TECHNOLOGY CHOICE IN THE TRANSPORTATION SYSTEM OF DELHI: EMERGING POLICY ISSUES AND IMPLICATIONS IN THE POST LIBERALISATION ERA

Dissertation submitted to the Jawaharlal Nehru University
In partial fulfilment of the requirements for the
award of the degree of

MASTER OF PHILOSOPHY

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JULY 2003

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Date: 31.07.2003

CERTIFICATE

This is to certify that the dissertation entitled **"Technology Choice in the Transportation System of Delhi: Emerging Policy Issues and Implications in the Post-Liberalisation Era"** submitted by **Pritpal Singh Randhawa** in partial fulfillment of the requirements for the award of the degree of **Master of Philosophy (M Phil)** of this University is original work according to the best of our knowledge and may be placed before the examiners for evaluation.

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ACKNOWLEDGEMENT

The work with this dissertation has been extensive and trying, but in the first place exciting, instructive, and enjoyable. Without the help, support, and encouragement from several persons, I would never have been able to finish this work.

First of all, I would like to thank my supervisor Prof. Ashok Parthasarthi under whose guidance I have successfully completed my dissertation. His valuable inputs in my research and his support in organising visits to the experts cannot be acknowledged merely in words. I acknowledge my indebtedness to Prof. Nasir Tyabji. The series of discussions with him has provided me immense insights in giving my topic a proper shape. I wish to thank all the faculty members at CSSP Dr. V V Krishna, Dr. K J Joseph and Dr. P N Desai for providing various perspectives on Science Policy during my M.Phil. course work.

I am grateful to Dr. P.K Sikdhar, Director, Central Road Research Institute (CRRI); Dr T.S. Reddy, CS, Traffic and Transportation, CRRI and Prof. Dinesh Mohan, Transport Research and Injury Prevention Programme (TRIPP) at IIT Delhi for taking out their precious time and expressing their keen interest in my topic. Their valuable suggestions have added varied perspectives in my research. I would like to thank the entire staff who helped me in my search for the necessary and relevant information in JNU, IIPA and DDA Libraries. I am thankful to Mrs. Shyamala and other staff at our Centre for their kind co-operation.

I wish to acknowledge all my colleagues at Hazards Centre for providing motivation and strength to me. I wish to extent my gratitude to these very special people Vinod, Manish, Shashikant and Ravinder, for being there to tap my shoulders whenever I felt down towards my work. I especially wish to thank Chandan, who took lot of pain to read my entire dissertation for proofing. I wish not to thank Mahesh, Nimesh, Sanjay, and Amiya since thanking them would definitely blemish the wonderful relationship we share.

Above all, I wish to acknowledge my parents. This dissertation would have not been possible without their encouragement and emotional support.

LIST OF ABBREVIATIONS

AITD	Asian Institute for Transport Development
ALL	Ashok Leyland
BIS	Bureau of Indian Standards
BJP	Bhartiya Janata Party
BLC	Bhurelal Committee
CCTV	Closed Circuit Television
CNG	Compressed Natural Gas
CORE	Central Organisation for Railways Electrification
CPCB	Central Pollution Control Board
CRRI	Central Road Research Institute
CSDS	Centre for Study of Developing Society
CSE	Centre for Science and Environment
CSIR	Council for Scientific and Industrial Research
DDA	Delhi Development Authority
DMRC	Delhi Metro Rail Corporation
DMTA	Delhi Metro Transport Authority
DTC	Delhi Transport Corporation
DTPG	Delhi Transport Planning Group
DTS	Delhi Transport Service
DTU	Delhi Transport Undertaking
EMU	Electric Multiple Unit
ETB	Electric Trolley Buses
FRLS	Fire Retardant Low Smoke
GHG	Green House Gas
GNCTD	Government of National Capital Territory of Delhi
GOI	Government of India
HCBS	High Capacity Bus System
HCV	Heavy Commercial Vehicle
HSTS	High Speed Tram System
ICB	International Contract Bidding

IDI	India Indirect Injection
IGL	Indraprasth Gas Limited
IIT	Indian Institute of Technology
IMTA	Integrated Metropolitan Authority
IPT	Intermediate Public Transport
ISBT	Inter State Bus Terminal
JBIC	Japanese Bank of International Corporation
LCV	Light Commercial Vehicle
LPG	Liquid Petroleum Gas
LRT	Light Rail Transit
MCD	Municipal Corporation of Delhi
MRTS	Mass Rapid Transit System
NCF	Net Capital Formation
NCR	National Capital Region
NDA	National Democratic Alliance
NDMC	New Delhi Municipal Corporation
OCC	Operation Control Centre
OEM	Original Engine Manufacturer
OHC	Overhead Camshaft
ORG	Operation Research Group
PCV	Positive Crankcase Ventilation Valve
PIL	Public Interest Litigation
PWD	Public Works Department
RITES	Rail India Technical and Economic Services
RTV	Rural Transport Vehicle
SCAD	Supervisory Control and Data Acquisition System
STA	State Transport Authority
TELCO	Tata Engineering and Locomotive Company Limited
TERI	Tata Energy and Research Institute
TRIPP	Transportation Research and Injury Prevention Programme
USAID	United States Agency for International Development

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Chapter 1
INTRODUCTION

1.1 SCIENCE AND TECHNOLOGY (S&T) POLICY AND SOCIO-ECONOMIC DEVELOPMENT

The importance of science and technology in the socio-economic development of the nation was recognised by India, much before the country achieved independence. In 1939, the Indian National Congress appointed a National Planning Committee and invited leading scientists to participate in the formulation of plans for economic development and social betterment (Rahman, 1969). This committee had dealt with the problems of general education, technical education and scientific research. Pandit Jawaharlal Nehru, the chairperson of this committee emphasised the importance of scientific outlook in seeking solution to the problems faced by the country.

India was the first country in the world to create a Ministry of Scientific Research and Natural Resources, the purpose of which was to organise and direct scientific research for national development. All Five-Year Plan documents had also emphasized the role of S and T in economic and social transformation (Sharma, et al, 1980). However the most important step was the adoption of the Scientific Policy Resolution in the parliament in 1958. This bold decision had a twofold effect (i) evolution of formal policy for science and its development (ii) inclusion of science in policy making for social and economic policies. After the three decades of planning and the Scientific Policy Resolution of 1958, Government of India in the preamble of its Technology Policy Statement in 1983 accepted that:

> *"The use and development of technology must relate to people's aspirations. Our own immediate needs in India are the attainment of technological self-reliance, a swift and tangible improvement in the conditions of the weakest sections of the population and the speedy development of backward regions. India is known for its diversity. Technology must suit local needs and to make an impact on the lives of ordinary citizens, must give constant thought to even small improvements, which could make better and more cost-effective use of existing materials and methods of work. Our*

development must be based on our own culture and personality ... technology must be viewed in the broadest sense covering agriculture and the services sectors along with the obvious manufacturing sector ... our directives must clearly define system for the choice of technology, taking into account economic social and cultural factors along with technical considerations..."

Two decades after the declaration of this policy Government of India recently has declared a Science and Technology Policy 2003 in view of the changing context of the scientific enterprise and to meet the present needs of the country in the new era of globalisation. There are several objectives of this policy document. One of the objectives reads:

"To encourage research and innovation in areas of relevance for the economy and society, particularly by promoting close and productive interaction between private and public institutions in science and technology. Sectors such as agriculture, water, health, education, industry, energy including renewable energy, communication and transport would be accorded highest priority..."

Thus one could observe a continuos affirmation of the role of Science and Technology in the socio-economic development of the country in the different policy pronouncements of the state. The question, however is, whether science and technology actually play any emphatic role in uplifting the socio-economic status of the majority of the citizens of the country. Using the technology choices in the transportation system of Delhi, the present study attempts to examine these crucial issues and to provide a critical appraisal of the emerging science and technology policy issues and its implications on the urban transportation sector in the post liberalisation era.

1.2 TRANSPORTATION: AN OVERVIEW

Transportation is the movement of person or property from one place to another. It is the function of carriage or conveyance, which is equally vital to primitive and civilised man. Although pre-historic man was often forced to roam widely for food and shelter, modern Man with improved technology of transport has a much greater range in the movement, both of his property and himself. To primitive Man, an improved means of conveyance, made for better food supply, but as man advanced,

improved transportation promoted trade and exchange of ideas and accomplishments. Through improvements in transport technology Man continually seeks to accomplish movement from one place to another with the least possible expenditure of time, cost and maximum convenience.

Time and cost are the two major dimensions of transportation improvement. The improvement of transportation has been an important consideration in all ages and particularly in the recent industrial age. The rate of improvement in transport in any country depends not only on the level of advanced technologies available to the transportation system designer, but also on the economic, social and political conditions in which technologies are chosen and put to use.

1.2.1 Development of Transportation

The first transportation vehicle of pre-historic man, although simple and crude, was among his greatest accomplishments, for him civilised man obtained the wheel, one of the most significant inventions of all time (Fair and William, 1959). Ancient civilisation employed animal power and wind power more effectively than primitive people did by developing better vehicles and constructing improved means of transportation. They developed larger and better sailing vessels, carts, chariots and wagons; built highways and canals; and in a few instances established lighthouses as navigation aids (Fair and William, 1959). Methods of transportation however remained comparatively crude until the nineteenth century. While incremental technological improvements did occur, there was no major break-through.

The invention of the steam engine, and its application to transportation early in the nineteenth century, introduced the modern age of technology driven transportation. The invention of large steam vessels with steel hulls furthered the progress of trade by water. Steam power was also applied to land transportation and the railroads were born. Later electric power and the gas engine furthered the conquest over land, water and air. To use these modern types of vehicles effectively, engineers have constructed railway system, hard- surfaced highways, canals, dams, navigation aids of many

kinds, large mechanised seaport terminals, and airways and airports (Vuchic, 1981). Wire and radio communications are used to dispatch and control the movement of vehicles and the traffic of modern mechanised forms of transportation.

1.2.3 Perspectives on Transportation

There is a large mass of literature on transportation, but it is not related to each other. Apart from planning and engineering, the current literature in social science reveals three identifiable approaches or dimensions in the area of transportation. These approaches tend to overlap, of course, but for the most part each has certain clearly distinguishable characteristics. These approaches could be designated as economic perspective geographical perspective and sociological perspective

Economic perspective: In economics, transportation involves the transfer of weight between non-coincident points. This weight has a certain bulk and it can be moved between these two points along a path that may be circuitous or direct, easy or difficult, safe or hazardous. Moreover, it may move over this path swiftly or slowly, in units that a large or small. All these factors affect the cost of moving this weight to a greater or lesser extent (Soberman, 1966).

Geographical perspective: In geography, transportation is being understood in terms of spatial expression by examining the geographical pattern of transport. Transport networks play pivotal roles in reducing spatial disparities and bringing about balanced and integrated development. This could be basic infrastructure helping in proper exploitation of the resources of a region. A transport network is thus, a necessary element of spatial expression. The linkages and flow between centres, their nature and size, function and accessibility are the major considerations in the structural aspects in transportation (Vaidya, 2003).

Sociological perspective: There is no theoretical scheme in sociology on transport as such but in sociology transport cannot restrict itself specifically to traffic (occurrences on the road) or even to movements or mobility but at the same time must consider

traffic and transport policy, since otherwise too much would remain unexplained in the operation of traffic and transport and in the changes therein (Boer, 1986).

1.3 URBAN TRANSPORT SYSTEM

According to a well-known transport theory, transportation is a derived demand (Munby, 1966). The demand for transportation in the rural area is completely different from the demand for transportation in urban centres. Urban development takes place only around stable economic activities. Mobility is crucial for the economic growth of any urban centre's economic activities. Activities such as trade, commerce and industry flourish in a city where accessibility is good and mobility is fast and easy. A view echoed by (Shreedharan, 2001) when he opines, "Substantial contribution to city efficiency is possible only where men and material are transported at minimal investment and operational cost". Thus an able transport service permits cities and towns to become catalyst for economic, social and industrial development. Urban transport system consists of a set of sub-systems including road network, bus system, intra-urban rail system, para-transit system and personal transport system (Kulshrestha, 1996).

1.3.1 Urban Transport Scenario in India

In India, transportation demand in urban centres continues to increase rapidly as a result of both population growth and changes in travel patterns. Today the mass transportation in our cities is primarily road-based apart from the rail-based services that exist in the metropolitan cities like Mumbai, Kolkata and Chennai. The Indian Railways are operating Electric Multiple Unit (EMU) sub-urban trains in Mumbai, Kolkata and Chennai to cater to commuter traffic from the suburbs of the cities (Shreedharan, 2001). In Delhi, only skeleton rail service exists and buses are almost the only means of public transport.

In Indian cities, walk trips constitute about 30 per cent of all intra-urban transport. In vehicular trips, share of Mass Transit generally varies from 16 per cent to 60 per cent, increasing with increase in city size, although some individual cities have very low

modal split in favour of mass transport. Cycle passenger rickshaw and to some extent horse driven tonga play a significant role in meeting transport demand in small and medium size cities in the absence of adequate mass transport system (Sibal, 2001).

Due to the encouragement by government to the automobile industry, number of personalised motor vehicles has been growing at the rate of 6-15 per cent per annum in different cities. Table 1.1 presents the number of registered motor vehicles in nine largest metropolitan cities of India.

Table 1.1

Registered Motor Vehicles in Nine Largest Metropolitan Cities of India (March 1993) and All India Figures

Cities	Two-wheelers	Cars/ Jeeps	Three-wheelers	Taxis	Buses	Goods Vehicles	others	Total
Kanpur	167375	15287	2583	309	1177	8380	1371	196482
Pune	235735	29159	19569	2170	3716	21198	1780	313327
Ahemedabad	341943	46176	35953	2927	11734	13101	594	449268
Banglore	498272	93067	25165	2766	8109	20908	6101	654388
Hyderabad	410173	59018	19957	2016	2975	24308	1280	519727
Chennai	461638	127237	18630	611	8256	19154	5848	641374
Delhi	1403050	477783	70459	11365	23221	111277	-	2097155
Delhi (2000)	2527000	844000	133000	19000	38000	209000	-	3770000
Kolkata	222069	193947	6304	19943	13062	51115	10077	516517
Mumbai	246404	187176	26195	32431	8792	40685	5243	546926
All India (2000)	**35319000**	**6189000**	**1755000**	-	-	**3348000**	-	**46611000**

Source: Traffic and Transportation Policies in Urban Areas in India, India Infrastructure Report 2001 cited in Indian Journal of Public Administration, July-September 2001

It can be seen that in most of the cities, scooters/motorcycles comprise more than 70 per cent of total motor vehicles. In 1997, there were 12.1 million registered vehicles in 23 metropolitan cities. In 1999, the number of registered vehicles in Delhi had increased to 3.2 million from 2.1 million in 1993 (an annual increase of more than 7.2 per cent). The motorised two-wheelers have grown faster than the others

1.4 CHANGES IN THE TRANSPORT SECTOR

The process of deregulation and privatisation has become a central dynamics within transport system over the past two decades. The profound organisational changes involved in this process are now being applied over a widening range of both national and international settings, and across a wide spectrum of transport modes. The dramatic impact of policy changes throughout the 1980s on the nature and the evolution of various transport modes precipitated a transformation in the content of the transport sector (Charlot and Gibb, 1998).

Many academicians from social sciences refer to the neo-classical hegemony that now orientates perhaps even dominates, policy in the entire world. Transport has by no means been isolated from this movement towards a widespread acceptance of neo-liberalism. The policies of market, liberalisation, privatisation and deregulation have had a widespread impact on the transport sector in the past ten years (Charlot and Gibb, 1998). However, the application of the neo classical agenda to transport is contested, both in terms of transport performance and the quality of services offered under the reformed regimes, and with respect to the wider environmental, social equity and political implication.

India's urban transport has also perceived the impact of transport deregulation and privatisation. The economic policy in the country has changed tremendously from the time the National Transport Policy Committee submitted its report in 1980. Though the basic observations and recommendations of the committee remain unaffected by the changes yet, the new dimensions of economic policy have altered the parameters of transport policy substantially (Bezbaruah, 1995). The policy of economic liberalisation introduced in 1991 sought among others to remove barriers to entry and to encourage competition. As a corollary to this overall objective it follows that there would be reduction in subsidies in all services and products will be based on market determined cost; and there will be more scope for private participation in areas so far reserved for public sector. This has implied larger investment requirements, especially for infrastructure development. As these reforms were characterised by

gradual withdrawal of the State from a number of core and non-core sectors, the private sector has become more dominant for continued growth of economy (Gandhi, 2002). The transport sector is one of the key infrastructure sectors in this liberalised economy, which seems to face the impact. Being the capital city of the country, Delhi has been witness to the massive interplay of these forces in its transportation system and would be harbinger for nationwide transportation polices. Hence it is imperative that a critical analysis of the transportation policies of Delhi is performed to examine it in terms of the actual fit between the stated pious policy pronouncements and the realities of the market place.

