8.7

Road Accidents Fatalities According to the Type of Vehicles Involved

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	Three Wheelers	Two Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles	Total
1997-1998	598	641	508	474	1091	1803	145	71	112	5443
1998-1999	621	665	527	492	1135	1873	150	73	103	5639
1999-2000	643	689	546	509	1176	1940	155	75	94	5827
2000-2001	666	713	565	527	1218	2010	160	77	85	6021
2001-2002	690	738	585	546	1262	2082	165	79	75	6222
2002-2003	715	757	606	565	1307	2157	170	81	72	6430
2003-2004	740	791	627	585	1354	2235	176	83	54	6645
2004-2005	723	819	649	606	1403	2316	182	86	76	6860
2005-2006	817	839	665	621	1438	2375	186	88	77	7106
2006-2007	819	878	696	650	1505	2486	194	92	80	7400
2007-2008	864	924	732	684	1584	2616	204	96	84	7788
2008-2009	441	553	51	1009	12	1684	92	12	8	3862
2009-2010	492	573	63	1182	18	1876	97	18	11	4330
2010-2011	542	593	94	1355	23	2052	102	23	14	4798
2011-2012	592	613	125	1528	28	2228	107	28	17	5266

Source: Annual Administration Reports, Motor Vehicles Department, Ernakulam

Distribution of accident according to type of vehicles showed certain peculiarities in the city. The city registered an abnormally high proportion of two-wheeler accident. A detailed analysis of the road accidents in the district requires in this context. The following Table: 8.7 clearly shows the road traffic accident of fatal cases in the district according to the type of vehicles involved from 1997 until 2012. It indicates an increasing trend. The district registered an abnormally high proportion of two-wheeler fatal accident. Out of the 5266 road accident fatalities during 2012, 2228 caused by two-wheelers crashes and 1528 due to three wheelers accidents. Other category like van, tempos, tractor, trailers etc constituted 17 fatalities.

Table: 8.7 (A)
Future Values: Road Accidents Fatalities
According to the Type of Vehicles Involved

Year	Truck	Buses	Mini Buses	Car/Jeep/Taxis	Three Wheelers	Two Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles	Total
2012-13	625	691	210	1283	305	2253	125	35	11	5538
2013-14	620	687	177	1349	222	2271	122	31	4	5484
2014-15	615	683	145	1415	139	2288	119	27	-2	5429
2015-16	611	680	112	1481	56	2305	115	24	-9	5374
2016-17	606	676	80	1547	-27	2322	112	20	-15	5320
2017-18	601	673	47	1613	-111	2340	109	16	-22	5265
2018-19	596	669	15	1679	-194	2357	105	12	-29	5210
2019-20	591	666	-18	1745	-277	2374	102	8	-35	5156

Table: 8.7 (A) shows the future value of road accidents fatalities from 2012 to 2020, according to the type of vehicles involved. In order to predict the future trend, we fit the linear trend line (y=at+b) and based on the fitted line we predict the future values for next 8 years. The total number of vehicles shows a declining trend from 5538 to 5156 during the same period. Cars, Jeeps and Taxis future values predicted as 1745 during 2019-2020. Two wheelers increased from 2253 to 2374 during the same period. The percentage wise road traffic fatalities due to different categories of vehicles are shown in Table : 8.8 below. This table helps us to compare the share of district to that of State's total in road accident. It indicate that 42.31 percent of total fatal accidents in the district responsible by two wheelers. With the district, Kochi Corporation and Ernakulam rural area accounted more than 15 percentage of the two-wheeler accident. From 1997 to till 2009, we can see a 10.47 percent of increase in two-wheeler accident (fatal only). It shows a declining trend from the last half decades. The share of fatal accident cases due to Car/ Jeeps and Taxis also shows an increasing trend, it grows at four times than that of the figure in 1997. The period of analysis that is from 1997 to 2012, a span of 15 years, revealed that 9.4 percent of the State's two wheelers accident contributed by the district Ernakulam, thus, this part of the State has become the most unsafe area for two-wheelers. The share of three wheelers to total fatal cases of road became negligible from the last four years onwards. In 1997, it is 20.04 percent but in 2012 it declined to 0.53 percent.

Table: 8.8

Percentage of Road Accidents Fatalities Due to Different Category of Vehicle

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	Three Wheelers	Two Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles
1997-1998	10.99	11.78	9.33	8.71	20.04	33.13	2.66	1.30	2.06
1998-1999	11.01	11.79	9.35	8.72	20.13	33.22	2.66	1.29	1.83
1999-2000	11.03	11.82	9.37	8.74	20.18	33.29	2.66	1.29	1.61
2000-2001	11.06	11.84	9.38	8.75	20.23	33.38	2.66	1.28	1.41
2001-2002	11.09	11.86	9.40	8.78	20.28	33.46	2.65	1.27	1.21
2002-2003	11.12	11.77	9.42	8.79	20.33	33.55	2.64	1.26	1.12
2003-2004	11.14	11.90	9.44	8.80	20.38	33.63	2.65	1.25	0.81
2004-2005	10.54	11.94	9.46	8.83	20.45	33.76	2.65	1.25	1.11
2005-2006	11.50	11.81	9.36	8.74	20.24	33.42	2.62	1.24	1.08
2006-2007	11.07	11.86	9.41	8.78	20.34	33.59	2.62	1.24	1.08
2007-2008	11.09	11.86	9.40	8.78	20.34	33.59	2.62	1.23	1.08
2008-2009	11.42	14.32	1.32	26.13	0.31	43.60	2.38	0.31	0.21
2009-2010	11.36	13.23	1.45	27.30	0.42	43.33	2.24	0.42	0.25
2010-2011	11.30	12.36	1.96	28.24	0.48	42.77	2.13	0.48	0.29
2011-2012	11.24	11.64	2.37	29.02	0.53	42.31	2.03	0.53	0.32

Source: Annual Administration Reports, M V D, Ernakulam District

Next, we look into the number of persons killed in road accident fatalities because of different category of vehicles (Table: 8.9). The table revealed that during 1997-98, there were 246 persons killed in road traffic accidents in the district Ernakulam, of which two-wheelers caused the lion share, 76 persons faced death in two-wheelers accident. From table it is also to note that at the same period (1997-98) three wheelers responsible or 46 person's death. In 2011-12, two wheelers accident took 109 persons life. Car/ jeeps/ taxi took 46 people's life, 35 persons face death due to three-wheelers accident. Bus accidents resulted into 41 person's death in 2012.

Table: 8.9

Number of Persons Killed in Road Accidents Fatally According to the Type of Vehicles Involved

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	3 Wheelers	2 Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles	Total
1997-1998	18	60	2	22	46	76	10	12	0	246
1998-1999	20	60	4	22	48	81	0	12	0	247
1999-2000	19	60	10	22	49	63	20	12	0	255
2000-2001	22	60	15	22	50	85	0	12	0	266
2001-2002	10	55	32	22	51	58	30	12	0	270
2002-2003	19	68	18	22	52	91	0	12	0	282
2003-2004	21	68	28	22	53	94	0	12	0	298
2004-2005	25	65	35	24	54	97	0	12	0	312
2005-2006	20	49	39	67	55	99	0	12	0	341
2006-2007	30	58	27	23	57	103	0	12	0	310
2007-2008	10	60	10	54	60	68	0	32	33	327
2008-2009	21	18	7	62	4	149	28	4	2	295
2009-2010	21	50	24	46	46	103	6	14	7	317
2010-2011	26	19	11	46	6	121	14	1	1	245
2011-2012	22	41	16	46	35	109	10	13	9	301

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.10

Percentagewise Number of Persons Killed in Road Accidents Fatally According to the Type of Vehicles Involved

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	Three Wheelers	Two Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles
1997-1998	7.32	24.39	0.81	8.94	18.70	30.89	4.07	4.88	0.00
1998-1999	8.10	24.29	1.62	8.91	19.43	32.79	0.00	4.86	0.00
1999-2000	7.45	23.53	3.92	8.63	19.22	24.71	7.84	4.71	0.00
2000-2001	8.27	22.56	5.64	8.27	18.80	31.95	0.00	4.51	0.00
2001-2002	3.70	20.37	11.85	8.15	18.89	21.48	11.11	4.44	0.00
2002-2003	6.74	24.11	6.38	7.80	18.44	32.27	0.00	4.26	0.00
2003-2004	7.05	22.82	9.40	7.38	17.79	31.54	0.00	4.03	0.00
2004-2005	8.01	20.83	11.22	7.69	17.31	31.09	0.00	3.85	0.00
2005-2006	5.87	14.37	11.44	19.65	16.13	29.03	0.00	3.52	0.00
2006-2007	9.68	18.71	8.71	7.42	18.39	33.23	0.00	3.87	0.00
2007-2008	3.06	18.35	3.06	16.51	18.35	20.80	0.00	9.79	10.09
2008-2009	7.12	6.10	2.37	21.02	1.36	50.51	9.49	1.36	0.68
2009-2010	6.62	15.77	7.57	14.51	14.51	32.49	1.89	4.42	2.21
2010-2011	10.61	7.76	4.49	18.78	2.45	49.39	5.71	0.41	0.41
2011-2012	7.31	13.62	5.32	15.28	11.63	36.21	3.32	4.32	2.99

It is to note here that the accident may be either fatal or grievous injury or minor injury cases. The different cases of accidents are reported and recorded based on the severity of the accident. Thus in each category, that is for both fatal category, and grievous injury category, have grievous injury and minor injury cases. In Table: 8.10, we take into account both grievous injury and minor injury in fatal category, grievous injury and minor injury in grievous injury category, and minor injury in minor injury category as a entirety, then considered the category wise vehicles responsible for injury in the last fifteen years in the district.