1.4.1 Delhi: The City and the People

Delhi is a sprawling metropolitan area of nearly 1,500 square kilometers that contains much that is old and new. Delhi has grown rapidly in area, density, and population. Its spatial area has expanded fifteen folds since 1911. In 1991, 29 new towns were annexed, increasing the area from 445 to 1,483 square kilometers Most of the Delhi metropolitan area is governed by two units: the New Delhi Municipal Corporation, an independent city-level administrative body serving as the capital of India, and the Municipal Corporation of Delhi whose administrative jurisdiction covers most other areas in the Delhi metropolitan area. Metropolitan Delhi, encompassing New Delhi and other smaller communities, has grown physically in all directions, extending out from Delhi along the corridors of the five national highways that converge in Delhi (Bose and Sperling, 2001). Land use is highly mixed with few clearly defined zones of activities.

Delhi is home to over 140 lakhs people and the capital of India (Economic Survey of Delhi, 2002). Delhi is an international political and cultural centre and, increasingly, an important commercial and industrial centre. Population growth has been extraordinary, increasing from 17 lakhs in 1951 to over 140 lakhs in 2002. Even with the expanded spatial area, population density continues to increase (roughly doubling between 1971 and 1991). In 1991, the average population density for the entire sprawling Delhi region was 6,352 persons per square kilometer, with a maximum

density of 19,866 in the area of the Municipal Corporation of Delhi (Sustainable Development Foundation, 1998). The rate of growth is expected to slow, but the population is still expected to reach 220 lakhs by 2020[1] (GNCTD, 1999).

Population growth is largely due to the migration of rural poor to the city. Over three-fourth of Delhi residents live in substandard settlements. Most of these people live in unauthorised colonies, slums and resettlement colonies without formal arrangements for water and electricity supply (Hazards Centre, 2001). Delhi's average income is low compared to industrialise countries, though twice that of the rest of India, and increasing. Total gross domestic product for the Delhi region increased over 7 per cent per year in real terms from 1980 to 1996, and is forecast to continue that rate of increase through 2020 (GOI, 1996). Delhi's per capita income increased about 3 per cent per year over the same period, reaching about Rs 40 000 per year in 1996. It is expected to increase 4.3 per cent per year from 2000 to 2010 and 5.4 per cent annually the following decade.

Rising incomes, combined with demand for greater personal mobility and inadequate public transport, has inevitably resulted in continuing increase in personal vehicle use and ownership of not only inexpensive scooters and motorcycles, but also cars (Bose and Sperling, 2001). By March 2001, Delhi had about 34.56 lakhs registered motorised vehicles (Economic Survey of Delhi, 2002), up from 1.8 lakhs in 1970.[2] This represents 200 vehicles for every 1,000 inhabitants, a rate much higher than most cities with similar levels of per capita income. Most vehicles in Delhi are small, motorised two-wheelers (motorcycles and scooters).

1.4.2 Transport Scenario in Delhi

Delhi ranks third in population among other Indian cities. However, its vehicle

[1] Population projections for 2011 are by Registrar General, Census of India; projections for 2021 are by Shri K.S. Natrajan, Former Deputy Registrar General, Census of India

[2] There are no registration data for 1971 and 1980 to estimate attrition. Projections are from Bose and Nesamani, 2000

population exceeds the total vehicle population of Mumbai, Kolkata and Bangalore, put together (Tata Energy and Research Institute, 1999). Apart from other reasons, the city, due to its physical characteristics encourages movement in multiple directions. And inadequate public transport contributes towards increased motorisation. In Delhi, the phenomenal increase in motorisation is a manifestation of high mobility pattern that gets induced due to rising economic activities within the city. Mobility is measured in terms of number of 'trips' made during a day. Increasing motorisation is not simply a result of population size. Several other factors determine the motorisation level in the city. High levels of motorisation are manifested in increasing number of vehicles and their utilization.

1.5 RESEARCH QUESTION

Based on various urban transport theories, it could be argued that when a single mode of transport is not able to cater to the needs of commuter then it should be supplemented by other modes of transport. There is an obvious distinction between the use of transport and modes of transport but this fact is not observed by the policy makers while deciding about the choice of technology made in the transport system. This study would answer the following questions:

- Whether the present technology choice in various modes of transport satisfies the need of people while commuting in a teeming city like Delhi?
- What are the factors that have determined the technology choice in the transport system of Delhi?
- What are the emerging S and T policy issues?

1.6 METHODOLOGY

The information regarding transport system and technological issues has been obtained from government documents, reports and press clippings. A historical approach has been followed in understanding and interpreting the relevant literature and policy documents. In the process, views and opinions of experts from the institutions like Indian Institute of Technology (IIT), Delhi and Central Road Research Institute (CRRI) have also been incorporated.

Independent Studies on the subject by organisations like Centre for Studies of Developing Societies (CSDS), Lokayan, Transport Research and Injury Prevention Programme (TRIPP), Tata Energy Research Institute, (TERI), Centre for Science and Environment (CSE) and Hazards Centre have also been examined.

1.7 CHAPTER SCHEME

The study is divided into five chapters including the conclusion drawn from these chapters The introduction is followed by Chapter 2 titled as *Transportation System of Delhi.* It basically tries to examine the different modes of transportation in Delhi and their utility in terms of providing service to the commuters By doing so, an attempt has been made to analyse and understand the transportation problem of Delhi. Chapter 3 titled as *Technology Choice in the Transportation system of Delhi*, maps the various technologies involved in the transport system of Delhi as also the technological changes and upgradation that have taken place in the different modes of transport. In Chapter (4), which discusses the *Emerging Policy Issues and Implications* an attempt has been made to analyse the policies formed in order to plan the transportation system of Delhi. Beside this, the chapter also examines the underlying factors, which determine the technology choice, technological changes and its upgradations, on the basis of which emerging Science and Technology Policy issues are being unveiled.

Chapter 2
TRANSPORTATION SYSTEM OF DELHI

The transportation system produce outputs of many dimensions: both freight and passenger services are involved, and their description involves travel time, costs, comfort, convenience and a host of other considerations. A variety of market structures exist in transportation sector, including many that are not competitive. Both government and private decision-makers are commonly involved in it (Meyer, 1972).

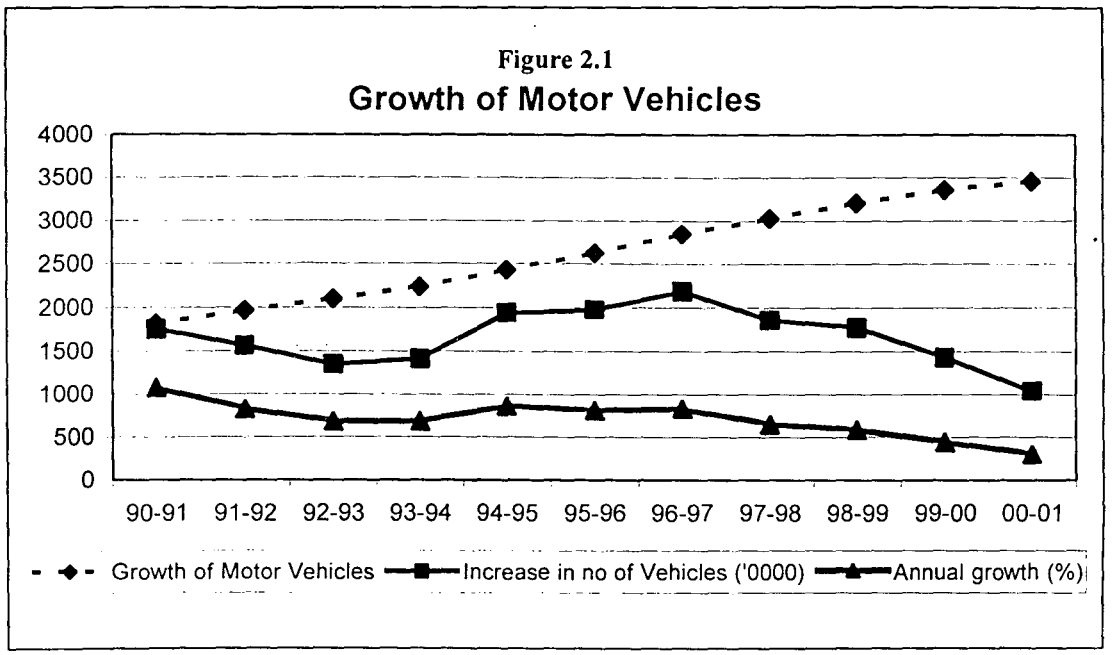
The objective of a transportation system for any city should be to provide safe, efficient, eco-friendly and affordable modes of transportation to the commuters, but today in India most of the metropolitan cities are under acute pressure due to the lack of efficient public transportation. By analysing and understanding the transportation problem of Delhi, an attempt has been made in this chapter to identify the reasons for this acute pressure.

2.1 TRANSPORTATION SYSTEM OF DELHI: AN OVERVIEW

2.1.1 Growth of Vehicles

Different modes of transportation system evolve on the basis of distinct technological underpinnings. Since independence various technological changes have taken place in the different modes of transportation system in Delhi. According to the first Delhi Master Plan, in 1962 majority of the commuters either used to cycle or walk to their work places, buses were in the second place and tongas were in the third place followed by private vehicles (Delhi Master Plan, 1962). The pollution free city, where the commuters relied upon cycling and walking, twenty years hence, has turned to depend upon buses and today government's ambiguous policies have led to an inappropriate Mass Rapid Transit System, which have forced the people of Delhi to opt for private vehicles.

Figure 2.1



Source: Economic Survey of Delhi 2002

It could be revealed from figure 2.1 that there is a tremendous increase in the number of private vehicles during the last decade. As on March 2001, 34.56 lakh motor vehicles were registered in Delhi. The Census 2001 reported Delhi's population to be 137.8 lakh, which implies 251 vehicles per 1000 population in March 2001 as compared to 192 vehicles in March 1991. There has been an increase of about 90 per cent in overall growth of registered vehicles during 1991-2001 at an average annual compound growth rate of about 6.7 per cent. Data on motor vehicle population and its growth rate (registration) from 1990-91 can be seen in Appendix I (b).

The percentage distribution of categories of motor vehicles in Delhi in table 2.1 shows that there has been a rapid proliferation in the number of cars and jeeps during the decade, although there has been a decline in the relative share of motorcycle and scooters but they still dominate the total share of motor vehicles. Autorickshaws have declined from 3.84 per cent in 1990-91 to 2.52 per cent in 2000-01.

Table 2.1

Percentage Distribution of Motorised Vehicles in Delhi

Types of vehicles	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
Cars & Jeeps	21.98	22.42	22.78	23.32	23.67	24.10	24.79	25.24	25.51	25.94	26.64
Two-wheelers	67.32	67.11	66.90	66.65	66.51	66.23	65.88	65.67	65.47	65.15	64.53
Auto Rick-shaws	3.84	3.42	3.36	3.22	3.08	3.00	2.81	2.64	2.71	2.59	2.52
Taxis	0.56	0.54	0.54	0.53	0.52	0.52	0.53	0.53	0.53	0.53	0.53
Buses	1.04	1.03	1.11	1.08	1.08	1.06	1.04	1.10	1.10	1.13	1.20
Goods Vehicles	5.62	5.48	5.31	5.20	5.14	5.09	4.95	4.68	4.68	4.66	4.59
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Transport Department, GNCTD cited in Economic Survey of Delhi 2002

The share of buses has almost remained static, in 1990-91 it was 1.04 per cent and 2000-01 it increased only by 0.16 per cent. The annual growth rate of total motor vehicles (Registration) in Delhi has shown a declining trend since 1997-98, while the number of cars and jeeps has increased from 21.9 per cent in 1991 to 26.6 per cent of the total vehicles in 2001.

There is a controversy on the actual number of vehicles plying on Delhi-roads. A large number of vehicles registered in Delhi can be seen plying on National Capital Region (NCR) town roads. Similarly, vehicles registered outside Delhi but plying on Delhi roads are of two categories (a) plying on Delhi roads while crossing Delhi territory to reach a destination outside Delhi; and, (b) now shifted to Delhi on temporary or permanent basis.

There is also a controversy on the actual number of non-motorised vehicles plying on Delhi-roads. According to the government data, registered man and animal-driven vehicles constitute about 4.6 per cent of the total vehicle population in Delhi out of which about 52.3 per cent are passenger cycle rickshaws [see Appendix I (c)]. However, the registration of passenger cycle rickshaws has been discontinued from

the year 2001 onwards and therefore government does not have an exact data on the number of passenger cycle rickshaws plying in Delhi.

2.1.2 Modal Share of Public Transport Modes

Public transport is the key of any transport system. Delhi is predominantly dependent on road transport, with the railways catering to only about 1 per cent of the local traffic (Table 2.2). The ring rail network in Delhi is grossly underutilised.

Table 2.2

Modal Share of Transport Modes in Total Trips (per cent)

Mode	1981	1994	2001
Cycle	17.0	6.6	5.3
Bus	59.7	62.0	59.8
Car	5.5	6.9	10.2
Two-wheelers SC/MC	11.1	17.6	17.2
Auto Rickshaw	0.8	2.8	3.1
Taxi	0.2	0.1	0.1
Rail	1.6	0.4	0.7
Others	4.1	3.6	3.6

Source: Theme paper on IPT presented by RITES in the workshop on Tackling Urban Transport in Delhi – Choices, 2002

Buses constitute only 1.2 per cent of the total number of vehicles, but cater to 60 per cent of the total traffic load. Among personalised vehicles, motor cycles and scooters comprise about 64.5 per cent of the total number of vehicles in Delhi, but caters to only 17 per cent of the total traffic, while cars and jeeps account for 25.4 per cent of the total vehicles, but caters to only 10 per cent of the total traffic.

A survey conducted by Centre for Study of Developing Society (CSDS) revealed that close to 30 per cent of the people of Delhi either cycle or walk to their work place. This fact was confirmed by an Operation Group (ORG) survey in 1994, which found 28 per cent of Delhi household earning less than Rs 2,000 a month either cycle or walk to their work place (Mishra, 2000). 70 per cent of Delhi's population inhabits in

substandard settlements[3] (Hazards Centre, 2001). According to the survey conducted by Hazards Centre in these settlements, 46 per cent of them either walk or cycle from 6-20 km to their work and for most of them travel is the biggest hazard (Hazards Centre, 2001).

2.1.3 Road Network

From table 1.1 and table 2.2 two important points are emerging. The first point is that the numbers of private vehicles are increasing whereas the numbers of public vehicles are decreasing. Supreme Court's order of July 28, 1998 to convert public transport into CNG mode is one of the major reasons for the decline in the number of public vehicles. The majority of private vehicles comprise of personally owned cars and two-wheelers - owned obviously by the middle class and upper classes. The situation of Delhi's road could be better understood through the table 2.3.

Table 2.3

Number of Motor Vehicles and Pressure on Roads

YEAR	No of motor vehicles (lakhs)	Road length available for traffic (Kms)	Road length available per 100 vehicles (Kms)	No. of vehicles per km of road length
1991	19.24	16,985	8.8	113
1992	21.24	16,985	8.0	125
1993	23.24	16,985	7.3	137
1994	25.24	16,985	6.7	149
1995	27.24	16,985	6.2	160
1996	29.24	16,985	5.8	172
1997	31.24	16,985	5.4	184
1998	33.24	16,985	5.1	196
1999	35.24	16,985	4.8	208
2000	37.24	16,985	4.6	219
2001	39.24	16,985	4.3	231

Source: Background to 'Delhi vision 2010', a seminar organised by the PHD Chamber of Commerce and Industry cited in Economic and Political Weekly June 2000

It can be depicted from the above table that the road length has remained unaltered at 22,487 km. In fact the effective road length works out at only 16,985 km because of encroachments. The road length per 1,000 vehicles shows a steadily decreasing trend,

[3] In Delhi, slums, resettlement colonies and unauthorised colonies are considered to be sub-standard settlements.

matched by an upward graph of number of vehicles per km of available road length. The consumption of road space per passenger is significantly higher in the case of private transport than that of public transport. The fact that private vehicles occupy much more road space than public transport for carrying the same number of passenger is a matter of common observation.

The road network in Delhi is being developed and maintained by PWD, MCD, NDMC, Delhi Cantonment Board and DDA (Economic Survey of Delhi, 2002). This shows that there is plethora of institutions, which look after the road network of Delhi. Some of them are under the Government of India (GOI) and some of them are under the Government of National Capital Territory of Delhi (GNCTD). Due to the lack of effective coordination between these agencies the problem of road network in Delhi has become very acute.

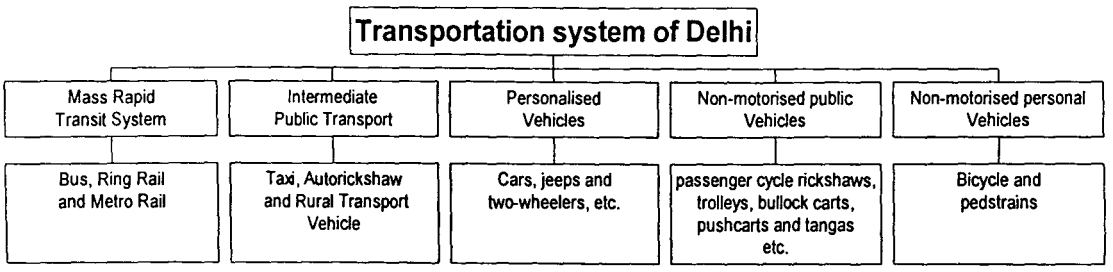
2.2 PRESENT STATUS OF TRANSPORTATION SYSTEM IN DELHI

Presently the transportation system of Delhi could be divided into the following categories:

1. Mass Rapid Transit System such as buses, train and most recently metro rail also.
2. Intermediate public transport such as three-wheelers, taxis and rural transport system (RTV).
3. Personalised modes of transport such as cars, jeeps and two-wheeleRs
4. Non-motorised public vehicles such as passenger cycle rickshaws, trolleys, bullock carts, pushcarts and tongas.
5. Non-motorised personal vehicles such as bicycle and pedestrian.

This categorisation could be better understood through this chart.

Figure 2.2



The above chart shows that both the categories of vehicles are inseparable in forming the transport system of Delhi. An attempt has been made to discuss the role they have played in the past and its present endeavours.

2.2.1 Mass Rapid Transit System (MRTS)

The proposed multi-modal MRTS system for Delhi has three components comprising of rail corridors, metro corridors and dedicated bus way for High Capacity Bus System. But at present the Delhi Transport Corporation (DTC) fulfills the task of providing mass transport system along with private operators. Next in the row is ring rail and to augment mass transport facility, construction work of metro rail has started in the city by the Delhi Metro Transport Authority (DMTA) set up by the Government of India. The first line of metro rail between Sahadra and Tis Hazari has already been operationalised.

Buses

The liberalisation of economy in 1991 led towards the denationalisation of public enterprises. A policy was adopted to encourage private sector involvement in the supply of goods and services, which hitherto were the domain of the public sector. This section basically examines the impact of privatisation on the city bus transport in Delhi.

The public transport system of Delhi is primarily based on buses. At present, public operators, Delhi Transport Corporation (DTC) and individual private operators control the bus system of Delhi.

Delhi Transport Corporation (DTC)

Origin and Growth: Since 1971 bus transport in Delhi has been the primary responsibility of Delhi Transport Corporation (DTC), a statutory Corporation established under the Road Transport Corporation Act, 1950, as amended by Delhi Road Transport Laws (Amendment) Act, 1971 (Gupta, 1983). It was formed as a

statutory corporation under the Ministry of Shipping and Transport[4], Government of India (GOI). The management of bus service in Delhi has been subject to number of organisational changes prior to 1971. Bus services in Delhi were first introduced in 1935 when Gwalior Northern India Transport Company Ltd. (GNIT) was given the license to operate in the city. This company was nationalised in the year 1948 and Delhi Transport Services (DTS) was established under the direct control of Ministry of Shipping and Transport, Government of India. This carried on and remained so for two years. Again in 1971, it was converted into DTC under the control of Ministry of Shipping and Transport, GOI, after its operation as Delhi Transport Undertaking (DTU) as a unit of Delhi Municipal Corporation since 1957 (Dhameja, 2001). It enjoyed budgetary support from the GOI till August 1996, when it was transferred to Government of National Capital Territory of Delhi (GNCTD).

Objectives and functions of the DTC: In section 22 of the Road Transport Corporation Act, 1950, following objectives were laid down for the DTC:

- To provide or secure or promote an efficient, economical, reliable and properly coordinated system.
- In doing so, it shall act on business principles.
- To achieve a high-level operational efficiency.
- To charge fares not exceeding those prescribed by the State Under Section 43(1)(i) of the Motor Vehicle Act, 1939.
- To attain financial self-sufficiency.

Performance of DTC: Performance of a city bus transport corporation is normally evaluated by ratios like, staff per bus, fleet utilisation; average age of fleet; surplus or budgetary support. An attempt has been made to analyse DTC's performance in terms of these ratios.

[4] The name of this Ministry has been changing since its inception. At present this Ministry is named as Ministry of Road Transport and Highway. The various names of this ministry have been used in the study, which it had in the past.

Table 2.4

DTC- Profile and Financial Performance

Year	Fleet	Buses on Roads	Fleet Utilisation per cent ~	Staff per Bus	Average Age of Fleet (yrs)	Budgetary Support (Rs Crore)
1990	4399	3860	87.7	9.28	-	697
1991	4392	3722	84.7	9.24	-	165
1992	4375	3750	85.7	9.11	-	80
1993	3840	3665	95.4	10.11	-	90
1994	3502	3247	92.7	9.56	-	94
1995	3480	2313	66.7	9.27	-	64
1996	2770	1722	62.2	11.01	-	84
1997	2713 (*31)	1947 (*28)	71.6	11.07	6.26	35
1998	3847 (*1180)	3368 (*994)	89.0	9.47	7.53	117
1999	5691 (*2565)	4874 (*2198)	85.6	7.72	6.96	268
2000	6161 (*3250)	4844 (*3250)	54.6	10.34	7.10	880

*Include private buses under the administrative control of DTC on Kilometer Scheme.
~Fleet utilisation: Ratio of fleet size and number of buses on roads

Source: Dhameja N, *City Bus Transport Privatisation*, Indian Journal of Public Administration, Vol. XLVII, No. 2, April-June 2001 and *Audit Report on Government of NCT of Delhi of 2002*, Government of India, New Delhi, 2002

Fleet size owned by DTC reduced from 4,399 buses in 1990 to 2,911 in 2000; in 2000 fleet was augmented with 3,250 private buses under its control. DTC fleet utilisation, which stood 95 per cent in 1993, dropped heavily thereafter, and in 2000 it decreased to 54.6 per cent. The DTC buses on an average were older and were used for longer hours and it is reflected by the increasing average age of the fleet over the years, which stood 7.10 years in 2000[5]. The ratio of DTC staff-per-bus[6] improved over the year, from 9.28 in 1990 to 10.34 in 2000 primarily due to the reduction of DTC fleet strength.

Till 1996, when DTC was transferred to GNCTD in October 1996, it was receiving budgetary support from Government of India. However, there has been a massive decline in the budgetary support between 1990 to 1997. In 1990 the budgetary

[5] After the conversion of the entire bus fleet into CNG, majority of the buses is new. Today, if we calculate the average age of the DTC buses, it is going to be very low.
[6] As per the latest data published in TOI July 4, 2003, DTC is having 12 staff-per-bus.

support from GOI was Rs 697 crore, which came down to Rs 35 crore in 1997. This is one of the major reasons for the degradation of DTC's performance over the years. After 1997 DTC was getting budgetary support from GNCTD. Since then, the budgetary support has increased. But there has not been any major improvement in the overall performance of DTC because the large amount from the fund sanctioned was used for overcoming the losses incurred by DTC in the past.

Private Buses (Red Lines and other Lines)

As per its objective DTC could promote an efficient, economical, reliable and properly coordinated system and consequently it can also encourage private buses to augment its fleet to the requirements. On this account the working group on eighth five-year Plan (1992-1997) had recommended that considering a population growth of 4.3 per cent per annum. DTC should have a bus fleet of 9093 buses including 2598 private buses by 1992- 1993. As against this DTC's fleet as on 30-11-92 was 4315 buses including 600 private buses. As a result, GNCTD gave stage carriage[7] permits liberally to private operators since the bus routes in Delhi are not nationalised (Dhameja, 2001). In 1992, Delhi became the first city to adopt large-scale privatisation of bus services. It liberalised the permit conditions, which paved the way for the induction of private buses in the city on a large scale. The objective stated was "to augment the public transport in Delhi". The State Transport Authority (STA) formulated a scheme for the grant of Stage Carriage Permits to private operators on certain routes in Delhi. Accordingly the GNCTD have drawn up a scheme of 3000 stage carriage permits to private operators (GOI, 1993).

As per the scheme, private buses on stage carriage permit operated directly under the administrative control of State Transport Department. Various schemes like Red Line, White Line, Yellow Line Suvidha Scheme, SC/ST Scheme, etc., were launched to increase the private sector participation in stage carriage bus operation. Among these various "line", Red Line bus Scheme was the most prominent one.

[7] Stage Carriage Bus is one in which the vehicle stops at multiple points (called as stages and hence they name) in route while executing the trip, while as the contract carriage has no such stoppages.

The private buses that were supplemented in the public bus fleet, instead of providing better service to the commuters brought intense competition in the city. Private buses were overcrowded, it contributed to traffic anarchy and the poor driving habits of private bus operators caused congestion. Private buses indulged in rash driving and violated all traffic rules for instance stopping buses on unscheduled stops or in the middle of the road. The working conditions in the private buses did not show a healthy sign either, with long working hours and absence of any job security or prospects (Dhameja, 2001).

DTC Hire Private Buses

With a view to check the growing disorder in the city bus service, the GNCTD introduced in September 1996, a plan of engaging private buses with DTC under kilometer (KM) scheme. The scheme envisaged hiring of private buses along with the drivers at a specified per kilometer rate to be paid to private bus owner and the DTC would provide the conductors with such buses so that the revenue earned goes to the DTC. There would be no subsidy and the scheme would be self-sustaining. The numbers of buses engaged from 1996-97 to 2000-01 were 45, 1201, 2652, 2581 and 3250 respectively (GOI, 2002). After the Supreme Court's order to convert the entire public bus transport fleet into CNG, the KM scheme was scraped in 2002. All the buses under KM scheme were given stage carriage permit.

At present there are 2600 DTC buses and 4000 private buses plying under stage carriage permit (Times of India, June 16, 2003). Today the situation on the roads of Delhi is same as it was before 1996 after the introduction of different lines. There are multi regulatory authorities looking after the city bus services - Delhi Transport Corporation, State Transport Authority, Delhi Traffic Police (Dhameja, 2001). There is a lack of coordination between these authorities. Actually there is an absence of approach to coordinate city bus services through a single agency.

Ring Rail

In 1971, the government of India set up the metropolitan transport project with a view to asses the traffic demand and the future development of the metropolitan areas of Delhi as well as to carry out techno-economic feasibility studies for a mass rapid transit system. However the project could not be implemented due to financial constraints. Some immediate relief was offered by means of rail service for which the railways introduced four coach locomotives. Four of such services called parikrama services were introduced in October 1975 (Gupta, 1983).

Today Delhi has an electrified rail network. The Delhi rail network has been laid down over 120-route km and has 38 stations. It encompasses two rings and is fed by eight radial lines from – Mathura, Rewari, Rohtak, Panipat, Aligarh, Meerut, Moradabad and Shamli (Mishra, 2000).

Northern Railway runs about 180 commuter trains and brings about 1.75 lakh passengers into Delhi everyday. In addition to these, the rail network also has to carry the burden of freight trains. At present, 55 trains on average come to Delhi everyday from northeastern, eastern, central and southern India. Of these 20 are unloaded in the Delhi area and the rest are meant for areas north and northwest of Delhi. Another 25-30 trains enter the Delhi area from the north and northwest, most of them are 'through trains'. This is the present situation of rail network in Delhi.

Today the popularity and the utility of ring rail for the local people are very low. Only 1 per cent (table 2.2) of the total commuters in Delhi travel on ring rail. That is principally because of two reasons. First, ring rail is not properly linked with the other modes of public transport, second, the routes/links leading to Delhi and New Delhi is space bound and almost saturated with mainline operations. The ring rail is therefore in no position to support an efficient, frequent suburban service on those very lines (Mishra, 2000).

Metro Rail

History of Metro Rail: Metro rail is one of the components of MRTS project in Delhi. In Delhi the initial plan to construct metro rail came up in 1969[8] (GOI, 1970), but it was initiated only in 1990.

Rail India Technical and Economic Services (RITES) was the authority that prepared the feasibility plan for MRTS. RITES submitted its Feasibility Report in 1990. This report recommended for a three-component system comprising of rail corridors, metro corridors and dedicated bus way. The total network of MRTS contains 16 sections to be implemented in a sequence based on passenger kilometer carried per kilometer length of each section.

Although the report was submitted in 1990, it was approved only in September 1996 (Times of India, September 18, 1996). The Delhi Metro Rail Corporation (DMRC) was formed. The implementation and the project operations are the responsibility of DMRC. The phase I of the Delhi Metro rail was taken up by DMRC in 1996 itself. The construction however, started in October 1998 (Anonymous, 2002).

Present Status: DMRC is presently constructing 55.3 km of metro system. There are two main routes in the system. One runs 11 km from the University in the north to the Central Secretariat in the centre of the city. It is underground. The other, which is a longer route runs from the industrial area of Shahdara in the east to the industrial area of Nangloi in the west (the first part of this route has already started from Shahadra to Tishazari). Both the routes intersect at the main Bus Terminus of the city. The second route also has a branch going to Holambi Kalan in the northwest, which is near the new industrial township of Bawana (Roy, 2002).

[8] The Central Road Research Institute (CRRI) undertook the first exhaustive study on traffic and travel characteristics of Delhi in 1969-70. While bringing out extensive data describing the traffic and travel characteristics, it developed mathematical models to project travel demand. By examining several alternatives, it recommended for a Mass Rapid Transit Network for Delhi.

Funding Plan: The capital cost of phase I is Rs 6,000 crores at April 1996 price level (Gupta, 1997). However, if the element of escalation during the construction period of 7 ½ years is taken into account, the completion cost has been estimated to be Rs10, 571 crores.

Table 2.5

Funding Plan of Metro Rail

Govt. of India	14%
Govt. of National Capital Territory of Delhi	14%
Property Development	3%
Japanese Bank for International Cooperation (JBIC) Loan	64%
Interest Free Subordinate debt towards land cost	5%

Source: www.delhimetrorail.com

When the Metro was first planned ten years ago the route length was only 27.9 km and was expected to cost Rs 6,000 crores. Now even though the route length has been doubled, there has not been much increase in the completion cost. The total cost if calculated after the addition of new route length as per the inflation rate, would be much higher than the cost claimed by DMRC. As the above table shows 64 per cent of this amount has been given as a long-term loan by the Japanese Bank for International Cooperation (JBIC) at a low interest rate of about 2.5 per cent. This rate is misleading because Japan's domestic rate for short-term lending is less than 1.5 per cent and hence there will be no loss in profits to the lender. Furthermore, the loan has to be repaid by India in Yen currency, which protects the Japanese investment fully. Given the Rupee's declining value in the international market, India will actually pay almost 15 per cent in interest in the long-term (Roy, 2002). In addition, a large amount of the Japanese loan is being used to pay Japanese consulting firms and manufacturers for design, engineering skills, fabrication, and equipment. Indian executives of DMRC are even required to take loans to buy Japanese cars. Thus, the Japanese economy is likely to benefit a great deal from the construction of the "environment-friendly" Delhi Metro. Will the Indian economy and "environment"

benefit as much? The trends have started coming. The Delhi Metro Rail Corporation (DMRC) has reported an operational loss of Rs 26 lakhs on the 8.3 km long Sahadra-Tis Hazari section, for the period from January to March 2003 (Business Standard, May 31, 2003).

2.2.2 Intermediate Public Transport (IPT)

Intermediate public transport (IPT) or para transit modes[9] can be loosely defined as a service, which is between public transport and private transport (GNCTD, 2002 (c)). IPT is important in under- developed countries as a prime mover of person and as a generator of large-scale employment (Gupta, 1983). Today in Delhi IPT modes are taxis, autorickshaws and rural transport vehicles (RTV). They serve the need for door to door and journey at will for the less affluent people. IPT modes have been generally available and have been functioning for years. However, despite the fact that they play a significant role in the overall urban transport, they have until recently received little recognition in the policy as compare to other forms of transportation.

Growth of Autorickshaws and Taxis: IPT modes have been growing at a fast pace. Table 2.6 shows the growth of autorickshaws and taxis in Delhi. The growth in the number of autos was at the rate of 8 per cent per annum (from 20,000 to 82, 000) during 1980-2000, Taxis 6.3 per cent per annum (from 6,000 to 17, 000) and the total vehicles have grown at the rate of 10 per cent per annum during the same period. But if we see the growth of autos as a percentage of total vehicles, their share has been declining over the years from 3.8 per cent in 1980 to 2.6 per cent in 2000. Share of taxis in total vehicles has also been declining over the last two decades and has been reduced to half in the year 2000 of what it was in the year 1980.

[9] Transit service provided by vehicles, usually smaller than full transit buses, that carry passengers on routes or schedules that are not fixed.

Table 2.6
Growth of Auto Rickshaws and Taxis over last decades
('000)

Year	Auto Rickshaws	Taxis	Total motor vehicles
1980	20 (3.8)	6 (1.1)	521
1985	31 (3.3)	9 (0.97)	925
1990	62 (3.5)	10 (0.56)	1765
1995	78 (3.0)	13 (0.50)	2576
2000	82 (2.6)	17 (0.56)	3167
2002	42 (0.01)	0.9 -	3500

Figures in the brackets represent percentage of total vehicles

Source: *Intermediate Public Transport,* Theme paper presented by RITES in the Workshop on 'Tackling Urban Transport in Delhi- Choices', New Delhi, 2002

In 1997, the Supreme Court of India gave an order to fix the number of autorickshaws at 82,000 and to phase out all the 15 years old commercial vehicles (Hindustan Times, December 27, 1997). According to this order no new permit was to be given to autorickshaws. Further with the Supreme Court's order of conversion of public vehicles into CNG in the city, the number of autorickshaws and taxis dropped to 42, 000 and 900 respectively in the year 2002.

According to RITES[10], the current interest in these modes is largely due to the emergence of new set of values relating to economic and environmental issues (RITES, 2002). Specifically, it has been viewed recently that these modes of transport potential of reducing pollution and parking problems which Delhi is facing due to the increasing number of personalised modes of transport on the roads. RITES opinion is contradictory because if autorickshaws and taxis are considered to be economic and environment friendly then why did the Supreme Court order that the autorickshaws

[10] These views were expressed by RITES in the presentation made by them in the workshop held on August 2002 on 'Tackling Urban Transport in Delhi- Choices'.

and taxis should run only by the "environment friendly" CNG.