Table: 8.10 shows the percentage wise persons killed on road accident fatally responsible by different type of vehicles. The table points out that, during 2008-2009, 50.51 percent of accidental death is due to two-wheeler accident and in 2012, it decreased to 36.21 percent (a decrease from 149 to 109). Buses, car/ jeeps/ taxi and three wheelers are the other category of vehicles, which took approximately same percentage of the life of people in road crashes. When we analyze the trucks and goods vehicles playing on the road in the district, we identified that the number of outside station and outside State trucks is much higher than what existed in the district (Tamilnadu, Andrapradesh and Maharashtra registered vehicles). Among the registered vehicles within the district, trucks contributed 7.31 percent of death. The share of Mini buses, heavy vehicles etc contributed negligible percent of death. The share of three-wheelers accidental death is also shows a decreasing trend from the last 15 years on wards. In 2009, it was 1.36 percent (18.70 percent in 1997-98) and now 11.63 percentage of death.

The total numbers of persons injured due to road accidents because of different category of vehicles shown in the following Table: 8.11. It revealed that the total number of persons injured due to road traffic crashes increasing at an alarming rate. During 1997-‘98, only 8302 number of persons reported as road traffic injured persons, and it increased to12279 during the year 2007-‘08. During the year 2008-09 we can observe that, in this district, there was a sudden increase in the number of injured persons (22309). In 2012, the number of person injured again increased to 25596. Of the various types of vehicles involved in crashes, two-wheeler is the villain. During 2012, out of the 25596 persons injured, two-wheeler accounts 6359 injuries. 4081 injuries are due to Car, Taxi and Jeep crashes.

Percentage share of each vehicle causes road traffic injuries shown in the Table: 8.12. It shows that that during 1998, two wheelers responsible for 30.09 percent of total traffic injuries in the district. Its share slowly decreased.

Table: 8. 11

Persons Injured According to the Type of Vehicles Involved

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	Three Wheelers	Two Wheelers	Other Heavy	Vehicles Not Known	Other Vehicles	Total
1997-1998	210	270	373	655	2388	2498	947	887	74	8302
1998-1999	222	281	388	669	2402	2514	948	1180	323	8927
1999-2000	278	339	400	691	2386	2602	968	930	625	9219
2000-2001	284	347	412	713	2474	2694	1026	937	635	9522
2001-2002	270	376	425	737	2565	2790	1061	955	657	9836
2002-2003	286	375	438	762	2659	2887	1097	1027	628	10159
2003-2004	282	394	451	787	2757	2989	1135	961	737	10493
2004-2005	540	558	664	813	2836	3095	1174	1098	50	10828
2005-2006	463	615	872	832	2932	3173	1202	1124	0	11213
2006-2007	321	405	492	869	3071	3319	1256	1175	932	11840
2007-2008	338	422	516	912	3236	3492	1320	1236	807	12279
2008-2009	1745	1887	987	3210	2114	5145	2881	1998	2342	22309
2009-2010	1870	1926	1047	3501	2124	5549	2847	2059	2482	23405
2010-2011	1995	1965	1107	3791	2134	5954	2813	2120	2621	24500
2011-2012	2120	2004	1167	4081	2144	6359	2779	2181	2761	25596

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.12

Percentage Share of Different Types of Vehicles Caused Road Traffic Injury

Year	Truck	Buses	Mini Buses	Car/Jeeps/ Taxis	Three Wheelers	Two Wheelers	Other Heavy Vehicles	Vehicles Not Known	Other Vehicles
1997-1998	2.53	3.25	4.49	7.89	28.76	30.09	11.41	10.68	0.89
1998-1999	2.49	3.15	4.35	7.49	26.91	28.16	10.62	13.22	3.62
1999-2000	3.02	3.68	4.34	7.50	25.88	28.22	10.50	10.09	6.78
2000-2001	2.98	3.64	4.33	7.49	25.98	28.29	10.78	9.84	6.67
2001-2002	2.75	3.82	4.32	7.49	26.08	28.37	10.79	9.71	6.68
2002-2003	2.82	3.69	4.31	7.50	26.17	28.42	10.80	10.11	6.18
2003-2004	2.69	3.75	4.30	7.50	26.27	28.49	10.82	9.16	7.02
2004-2005	4.99	5.15	6.13	7.51	26.19	28.58	10.84	10.14	0.46
2005-2006	4.13	5.48	7.78	7.42	26.15	28.30	10.72	10.02	0.00
2006-2007	2.71	3.42	4.16	7.34	25.94	28.03	10.61	9.92	7.87
2007-2008	2.75	3.44	4.20	7.43	26.35	28.44	10.75	10.07	6.57
2008-2009	7.82	8.46	4.42	14.39	9.48	23.06	12.91	8.96	10.50
2009-2010	7.99	8.23	4.47	14.96	9.07	23.71	12.16	8.80	10.60
2010-2011	8.14	8.02	4.52	15.47	8.71	24.30	11.48	8.65	10.70
2011-2012	8.28	7.83	4.56	15.94	8.38	24.84	10.86	8.52	10.79

Source: Annual Administration Reports, MVD, Ernakulam

During the year 2012, two wheelers account 24.84 percent of injuries. Likewise, the shares of three wheelers are also responsible for high increase in the traffic injuries in the last nineties and early twenties. Now its share is 8.38 percent. Mini buses account only 4.56 Percent of total traffic injuries. We know that accidents occur not due to the negligence of driver alone. A number of factors are behind this.

Road accidents occur due to the following reasons:

- Fault of driver
- Fault of pedestrians
- Bad weather condition
- Engine problems
- Technical defect
- Fault of passenger

Table: 8.13

Road Accidents by Different Causes in Ernakulam District

Year	Fault of Driver	Fault of Passenger	Bad Driver	Bad Weather	Technical Defect	Fault of Pedestrian	Others	Total
1997-1998	1641	545	2178	265	543	271	0	5443
1998-1999	1816	547	2179	275	547	275	0	5639
1999-2000	2004	547	2179	275	547	275	0	5827
2000-2001	2198	547	2179	275	547	275	0	6021
2001-2002	2201	575	2293	289	575	289	0	6222
2002-2003	2199	605	2413	304	605	304	0	6430
2003-2004	2196	636	2539	319	636	319	0	6645
2004-2005	2180	669	2672	335	669	335	0	6860
2005-2006	2182	704	2812	352	704	352	0	7106
2006-2007	2218	741	2960	370	741	370	0	7400
2007-2008	2336	779	3115	389	780	389	0	7788
2008-2009	2433	985	12	8	3	265	156	3862
2009-2010	2643	1211	20	13	2	282	159	4330
2010-2011	2852	1436	27	17	0	301	165	4798
2011-2012	3061	1661	34	21	0	318	171	5266

Source: Annual Administration Reports, MVD Ernakulam District

It is clear from Table: 8.13 that, during 1997-98 drivers contributed 2178 cases of accident out of the total 5443 accidents occurred in the district. This is due to using alcohol, drugs etc while driving, age of the driver etc. Due to lack of experience and expertise from the part of driver (fault of driver) causes road accident. 1641 road crashes occurred in 1997-98 due to the fault of driver. From the last four years onwards, the contribution given by bad driver decreases, but at the sometime, that of fault of driver increases. Out of the total 5266 accident occurred in the district during 2011-12, 34 contributed by bad driver while 3061 contributed by fault of driver. Fault of passengers also invite road accident, 1661 crashes contributed by this category (other than driver).

Table: 8.14
Percentage Share of Road Accidents by Different Causes

Year	Fault of Driver	Fault of Passenger	Bad Driver	Bad Weather	Technical Defect	Fault of Pedestrian	Others
1997-1998	30.15	10.01	40.01	4.87	9.98	4.98	0.00
1998-1999	32.20	9.70	38.64	4.88	9.70	4.88	0.00
1999-2000	34.39	9.39	37.39	4.72	9.39	4.72	0.00
2000-2001	36.51	9.08	36.19	4.57	9.08	4.57	0.00
2001-2002	35.37	9.24	36.85	4.64	9.24	4.64	0.00
2002-2003	34.20	9.41	37.53	4.73	9.41	4.73	0.00
2003-2004	33.05	9.57	38.21	4.80	9.57	4.80	0.00
2004-2005	31.78	9.75	38.95	4.88	9.75	4.88	0.00
2005-2006	30.71	9.91	39.57	4.95	9.91	4.95	0.00
2006-2007	29.97	10.01	40.00	5.00	10.01	5.00	0.00
2007-2008	29.99	10.00	40.00	4.99	10.02	4.99	0.00
2008-2009	63.00	25.50	0.31	0.21	0.08	6.86	4.04
2009-2010	61.04	27.97	0.46	0.30	0.05	6.51	3.67
2010-2011	59.44	29.93	0.56	0.35	0.00	6.27	3.44
2011-2012	58.13	31.54	0.65	0.40	0.00	6.04	3.25

Source: Annual Administration Reports, MVD Ernakulam District

The percentagewise analysis of the share of road accidents by different causes depicted in Table: 8.14. From this table, we can identify that in the year 2008-09, 63 percent of the total road accident occurred in the district is mainly due to the fault from the part of the driver. Fault from the part of passenger (25.50) also significant. During the year 2011-12, it is 58.13 percent and 31.54 percent respectively. Fault of pedestrians contributed 6.04 percent of the total accidents. Others category includes night driving, lack of proper maintenance, damaged condition of road, alcoholic driving, etc which constitute 3.25 percent of the total accident during the year 2011-12.