Taxis

The number and use of taxis is very limited as compared to that of autorickshaws. It is mostly while going either to the airport or the railway station that taxis are made use of. In taxi operation the metered taxis are almost negligible and private cars attached to taxi stands are operating as taxis. In the absence of fare meter these private car drivers demand exorbitantly high fares on their own, which often leads to conflict between the drivers and the commuters. Even though there is an authority to look into these problems of taxi operation, it is hardly concerned.

Autorickshaws

Autorickshaws are also known as TSRs (Three-seater Rickshaws). At Present autorickshaws are operating all over Delhi. In the absence of good mass transport in the city, the use of autorickshaws is very common and very frequently autorickshaws also undertake cross-city journeys (RITES, 2002).

Over the past few years autorickshaw drivers have been facing immense pressure due to rise in costs of operating their vehicle (Mohan and Roy, 2003). In addition, as per the reports from various newspapers the autorickshaw drivers have also been very dissatisfied with the newly installed electronic fare meters of their vehicles as this imposes an extra cost without any advantage as the meters are not reliable and do not follow BIS standards (Times of India, July [illegible], 2002). This is proven by the everyday complaints from the commuters regarding the auto drivers which find a prominent place on the city pages of the newspapers and the drivers on the other hand continue to voice their complaints regarding nonstandard electronic meter and intolerable working conditions.

Rural Transport Vehicles (RTVs)

The Rural Transport Vehicle (RTV) was seen for the first time on the roads in 1997. The RTV has mainly been created keeping in mind the rural India. However during the period of CNG crisis in Delhi it was promoted by the government for

supplementing public transport. The RTV is being used for varied purposes such as passenger carriers, troop carriers, as well as distribution/delivery needs of individuals, institutions and corporate. RTV, today in Delhi, plays the role that mini bus use to play few years back. RTV actually is an attempt to encourage the private operators to participate in the public transport system of Delhi. The introduction of RTV in Delhi is actually an outcome of the decreased public investment in transportation sector.

2.2.3 Peronalised Vehicles

A personalised mode of transport is that in which the user and the owner of a means of transport are the same. Compared to mass transit transport and intermediate transport, personalised mode of transport is expensive. Commonly known personalised modes of transport are cars and two-wheelers. Today in Delhi personalised vehicles like two-wheelers and cars comprise about 86 per cent of the total number of vehicles, but cater to less than 30 per cent of the total traffic load. Due to an inappropriate and inefficient public transport system in Delhi, roads of Delhi are flowing with personalised modes of transport.

2.2.4 Non-motorised Public Vehicles

Despite rapid rates of motorisation and the importance of bus transport, non-motorised vehicle has maintained its important role in terms of mobility, especially for the poor segments of the population. Non-motorised vehicles comprise public vehicles such as passenger cycle rickshaws, trolleys, bullock carts, pushcarts and tongas. Passenger cycle rickshaws play an important role in the non-motorised public vehicles of Delhi. While rickshaws are used for providing short distance service, trolleys, bullock carts, pushcarts are used for services such as delivery of goods.

There are lakhs of rickshaws running on the roads of Delhi. The numbers of licensed rickshaws in Delhi are 73,000 (Lokayan, 2002). It is an assumption that the numbers of non-licensed rickshaws are four times more than the figure of licensed rickshaws. In Delhi there are three independent administrative bodies - Municipal Corporation of Delhi, New Delhi Municipal Corporation and Delhi Cantonment Board. Rickshaws

are strictly prohibited in the area falling under New Delhi Municipal Corporation. However, it is allowed in the areas covered by the other two administrative bodies. The roads of Delhi are divided into red, yellow and blue zones by the Delhi Police for passenger cycle rickshaw. Rickshaws are strictly prohibited in the red zones, in the yellow zone rickshaws are restricted between 8.00 am to11.00 pm, there is no restriction in blue zone. Strict regulations are implemented to phase out passenger cycle rickshaws from the roads of Delhi (Lokayan, 2002).

2.2.5 Non-motorised Personalised Vehicles

Bicycles and Pedestrians

The other category of non-motorised vehicles is personalised vehicles such as bicycle. In Delhi there are large numbers of commuters who either cycle or walk down to their work place. Majority of them are the low-income residents living in the substandard settlements (Hazards Centre, 2001). Industrial workers, construction workers, carpenters, masons, plumbers, postmen and courier services use bicycles. Bicycles and pedestrians are present in significant numbers on the arterial roads and inter-city highways designed for fast moving uninterrupted flow of motorised vehicles, as a result of which there is a dangerous conflict between heavy motorised vehicles and bicycles and pedestrians. According to the report of Delhi Traffic Police, in the year 2002, 1646 people died in the road accidents. Out of this 49.11 per cent were pedestrians (Rashtriya Sahara, January 11, 2002).

At present even a "subsidised public transportation system" is cost prohibitive for a significant segment of the Delhi population. If we assume a minimum of 4 trips per household per day at a cost of Rs 4 per trip for public transportation, a household would need to spend a minimum of Rs 320 per month for 20 working days. For low-income people living in the substandard settlements of the city, the cost per trip may be Rs 8 to Rs 10 depending on the number of transfers. On an average, a household cannot spend more than 10 per cent of its disposable income on transportation. This implies that the household monthly income must be at least Rs 3,200 for use of the public transport system at minimum rates (Mohan and Tiwari, 2000). According to

ORG 1994 survey, approximately 28 per cent of the households in Delhi have a monthly income of less than Rs 2,000 (Mishra, 2000). For these people, the only feasible choice that remains is that of either cycling or walking down to their work place.

Unless the needs of non-motorised modes of traffic are met it will be almost impossible to design any sustainable transportation system for urban areas. It is apparent that pedestrians, bicyclists and passenger cycle rickshaws are the most critical elements in mixed traffic. If the infrastructure design does not meet the requirements of these elements all the other modes of transport will continue to operate in sub-optimal conditions. In order to address the issue of non motorised vehicles in Delhi, Indian Institute of Technology (IIT), Transport Research and Injury Prevention Programme[11] (TRIPP), proposed bicycle master plan, but it was never implemented by the government.

2.3 CONCLUSION

In Delhi, the government's anti people policies has led to the proliferation of personal vehicles, two-wheelers and four wheelers, the lack of mass transport options and the overall degradation of urban infrastructure. It has further led to a situation where bad roads, traffic congestion due to personalised modes of transport has made the available mass transit and movement highly unreliable, unsafe and uncomfortable.

[11] Transport Research and Injury Prevention Programme. TRIPP at the Indian Institute of Technology (Delhi) is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport.

Chapter 3

TECHNOLOGY CHOICE IN THE TRANSPORT SYSTEM OF DELHI

Transport technology can be represented as a series of particular modes which represent certain combinations of available technologies, often described in the form of prescribed design standards. Implied in these descriptions, however, are significant trade-offs- between vehicle size and weight, pavement structure, control procedure, and performance characteristics such as speed, safety and schedule frequency (Meyer, 1972). This chapter maps the various technologies involved in running the transportation system of Delhi as also the technological changes and upgradation that have taken place in different modes of transport.

Technology choice in the transport system of Delhi could be broadly divided into the following categories:

1. Motor Vehicle Technologies
2. Non-motor Vehicle Technologies
3. Rail Technologies

3.1 MOTOR VEHICLE TECHNOLOGIES

The transportation system of Delhi mainly comprises of motor vehicle technologies. Buses, taxis, private cars, three-wheelers and two-wheelers fall under this category.

3.1.1 Waves of Technological Innovations in the Motor Vehicle Industry

According to a recent study done jointly by California University and Tata Energy Research Institute (TERI) on the green house scenario in Delhi, there are three waves of technological innovations taking place in the international motor vehicle industry (Sperling and Bose, 2001). These are as follows:

- The first wave is aimed at reducing air pollutant emissions from conventional internal combustion engines.

- The second wave of innovation is aimed at increasing the energy efficiency of conventional engines.
- The third wave of innovation involves a transition away from internal combustion engines to electric drive propulsion technology.

It has been observed that the first wave of innovation has predominantly taken place in Delhi after the Supreme Court's order of July 28, 1998. As per the order, the entire public transport fleet was converted into CNG. The Government of India has adopted stringent emission standards[12] after this order. This includes improvements in combustion processes, treatment of exhaust gases (i.e., with catalytic converters), and use of cleaner burning fuels. As a result, today the auto manufacturers in India are busy in manufacturing vehicles with the improved technologies for engines running on CNG and alternative fuels.

It appears that the second wave of innovation is mainly taking place in two-wheelers and cars in India. The majority of the vehicles operating today in India are not energy efficient by international standards. The average fuel economy for a new small car sold today in India is under 8 liters/100 kilometers. Small two-stroke motorcycles achieve under 3 liters/100 km and buses over 34-liters/100 km. These impressive fuel economy numbers are due to low power and small size and not because of any other reason. The auto manufacturers are continuing to increase vehicle efficiency in response to existing fuel economy standards in Japan and the United States. This is debatable. In the context of two-wheelers and cars, up to some extent it is true, but as far as buses are concerned, the engine efficiency of buses has remained the same in India since many years.

The third wave of innovation seems to be more radical. It is not taking hold as fast as the other two waves of innovations. According to the study, these innovations have

[12] The Central Pollution Control Board (CPCB) sets standards of air quality, which aim at protecting human health, vegetation and living creatures, property, and environment from adverse effects of air pollution. Similarly vehicular emission standards are set by CPCB in order to check the vehicular pollution.

the potential to induce massive reductions in Green House Gas (GHG) emissions. The use of electric-drive systems - fuel cells, batteries, and hybrid electric systems - would improve energy efficiencies by 50 per cent or more, with much less pollution. These technologies are expensive. In comparison to these technologies, the common user would definitely prefer the conventional technologies because they are more cost-effective and also have less maintenance cost.

3.1.2 Present Status of Technology Choice in the Motorised Vehicles

***Judiciary decides technology*:** Vehicular pollution has become a major contributor to deteriorating air quality in cities. Number of vehicles, especially two-wheelers are increasing at an unprecedented rate. In just seven years, the number of vehicles in India has shot up by 17 million and 48 per cent of these vehicles are in the three metros alone (GOI, 2001). The ambient air quality data of Delhi showed high proportions of suspended particles at all the monitoring stations set up by the Central Pollution Control Board (CPCB) (Gupta, et. al., 2002). According to a report by CSE, vehicular pollution contributes to a shocking 64 per cent of the total pollution in Delhi, 52 per cent in Mumbai and 30 per cent in Kolkata. In order to improve the air quality and reduce vehicular pollution of Delhi, on 28th July 1998, Supreme Court of India ordered that the entire public transport fleet of Delhi should run on alternative fuel. Compressed Natural Gas (CNG), which is a gaseous transport fuel, was allowed as an alternative fuel by the Apex Court on the recommendations of Bhurelal Committee Report[13] (BLC) (Gupta, et. al., 2002). This order was vis-à-vis the Public Interest Litigation (PIL) filed by advocate M.C. Mehta with regard to the problem of pollution in Delhi.

Advocate M.C. Mehta in 1996 filed a petition calling for measures to improve air quality in Delhi in view of the failure of the government to do anything substantive in the matter. Many hearings were held and finally the Court passed the orders "realising the urgency and importance of protection and improvement of the environment",

[13] It is also known as EPCA Report. This committee was formed under Supreme Court Directive in January 1998, in order to suggest ways to cut pollution in Delhi.

particularly in relation to vehicular pollution (Mehta, 2002). Some of the important points of the Supreme Court's orders of July 28, 1998 are as follows:

1. Augment public transport to 10,000 buses by 1/4/2001
2. Introduce unleaded petrol in NCT Delhi by 1/9/1998
3. Supply pre mix petrol for two-stroke engines by 31/12/2000
4. Replace all pre 1990 autos and taxis on CNG or alternative clean fuel by 31/3/2000
5. Financial incentives for the replacement of post 1990 autos and taxis by 31/3/2001
6. Entire city bus fleet to be converted to CNG by 31/3/2001
7. New Interstate Bus Terminals (ISBTs) to be built at entry points to Delhi by 31/3/2001
8. Indraprastha Gas Limited (IGL) to expand CNG network to 80 supply stations by 31/3/2000
9. CPCB to set up new air quality monitoring stations by 1/4/2000
10. Restrict plying of all commercial vehicles to those, which are less than 15 years old.

Before one gets into the discussion on CNG being a cleaner fuel, one has to examine whether the public vehicles are the real culprits in creating pollution. The figures speak for themselves. If all the different modes of public transportation are put together, it would not constitute more than 10 per cent of the total number of vehicles in Delhi. However, private vehicles like two-wheelers and cars comprise about 86 per cent of the total number of vehicles. So it is not surprising that even if one were to remove the entire public fleet there would be hardly any significant change in pollution levels. While these vehicles may be far more "polluting", their numbers do not add up to much for ambient pollution levels.

Just before the Bhurelal Committee came out with its recommendations, the papers of a World Bank Workshop on Vehicular Pollution Control were published. These papers not only analysed a range of options in fuels, lubricants, engines design and

technological upgradations but they also looked into traffic patterns, transport modes, enhancing public transport and most importantly, petrol engine emissions. Several of the authors also presented evidence before the BLC. But BLC rejected the recommendations of all these experts. And till today, no one knows the reasons of rejection.

During the time of CNG controversy, there has been a discussion on CNG vs. low sulphur diesel. Some of the arguments of experts in favour of low sulphur diesel are as follows:

- The combination of low sulphur diesel and after treatment technology creates emission results comparable to CNG.
- Low sulphur diesel conserves more energy consumption than CNG.
- CNG produces more potent greenhouse gases than low sulphur diesel.
- The low sulphur / after treatment filtration system reduces particulate emissions comparable to CNG.
- The assumption that CNG is not toxic is not verifiable.
- The assumptions that low sulphur diesel is a carcinogen is not verifiable.
- Low sulphur diesel is safer than natural gas.

Thus, one could argue that low sulphur diesel would have been better option than that of CNG and the Government, in order to bring the pollution levels down, could have opted for low sulphur diesel instead of channelising its entire energy in converting public fleet into CNG.

Between July 28, 1998, when the Supreme Court ordered for the use of alternative fuel and January 31, 2001, when Supreme Court asked the GNCTD to report about the steps taken to implement the order, very few public vehicles were converted into CNG. It was in 2001, when the public transport system of Delhi was collapsed completely due to the various deadlines set by the Court. Realising the urgency of the situation, a meeting was organised by the Prime Minister of India in the month of August in order to resolve the crisis. It was decided in the meeting to appoint a committee under R A Mashelkar, Director-general of Council for Scientific and

Industrial Research (CSIR), to work out an Auto Fuel Policy for the nation (Hindu, March 15, 2002).

***Mashelkar Committee Report*:** A report on Auto Fuel Policy was submitted by Mashelkar Committee in January 2002. According to the report the quality of diesel and petrol has significantly improved in the past few years and substantial investments being planned in the future are expected to improve the quality further. The committee recommended that alternatives such as CNG and Liquid Petroleum Gas (LPG) should also be encouraged with the caveat that urban bus transport should not be dependent on a single fuel. This committee in its report has also recommended various changes in the motor vehicle technologies in order to meet the emission standards 2000.

***Emission Standards*:** The emission standards in the country at present are India 2000 level equivalent to Euro I for passenger cars, light commercial vehicles (LCVs) and Heavy commercial vehicles (HCVs). Euro II vehicles are being supplied to four mega cities- Delhi, Mumbai, Kolkatta and Chennai. According to the National Auto Fuel Policy 2002, Euro II vehicles should also cover three more cities Ahmedabad, Banglore and Hyderabad by the end of 2003. Emission norms for two-wheelers and three-wheelers are not based on Euro pattern because at present two-wheelers and three-wheelers manufacturers in India have not developed the technology equivalent to Euro norms [For details on Euro I and Euro II norms, see Appendix II (a), Appendix II (b)].

3.1.3 Technological Change and Technological Upgradation in Motorised Vehicles

On the basis of various Government of India (GOI) reports such as Auto Fuel Policy 2002, Annual Reports of Ministry of Surface Transport, Annual Reports of Delhi Administration and few independent studies, it has been observed that in the last decade various technological changes have taken place in motorised vehicles. An attempt has been made to map these technological changes and upgradations.

Buses

The design of public buses until the Court's order was technologically primitive. Chassis of buses were similar to those of trucks. Most bus body builders do not have engineering expertise either in design or manufacturing. All the buses were powered with diesel engines. Since 1970, when double-decker buses were initiated in the metropolitan cities (GOI, 1970), the bus technology in terms of engines, chassis and body has remained unchanged.

After the Court's order diesel engine buses were converted into CNG engines. This required major modification to reduce the compression ratio, fitment of carburetor, spark plug, ignition circuit and expansion valves to reduce pressure of CNG before induction into the cylinders. The diesel engine converted to CNG has different speed - torque characteristics. The newly designed and developed CNG engine includes specially designed chassis. Lightweight material has replaced the conventional material.