Road accidents lead to either death or injury or in some cases non injury. So next we can analyze the number of persons killed in accidents. Table: 8.15 below summarizes the year wise road accidental death due to the deficiencies and defectiveness from different sources like fault from the part of driver, passengers, pedestrians, technical inefficiency and inappropriate climatic and weather conditions etc. The table indicates that in 1998 there were 246 persons killed in road accident in the district.

Table: 8.15
Year wise Number of Persons Killed in Road
Accidents by Different Causes in Ernakulam District

Year	Fault of Driver	Fault of Passenger	Bad Driver	Bad Weather	Technical Defect	Fault of Pedestrian	Others	Total
1997-1998	128	19	60	10	19	10	0	246
1998-1999	129	19	60	10	19	10	0	247
1999-2000	137	19	60	10	19	10	0	255
2000-2001	148	19	60	10	19	10	0	266
2001-2002	149	19	63	10	19	10	0	270
2002-2003	158	19	66	10	19	10	0	282
2003-2004	171	19	69	10	19	10	0	298
2004-2005	182	19	72	10	19	10	0	312
2005-2006	208	19	75	10	19	10	0	341
2006-2007	173	19	78	10	20	10	0	310
2007-2008	91	80	82	10	31	20	13	327
2008-2009	163	78	6	0	0	23	25	295
2009-2010	192	63	6	0	0	19	37	317
2010-2011	137	52	6	0	0	32	18	245
2011-2012	202	39	6	0	0	37	17	301

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.16
Percentage share of Persons Killed in Road
Accidents by Different Causes in Ernakulam District

Year	Fault of Driver	Fault of Passenger	Bad Driver	Bad Weather	Technical Defect	Fault of Pedestrian	Others
1997-1998	52.03	7.72	24.39	4.07	7.72	4.07	0.00
1998-1999	52.23	7.69	24.29	4.05	7.69	4.05	0.00
1999-2000	53.73	7.45	23.53	3.92	7.45	3.92	0.00
2000-2001	55.64	7.14	22.56	3.76	7.14	3.76	0.00
2001-2002	55.19	7.04	23.33	3.70	7.04	3.70	0.00
2002-2003	56.03	6.74	23.40	3.55	6.74	3.55	0.00
2003-2004	57.38	6.38	23.15	3.36	6.38	3.36	0.00
2004-2005	58.33	6.09	23.08	3.21	6.09	3.21	0.00
2005-2006	61.00	5.57	21.99	2.93	5.57	2.93	0.00
2006-2007	55.81	6.13	25.16	3.23	6.45	3.23	0.00
2007-2008	27.83	24.46	25.08	3.06	9.48	6.12	3.98
2008-2009	55.25	26.44	2.03	0.00	0.00	7.80	8.47
2009-2010	60.57	19.87	1.89	0.00	0.00	5.99	11.67
2010-2011	55.92	21.22	2.45	0.00	0.00	13.06	7.35
2011-2012	67.11	12.96	1.99	0.00	0.00	12.29	5.65

Source: Annual Administration Reports, MVD, Ernakulam District

The percentage wise analysis shown in Table: 8.16, which explained that 67 percent of the road accident death occurred in the district in 2012 due to that fault of the driver. The fault of passengers and pedestrians bear only 12 percent of the responsibility. In 1997-98, due to the behavior of the driver, 24.39 percent of the accidents occur, but due to strict law enforcement, the contribution given by this category decreases and in 2012, it's only negligible percent (1.9 percent). Accident death due to technical defect reduced from the period of the study onwards and from 2009 onwards, no case is reported in that category (details can be viewed from table). Now-a-days bad weather is not a problem in road accident death. Others category includes bad road conditions, defect in planning of road construction, inappropriate turnings, traffic congestion etc. In 2010, such category of reasons accounted 11 percent of the total accidental death.

Number of persons injured in road accident due to different causes analyzed and it can be seen in Table: 8.17. When analyzed, it is clear that, road traffic accident injury cases increases at an increasing rate. During 1997-98, it was only 8302 traffic injuries reported, but in 2012, it increase four times. Now the figure is 255596, of which 14865 is due to fault of driver, 6331contributed by passenger's fault, 2279 provided by the fault of pedestrians. Other category contributed 1917 number of injuries in the last year.

Table: 8.17
Year wise Number of Persons Injured in Road
Accidents by Different Causes in Ernakulam District

Year	Fault of Driver	Fault of Passenger	Bad Driver	Bad Weather	Technical Defect	Fault of Pedestrian	Others	Total
1997-1998	2636	807	3217	413	813	416	0	8302
1998-1999	3241	818	3219	417	815	417	0	8927
1999-2000	3533	818	3219	417	815	417	0	9219
2000-2001	3836	818	3219	417	815	417	0	9522
2001-2002	3865	858	3386	436	855	436	0	9836
2002-2003	3891	899	3561	456	896	456	0	10159
2003-2004	3908	944	3746	477	941	477	0	10493
2004-2005	3909	991	3940	500	988	500	0	10828
2005-2006	3941	1041	4145	524	1038	524	0	11213
2006-2007	3545	1186	4735	596	1183	595	0	11840
2007-2008	3441	1748	4788	575	1145	575	7	12279
2008-2009	13113	4963	120	49	389	2133	1542	22309
2009-2010	13762	5419	126	55	195	2182	1667	23405
2010-2011	14411	5875	131	61	0	2230	1792	24500
2011-2012	14865	6331	137	67	0	2279	1917	25596

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.17 shows that 58.08 percent of the total traffic injuries contributed by driver, 24.73 by fault of passenger. Until 2008, bad driver was a significant factor contributed to 38 percent of the injuries in relation to traffic, but in 2012, the figure is not so significant. Fault of driver causes 58 percent of road accidents in the district from 2008 onwards. Till the year 2008, an average of 30 percent of accidents responsible by this category. Up to 2008, fault of passenger responsible for an average of 10 percent road accidents in the district. The percent is almost double in the next five years.

Table: 8.18

Road Traffic Fatalities on Different Types of Roads in Ernakulam District

Year	Number of Accidents in NH	Percentage of Accidents in NH	Number of Accidents in SH	Percentage of Accidents in SH	Accidents in Other Type of Roads	Percentage of Accidents in Other Type of Roads	Total Number of Accidents
1997-1998	2752	50.56	2042	37.52	649	11.92	5443
1998-1999	2874	50.97	2107	37.36	658	11.67	5639
1999-2000	2970	50.97	2177	37.36	680	11.67	5827
2000-2001	3069	50.97	2250	37.37	702	11.66	6021
2001-2002	3172	50.98	2325	37.37	725	11.65	6222
2002-2003	3278	50.98	2403	37.37	749	11.65	6430
2003-2004	3388	50.99	2483	37.37	774	11.65	6645
2004-2005	3498	50.99	2563	37.36	799	11.65	6860
2005-2006	3624	51.00	2655	37.36	827	11.64	7106
2006-2007	3774	51.00	2765	37.36	861	11.64	7400
2007-2008	3972	51.00	2910	37.37	906	11.63	7788
2008-2009	864	22.37	559	14.47	2439	63.15	3862
2009-2010	1872	43.23	999	23.07	1459	33.70	4330
2010-2011	2879	60.00	1440	30.01	479	9.98	4798
2011-2012	3226	61.26	1881	35.72	159	3.02	5266

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.18 summarizes the number of traffic accident happened in NHs, SHs, and other Major District Roads and Rural Roads. It indicated that out of the total 5443 accident occurred in the district during 1997-98, 2752 were in National Highways, 2042 in State Highways and the rest was in other regional roads. Up to 2007-08, 50 percent of the total accident occurred in the district happened in National Highways and 37 percentages in State Highways. The main reason is the metropolitan facet of Ernakulam district, which is well connected with other major part of the world by air, rail, water and road. In 2011-12, the proportion of accident in National Highways is 61.26 percent, which is out of the total 5266 accident, 3226 reported at National Highways, 1881 in State Highways. The accident share on other category of is only 3.02 percent.