Problems of CNG buses: CNG buses have a distributor based ignition system, which can be dangerous if the CNG cylinders leak. The distributor produces sparks, which ignites the CNG gas inside the ignition chamber. In addition, distributors also produce sparks outside the chamber. This makes them vulnerable to the highly inflammable CNG. It is a first generation system, which has been discarded in many countries. China has been the latest to ban this obsolete technology (Gupta et. al, 2002).

Cars and Taxis

Cars/Taxis petrol engines: All petrol cars manufactured after April 1, 1996 are equipped with Positive Crankcase Ventilation Valve (PCV) system. PCV is a low cost hardware, prevents noxious gases from escaping into the atmosphere and recycles them to intake air system. A few pre-1996 petrol cars also had PCV system. Vehicles manufactured in India after April, 1996 have evaporative emission control system, hardware that decreases the intensity of noxious gases before escaping into the atmosphere.

Two-wheelers

Two - wheeled vehicles are popular for personalised transport. The population of two-stoke engine powered in two-wheelers in Delhi is very large, although the number of four-stroke vehicle is increasing rapidly. Two stroke engines are widely used for motorcycles, scooters and mopeds, primarily because of their high specific power output, simple and compact design, lower engine friction, less pumping losses at part load, better cold startability, and low production and maintenance cost. Two-stroke engines are 20 per cent poorer in the fuel efficiency and more polluting than that of a four-stoke engine.

The market competition in the past few years have lead the manufacturers to overcome the disadvantages of two-wheelers in terms of fuel consumption and higher hydrocarbon emissions.

3.1.4 Technology and Automobile Industry

Buses: For the past 50 years Ashok Leyland (ALL) and Tata Engineering and Locomotive Co. Ltd (Telco) are the two major companies that have been manufacturing buses (both DTC as well as private) plying on the roads of Delhi. The State Transport Authorities (STAs) opine that they do not have a choice in any other technology in case of buses because these two companies are the major manufacturers of buses in India (Pioneer, July 9, 1997).

The Supreme Court's order of 28th July1998 had obviously thrown up a big opportunity for the commercial vehicle manufacturers both for new vehicles and for retrofitting the existing diesel vehicles with CNG kits. Commercial vehicle majors, ALL and Telco came up with their experience and relationship with the state to build up a dominant market share in the CNG bus segment.

ALL, by virtue of the fact that it was an early starter in this technology, exploited the situation. The advantage for ALL was that it was the only manufacturer to have tested the vehicle on road, as its CNG buses were running in Mumbai for the last few years.

Cars/Taxis diesel engines: Diesel engines are popular for taxis most of which are retrofitted by diesel engines. In India Indirect Injection (IDI) diesel engines are commonly used in cars. Due to the pricing policies of fuels, the running cost of diesel cars is lower than that of petrol cars.

In order to match the India 2000 norms all the car manufacturers have now started manufacturing with Euro II and Euro I engines. After the Court order the engines of taxis were converted into CNG mode. Original Equipment Manufactures (OEM) engines or the kits were used for this purpose because in order to match emission standards they were found technically acceptable.

Due to the competition in the market, the design of the cars and taxis (both running on petrol as well as on diesel) have been changing rapidly since mid-1980s after the arrival of Maruti.

Autorickshaws

Two stroke engines are widely used in autorickshaws as also in two-wheelers. The older autorickshaw in Delhi had a Lambretta designed engine but it has been phased out as it consumed too much petrol. Vespa-designed engines, the commonest one found in India, today took over. The newer ones have the engine at the back and are less noisy.

After the Court order all the autorickshaws in Delhi were converted into CNG. A 175cc four-stroke single overhead camshaft (OHC) engine powers the CNG autorickshaws. The CNG auto has a minimum range of 110 km on a three-kg fuel tank. It also has a standby petrol tank for emergency use (Business Line, May 30, 2000). Petrol taxis and autorickshaws have bi-fuel capabilities. According to the experts it is an undesirable feature because the engine can only be optimised for one specified fuel.

Telco, its competitor, had CNG buses, but it could not offer them for commercial use. ALL also designed the body of CNG buses based on the experience it had (The Financial Express, July 9, 1999).

The company also retrofitted diesel engines with CNG engines. The company's CNG kits were cheaper than imported kits as it had been indigenised to the extent of 80 to 85 per cent in value terms. In this regard the company also got contracts from GNCTD for replacement of diesel engines by CNG engines.

Autorickshaws: Lambretta manufactured the older autorickshaws in Delhi. After the Supreme Court's order requiring all the pre-1990 autorickshaws and taxis plying in the Capital to be replaced with new vehicles operating on the clean alternative fuel, all the autorickshaws had to change the engines to run on CNG. Today in India, Bajaj is the major manufacturer of autorickshaw. There are several models. At first there was engine conversion kit and now there is a new vehicle. Today in Delhi, Bajaj autorickshaw is mainly seen as an intermediate public transport, painted bright yellow and green. These are priced[14] at around Rs 90 000 plus local taxes as applicable in Delhi.

Rural Transport Vehicles (RTVs): Hindustan Motors Limited manufactures RTV from its Pithampur plant in Madhya Pradesh. It was developed in collaboration with OKA Motor Company, Australia. The Pithampur plant where the RTV is manufactured has the capacity to manufacture 7500 vehicles per annum. It was launched with CNG engine in Delhi in 2000. RTV is available in diesel, petrol, CNG/LPG variants and conform to Euro II emission norms (Hindustan Motors, 2002). RTV is considered to be the first commercial vehicle in its category to have given Delhi City the "environment friendly commercial passenger vehicle".

[14] In case, the autorickshaw is bought through financer or agent, its cost comes around Rs 1,75 000. For more details see Mohan.D and Roy.D, Operating on three Wheels: Auto Rickshaw Drivers of Delhi, *Economic and Political weekly,* January 18, 2003

Table 3.1

List of Manufacturing Companies authorised by the GNCTD for the conversion and manufacturing of CNG Vehicles

Company	Vehicle Type	CNG Mode	Cost
Ashok Leyland	Bus	Retrofit (I)	Pre Euro Bus: Rs 5,98,320 (inclusive of sales tax) Euro 1 Bus: Rs 6,88,338/ (Inclusive of sales tax) Retrofitment labour charges: Rs45-50,000
	Bus	CNG Chasis	Rs 10,37,415 +sales tax of 1,24,439.80 (@ 12 per cent) = Rs 11,61,904.80 (Inclusive of sales tax)
Telco	Bus	Retrofit (Company has not yet started retorfitment work, this proposal is in pipeline	Rs 7,25,000 + Applicable tax in Delhi
	Bus	CNG Chasis	Rs 10,29,000 + 1,23,480 (@ 12 per cent) = 11,53,000 (according to Tata Sales and Services, New Delhi)
Hindustan Motors	RTV (mini bus)	New CNG vehicle	Rs 4,70,000 (on road HM RTV)
Bajaj Auto Ltd	Auto	New	Rs 89,000 (According to a Bajaj Auto Dealer the CNG autos are only available through replacement of old petrol autos at STA office at Burari, Petrol autos are not sold in Delhi right now)
Nugas' Technology Ltd.	Bus	Conversion	Rs 4,86,000(inclusive of sales tax)
Rates Fuel & Automobile Technologies	Bus	Conversion	Rs 3,49,000 (inclusive of all tax)
VIP- Build Con	Bus	Conversion	Rs 3,30,000 – Type approval
Trans-Energy	Taxi/Petrol cars	Conversion	Rs 35,440 (inclusive of sales tax) Additional 10,000 for MPFI engine cars
Shrimankar Gas Service	Auto	Conversion	Rs 22,700 (inclusive of sales tax)

Source: O.P. Gupta, Er. D. Mukhopadhyay and Vijay Gupta; *Alternative Fuel (CNG) For Pollution Free Delhi: Implementation Problems, Remedies And Standard Norms*, Indian Road Congress

The above table shows the list of manufacturing companies authorised by GNCTD for the conversion and manufacturing of CNG vehicles. This elucidates that the

conversion of the means of public transportation to CNG did not happened in isolation. It appears that there has been a strong lobby of industrialists and gas companies, who have played an active role behind the scene. The fact that Ashok Leyland had developed a CNG prototype in 1987 (Indian Express, 1999) gives the sign of conspiracy that took place behind the scene in CNG crisis.

3.2 NON-MOTOR VEHICLE TECHNOLOGIES

3.2.1 Technological Change and Technological Upgradation in Non-motorised Vehicles

The non-motor vehicle technologies include passenger cycle rickshaws, bicycles, trolleys, bullock carts, pushcarts and tongas etc. Trolleys, bullock carts, pushcarts and tongas have remained the same for the past so many years. In fact, till today they provide those services in the city, which the motorised carrier vehicles could not provide. In the case of passenger cycle rickshaws, recently major technological changes and upgradations have taken place. As far as bicycle technology is concerned, it is changing rapidly since 1980s.

Passenger Cycle Rickshaws[15]

The technology of the normal cycle rickshaw remained unchanged between 1958[16] and 2000. It has been observed that for the first time after 2000 some distinct efforts were taken to change the technology of cycle rickshaw.

Even though passenger cycle rickshaws vary in design across different cities in the country but its technology is same. The front part is almost similar to that of a bicycle, the only difference is that the pipe used for that triangular shape is stronger than that of bicycle, so that it can resist more weight. Just behind this triangular frame, Y-shaped frame is attached, to which the two back wheels on the axle are

[15] All the information on the technology of passenger cycle rickshaw is primarily based on newspaper clipping because there is no information on the technology of cycle rickshaw in the government documents.

[16] There is a contradiction on the exact year, when cycle rickshaw first started in India. According to some other newspapers, it started in India in 1940.

attached. Just above this frame a wooden seat for commuters is fixed with bolts. There are 48 teeth in the front cogwheel and 22 teeth in the back cogwheel of the rickshaw. This shows that the difference between the gearing ratio of front and back cogwheel is very high, as a result the speed of rickshaw remains steady. Almost similar gearing ratio is found in a bicycle. However, a rickshaw is four times heavier than that of a bicycle. There are no differential gears in traditional rickshaws therefore drivers need to be extra careful while taking a turn. The seat of traditional rickshaw is quite heavy (Grassroots, 2002).

In order to overcome all the shortcomings of the traditional rickshaw, project *Chakra* was launched. The project funded by the United States Agency for International Development (USAID) was worked upon conjointly by the Asian Institute for Transport Development (AITD), the New York based Institute for Transportation and Development Policy (ITDP) and IIT, Delhi (The Financial Express, April 9, 1999). The main features of the improved and newly designed rickshaw were:

Lightness: the use if GI pipes in the new model has brought their weight down to 55 Kg, as against the existing 90 Kg.

Better design: The ergonomically correct saddles and mountain-bike handlebars reduce wrist strain and the wider chassis lends stability and makes it easier to get on and alight. Wider, comfortable nylon-webbing seats act as shock absorbers. The rear axle is aligned with the chassis, thus decreasing friction and wear.

Seats: The seats have been widened to 36 inches from the existing 25 inches: nylon webbing has been added to absorb shock and ventilate. It is also lighter and more comfortable than the standard wood and steel spring cushioned seat.

Competitive price: There is no variance in the cost of the new and the traditional models i.e. Rs 4,500 but the new model provides storage seat under the seat, reflectors for night time safety and a new gear system that dramatically reduces pedaling efforts, as further pluses.

The new rickshaws are increasingly replacing the old one. In other words, technology upgradation has taken place and both, the owners and users of rickshaw, have

accepted it, but at the policy level attention have not been given to this new innovation.

Bicycles

Bicycle is a popular means of transportation in Delhi especially for the industrial workers and construction workers. Bicycle actually evolved from a little wooden horse with a fixed front wheel, in France in 1790's. In 1817, this model was improved by Baron Karl von Drais in Germany. The model for the modern bike was the "safety bicycle", invented in England in the early 1880's, with a chain, sprocket driving rear wheel and equal sized wheels. The years that followed saw further development of the bicycle with pneumatic tires, two and three speed hub gears and the derailleur gears, which was the last major innovation of bicycle design until the 1970's (Gupta, 2001).

Most bicycle components and bicycle spare parts in India, except for free wheels and single piece bicycle hubs are manufactured by the Small Scale Sector, while the large-scale units are permitted to manufacture bicycle frames, chains and rims for captive consumption. The major bicycle manufacturing industries in India are HERO CYCLES LTD., ATLAS CYCLES LTD. and AVON CYCLES LTD.

Bicycle technology in India has remained stagnant till 1980s. In late 1980s through the introduction of lightweight raw material some innovation took place in bicycle technology (The Financial Express, April 5, 1999). The cost of new bicycle was much higher than that of a traditional bicycle therefore these innovations have only attracted middle class and not the working class. Because of its cost-effectiveness the working class continued to use the traditional bicycle.

3.3 RAIL TECHNOLOGIES

3.3.1 Technological Change and Technological Upgradation in Railways

Indian Railways were built by the British to serve their strategic and economic interests. Indian railways are the largest in Asia. The development of the railway system tended to track British technology until the 1940s at least. Since then, the influence of both the U.S. technology and of the European practice has grown rapidly. Indian railways were among the first major agents of technology transfer and remain among the most experienced. The design of Indian Railway locos, rolling stock, track, signaling, and structures has never exactly mirrored British, U.S., or other influences, but it has been strongly influenced by them, and as a result, look-alike of all kinds can be found. Steam locomotive practice has always been strongly influenced by British practice, reinforced until 1947 by the Imperial Preference system, which restricted the purchase of non-British goods and inhibited the establishment of an indigenous manufacturing base (Anonymous, 2000).

In the past fifty years both the network and the technology of Indian Railways have developed. Today electrification of rail network is taking place on large scale. Railway Electrification Organization has been entrusted with the electrification of railway network throughout the country. This organisation has been functioning since 1961 but a centralised organization known as Central Organisation for Railways Electrification (CORE) was set up at Allahabad in 1979. Starting with 1500 Volt direct current electric traction on 3rd February, 1925 over a small section of 16 Kilometers between Bombay VT And Kurla Harbor, Indian Railways are today having 14579 kilometers route of its track under electric traction system which comprise of about 23 per cent of total railway network (Singh, 2001).

There are two types of rail system that come under the category of rail technology in Delhi- Ring Rail and Metro rail.

Ring Rail

Ring Rail basically depends upon EMU services. Electric Multiple Units (EMU) are ideal for suburban services with high acceleration and braking features required for frequent starts and stops (Singh, 2001). EMU services are the backbone of suburban transportation in the metropolitan cities like Mumbai and Kolkatta, but in Delhi this service is not very successful. Only one per cent of the total commuters in Delhi travel in ring rail services (Mishra, 2000).

Metro Rail

Delhi Metro is completely dependent on the technology and techniques from Japan. Several leading companies of Japan, who have won contracts on International Contract Bidding (ICB), are the overall incharge of constructing metro rail. The work, right from the stage of construction to the final commissioning and operation of the Metro Rail services, is in the hands of these companies.

Apart from construction the technology required in metro rail could be categorised in two parts - Technology for running metro rail[17] and Technology of metro trains.

***Technology for running metro rail*:** This could be further categoried into electrical, signalling and telecommunication.

Electrical: Power supply system for Delhi MRTS is being designed to ensure continuous and reliable power for running electric trains in the underground Metro Corridor and on the Surface Corridor. Total power required for running trains with modern coaches on both the corridors is estimated to be 75 MW by the year 2005. This power will be used for running trains including auxiliary loads such as lifts, escalators, lighting, ventilation and air conditioning etc. In addition 45 MW power would be required to meet the loads for new commercial complexes planned to be built over and around MRTS stations. The power (75 MW) required to operate the

[17] The information on the technology for running metro rail has been extracted from the website www.delhimetrorail.com

trains in the MRTS corridors constitutes about 3 per cent of the total peak hours requirement presently estimated to be 3000 MW for Delhi Area.

Delhi Metro Rail Corporation Ltd., have made arrangements to get 120 MW power from NTPC Thermal Power Station at Oriya stage II through extra high transmission (400kv / 220kv / 66kv) network in Delhi Area. In the event of failure of Northern Grid, power supply to Delhi MRTS stations of underground Metro Corridor will continue to be fed from the Inderprastha (IP) Gas Turbine Power Station.

To ensure all time power availability for the underground Metro Corridor, 3 MRTS power-receiving stations have been inter-connected for transferring power from one to another through Fire Retardant Low Smoke (FRLS) cable feeders. These receiving stations will be remote controlled from Centralised Operation Control Centre through Supervisory Control and Data Acquisition System (SCADA).

In the unlikely event of total power failure due to simultaneous collapse of Northern Grid and IP Gas Turbine Power Station, emergency lighting in the tunnel and at the MRTS stations will be automatically switched on and fed the stand by Generator Sets. In addition, all the trains will also have modern Ni-Cd batteries to continue to provide lighting and air conditioning even when the train is stopped in event of complete power failure.

Signalling: DMRC claims that the signalling requirements for Delhi Metro have been worked out keeping in mind the smaller headway of train operation and consequent safety requirement for effective, smooth and safe operation. By deploying the built in safety feature of speed regulation, braking and fast flow of information, and strain on driver has been reduced. Once the first phase of the metro is completed, it will use CATC (i.e. ATP + ATS + ATO) system for Metro corridor

Telecommunication: The Telecommunication System shall comprise of the following five subsystems:

(1) Fibre Optic Transmission system

(2) Telephone system

(3) Train Mobile Radio system

(4) Public Address system

(5) Closed Circuit Television (CCTV) system

The System will provide voice, data and video signal communication among stations, OCC (Operation Control Center), Headquarters building, Depots, ancillary buildings and all necessary designated areas and facilities.