Number of persons killed in National Highways, State Highways and other category of roads due to road traffic fatalities shown in Table: 8.19 below. During 1997-98, 47.56 percent (117 persons) of the total number of persons killed in National Highways accident, and 21.54 percent (53 persons) in State Highways. 30.89 percent (76 persons) of the total traffic death happened in other category of roads. However, in 2012, the figure and share increases. Out of the total 301 persons killed, 163 reported in National Highways, 96 in State Highways, 42 in other category of roads, a share of 54.15 percent, 31.89 percent, 13.95 percent respectively.

Table: 8.19

Persons Killed in Road Traffic Fatalities on Different Types of Roads

Year	Number of Persons Killed in NH	Percentage of Persons Killed in NH	Number of Persons Killed in SH	Percentage of Persons Killed in SH	Persons Killed in Other Type of Roads	Percentage of Persons Killed in Other Roads	Total Number of Persons Killed
1997-1998	117	47.56	53	21.54	76	30.89	246
1998-1999	128	51.82	55	22.27	64	25.91	247
1999-2000	144	56.47	67	26.27	44	17.25	255
2000-2001	154	57.89	68	25.56	44	16.54	266
2001-2002	137	50.74	69	25.56	64	23.70	270
2002-2003	156	55.32	76	26.95	50	17.73	282
2003-2004	165	55.37	78	26.17	55	18.46	298
2004-2005	172	55.13	84	26.92	56	17.95	312
2005-2006	183	53.67	94	27.57	64	18.77	341
2006-2007	175	56.45	82	26.45	53	17.10	310
2007-2008	185	56.57	87	26.61	55	16.82	327
2008-2009	135	45.76	81	27.46	79	26.78	295
2009-2010	141	44.48	87	27.44	89	28.08	317
2010-2011	147	60.00	74	30.20	24	9.80	245
2011-2012	163	54.15	96	31.89	42	13.95	301

Source: Annual Administration Reports, MVD, Ernakulam District

Road accident leads to grievous injury or minor injury. Here we take into the figure as total injuries. Injury cases reported in category wise road are as follows (Table: 8.20). In this cases too, the share of National Highways exceeded to that of State Highways. In 2012, 15962 persons injure in road accident on National Highways. It constituted 62.36 percent of the total injuries. 7869 injury cases reported on State Highways. Table: 8.21 summarizes the fatal cases of road accident in the district. The number of accidents reported as fatal in 1997-98 was 5443, the figure reached 7788 during 2007-08. In 2012, 5266 road accidents reported under fatal category.

Table: 8.20

Persons Injured in Road Accidents on Different Types of Roads

Year	Number of Persons Injured in NH	Percentage of Persons Injured in NH	Number of Persons Injured in SH	Percentage of Persons Injured in SH	Persons Injured in Other Type of Roads	Percentage of Persons Injured in Other Roads	Total Number of Persons Injured
1997-1998	4080	49.14	2547	30.68	1675	20.18	8302
1998-1999	4602	51.55	2604	29.17	1721	19.28	8927
1999-2000	4755	51.58	2689	29.17	1775	19.25	9219
2000-2001	4913	51.60	2776	29.15	1833	19.25	9522
2001-2002	5076	51.61	2867	29.15	1893	19.25	9836
2002-2003	5244	51.62	2960	29.14	1955	19.24	10159
2003-2004	5418	51.63	3057	29.13	2018	19.23	10493
2004-2005	5593	51.65	3154	29.13	2081	19.22	10828
2005-2006	5793	51.66	3266	29.13	2154	19.21	11213
2006-2007	6032	50.95	4454	37.62	1354	11.44	11840
2007-2008	6348	51.70	3575	29.11	2356	19.19	12279
2008-2009	5352	23.99	3513	15.75	13444	60.26	22309
2009-2010	10026	42.84	5431	23.21	7947	33.96	23404
2010-2011	14700	60.00	7350	30.00	2450	10.00	24500
2011-2012	15962	62.36	7869	30.74	1765	6.90	25596

Source: Annual Administration Reports, MVD, Ernakulam District

Table: 8.21

Year wise Fatal Cases in Road Accidents

Year	Number of Accidents	Persons Killed	Grievously Injured	Minor Injured
1997-1998	5443	246	2682	1669
1998-1999	5639	247	2777	1728
1999-2000	5827	255	2868	1785
2000-2001	6021	266	2963	1843
2001-2002	6222	270	3061	1904
2002-2003	6430	282	3163	1967
2003-2004	6645	298	3268	2031
2004-2005	6860	312	3373	2095
2005-2006	7106	341	3494	2169
2006-2007	7400	310	3638	2258
2007-2008	7788	327	3828	2376
2008-2009	3862	295	948	1862
2009-2010	4330	317	981	2241
2010-2011	4798	245	1014	2619
2011-2012	5266	301	1047	2998

Source: Annual Administration Reports, MVD, Ernakulam District

The number of persons killed in road accident shows an increase until 2006 (341 deaths), then declined and in 2012, it is 301. Fatal cases grievously injured are also very high. There were 2682 cases reported in 1997-98, and 2012 it become 1047. The minor injured reported cases increases. In 1997-98, 1669 persons minor injured, but in 2012, the figure touches 3000. In the figure of road accidents, grievous injury reported cases and minor injury reported cases significant in the district case.

One important point to be worth mentioned here is that, the whole city roads of Ernakulam is under the eyes of cameras placed at the top of the electric post. This is for checking and enacting strict law enforcement. Thus, no one can escape from the eyes of these cameras after doing any unruly road and traffic manners. If anyone does, he will be fined. This is, to a large extent decreases the drinking habit of drivers, increases the use of helmets and seat belts while driving, etc.

8.7 CONCLUSION

Road transport is the lifeline of India. The growth of this sector is essential for the growth of Indian economy. On the contrary, the damage caused by road accident is enormous and the estimated loss is about 3.2npercent of GDP. Road death takes the greatest toll on the Asia and Pacific region where 44 percent of the world's road deaths occur and 16 percent of the total motor vehicles are found. This can be curtailed only through a sound and sustainable urban transport policy. It is the duty of every citizen to follow the traffic rules strictly, so that every one can avoid accidents. It is in the hands of all those who are directly or indirectly involved in following the law and regulations.

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CHAPTER - 9

SUMMARY, FINDINGS, POLICY INITIATIVES AND CONCLUSION

9.1 SUMMARY OF THE STUDY

Urban road transport is one of the most important sectors having a direct bearing on Sustainable Development because of the transport sector's energy consumption and Green House Gas emissions. The environmental implications of this rapidly growing and poorly regulated motorization are highly problematic at local scale. It has permanent and even irreversible impact on the environment. Therefore, it requires rationalization and management of demand by shifting towards environment- friendly modes, collective transport and better utilization of existing capacity. Developing a sustainable transport system have been espoused as potential solution to transport development. With out proper planning of future transport systems, we cannot achieve the Principles of Sustainability. The present thesis examined the environmental externalities of urban road transport in Ernakulam district.

The thesis titled as 'Environmental Issues of Urban Road Transport in Ernakulam District', presented in nine chapters. The study start with 'Design of the Study', which includes a brief introduction followed by review of studies on urban transport, then statement of the research problem, objectives of the study, data sources and methodology of analysis and different terms and concepts used in the study. The second chapter, 'Economics Transport: An Overview', discussed the theoretical background of the study. It examines various theories, worldwide agreement and efforts related to transport and environment and development. After that, 'Linkages Between Economic Development, Urbanization and Transport Development', presented in chapter third, provides a glimpse of the link between urbanization and economic development, transport and environment, environmental impact of transport and urban air pollution in India. Next chapter, 'Urban Road Transport Network in India: An Exploration', presents an outline of the urbanization and transport trend in the international, national and regional context. Chapter five, 'Road Transport in Ernakulam District', focused on an overview of urban transport and vehicular mobility in Ernakulam and Kochi. In, 'Vehicular Emission: The Case of Ernakulam District', explains, motor vehicles emission in Ernakulam and Kochi both for registered vehicles and in-use vehicles. Chapter seven, 'Motor Vehicles Fuel Consumption in Ernakulam District', estimates consumption in Ernakulam district. Subsequent chapter, 'Road Accident in India: An Account', analyses road accidents in India, Kerala and Ernakulam district. Last chapter, 'Summary, Findings, Policy Initiatives and Conclusion', outlines the summary of the study, major findings of the study, policy initiatives and conclusion.

9.2 MAJOR FINDINGS OF THE STUDY

9.2.1 Urban Road Transport Network in India: An Exploration

1. In India the rural and urban population constitutes 83.31 crore and 37.71 crore respectively and the total population is 121.02 crore as per the 2011 Census. Urban population increased to 31.16 percent from 27.78 percent in 2001 and the urban- rural ratio increased to 45.26 percent from 38.47 percent during the same period.
2. Compared to other States, Kerala occupies 4th position with regard to urbanization. The share of urban population in Kerala recorded steady growth from 7.11 percent in 1901 to 47.72 percent in 2011. The higher growth of urban population is mainly due to the increase in the number of town's from 159 to 520 during the period 2001 to 2011. Urban-rural ratio shows an increasing trend over a century. The data of census 2011 shows that in Kerala, the urban rural ratio is 91.27percent.
3. Ernakulam district is the most urbanized district in the State in terms of absolute number of urban population (14.77 lakhs) and the percentage of urban to total district population (47.56 percent) as per 2001 census and 68.07percent as per 2011 census. The district is highly urbanized with Kochi Urban Agglomeration acting as a magnet attracting economic investments in many sectors. Kochi is one among the eleven cities, which have newly emerged as big cities in India having more than 10 lakh populations (2011 Census).
4. In India, transport sector caters to the needs of 1.1 billion people. The share of transport sector in Gross Domestic Product (GDP) of India has increased from 6.0 percent in 2001-02 to 6.5percent in 2010-11. Today, India has one of the largest road networks in the world, of 41.09 lakh km. National Highway network of about 71,772 km comprises only 2 percent of the total length of roads, but carries over 40percent of the total traffic across the Country. State Highways and Major District Roads carries about 40% of the total road traffic, although it constitutes about 13% of the total road length.
5. The total road length has increased from 4.0 lakh km. as on 31.03.1951 to about 42.4 lakh km as on 31.03.2012, an increase of more than 10 times. The total length of National highways has increased from 22.2 Th. Km to 75.1 Th. km, an increase of about 3 times only, during this period.
6. The National Highway network has grown at CAGR of 5.7 percent after the launch of the National Highway Development Programme (NHDP) in 1998. The NHDP is the

largest and foremost infrastructural program being undertaken in Country for the purpose of achieving its growth target. In 2009-10, the National Highways Authority of India was able to build highways at an average of 13.72 km per day. This dropped further to an average of 10.39 km per day in 2011-12, against the much higher and seemingly formidable target of 20 kms a day.

7. Total number of registered motor vehicles increased from about 0.3 million as on 31st March, 1951 to about 142 million as on 31st March, 2011 in India. It grew at a Compound Annual Growth Rate (CAGR) of 9.9percent between 2001 and 2011.The share of two wheelers was about 72 percent of the total registered motor vehicles in India as on 31st March, 2011, having increased from 8.8percent as on 31st March 1951.
8. Maharashtra State accounted for the largest share (12.3percent) of the total registered motor vehicles in the Country. Sikkim reported the lowest number of the total registered vehicles of 0.39 lakh (0.03percent).
9. During 2001-2011, the growth rate of registered motor vehicles was almost three times the growth rate of the road network. Amongst the various categories of vehicles, the highest CAGR during 2001-2011 was recorded by cars, jeeps and taxis (10.5 percent), followed by two-wheelers (10.2percent). Two-wheelers accounted for the largest share of 72 percent, followed by cars, jeeps and taxis (14 percent).
10. Kerala, southernmost State of India, has a good network of roads. It has eight National Highways, number of State highways and many district roads. National Highway authority of India maintains 444.9 km and Kerala PWD (NH) section maintains rest of the National Highways from direction of Ministry of road Transport and Highways (MoRTH). There are about 1.6 lakh kilometers of roads in the State of which only 20 percent are motorable. 80 percent of motorable traffic uses the arterial and sub-arterial roads consisting of National Highways, State Highways and Major District Roads.
11. The vehicle population in the State is growing at an average rate of more than 10 percent every year. The number of motor vehicles registered in the State was 5.81 lakh in 1990, 48.80 lakhs in 2009 and had crossed 52 lakh in 2011. Of these 25,000 are stage carriages (bus services). 63 percent of the vehicles are two wheelers. Around 5 lakh vehicles are now added on the state roads every year. The road length in the State is 1.74 lakh km and the road density is about 1417 km / 100 sq km, which is higher than the national average.

9.2.2 Road Transport in Ernakulam District

1. Ernakulam district has excellent road connectivity, connecting between northern and southern part of State. Out of the total road length of the State (1.6 lakh km), the district ranks top with a total road length of 2172 km. Out of the total length, 72.1 km (11.74 Percent) is owned by PWD and 541.865 (88.26 Percent) by Kochi Corporation. In Kochi, 56.6 Percent of total road length is single lane, only 7 Percent is three laned, less than single lane is 16.3 Percent, 28.46 km road length is four laned ones.
2. The annual growth of newly registered vehicles in the district is 7.5 Percent. At the end of 2012 there were 1136226 registered vehicles in the district. From 2011 April to 2012 March, an increase of 100723 vehicles reported in the district.
3. In the Corporation, the number of newly registered motor vehicles shows an annual growth of 7.4 Percent from the last decade onwards. As on 2011, a total of 1072868 vehicles are registered in Ernakulam, of which 601801 registered in Kochi (56.09 Percent). In 2011, it is 67643 and 39190 respectively (57.94 Percent of the district total). Kochi Corporation with that of the district is 59.33 Percent of newly registered and 53.43 Percent of total registered vehicles.
4. Road vehicles are categorized into two: Transport and Non-Transport, on the basis of the purpose it served. In the district, out of the total 1231404 number of vehicles, 293583 are Transport Vehicles and 937821 are Non-Transport Vehicles. Total Transport vehicles grow at 23.84 Percent of total vehicles in 2011-12 year, and that of Non-Transport is 76.16 Percent of total vehicles. During 2011-12, newly registered (both Transport and Non-Transport) vehicle's are 88321, of which Transport vehicles account 13256 and that of Non-Transport Vehicles 75065.
5. For the Kochi Corporation, the registered transport vehicles are estimated at 5409. It is 40.81 percent of the total transport vehicles in the district as on 2012 and of Non-Transport are 36949 (49.22 percent of the Non-Transport Vehicles in the district).
6. Newly Registered Transport Vehicles in the District grow at an average of 14.29 Percent from the last 15 years onwards. While, in the case of Kochi, it is 12.74 Percent. The increase of Non-Transport Vehicles in Ernakulam District is 85.72, and in Kochi it is 87.26. That is the growth of Newly Registered Non- Transport Vehicles is 6 fold of the growth of Transport Vehicles. Out of the district total, in each year, an average of 50.6 Percent of Newly Registered Transport Vehicles is registered under Kochi Corporation limit. Likewise 56.3 Percent of the total district's Non-Transport Vehicles comes under the corporation area.

7. Two wheelers growth in the district in each year is 60.14 Percent of the total vehicles growth. Passenger transport vehicles grow at 24.28 Percent. Non- Transport vehicles except two-wheelers increase at 8.5 Percent per annuam on an average. 5.65 Percent is goods vehicles growth.
8. During the year 2011-12, 47.96 percent of the newly registered motor vehicles in the district is from Kochi that shows the mobility at the centre of the district. Also 52.31 percent of the total vehicles in the district were come under the Kochi regional transport office (Mattanchery, and Ernakulam RT Offices).
9. Every year on an average 4077 Passenger vehicles added in the district. Out of these, 816 are Autorickshaw 3 in all (12.53 Percent of total Passenger Vehicles) and 1438 number of Autorickshaw 4 in all, which constitutes 35.44 Percent of Passenger Vehicles in the District. Motor Cab is also registered in the district, which is on an average 1205 numbers per year that have a share of 28.74 Percent.
10. In the year 2019-20, future values for the outlay for traffic and transport sector is -782.93 and total outlay is 1210.42. Future values of the operation and maintenance expenditure for roads and pavements in Kochi for the year 2019-2020 is 240986022.93. Vehicle tax and transportation expenditure shows a diminishing trend.
11. During the year 2019-20, the newly registered vehicles estimated to be as 44881.36308, total motor vehicles would be 788016.9692 and that of growth percent calculated as -17.79. in the case of Kochi, it would be 51696.79 and 89834.52 that of the district Ernakulam. In the case off total registered vehicles, it is 874311.65 and 1589532.13 respectively.
12. It is predicted that vehicles transferred in the district would be 23308.02 during 2019-20, 571.63 registration cancelled vehicle and the number of vehicles transferred out from the district would be 16135.73.
13. The estimated value of total transport vehicles is 283810.29 and that of non-transport vehicles is 1305721.85. That is, 1589532.13 for the total transport and non-transport vehicles during the year 2019-20.
14. In the case of newly registred non-transport vehicles, the future value estimated as 39424.93 and that of non-transport vehicles is 679340.84 during the same period. In the case of grand total that is, total of transport and non-transport vehicles the figure is estimate as 788016.97 at the period of 2019-20.

15. In the district Ernakulam, the future value of newly registered transport vehicles at the year 2019-20 estimated as 12707.56 and that of Kochi Corporation is 7705.49. In the case of non-transport vehicles, the estimated figures are 76987.90 and 43991.30 respectively.
16. Highest Compound Annual Growth Rate shown by goods vehicles in the District (14.37 percent), even though all other vehicles category shows a percent of 24.02. The Compound Annual Growth Rate of two wheelers estimated as 5.58 percent. Passenger transport vehicles grow at 24.28 Percent. Non- Transport vehicles except two-wheelers increase at 8.5 Percent per annuam on an average. 5.65 Percent is goods vehicles growth. Average Annual Growth Rate of Goods vehicles are, 15.81 percent and its Exponential Growth Rate is 7.46 percent.
17. During the year 2019-20, it is predicted that, in the district 909055 two wheelers, 305774 passenger transport vehicles, 225054 non- transport vehicles, 112799 goods vehicles, 3007tractors and trailers and 33844 all other category of vehicles.
18. Annual Average Growth of Multi Axled and Articulated vehicles shows a percent of 123.88 while that of Light Motor Vehicles (LMV) shows a figure of 113.59 percent. In the case of Three Wheeler, calculated AAG shows a percent of 58.69, while that of Four Wheelers is 19.5 percent. The Exponential Growth rate of other vehicles shows a figure of 13.3 percent.
19. The future values predicted during the year 2019-20 for the growth of Non-Transport Vehicles in Kochi, is 27537 for Motor Cycles, 12392 for Cars, 3031 for other vehicles, thus 42109 Non-Transport vehicles.