***Technology of metro trains*:** DMRC has introduced 3.2m wide lightweight modern coaches. Each train set consists of four coaches comprising two driving cars and two trailer cars. Each coach has the capacity to carry 350 people. A total of 240 coaches will be constructed for the first phase of the metro, which will become fully operational by 2005. Sixty coaches will be manufactured in South Korea while DMRC claims that the rest will be indigenised (The Hindu, October12, 2002).

According to the DMRC, lightweight and steel made, the air-conditioned coaches are safe, reliable and energy efficient with comfortable interiors. They are equipped with wide and profiled stainless steel seat, grab handles and steel bars for standees to hold on to. With a low noise level of about 70 decibels, these coaches are fully equipped with minimum vibrations. They can accelerate to 40 kmph in 15 seconds and 80 kmph in 65 seconds with median speed of 35 kmph. The coaches have automatic electric doors, which open fully within 2.5 seconds and close in less than 3.5 seconds. With an automatic feature to detect and release obstructions of over 15-mm width from within the gap between the doors, the train would only move when all the doors and cab side doors are closed and locked. If a door opens accidentally, while the train is on the run the brakes will be applied automatically and the train will come to a halt (The Hindu, October 16, 2002). Since December 2002, eight trains have been plying between Tis Hazari and Sahadra. The results of technology involved in metro rail are yet to come.

3.3.2 Metro Rail, Technology and the International Companies

According to the press release taken out by the Japanese Embassy, a consortium of five international consultancy companies is involved in Delhi Metro Rail Project. Pacific Consultants International of Japan, is assisting DMRC in the implementation of the project. The designing and construction of the 11-kilometer long underground corridor line between University and Central Secretariat has been entrusted to two leading construction companies of Japan, Kumagai Corporation, and Shimizu Corporation. The incorporated system such as propulsion system, installation and control system for the rolling stock is being provided by Mitsubishi Electric Corporation of Japan. Besides these four technical companies, three leading corporate houses of Japan namely, Mitsubishi Corporation, Itochu Corporation and Sumitomo Corporation are also associated with the Delhi Metro Project (Embassy of Japan, 2002). In terms of design and construction technology, it seems that these companies are trying to test their latest technologies in the field.

3.4 TECHNOLOGIES PROPOSED

It has been observed that new technologies have been proposed in the past, but have never been implemented. Recently in October 2002 GNCTD declared an operating plan for tackling urban transportation problem in Delhi. The plan proposed three new modes of transportation in Delhi - High Capacity Bus System, Electric Trolley Buses and Modernised Tram. These new modes of transportation also involve technologies, which are new for a city like Delhi. No one knows whether these new modes of transportation along with a new technology would be implemented in Delhi or not.

3.4.1 High Speed Tram System (HSTS)

In 1994, the then Urban Development Minister Jagdish Tytler proposed high-speed tram system. The scheme was projected as a substitute for the high cost mass rapid transport system (Indian Express, September 9, 1994). Following was the plan.

- Trams would run on lines laid on platforms atop 17-feet high pre-cast Y shaped pillars. The pillar will be inserted into 3m x 3m holes, dug by a small machine along the central verges of roads without causing any disruption in the traffic.

- HSTS would run on electricity. The estimated consumption of electricity was 15 MW on four-feet wide rails.
- Each tram will have three bogie capacities to carry 836 passengers, likely to be imported. The speed of HDTS will be 70 km per hour.

The scheme envisaged to be entirely implemented under the private sector. The objective was to bring all the major cities under the scheme. The idea was that once this scheme is implemented the country's oil import bill is expected to come down by half. More than a score of national and international companies showed interest in the project. Especially, several Canadian companies showed keen interest. Finally a committee comprising officials Ministry of Surface and Transport (GOI) and GNCTD shortlists 5 private sector bidder for the project (Indian Express, September 8 1994).

However, the project was never implemented. No one knows what happened to the project after that. There is no news in the press with regard to this and nothing has been found in the annual reports of Ministry of Surface transport.

3.4.2 High Capacity Bus System (HCBS)

Delhi Transport Corporation (DTC) will run high capacity buses. These buses will ply on dedicated bus lanes on selected corridors (GNCTD, 2002 (b)). These buses are fuelled by CNG. Each of these buses is AC, having a carrying capacity of 150 passengers as against the capacity of 64 passengers in the normal buses. Each of these buses is 18 m in length, with two coaches being linked via a vestibular system. The doors of these vehicles are twice the width of those in normal DTC buses to enable two passengers to board and descend at a time. There is adequate passage space inside the buses so that passenger can move around and stand comfortably. The official estimated price of each of these buses comes around Rs 21 lakhs (Times of India, 27 May 2003, 2003). Decision regarding the manufacturing of these buses has been taken. GNCTD will purchase 16 buses from two leading manufacturers, ALL and Telco (The Hindu, May 17, 2003).

3.4.3 Electric Trolly Buses (ETB)

An ETB has a carrying capacity of about hundred passengers and an average load factor of about 55 per cent. The total cost of the project will include electrical power supply, a collection system and maintenance depot, modification to road surface, existing electricity poles and other utility services and signals at intersections. The ETB itself costs approximately Rs60-70 lakhs at April 2002 prices. The total capital cost of a modern ETB including modifications to fixed infrastructure for dedicated bus ways, has been tentatively estimated at Rs 5 crores per km. O and M cost per passenger, however, is much lower than metro (and even a regular bus) and works out to 69 paise per passenger per km (GNCTD, 2002 (c)).

3.3.4 Modernised Tram

Officially called the Light Rail Transit (LRT), is a narrow vehicle of about two-metre width, suitable for the congested and narrow roads in the Walled City. The tram system — an older version of LRT — was operational here earlier and will run from Chandni Chowk to Chawri Bazar area.

3.5 CONCLUSION

The motor vehicle technologies in India have been changing rapidly since the arrival of Maruti in India in mid-1980s. These changes have mainly taken place in cars and two-wheelers technologies. The car and the two-wheeler manufacturers in India have either licensed technology or have foreign collaboration for new technologies, whereas this does not imply to the heavy vehicles, buses and trucks. It has been observed that in the past few years, in Delhi, motor vehicle technologies in the public vehicles have changed radically only due to the Supreme Court's order of July 28, 1998.

In non-motor vehicle technologies, technological changes in passenger cycle rickshaw have taken place very recently. Both the owners and users of rickshaw have accepted it, but at the policy level no attention has been given to this new innovation. Technology in bicycle in India has changed in the late 1980s but the cost of new

bicycles was much higher than that of traditional bicycle therefore it only attracted middle class and not the working class.

Since its electrification in 1980, no major technological change or upgradation has taken place in ring rail. However, in the case of metro rail many new technologies are being experimented by the major Japanese consulting firms. The results of these technologies are yet to come.

Chapter 4
EMERGING POLICY ISSUES

An attempt has been made in this chapter to analyse the policies formed in order to plan the transportation system of Delhi. Besides this, the chapter also examines the underlying factors, which determine the technology choice, technological changes and its upgradations, on the basis of which emerging S and T Policy issues are being unveiled.

4.1 POLICIES FOR THE TRANSPORTATION SYSTEM IN DELHI: PAST AND PRESENT

Transportation is a vital sector of any urban locale. In order to provide efficient and convenient transport facilities to the commuters it is imperative to improve the services of the various modes of transport through a time bound programme of action. In this direction the right approach would be the identification of problems faced by each one of these modes individually as well as collectively. However, it seems that this criterion has not been taken into consideration adequately after Independence. This is evident from the fact that there are only three policy documents in the post independence era that deal directly with the policy of the transport system of Delhi. These policy documents are: (i) Delhi Master Plan 1962 (ii) Delhi Master Plan 1982 (iii) Tackling Urban Transport An Operating Plan for Delhi 2002. An attempt has been made to analyse each of them.

4.1.1 Delhi Master Plan 1962

In order to provide better administrative support to the planning exercise, Delhi was declared a Union Territory in 1956. The Delhi Development Authority (DDA) was constituted in 1957 by an Act of the Parliament, " to check the haphazard and unplanned growth of Delhi with its sprawling residential colonies, without proper layouts and without the conveniences of life, and to promote and secure the development of Delhi according to the plan." For the next three years the TPO,

guided by the experts from the Ford Foundation, developed a Master Plan for Delhi, for a period of 20 years (Delhi Master Plan, 1962).

The objectives of transport planning for the Delhi metropolitan area according to the Master Plan were as follows:

- Rapid transport and convenient terminals to link Delhi with different regions throughout India in order to give an easy access to both the private citizens as well as the state officials to their respective parliamentary constituencies, Courts, Ministries, public and private financial institutions and large industrial training headquarters.
- Adequate and conveniently located terminals in order to encourage international tourism, which would help in the accumulation of foreign exchange. This was also required to promote Delhi as a centre for international conference.
- Adequate transport terminals for the visitors to the various cultural, historical and religious centres; national museums; festivals and various exhibitions related to handicraft, music and sports.

Adequate bus and rail services were required for the intra-urban transport as per the plan. Bus service already existed and it needed to be supplemented by more buses, which, as the data shows, was obviously done. But rail system was only started in 1971, that is nine years after the declaration of Master Plan. Since bicycles used to serve about 36 per cent (GOI, 1957) of the total trips made by the various modes of transport, arterial bicycle tracks were proposed. The present structure of road construction in Delhi does not reveal any signs of the existence of arterial bicycle tracks. The only institution responsible for the entire planning of Delhi was DDA. Thus it can be said that DDA had a monopoly over Delhi planning. Thus, transportation planning was also covered by the DDA. The fact that DDA did not play its role effectively is very evident from the present dismal scene of the transportation sector of Delhi.

The plan can be evaluated in the light of the political vision that outlined most of the policy decisions taken during the early days of independent India. The period when this plan was formulated was the period of planning based on the Nehru-Mahalanobis framework. The prime concern under this framework was the construction of Social Democracy and strong Capital Good sectors. The underlying assumption of this framework is that the induction of development in other relevant sectors could be possible through the development of the industrial sector (Chakravarty, 1986). That is why the transportation system was viewed as a tool helpful in prospering industry and it does not mention anything regarding public transport. And this is precisely the reason why the plan does not consider transport as a service but a part of travel and tourism industry.

The technological considerations can also be explained in the light of the Nehru-Mahalanobis model of planning. On the one hand where heavy investment in infrastructure was the essence of this model, technological efficiency involved in the development of infrastructure was completely neglected. Heavy public investment in infrastructure, as decided by the government under the five year plan framework of development, was one of the recommendations of the Bombay Plan (prepared by the leading industry groups) that supported the big industrialists in making profit (Chakravarty, 1986). So it can be inferred that with this background technologically efficient public transport at that point of time, when Delhi was geographically small, was not of any significant use for industrialists as it was not a factor that could affect their profits in any way.

4.1.2 Delhi Master Plan 1982

The second Master Plan should have been ready by the year 1982. Instead, the entire city was geared to host the Asian Games held in Delhi that year. Numerous roads, hotels, flyovers, offices, apartments and colonies were constructed to cater to the needs of the Games and the anticipated commercial spillovers. The second ring road became a magnet for further commercial and residential development. The enormity of the tasks undertaken for the purpose of the Asian Games, no doubt, called for a

large number of the working class population and it is estimated that approximately 10 lakh workers came into Delhi during that period alone. But the city could not cope up with this additional burden. In 1985, the National Capital Region Board was set up in an attempt to plan for the balanced growth of the extended region around the capital. Simultaneously in 1985 the second Master Plan was announced (Hazards Centre, 2001).

As far as the transportation planning of Delhi was concerned, the plan aimed at minimising the gap between demand and supply by increasing the capacity of the urban transport plan involving projections of past trends which had been snow balling towards increased supply of roads for automobile traffic. It was realized that the problems of the vast majority of the population relating to the public mass transportation system, bicycle and pedestrian needs was to be immediately attended. An environmentally and economically acceptable approach based on innovations both in techniques as well as technology could help in minimising the problems.

In order to meet the technological needs, a multi modal mixed transport system was proposed by the plan. This included bus transport, ring rail and light rail transit on selected corridors. The seriousness of the government in implementing the plan could be assessed from the fact that even after 30 years of its initiation, ring rail is catering to the need of only 1 per cent of the total commuters in Delhi (RITES, 2002). As far as bus transport is concerned, it has gone through different phases. DTC was supplemented by red line buses, which were replaced by blue line and KM scheme, and now stage carriage. As far as light rail transit was concerned, at present it has become invisible. According to the plan the problem of the bicycle was to be resolved by the construction of segregated cycle tracks. The plan proposed four major cycle tracks in various parts of the city. Unfortunately the bicycle tracks are yet to be constructed. A number of pedestrians and bicyclists lose their lives due to accidents with heavy vehicles.1646 people have been reported to have died in the year 2002, according to the report of Delhi Traffic Police. 49 per cent people out of these were pedestrians (Rashtriya Sahara, 11 January 2002).

With regard to the institutional issue, the plan held that the multi modal mix transport system should be under the charge of a single authority for planning, development and enforcement. A unified single transport system as recommended by the National Transport Committee 1980 (GOI, 1980) was proposed by the plan in order to run a multi-modal complex transportation system for Delhi. The past two decades have witnessed the formation of many new authorities in Delhi but the Metropolitan Transport Authority is yet to be formed.

This plan should be viewed within the framework of liberalisation of economy, which began with the entry of Maruti Suzuki in 1985 in the automobile industry. The year 1991 saw major changes in macro economic policies. The economic reforms launched in that year have resulted in a decline in public sector investment, despite what was called for being large investments, especially for infrastructure development. As these reforms were characterized with a gradual withdrawal of the State from a number of core and non-core sectors, the private sector was encouraged for the continued growth of economy. The transport sector was one of the key infrastructure sectors, which seems to have faced the impact. The emergence of red line, white line and blue line buses is an illustration of such an impact of these changes particularly adversely. They constituted the *baniya class* (business class) taking over the public transportation system of Delhi. The various proposals made by the plan cannot be viewed independently of the political and class biases prevailing in the society. Transport options in the Master Plan are not in any way different from other public issues like housing, health, education etc. in terms of ignoring the poor segment of the city.

4.1.3 Tackling Urban Transport: An Operating Plan for Delhi, 2002

In October 2002, the Government of the National Capital Territory of Delhi announced an operating plan for tackling urban transport in Delhi. The plan stated that by the year 2021, Delhi would be a model city - well managed, clean and dynamic serving its citizens as a model capital city. This operating plan listed a number of steps to be taken by the government in order to achieve its future vision.

The plan has a twofold objective- that of achieving a balanced multi modal mix transport system in Delhi and of discouraging personalised transport. It is quite interesting to note that the whole policy document stresses mainly on the first objective only and the second objective does not figure anywhere in the policy.

The technological issue is being dealt with by increasing the mass transport options by providing a high capacity bus system, mini buses, electric trolley buses supplemented by a network of a rail based mass rapid transit systems like metro and commuter rail. Among the various modes of transport, it is claimed that the metro rail will be the most important medium of mass transportation. According to the plan, phase I of Delhi Metro Rail Corporation (DMRC) would be completed and put into operation in three corridors by the year 2005. DMRC has been repeatedly claiming that once the metro network is completed, the environmental pollution and traffic accidents would be reduced because of the need for a fewer number of buses. However, a careful look at the details depicts an altogether different story. It is estimated by the feasibility report of the metro that only 2 per cent of the total commuter traffic would be catered to by the metro after the completion of the entire project i.e. 41 kms underground and 140 kms surface corridor (Tiwari, 2002). At present, it is on 650 different routes in the city that the DTC is running. A 200-km long metro system[18] cannot match the catchment area covered by an extensive bus system like the DTC.

The plan accepts the fact that the public transport system of Delhi is primarily bus based. Therefore, the bus system is proposed to be augmented to 10 000 CNG buses within a year on stage carriage to be supplemented with about 4000 CNG buses on chartered and premium services. Its been almost eight months and the 10 000 buses

[18] According to Geetam Tiwari from Indian Institute of Technology (IIT), Delhi, "At best this event may be understood as inauguration of a piece of art or a decorative statue with very little utility to the masses. However at a cost of Rs300 crore per km, this is indeed an expensive statue for the city! Perhaps at a cost of real mass transport system for the city. The major beneficiaries of the metro system seem to be the DMRC and the consultants for metro system".

are yet to start plying. According to the latest data, 2600 DTC and 4000 private buses are plying on the roads of Delhi (Times of India, June 16, 2003). The plan also mentions electric trolley buses. However, successful implementation of the electric trolley buses in a chaotic city like Delhi is highly doubtful. It is quite obvious that these buses would ply on electricity and at present no one has any idea as to how much electricity would be required to run these buses everyday. As far as the metro is concerned, once the first phase of its construction is completed, 125 MW of electricity will be required by it everyday (Roy, 2002). Due to the dismal condition of electricity in Delhi, which already faces a scarcity of 300 MW per day the perplexed question that arises is what would be the source of providing electric power to run the metro rail and electric trolley buses? High Capacity Bus System has also been proposed. Being a European concept, whether it will be compatible with the Indian conditions is highly doubtful. Once again much emphasis has been laid on the construction of more flyovers in order to get rid of the problem of traffic congestion. This clearly indicates the intention of policy makers to encourage personal vehicles.