9.2.3 Vehicular Emission in Ernakulam District

1. The ambient air monitoring in Ernakulam district are carried out in M.G. Road, South Over Bridge, Vytila, Irumpanam, Kalamassery, Eloor-Methanam and Udyogamandal Eloor. Air characteristics monitored include Sulphur Dioxide (SO_2), Nitrogen Oxides (NOX), Respirable Suspended Particulate Matter (RSPM) and Suspended Particulate Matter (SPM). The monitoring of pollutants is carried out for 24 hours (8 - hourly sampling for SO_2, NO_X, SPM and RSPM /PM_{10}). The emission rate of each of the pollutant is measured by a nine days monitoring at each station in every month and finding out the mean value for getting, the Annual Average.
2. During the year 2009, the highest mean value, of SO_2 recorded at Kalamassery (4.58 Mg/m3), of NO_X at South Over Bridge monitoring station (18.51 Mg/m3), of RSPM

at Eloor-Methanam (50.42 Mg/m3), and of SPM at Udyogamandal monitoring station (118.83 Mg/m3).

3. The ambient air quality during 2010 shows that, the highest mean value, of SO_2, NO_X and RSPM are recorded at Kalamassery (5.67 Mg/m3, 17.04 Mg/m3 and 45.93 Mg/m3). The highest SPM value recorded at Udyogamandal monitoring station (76.85 Mg/m3).
4. During the year 2011, the highest mean value of SO_2 and NO_X are recorded at M.G. Road (4.28 Mg/m3 and 19.03 Mg/m3), of RSPM recorded at Kalamassery (58.67 Mg/m3),
5. Air Pollution values in each station determined. Here we take into account the Revised National Ambient Air Quality Standard of CPCB as the AAQ values of each pollutant (SO_2-50Mg/m3, NOx -40 Mg/m3, RSPM-60 Mg/m3 and SPM- 40 Mg/m3). It is clear that a total of seven monitoring stations in Ernakulam district show moderate air pollution during the year 2011. The Air Pollution Index of Kalamassery during 2011 was 74.51, touches the heavy air pollution level. During 2009, Near south over bridge, Eloor Methanam and FACT Udyogamandal Eloor, showed heavy air pollution.
6. Emissions of different category of vehicles are shown in Kg per one Km. Cars and Jeeps category emits more Carbon Dioxide (71560.3 Kg/Km) to the atmosphere even though Two Wheelers exceed in its number. The CO_2 of Two Wheelers is 18077 Kg/ Km. Trailors and Tractors emit less as these are less in number. Carbon Monoxide emission of Two Wheelers is very high (1495.1 Kg/Km) when compared to other category of vehicles. Trucks and Lorries emit more Nitrous Oxide (135.9), Taxi and Motor Cab emit 379.3 Kg/Km Sulphur Dioxide, Hydro Carbon emitted by Two Wheelers are high (695.0 Kg/Km).
7. The consolidated emission details shows that total emission of CO_2 from various categories of vehicles for one kilometre is 203093.34 kg, which is 96.75 percent of the road transport vehicles emission. For Carbon Monoxide it is 3193.66 that constitute only 1.52 percent of the total emission.
8. To get more clear emission of pollutants, we have to consider the Vehicle Kilometre Distance Travelled (VKT) by every vehicle in the district. The annual emission is calculated and is expressed in tonne (1000 Kg) by considering the travel distance of each category of vehicles. Trucks and Lorries emit more Carbon Dioxide emission, 2311264.3 tonne in a year. It constitutes 32.49 percent of the total carbon dioxide

emission in the district. The next highest emitter of CO_2 is light motor vehicles goods, 29.24 percent of total CO_2 emission in the district. Highest CH4 emitter is two wheeler 856.17 tonne for an average distance of 63000 km in a year (here we take 2013 as the year).

9. The total emissions of pollutants from various categories of vehicles in 2013 shows that Carbon Dioxide constitutes 97.52 percent of the total emission in the year 2013. 7113113 tonne is the emission of Carbon Dioxide in the district. Other pollutants values are negligible when compared to this value. Carbon Monoxide emission is only 71068.3 tonne. Hydro Carbons emit 15.71.17 tonne into the atmosphere.
10. In Kochi, 452.4 Kg Carbon Monoxide and 51087.7 Kg CO2 are contributed by Cars and Jeeps for one kilometre travel. Trucks and Lorries emit 16960.9 Kg/KM CO_2 even though they are 32921 in number. These categories of vehicles emit Hydro Carbon (28.6 Kg/Km).
11. Out of the total Carbon Dioxide emission in the district, 47.69% contribute to Kochi Corporation Registered Vehicles. The Corporation contributed 69860.11 Kg/Km CO_2 Emission. That is 97.35 percent of the total transport emission in the district. These figures are only for the emission per one kilometre.
12. The annual emission of each pollutant in the Kochi Shows that that Trucks and Lorries emit more Carbon Dioxide emission, 975251.8 tonne in 2013 year. It constitutes 32.29 percent of the total carbon dioxide emission in Kochi Corporation.
13. Traffic Volume Analysis is done to find in-use vehicles emission from the three outer area of Ernakulam district i.e, Angamaly, Aluva, Kothamangalam along with district centre, Kochi as per the Indian Road Congress Guidelines (04-05-2013 to 10-05-2013, seven days of each station) at both upward and downward direction of each location.
14. At Angamaly location, 8 AM to 9 AM is the peak hour, were an average of 1502 Vehicles counted (During the survey), those passed to Thrissur direction. But to Ernakulam direction, an average of 1766 vehicles passed at the peak hour, evening 5-6 PM. At Aluva station, during the survey time, the peak hour of traffic towards Aluva was 4 PM to 5 PM (969 vehicles counted) and that towards Ernakulam direction was 3 PM to 4 PM (2545 vehicles counted). An average of 1288 vehicles passes through to Perumbavoor during 12 PM to 1 PM at Kothamangalam station and that to backward direction was an average of 1279 during 11 AM to 12 PM. In the

case to Kochi to Vytila direction the peak hour is 7 PM to 8 PM, an average of 8863 vehicles passed, and to Ernakulam town direction 9217 vehicles counted..

15. From the traffic volume survey, it was observed that personalized vehicles such as two wheelers, Cars and Multi Utility Vehicles are the leading vehicles on the roads. When we analyzed the emission quantity among the four selected places, it has to be noted that, Kochi surpass all other three locations in all pollutants emission. The in-use vehicles as a total of these four locations emit 357364.59 Kg Carbon Dioxide, 5156.19 Kg Carbon Monoxide, 3018.29 Kg Oxides of Nitrogen, 2226.0 Kg Hydro Carbon, 322.54 Kg Methane, 867.48 Kg Sulphur Dioxide and 312.56 Kg Particulate Matter. In all the four locations, the emission of Carbon Dioxide exceeds other pollutants rate of emission.
16. Emission of Carbon Dioxide in Kochi city only estimated as 209138.06 Kg, and that of CO is 3272.79 Kg/km/week. This is only for one kilometre travelling emission. Actually the Vehicle Kilometre Travelled (VKT) of different vehicles are different, thus the emission rate is far exceed the above measured one. It is to be remembered that once the vehicles emitted the pollutants, it diluted in the atmosphere, and while it is contaminated in the air, it badly affect to the surrounding environment depending upon the wind direction.

9.2.4 Motor Vehicles Fuel Consumption in Ernakulam District

1. In Kerala, one refinery is situated at Kochi, which is run by BPCL from 2002 onwards. A total of 6 terminals (places were refined products pumped to a storage point), 5 Bulk depots and 7 LPG bottling plants functioning in our State. Total number of retail outlets in Kerala is 1766, which supplied various petroleum products like LPG, Naphtha, Motor spirit, Kerosene, High Speed Diesel (HSD), Furnace Oil, Bitumen, Lubes, and Aviation Fuel (ATF). Out of these, IOC has 795, BPC have 425 and HPC have 546 retail outlets.
2. In Kerala, Ernakulam district ranked highest in the consumption of petrol and diesel from the last ten year onwards. The petrol and diesel consumption of the district increases more than double with in the last ten years. As per the latest report, the district consumed 166585 KL petrol and 434601KL diesel.
3. Among the fourteen districts, the highest percent of motor spirit consumed by Ernakulam district. The total consumption is 1173547 KL during 2012-13, of these 166585KL Consumed by Ernakulam district followed by Trivandrum 154728 KL.