With regard to the institutional issues, the plan proposes to set up an Integrated Metropolitan Transport Authority (IMTA) which would look after the regulatory issues like fares and tariffs and provisioning as well as common functions/services for the metro, rail and bus systems. Until IMTA is formed a Delhi Transport Planning Group (DTPG) may be set up under the chairmanship of the Chief Minister. The Master Plan of Delhi (1982) also proposed to form a Metropolitan Transport Authority. Two decades later i.e. in 2002 the government proposed the same thing. How many times are we going to propose the same things again and again? Anyhow it seems logical and obvious that there should be a permanent body, which can ensure sustained, comprehensive and continuous transport system for the city but an important and complex point of consideration would be the composition of this proposed body. It would necessarily have a lot of government officials from the transport department but will it also have representatives from other government departments, academic institutions and other experts.

We now come to the political issues, at least those, which can be neatly delineated. The cost of improving transportation in Delhi is borne both by the GOI and the GNCTD. Presently the Government of India is under the control of BJP and the Government of National Capital Territory of Delhi is under the control of Congress. Though the economic policies of both these governments are not by any means different from each other, there is a serious political conflict between them. The Congress is the main opposition party in parliament. The MRTS in particular and urban transportation in general is an issue, which is very crucial and politically volatile. Both the Government of India and the GNCTD are financing the MRTS. Probably due to the international pressure on both the governments there has been no conflict between them with regard to the MRTS project. 64 per cent of the expenditure of MRTS has been given as a long-term JBIC loan by the Japanese government. However, at any point of time contradictions might emerge between both the governments and things might take a different turn. The various government agencies dealing with the transportation system of Delhi are not under the authority of a single government. On the contrary, there is a division of authority with some agencies falling under the purview of the GOI and the others under GNCTD. Nothing is mentioned about these agencies in the plan.

Before the declaration of the plan, the Department of Transport of GNCTD had organized a workshop of experts on the issue of autorickshaw operation. It was assured that the recommendations of the experts would be taken into consideration, but unfortunately those assurances have proved to be merely a lip service. The plan does not mention anything, even remotely about the autorickshaw operation. Furthermore, the plan also fails to tackle the problems associated with non-motorised vehicles. The issues concerning bicycles, passenger cycle rickshaws and pedestrians have been completely ignored by the policy makers. Sustainable transport implies that mobility concerns of the 'invisible section' must be essentially addressed. However, unfortunately it rarely happened in our country.

4.2 EMERGING SCIENCE AND TECHNOLOGY POLICY ISSUES

4.2.1 Technological Innovations in Transport Technologies

In the past few years several technological innovations have taken place in transport sector, but till now it has only been limited to automobile industries and in that too, primarily to the industries manufacturing four-wheelers and two-wheelers.

Before the July 28, 1998 order of the Supreme Court, negligible innovation had taken place in the public vehicle manufacturing industries in the last fifty years. Whatever innovation in the public vehicle manufacturing industries has taken place in the recent times is on the account of reducing pollution. Strict norms have been imposed on the basis of which technology has been developed by the public vehicle manufacturing industries, so the technological innovation has been brought about by forced technological improvements by legal regulations.

Innovations in rail and non-motorised vehicle technologies have remained almost stagnant for quite some time. In rail technologies, besides the electrification of trains in the suburban areas, nothing at all has been done in terms of technological upgradation in order to provide better services to commuters.

As far as non-motorised vehicle technology is concerned, it does not figure anywhere in government's policy document. Recently, some initiatives have been taken in order to improve the technology of passenger cycle rickshaw. Although it was a foreign aided project and therefore had its own vested interests, it has been appreciated by a certain section of society. Unfortunately, the government rather than giving due notice to this, is busy formulating hard regulations for passenger cycle rickshaws. In the last couple of decades an adequate number of technological innovations have taken place in the bicycle manufacturing industries. The newly designed bicycles are normally racing cycles, which are quite expensive than the traditional bicycles. Thus it is not of any advantage to the poorer sections and only the children of the middle class families and athletes are the end users of these bicycles. Although the bicycle manufacturers are increasingly making use of foreign technology due to the changing

patterns of demand, 80 per cent of the total population still makes use of the traditional bicycle (Singh, 1990). This implies that the majority of bicycle users still continue to use the traditional bicycle because it is both cost effective and also provides satisfactory service. At present the only requirement is that the bicycle riders should be provided some space on the roads in the city so that they can ride safely.

Technological innovations are crucial for the urban transport system, thereby implying that there is a greater need for technological innovations in the public vehicle manufacturing industries. Secondly, there is also a need to recognize the innovations taking place in the non-motorised vehicle industries so that it can be used for improving and encouraging non-motorised vehicles. This is because the non-motorised vehicles are cost effective and the working class in any city is fully dependent on it.

4.2.2 Research and Development Institutions

In India an important aspect of S and T policy is concerned with the promotion of co-ordination among the various science councils, commissions, autonomous agencies, institutions under ministries (Rahman and Chaudhary, 1980). Following are the government institution, which undertake S and T programmes in road and rail transport sector:

(a) Ministry of Road and Highway Transport, Central Road Research Institute (CRRI), Automotive Research Association of India
(b) Ministry of Defence (DRDO), Vehicle Research and Development Establishment
(c) State Governments- State Highway Research Laboratory
(d) Ministry of Railways- Research Design and Standard Organisation, Rail India Technical Services (RITES)

There is plethora of R and D institutions involved in transport research but their focus of R and D activities is centred on transport planning and engineering. These institutions should expand their horizon of understanding transport problem. There is

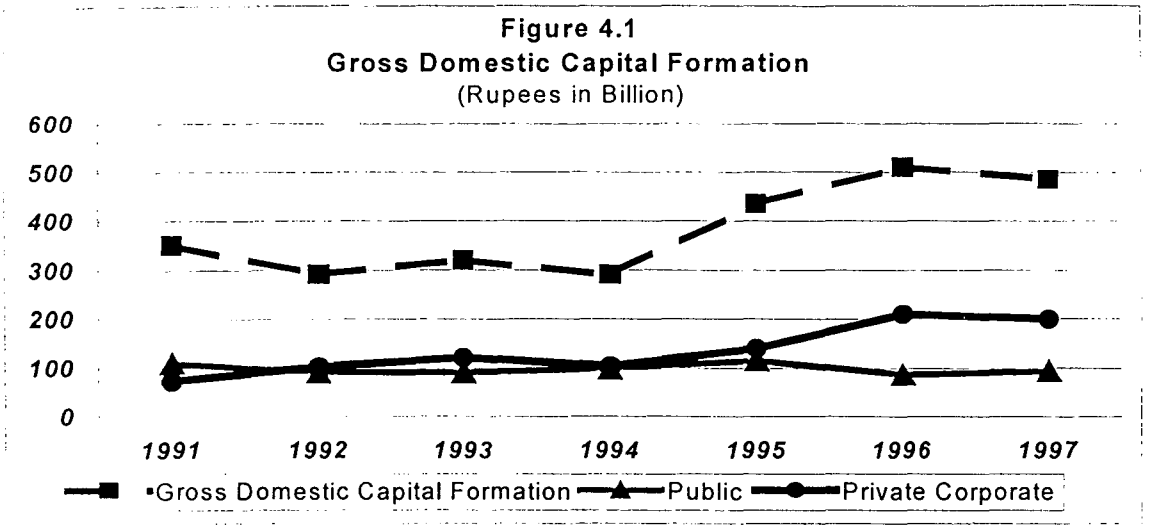
an immediate need to examine carefully the technological issues involved in the transportation sector. These institutions should realise that motor vehicle technology and rail technology are not the only solution for urban transport problem. Non-motorised vehicles cater to the needs of substantial number of commuters in any urban centre. So, R and D activities should also be undertaken on the issue of non-motorised vehicle technology. There is also a problem of effective coordination of S and T activities between these institutions, which should be immediately overcome.

4.2.3 Technology as a Link

Considering the size to which Delhi has grown, it is obvious that no single mode of transport can cater to the entire transport demand requirement of the city. Therefore, it becomes essential for a typical commuter to use more than one mode of transport or at times even change over in the same mode. Accordingly, convenient and passenger friendly inter-modal integration is the key to a commuter preferring to make interchanges among multiple public transport modes vis-à-vis using his personalised transport to undertake his journey. It seems that till today technology is not able to play any role in linking various modes of transport. Efforts should be made to link one technology with another.

4.2.4 Investment in the Transport Sector

The economic reforms launched in 1991 have resulted in a decrease of investment in the public sector. This has implied large investment requirements, especially for infrastructure development. As a result of the gradual withdrawal of the State from a number of core and non-core sectors, the private sector has become more important for the continued growth of the economy. This can be seen from the chart below.



Source: Government of India (1998) cited in Economic and Political Weekly, April 8, 2000

The share of the private sector increased from less than 20 per cent of the net capital formation (NCF) in 1990-91 to 43 per cent in 1996-97, while that of the public sector declined from over 33 per cent to about 18 per cent over the same period (Deb, 2000). To improve public transport the urgency of the situation makes it imperative to increase public sector investment.

4.3 FACTORS RESPONSIBLE IN DETERMINING TECHNOLOGY

The present technology choice in the transport system of Delhi is determined by a number of factors. The most important of them are:

1. Reduction of vehicular pollution in the city
2. Encouragement to automobile industry
3. Judicial activism
4. Role of non-government actors such as CSE, TRIPP etc.

4.3.1 Reduction of Vehicular Pollution in the City

It seems that pollution has been an issue of prime concern for the policy makers in the past decade. The various technologies vis-à-vis motor vehicles are designed with regard to reducing vehicular pollution.

Since 1991 the government has been busy in setting emission norms and improving the quality of fuel. In the past few years the actions taken by the government on emission norms are as follows:

- The Air Act, 1984 notified the standards of ambient air quality. It was further made stringent in 1994 and notified under the Environment Protection Act.
- In the year 1991, mass emission standards for vehicles, both at the manufacturing stage as well as in-use vehicles were notified for the first time in India. These norms were notified under Environment Protection Act, Motor Vehicles Rules and Air Act. The emission norms were revised in 1996, when crankcase emission norms and evaporative emission norms were introduced.
- In the year 2000, India Stage I (India 2000, Euro I equivalent) vehicle norms were introduced for new vehicles. These norms were notified under Motor Vehicles Rules during 1997.
- Based on the Supreme Court's directive, Ministry of Surface Transport (MOST) now renamed as Ministry of Road Transport and Highways (MRT&H) notified Euro-II equivalent Bharat Stage-II norms for new vehicles in Delhi and extended the same to the other three metro cities.
- Ministry of Road Transport and Highway has also notified the emission norms for CNG and LPG vehicles.

Above all the quality of petrol and diesel has also improved tremendously. According to the Auto Fuel Policy 2002 following are the major improvements made in the quality of petrol and diesel:

Petrol: Lead used to be added to petrol in order to increase the octane number. In 1994, the maximum specification of lead in Indian petrol used to be 0.56 grams/litre.

Within a period of six years lead has been removed from petrol. It was from 1.2.2000 that production and sale of only unleaded petrol gained a foothold in the entire country. Increase in octane number has been done with effect from 1.4.2000. The sulphur content in petrol has been reduced from a maximum of .20 per cent to .10 per cent, thereby amounting to a reduction of 50 per cent from1.4.2000 onwards. In addition to this, the four metro towns and NCR are being supplied with petrol having a maximum of 0.05 per cent sulphur content, thereby amounting to a reduction by 75 per cent from the original proportion. Unlike most other countries the Indian petrol did not contain benzene in it. However from 1.4.2000 onwards it has been introduced with a maximum of 3 per cent for the metros and 5 per cent for the entire country. The actual benzene content is substantially lower than the maximum specification. Moreover, in NCT/NCR and Greater Mumbai the benzene content has been reduced to a maximum of 1 per cent. Also, various improvements in the other specifications have been made effective from 1.4.2000.

Diesel: within a period of four years (between 1.4.1996 and 1.1.2000) the sulphur content in diesel has been reduced from a maximum of 1.0 per cent to a maximum of .25 per cent, thereby amounting to a 75 per cent reduction in the total sulphur content in diesel. It has been further reduced to a maximum of .05 per cent sulphur content. The ignition performance of diesel engine is notified by the Cetane number. Higher the cetane number, better the performance of the engine and lower the pollutant emission. From 1.4.2000 onwards the Cetane number in diesel has been increased from 45 to 48. Also, improvements have been done in the distillation specification of diesel thereby improving the performance and life of diesel engines and emission reductions. In addition to the above, various improvements in the other specifications have also been made effective from 1.4.2000.

It appears that in the last decade the government was busy in implementing emission norms and improving the quality of fuel. As a result, Euro I and Euro II engines were introduced in four-wheelers, the engines of buses and three-wheelers were converted into CNG and the oil companies have started supplying unleaded petrol and sulphur

free diesel. This shows that pollution has been a major concern and most of the technological changes that have taken place in the automobile industries were centred on reducing pollution.

4.3.2 Encouragement to Automobile Industry

That there has been an encouragement to automobile industry from the government through its policies can be gauged from the fact that there has been a tremendous growth in the number of personal vehicles and the choice of technologies in them.

The Indian Automobile Industry has reached this stage for more than six decades. The Industry started in a humble way. Till the decade of 1940s motor vehicles were either fully imported or assembled from parts that were imported from completely knocked down condition. During this period some 20,000 vehicles were imported for the Indian market by General motors and Ford. The country witnessed the dawn of vehicle manufacturing activity with Hindustan Motors (1942) and Premier Auto establishing their own manufacturing plants importing the know-how from General Motors and FIAT respectively. The early 1950s saw the entry of API in the two-wheeler segment. The 1960s and 1970s marked the entry of new manufacturers like Bajaj, Telco, Mahindra & Mahindra in the commercial vehicle segment. All these manufacturers started their production activity by entering into a licensing agreement with different world transnationals for importing the CKD[19] and SKD[20] units and thereafter localising the same in India (Piplai, 2001).

Through 1983, the industry was limited by strict controls on imports and foreign investment. The first multinational company to enter the Indian market was Suzuki in collaboration with an Indian partner company, Maruti, in the mid-1980s. This event initiated a period of rapid growth in the industry. Suzuki and Maruti were granted a variety of concessions including lower import and excise duties, on the condition that they steadily increase the local content of the vehicles (Bose and Sperling, 2001). In

[19] Completely Knock Down
[20] Semi Knock Down

automobile industry, till mid 1980s, supply was regulated by the manufacturers for their own benefit. Due to mismatch of supply and demand the 'price' was dependent mainly on the 'premium' the product used to enjoy due to artificial shortage created in the market by the manufacturer and the distributor together. The service to the customer and the quality of the product was at its lowest level and at the mercy of the suppliers (Piplai, 2001).

The Indian automobile industry, especially car manufacturing companies, has undergone a sea change after the liberalisation policies were announced in 1991. From the tiny sector dominated by handful of manufacturers till late 1980s the auto industry in India suddenly witnessed the entry of world auto transnationals in the market. In 1993-94, new automobile policy was introduced and licensing system was eliminated. The post-liberalisation period entered into 'supply dominated' era where all the existing auto manufacturers became suddenly busy in augmenting their production capacity, lest the new comers with the removal of entry barriers flood the market with their technologically improved well-designed fuel efficient vehicles (Piplai, 2001). The new comers, especially the world transnationals, wanted to avail this opportunity and inundate this supply starved market with their new products. Consequently, the growth of personal vehicles in the cities started increasing rapidly. In automobile production, the share of different categories of vehicles in the last five years is presented in Table 4.1.

Table 4.1

Vehicle Production in India (Quantity in lakhs)

Types of Vehicles	1995-1996	per cent	1996-1997	per cent	1997-1998	per cent	1998-1999	per cent	1999-2000	per cent
2 wheelers	26.6	72	29.8	70	30.7	72	33.7	75	37.8	74
3 wheelers	1.6	4	2.2	5	2.3	6	2.1	5	2.1	4
4&6 wheelers	-8.7	24	10.1	24	9.5	22	8.9	20	11.3	22
Passenger Cars	3.5	9	4.1	10	4.0	9	3.9	9	5.8	12
Multi utility vehicle	0.7	2	1.3	3	1.3	3	1.1	2	1.2	2
Trucks & Buses	1.3	4	1.5	4	1.0	2	0.8	2	1.1	2
LCVs	1.3	4	0.9	2	0.7	2	0.6	1	0.6	1
Tractors	1.9	5	2.3	5	2.6	6	2.5	6	2.6	5
All vehicles	**36.9**	**100**	**42.1**	**100**	**42.5**	**100**	**44.7**	**100**	**51.2**	**100**

Source: Calculated from ACMA 1999, 2000 used by Piplai. T. in *Automobile Industry: Shifting Strategic Focus*, Economic and Political Weekly, July 28, 2001

From table 4.1 it can be deciphered that the two-wheeler industry enjoyed around 72 per cent market share during 1995-96. This has gone up by 2 per cent, that is, at 74 per cent during 1999-2000. Four wheelers and six-wheeler hold the second place in the market share. It seems that they have lost their ground from 24 per cent to 22 per cent. The picture might be different if the data of four-wheeler and six-wheeler is segregated. Three-wheeler industry has somehow been managing the same share of business in the last five years. The share of buses and trucks came down from 4 per cent to 2 per cent and that of LCV fell from 4 per cent to 1 per cent. This shows that the demand of two-wheelers and four wheelers is more than that of other vehicles.