Ernakulam district petrol consumption was 14 percent State's consumption. The least consumption of petrol is in Wayanad district.

4. The consumption of petrol and diesel of both the State and district shows an increasing performance over the last years. The district shows an annual average of 15.35 percent of growth by petrol and 17.35 percent growth by diesel during the period. During the period 2012-13 the total petrol consumption of Kerala was 1173547 KL and that of diesel was 2553595 KL. The district Ernakulam consumed 14.20 percent of State's petrol and 17.02 percent of the State's diesel consumption.
5. In India, the Compound Annual Growth Rate of Petrol quantity from 2006-12 is 8.11 percent and that of Diesel quantity is 6.8 percent. Compound Annual Growth Rate of Petrol consumption in Kerala State during the year 2003-04 to 2012-13 is 14.66 percent. Among the various districts of the State, the highest growth rate recorded at Wayanad District (26.05 percent).
6. District wise consumption of Petrol distributed by IOC in Kerala shows 17.82 percent of Compound Annual Growth Rate, of these the highest growth rate recorded in Kannur district (25.57 percent) and the least in Pathanamthitta district (8.78 percent only). Compound Annual Growth Rate of district wise consumption of HSD supplied by IOCL in Kerala is 15.19 percent, by BPCL is 12.26 percent and that of HPCL is 14.62 percent during the year 2003-04 to 2012-13.
7. Compound Annual Growth Rate of district wise consumption of Petrol distributed by Bharat Petroleum Corporation in Kerala during the last ten years shows 11.25 percent. Among the various district cases Wayanad district recorded 68.62 percent Compound Annual Growth Rate.
8. Compound Annual Growth Rate of district wise consumption of Petrol distributed by HPCL during the last ten years that is from 2003-04 to 2012-13 is 13.01 percent. The highest is at Wayanad district (26.45 percent) and the least is at Ernakulam district (6.7 percent). During the year 2012-13 the annual utilization of Petrol distributed by HPCL was 321853 KL, of these Ernakulam district consumed 40704KL. Least is by Mahe, 3395 KL only.
9. Compound Annual Growth Rate of total Petrol consumption in Kerala is 10.05 percent and that of Diesel consumption in Kerala during 2003-04 to 2012-13 is 14.26 percent. Among the different district of our State, the highest growth rate recorded at Malappuram District (20.76 percent).

10. Compound Annual Growth Rate of Petrol consumption in Ernakulam district is 7.66 percent and that of Diesel consumption is 9.37 percent. The market share of IOCL shows a growth rate of 2.54 percent of Compound Rate of Petrol and that of Diesel with a growth rate of 0.34 percent. All other companies share shows a declining growth rate during the last ten years.
11. The Compound Annual Growth Rate related to the growth volume of Diesel in Ernakulam district is 5.41 percent. IOCL shows a marked growth rat of 20.62 percent of CAGR in relation to the growth volume of diesel in the district.

9.2.5 Road Accident in India: An Account

1. In India around 4.4 lakh road accidents occurred during 2010-11 - one road accident every minute - resulting in death of 130,000 persons - one road accident death in every 6 minutes. The incidence of accidental deaths has shown an increasing trend during the decade 2000-2011 with an increase of 50 Percent in the year 2010.
2. In Kerala, during the year 2000, the total number of road accidents was 37072; it goes on increasing till 2005 then begins to decline and in 2011 it was 35216. In 2000, only 2710 (7.3 Percent) of the total road accident cases met death, while in 2011, it is 4145 (Percent of 11.8 of total accident cases).
3. During 2011, out of the total number of case reported, two wheelers responsible for 11303 accident cases, (32 Percentage of State's accident case), Car, Jeeps and Taxi responsible for 8909 cases of accidents. Highest total number of people killed during the year 2011 is due to two wheeler accident, and there were 11329 persons injured due to the same reason. 11188 persons injured due to Car, Jeeps and Taxi. Two wheelers responsible for 32.10 of accident cases, 26.47 percent of person's road traffic accident death, 27.38 percent persons accident injury during the year 2011. The category of Cars, Jeeps and Taxi account 25.30 percent accident cases, 21.59 people's accident death, and 27.04 person's injury.
4. When we analyses different type of roads involved in accident, we known that, 9519 cases of road accidents reported occurred in National Highways (27.03 percent), 6401 cases in State Highways (18.18 percent). During 2011, 1432 persons killed, 11201 persons injured in the accidents occurred in National Highways (34.55 percent and 27.07 percent respectively).
5. District wise road accident details shows that during 2011, the number of accident case is very high in Ernakulam district (5251 cases, total of city and rural) while comparing to other districts. It is 15 percent of the State total. The reporting of road

accident among the five Municipal Corporations in Kerala revealed that the highest accident cases reported in Kochi Municipal Corporation (1986) and lowest in Thrissur Municipal Corporation (1262).

6. The number of death cases in accidents is also high in Ernakulam district (355). The number of grievously injured road accident cases is very high in district Ernakulam (2526) The reporting of grievously injured road accident cases is highest in Ernakulam range (8617).
7. The number of vehicle involved in accidents at Ernakulam are by KSRTC buses (202), by private buses (583), by Lorries (583), by Mini Lorries & Buses (265), by Car (1602), by Auto Rickshaws (770) and by two wheelers (3780) during 2011.
8. Accidents by unknown vehicles is also highest in Ernakulam (84). The reporting of accident cases during the Night is highest in Ernakulam range (3045). Kochi ranks 20th rank among the 35 metropolitan cities in India, however, ranks 6th among all the Metropolitan Accident Risk Index (4.98).
9. The district registered an abnormally high proportion of two-wheeler fatal accident. Out of the 5266 road accident fatalities during 2012, 2228 caused by two-wheelers crashes and 1528 due to three wheelers accidents. Other category like van, tempos, tractor, trailers etc constituted 17 fatalities.
10. The period from 1997 to 2012, revealed that 9.4 percent of the State’s two wheeler accident contributed by Ernakulam district.of the 25596 injury cases, 6359 by two wheeler and 4081 by car, jeeps and taxis.
11. Out of the total 5266 accident occurred in the district during 2011-12, 3061 contributed by fault of driver. Fault of passengers also invite road accident, 1661 crashes contributed by this category (other than driver).
12. In 2011-12, the proportion of accident in National Highways is 61.26 percent, which is out of the total 5266 accident, 3226 reported at National Highways, 1881 in State Highways. The accident share on other category of roads is negligible (only 3.02 percent).
13. Number of persons killed in National Highways, State Highways and other category of roads due to road traffic fatalities shows that out of the total 301 persons killed, 163 reported in National Highways, 96 in State Highways, 42 in other category of roads, a share of 54.15 percent, 31.89 percent, 13.95 percent respectively.
14. In 2012, 15962 persons injured in road accident on National Highways. It constituted 62.36 percent of the total injuries. 7869 injury cases reported on State Highways.

9.3 POLICY INITIATIVES

The present transportation system in the State evolved as a piece-meal process, which remains under connected and uncoordinated. It's characterized by high operating cost, inefficiency, environmental damage, health hazards and high accident risk. The situation is likely to worsen in future due to increase in population, urbanization and demand for personalized transport resulting from economic growth and higher income. The daily transport demand expected to grow from present 135 lakh trips to over 180 lakh passenger trips by 2015.

The goal of healthy and sustainable transport is to maximize access, personal mobility and healthy physical activity. There is no shortage of possible solutions to transport problems. The number and diversity of excellent alternatives is testament to widespread ingenuity and creativity. Ultimately a holistic approach, which includes enforcing stringent emission norms, efficient transport planning and public transport, land use planning providing for wider roads, more greenery and improved technologies and fuels etc, will lead to reduce the problems to a greater extent. Some of the broad action plans are listed below:

1. To improve infrastructure development, some of the broad action points need to be taken which includes streamlining the land-acquisition process, fast-tracking policy and regulation reforms for their enhanced implementation, effective and more expedious resolution of disputes, enhanced monitoring of projects for speedy regulatory approvals and facilitation of funding for infrastructure projects. There is need to prioritize action and reforms under the present conditions to facilitate increased private sector investments and faster execution of projects across the infrastructure sectors. We believe that, infrastructure dream can be realized and can place India's economy on a high growth trajectory.
2. Vehicular technology, fuel quality, inspection & maintenance of in-use vehicles, road and traffic management are the four the parameters determining emission from vehicles. The significant environmental implications of vehicles cannot be denied. The need to reduce vehicular pollution has led to emission control through regulations in conjunction with increasingly environment-friendly technologies. The high levels of pollution have necessitated eliminating leaded petrol, through out the country. There is a need for a better approach so that upgradation in engine technology can be optimized for maximum environmental benefits. India currently only transport vehicles, that is, vehicles used for hire or reward are required to undergo periodic

fitness certification. The large populations of personalized vehicles are not yet covered by any such mandatory requirement. In most countries that have been able to control vehicular pollution to a substantial extent. Inspection & Maintenance of all categories of vehicles have been one of the chief tools used. Implementation of CNG in the public transport and introduction of Bharat stage III norms has resulted in reduction in emissions of air pollutants but its effect was largely nullified by the tremendous increase in private gasoline vehicles. For improvement in ambient air quality, there are three aspects namely fuel specifications, engine technology and better maintenance and fitment of in-use motor vehicles. The test procedures should tighten to reduce emission. Transport systems should design to minimize air and noise pollution, risk of traffic injury, congestion and other health and environmental impacts. Apply environmental indicators and impact assessment as a basis for transport, water-land use policies, urban and regional development planning, location decisions, infrastructure planning and investment programmes, with the full involvement of environment authorities. More importantly, it is time now for the auto and oil industry to come together under the guidance of the Government in evolving fuel quality standards and vehicular technology to meet air quality targets.

3. In the mechanized and the fast-moving world of today, the consumption of Petroleum products has become an important yardstick of a country's prosperity. Thus, a very high priority is attached by the Government to conservation of Petroleum products in view of the need to reduce ever increasing gap between demand for and indigenous supply of crude oil and Petroleum products. Government has initiated various steps to promote conservation of Petroleum products in the transport, industrial, agricultural and domestic sectors. These include adoption of measures and practices, which are conducive to increase fuel efficiency and training programme in the transport sector; modernization of boilers, furnaces and other oil operated equipments with efficient ones and promotion of fuel-efficient practices and equipment in the industrial sector. Petroleum Conservation, then becomes our joint responsibility be it the industries, individual citizens, organizations, Oil Companies or the Government. Each one of us has specific and significant roles to play. Therefore, the need of the hour is to conserve Petroleum by its judicious use, substituting it by other resources wherever feasible and restricting its use only to the essential needs.
4. Remedial measures to reduce Road accident can be grouped into the following six categories. First one is driver related which includes sharpening of the driving skills

by means of driver training, conducting proper driving tests, screening of accident-prone drivers, refresher courses etc. Second one user related measures like imparting knowledge about rules of road use, traffic rule awareness, safe driving and legal aspects. Thirdly, vehicle based measures, which consist of introduction of greater safety measures in vehicles including efficient braking, glare free lights, proper and safer grip tyres, cushioned dashboards, seat belts, collapsible steering columns etc. Forth one is environment related contains inculcation of a safety environment. Fifthly road related measures incorporates improvement of road geometrics, improvement for junctions, improvement of accident prone locations/ black spots, use of medians and traffic islands, properly planned Zebra/ pedestrians crossings, road signages, etc. The number of bicycles lanes and pedestrians parks on urban roads also needs to be maximized. Sixthly traffic related includes speed control, entry restrictions, separate lane for bus etc.

5. Every round trip by public transport involves four non-motorized trips and at least two street crossings. Therefore, greater use of public transport cannot be ensured unless use of roads is made such safer for pedestrians and bicyclists. All arterial roads must have segregated lanes for non- motorized transport and safer pedestrian facilities. Urban road design characteristic must ensure the safety of pedestrians and bicyclists by wider use of traffic calming techniques, keeping peak vehicles speeds below 50 km/h on arterial roads and 30 km/hh on residential streets and shopping areas and by providing convenient street crossings facilities for pedestrians.
6. Urban transport systems should provide high quality mobility to all urban residents who need access to jobs, schools and commercial districts, regardless of whether they own a private vehicle. Such mobility should minimize health risks from pollution and injuries, and enhance opportunities for healthy physical activity and communal interactions across all sectors.
7. Measures have to be taken to facilitate safe walking on roads by providing footpath conforming to standards. In addition, lacks of awareness of traffic signals among pedestrians have to be wiped out. Crossing the roads in between the flow of vehicles should not be permitted and pedestrian subways and over bridges are to be provided at all major junctions.
8. High quality pedestrian and cycling networks, separated from vehicular traffic, can help to reduce injury risk and enhance the mobility of poor and vulnerable populations, such as children. Good non-motorized transport networks also provide

additional incentives to use public transport since usually these were accessed by those modes.

9. Proper control at intersections should be a necessary step. Signal systems at almost all the intersections fail during rainy seasons and due to power breakdown. The condition is worse during rains as poor drainage facilities of the road, also floods it, thereby slowing down the vehicle movement. At intersections, this may solved by proper signal timings.
10. Traffic calming and relocation of road space to most environment friendly vehicles and modes of transport. Restricting access for the most polluting road vehicles, fostering the use of cleaner, quiet and lower Co_2 vehicles. Restricting the import of second-hand vehicles reduce the level of pollution. Introduction of strict In-Use inspection maintenance systems and phasing out old vehicles of more than fifteen years to reduce pollution level from the vehicles. Economic tools such as fuel taxes, congestion charging or parking pricing may used to generate revenues for less polluting modes and to raise the price of polluting modes to reflect health and environment externalities that the market typically does not capture. In addition, these tools may be used as incentives to phase out older vehicles.
11. Achieving improved traffic flow by improvements in the efficiency of the existing transportation system, such as improved traffic signalization, ramp metering, reverse-flow lanes, quicker accident responses and improved driver information system.
12. Parking management and control is important because it has the potential to modify demand on area-wide basis yet, despite being readily available to authorities, often seems under-utilized to tackle traffic congestion. Parking management and control can assist the task of tackling traffic congestion by reducing the demand for travel to the area encompassed.
13. Proactive traffic operations management has much potential. Road traffic information systems, pre-trip guidance, co-ordinate traffic signal systems and the implementation of dynamic speed and incident management policies have often proven to be cost effective ways to deliver better travel conditions, allowing users to reschedule their trips away from traffic peak and select other travel modes.
14. Many approaches can squeeze additional capacity out of existing infrastructure. These include adding lanes, modifying the geometrical design of roads or creating one way streets.

15. Car ownership seems to be influenced by the relative price of cars compared to family incomes. Car use for work trips can be influenced by providing comfortable and reliable public transport options. Many policy planners have suggested that a further increase in fuel costs or prices of cars could decrease their use.
16. Construction of metro rail system and increase in the number of buses are considered an important counter measure for reduction in congestion and pollution. It would increase the number of access trips by walking and bicycling. In Ernakulam district too, the construction activities of metro is under going.

9.4 CONCLUSIONS

In an age of urbanization and motorization, the way people live and the way they move have become increasingly incompatible. The results, for urban society everywhere are congestion, pollution and a growing sense of frustration. When all efforts has been made to accommodate the vehicles, the streets are still congested, commuting is increasingly difficult, urban aesthetics have suffered and the quality of life has been eroded. In an age of motorization, cities have become the negation of communities. Continued growth of cities, increase in vehicle mile travelled; contribute to increasing externalities from vehicle emissions, including worsened heath, diminished visibility and possible global warming. The automobile has taken over motorist and non-motorist alike are caughtup in the congestion, pollution etc. and every one is a victim of the damaging side effects of the conflict between vehicles and the society.

Ernakulam district, a fast developing commercial and tourist destination, lacks for an efficient is thoroughly, well-planned traffic, and transportation system. The road network in the district is thoroughly devastated contributing to immense traffic jams in all the main roads and lengthy queues at intersections, ending up in increased travel time. Better infrastructure and traffic management solutions are the only key. Volume count at intersections shows that the capacity has already exceeded the limits, with very low level of service, characterized by lengthy queue during peak hours. As the vehicular traffic grow at an alarming rate in many of the surveyed urban intersections, it will increase the emission and hence pollution. Reduction in emission is due primarily to the application of pollution control technologies in vehicles and the role of fuel quality is to facilitate the use of such technologies. However, emissions of some pollutants depend on the fuel quality, i.e., on the level of pollutants in the fuel. Such substances in the fuel may undergo little or no transformation during the combustion process. Road side and ambient air quality deteriorates due to the increasing concentration of pollutants such as

Lead, Hydrocarbons and Sulphur from motor vehicles. Setting fuel standards could influence in reducing these emissions from motor vehicles. In developing countries vehicles, it is certain that CO2 emissions, air pollution, congestion, and other transport related problems will worsen.

Annual CO_2 emission in Kochi due to vehicular movement is 7.65 million tonne. This growing trend of emissions observed in Kochi was because the vehicles were used for extended lifetime without proper maintenance and excessive traffic congestion. Ill-maintained vehicles tend to emit more pollutants than others do. Improper inspection and maintenance, use of poor quality fuel, poor road conditions and increased congestion also add to the emissions. Like other Indian cities, two and three-wheelers occupy a significant share in total vehicular stock. The growing vehicular stock results in increased carbon emissions and hence the transport sector contributes a major share of environmental pollution. The introduction of vehicles with stricter emission control may decrease the overall emissions, but the vehicle population growth rate might neutralize that impact in overall emissions. This can be curtailed only through a sound and sustainable urban transport policy. It is the duty of every citizen to follow the traffic rules strictly so that accidents can be avoided by each and every one. It is in the hands of all those who are directly or indirectly involved in following the law and regulations.

Any scheme of the solution of the problem of environmental hazards cannot be successful until and unless a concerted effort by all sections of the people is made at grass roots. The official and voluntary agencies must work together to crate the needed awareness and the success of our efforts in this area will ultimately call for the involvement of the entire population at all levels. The quality environment is the only one resource that human beings must retain for the goodness of themselves and for their coming generations.

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