Car sales have been increasing at a rate of about 10 per cent per year since the mid-1970s, though with large fluctuations. This is considerably faster than population growth. The auto industry expects continued growth at that level into the future. Continued 10 per cent growth is plausible if income and population continue expanding near their historic rates. Greater availability of easy financing has also played a role. The current high interest rates (about 16 per cent) are expected to drop and thereby encourage vehicle purchases. Evidence from other Indian cities and

elsewhere indicates that car ownership in cities at Delhi's income level increases somewhat faster than the per capita income (Bose and Sperling, 2001).

With the erosion of the mass rapid transit services and continued growth in income private vehicle ownership would definitely show a rise. A large number of households already owning motorised two-wheelers are in a bid to purchase cars as well. On the rural fringes of Delhi, the sale of motorised two-wheeler may also depict a continued pattern of high growth. This is because of the fact that it is easier to transport small quantities of goods on improper roads.

Technological innovations in the automobile industry (especially in two and four wheelers) will continue taking place, which indirectly will continue determining technology, till the government encourages automobile industry through its policies.

4.3.3 Judicial Activism

Judicial activism was made possible in India through Public Interest Litigation (PIL). In the beginning, PIL was essentially a tool of the disadvantaged sections of society. Since they could not seek justice from the courts because of their poverty and ignorance, any individual from the public could file a PIL in the appropriate direction to seek justice (Rao, 2001).

Today, a new dimension has been introduced by the PIL in regard to the judiciary's involvement in public administration. Now PILs are also being filed in order to ensure green belts and open spaces for the maintenance of ecological balance, to forbid stone-crushing activities near residential complexes, to compel the municipal authorities of the Delhi Municipal Corporation so that they perform their statutory obligations of protecting the health of the community, to close certain industrial units in order to prevent pollution and for that matter to direct the conversion of public vehicles into CNG.

The *M.C. Mehta v. Union of India* case of vehicular pollution is an illustration of such a kind of PIL. This case of vehicular pollution went on in the court in different phases and ended up in the form of a policy. It has been observed in the recent times that the role of the judiciary is changing from that of policing to policy making. Earlier through PILs the judiciary was compelled to police the government and make it do its duties but today judiciary itself has started playing the role of government. In this direction the Bhurelal committee formed by the Supreme Court of India with regard to pollution could be seen as the best example. In this case, instead of asking the government to make policy in order to resolve the problem of vehicular pollution, the judiciary itself decided to make policy. Consequently the government was forced to abide by the orders and we are the direct witnesses of the chaos created in Delhi after the Supreme Court's order to convert the entire public transport fleet into CNG.

In this case, the Bhurelal Committee advocated the use of CNG as an alternative in the form of a non-pollutant fuel. Thus, it becomes evident that instead of academic and R and D institutions advocating technology, it is the judiciary that is advocating it.

4.3.4 Role of the Non-governmental Actors such as CSE and TRIPP

In recent times, non-governmental pressure groups such as Centre for Science and Environment (CSE) and Transport Research and Injury Prevention Programme (TRIPP), etc. play a major role in determining the technology choice in the transportation system of Delhi.

CSEs role in advocating CNG as a non-pollutant fuel

About CSE: Centre for Science and Environment (CSE) is an independent, public interest organisation, which aims to increase public awareness on science, technology, environment and development. The Centre was started in 1980. The objective of the Centre is to create awareness about the environmental challenges facing our nation; challenging India to confront its problems; inspiring it to take

action and pushing the government to create frameworks for people and communities to act on their own (CSE, 2003).

CNG was mainly propagated by CSE. Prior to the recommendations of Bhurelal Committee (BLC) Report, it was the CSE that undertook a study on CNG. It was shown that the CNG strategy would help to get closest to the clean air targets as compared to slow changes through diesel technology. Recommendations of the BCL report are entirely based on the CSE study. No doubt, the CSE Director was a core member of that committee. CSE, both inside the committee and outside the committee have propagated CNG as a non-pollutant fuel. The entire media attention during this phase of the CNG controversy was focussed on CSE. On every alternate day CSE director used to give statements in favour of CNG and indirectly in favour of the BLC report. He went up to the extent of saying that he had a vested interest in the implementation of CNG because of his struggle with asthma and cancer- which he mysteriously related to protecting the interests of the common commuters in Delhi. Finally, CSE achieved success in the form of the BLC Report that advocated CNG as a non-pollutant fuel and on the basis of which the Supreme Court issued directives to convert the entire public transport into CNG mode.

TRIPPs role in advocating High Capacity Bus System

About TRIPP: The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology (Delhi) is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport.

On January 20, 2002, a pilot project to develop a high capacity bus corridor on a 20-km stretch on one of the main arteries of Delhi was announced by the Transport Minister of the Government of National Capital Territory of Delhi. This is in direct response to the project undertaken by TRIPP on high capacity bus system. The project was commissioned to TRIPP by Volvo Research Foundation. The project involves the introduction of modern high capacity bus systems integrated with

information and communication technologies to decongest and improve urban transport situations (Indo-Asian News Service, 2002).

It is the duty of the state to propose the technology before civil society for its feedback but at present, the situation is exactly the opposite. The above two cases elucidates that since there is a lack of R and D activities in government institutions, the civil society institutions such as CSE has started playing role in advocating the choice of technology. It is quite obvious that the institution like CSE is governed by the various principles. It is ultimately the interest of the funding agency that plays the most significant role in determining the mood of the research undertaken.

4.4 PRESENT CHOICE OF TECHNOLOGY VS COMMUTERS

As discussed earlier, the majority of commuters in Delhi travel by public transport that comprises of buses, ring rail, autorickshaws, taxis, RTVs, passenger cycle rickshaws etc. The number of these modes of transportation is gradually decreasing. The annual growth rate of population in Delhi since 1991 has been 3.81 per cent (Economic Survey of Delhi, 2002) as compared to 1.93 per cent of the country. In 1991, out of the total vehicle population of Delhi, 1.04 per cent were buses, 3.48 per cent were autorickshaws, 0.56 per cent were taxis. In 2001 there were 1.20 per cent of buses, 2.52 per cent of auto rickshaws, 0.53 per cent of taxis of the total vehicle population in Delhi (GNCTD, 2001). More recently, the percentage distribution of public vehicles has come down drastically after the conversion of public transport system into CNG. This implies that on the one hand there has been a remarkable growth of population in the city and on the other the public transport system has been witnessing a continuous decline.

It has been observed that radical technological changes have taken place in the transportation system in the last decade. But as far as the question of improvement in the transport system and commuters service is concerned, the situation has been deteriorating each day. It would be interesting to note, as to how the new technologies are not playing any significant role in improving the transport system of Delhi. Table

4.1, table 4.2 and table 4.3 clarify the role being played by new technologies and their benefit to the commuters.

Table 4.2

Technological Changes/Upgradation in Motor Vehicle Technologies

Modes of Transport	Technologies				Role of new Technologies/Benefits
	Pre Liberalisation[21]		Post Liberalisation		
	Engine	Design	Engine	Design	
Buses	Diesel engine	Chassis made up of heavy material	CNG engine	Chassis made up of light material	Reduction of pollution[22]
Cars	Diesel engine India Indirect Injection (IDI)	Keeps changing	Euro I Euro II	Keeps changing	Increased engine efficiency, decreased fuel consumption and reduction of pollution
	Petrol Engine Positive Crankcase Ventilation Valve (PCV)	Keeps changing	Euro I Euro II	Keeps changing	Increased engine efficiency, decreased fuel consumption and reduce pollution
Taxis	Diesel engine India Indirect Injection (IDI	Body remained same	Conversion to CNG, catalytic converter	Same as it was earlier	Reduction of pollution
3-Wheelers	2 stroke and 4 stroke engine	Keeps changing	Conversion to CNG, catalytic converter	Keeps changing	Reduction of pollution
2-Wheelers	2 stroke and 4 stroke engine	Keeps changing	2 stroke is phasing out	Keeps changing	Increased engine efficiency, decreased fuel consumption

The table 4.2 shows that the technological change/upgradation in the public transportation has mainly taken place on the account of reducing the pollution level in Delhi. As far as providing better services is concerned, technology has no role to play. On the other hand the technological change/upgradation in the private vehicles has also taken place primarily on the account of reducing pollution levels. However, the implementation of new technologies in private vehicles is certainly playing an extra role by increasing engine efficiency and reducing fuel consumption.

[21] The pre liberalisation era basically underlines the status before the implementation of New Economic Policy in July 1991.

[22] This too is debated because the various studies done recently depict that the pollution levels have not come down as per the levels that were claimed by the promoters of CNG.

Table 4.3

Technological Changes/Upgradation in Non Motor Vehicle Technologies

Modes of Transport	Technologies		Role of Technologies/Benefits
	Past[23]	Present	
Passenger Cycle Rickshaw	Difference between front and back wheel was very high, Iron pipes (heavy weight), Seat size- 25 inches	Difference between front and back wheel has been decreased, GI pipes (lightweight), Seat size- 36 inches	Eco friendly and cost effective
Bicycle	Heavy in weight, one gear system and standard size	Light in weight, multiple gear system and various sizes	Eco friendly and cost effective

Eco-friendly and cost-effective technological changes have taken place both in passenger cycle rickshaw and bicycle. The new passenger rickshaw has additional benefits as well, such as reduced pressure on the rickshaw puller's health and the ergonomically proportioned seats with backrest that allows the passengers to sit comfortably (Financial Express, April 9, 1999). However, the technological change in bicycle has only benefited either the athletes or the middle class children and not the working class (the majority user of bicycle) because the traditional bicycle is more cost-effective to them.

Table 4.4

Technological Changes/Upgradation in Rail Technologies

Modes of Transport	Technologies		Role of Technologies/Benefits
	Past (Before 1982)	Present	
Ring Rail	DMU[24]	EMU, MEMU	Eco friendly, fast
Metro Rail	-	-	Eco friendly, fast

Ring rail is actually a supplement to the Mass Rapid Transit System. There has not been any significant change in the technology of ring rail. Prior to 1982 there were DMU services and since 1982, after the electrification of ring rail, there have been EMU and MEMU services. These are certainly eco-friendly and advanced technologies. However, they are not much of a benefit to the commuters because even

[23] In the case of passenger cycle rickshaw it is before 1999 and in the case of bicycle it is before 1980s.
[24] Diesel Multiple Unit

though the ring rail has a carrying capacity of 6.10 lakh passengers per day, it hardly carrics 6000 passengers per day (Ram, 1999). As far as the technologies involved in metro rail are concerned, the results and benefits are yet to come.

4.5 CONCLUSION

The policies illustrate that the transport issues concerning the majority of the commuters have never been addressed. The technological choices are not governed on the basis of commuter's need but there are other factors that govern them. Despite the various technological changes in different modes of transportation, the commuters are deprived of its direct benefits in terms of better services.

Chapter 5

CONCLUSION

Provision of a safe, efficient and affordable mode of transportation to majority of the commuters has to be the fundamental objective of any transportation system. But today none of the metropolitan transportation systems in India are able to meet these fundamental objectives. Of all major metropolitan cities, Delhi appears to be the most distressed as its vehicle population exceeds that of Mumbai, Kolkata and Bangalore put together. The public transport system in Delhi has been continuously shrinking. Historically, Delhi was never in such a miserable position. In 1962, when first Master Plan for Delhi was declared, majority of the commuters either used to cycle or walk to their work places. Buses were in the second place and Tongas were in the third place followed by private vehicles. The situation changed dramatically, by the time the second Master Plan came into being in 1982, commuters were forced to depend upon buses and other modes of intermediate public transport alongside large number of people cycling or walking to their work places. But the policy had stopped taking cognisance of this large section of the population using non-motorised transportation. Currently the government's policies have led to an inappropriate mesh of multiple modes of transport dominated by private vehicles with little or no integrated approach.

By closely examining the transport policies of the state, one could argue that technology or technology choice has never been a matter of concern for policy makers while making a plan or policy for Delhi. The policy makers have perceived the problem of transportation only from the point of view of planning and engineering. The real technological, economic and political issues have never been taken into consideration while making a transport plan. The present transportation system of Delhi as a part of the overall urban environment is in complete chaos. The technology choices in the transport system of Delhi have been determined on the account of reducing pollution, by competition among the manufacturers in the automobile market, through judicial activism and by the role played by non-

government actors. The user of the technology does not figure anywhere in this process. On the basis of a detailed study of the technology choice in the transportation system of Delhi, it could be concluded that despite the various technological changes in different modes of transportation, the commuters are bereft of its direct benefits in terms of better services. It is indicative of the fact that the needs of commuters remain unsatisfied under the present technology choice in the transport system of Delhi.

On the basis of various Government of India (GOI) reports and few independent studies, one could observe that in the last decade various technological changes and technological upgradations have taken place in almost all modes of transportation in Delhi. The technological changes and upgradation in the public vehicles such as buses, three-wheelers and taxis were followed by the Supreme Court order of July 28, 1998. As per the order, it was decided that the entire public fleet of Delhi would run on compressed natural gas (CNG) or on an alternative clean fuel. The CNG engines, which are being used in public vehicles, have been discarded in many countries because it is being considered as an obsolete technology. Even here the focus is on reducing the overall pollution levels in the city, and not the transportation efficiency or commuter comfort objectives. On the other hand the technological changes and upgradations in private vehicles have benefited commuters in terms of providing them comfortable and efficient services. The changes in private vehicles such as car and two-wheelers were done on the account of competition in the automobile market. The car and the two-wheeler manufacturers in India have got licensed technology or have a foreign collaboration for new technologies, whereas this does not imply to the heavy vehicles i.e. buses and trucks. As far as the benefits to the commuters are concerned, the technological changes and upgradations in the public vehicle have failed to provide safe, efficient and affordable public transport.

Technological changes and upgradations have also taken place in the non-motorised public vehicles as well as the non-motorised private vehicles. Passenger cycle rickshaw is the main component of non-motorised public vehicle, whereas bicycle is a non-motorised private vehicle. In the case of passenger cycle rickshaw the upgraded

technology has benefited both the rickshaw puller as well as the users of rickshaw. Unfortunately the policy has not given any attention to this technological upgradation. In the case of bicycle, only particular type of users has benefited from the technological upgradation. Although the new bicycle has various advantages, but the majority of users are still using conventional bicycle because it is cost-effective.

Ring rail and metro rail are other components of public transport in Delhi. In ring rail, apart from electrification, no major technological changes or upgradations have taken place. The fact that only 1 per cent of the commuters travels on it illustrates that there are no benefits to the commuters in traveling by ring rail. On the other hand in metro rail many new technologies are being experimented by the major Japanese consulting firms. The results of these technologies are yet to come.

There are certain S and T policy issues that call for immediate attention, in order to provide a sustainable urban transport system for Delhi or for that matter any other city in the country. Technological innovations are crucial for the urban transport system, thereby implying that there is a greater need for technological innovations in the heavy (public) vehicle manufacturing industries. Secondly, there is also a need to recognise the innovations taking place in the non-motorised vehicle industries so that it can be used for improving and encouraging non-motorised vehicles. This is because the non-motorised vehicles are not only cost effective but also the working class in any city is fully dependent on it. Thirdly, in order to improve the ring rail service, apart from innovations in the railways, there is an immediate need to link ring rail with the other modes of public transport.

There are a plethora of Research and Development institutions undertaking research on transportation. The understanding of these institutions is limited to a certain framework. These institutions need to expand their horizon of understanding with respect to transportation problems. In order to do so, an effective coordination of Science and Technology activities is required among these institutions. Moreover as JJ Solomon would argue "Science and Technology is a driver for development, but is

not development", it needs to be kept in mind that the technological choices which the actors in the transportation scene undertake have to take into consideration the socio- economic, political, and even cultural dimensions of the society in which these choices are put to use.

Limitation of the Study

The study is primarily based on the information drawn from government documents, reports, press clippings and few independent studies. If the information would have been supported with the archival records, it would have supported the arguments, which have emerged in the study, in a more emphatic manner. Due to the non-availability of experts, it was only possible to take views and opinions of few experts from the Indian Institute of Technology (IIT), Delhi and from Central Road Research Institute (CRRI). Views and opinions of more experts would have added more flavour to the study.

Scope for Further Research

Various issues related to the transport problems have been identified in the study. These issues need a further examination. Some of the issues are as follows:

- The study has arrived at a conclusion that the present technology choice in the transportation system of Delhi is not able to cater to the needs of commuters. The question that requires further examination is with regard to who should decide upon the technology choice in the transportation system and on what basis should it be decided?

- There is a reflection of an unseen connection between state and automobile industry in the study, which ultimately influences the policy. The study has failed to argue emphatically in this regard due to the lack of factual information. In order to put forth this argument emphatically, further examination is required in this regard.

- The study has been able to identify that the technological innovations in heavy (public) vehicle manufacturing industries is less than that of cars and two-wheelers manufacturing industries. This conclusion has been derived from the fact that the market share of buses is less than that of two-wheelers and cars. Further examination is required in this regard by using the other indicators such as R and D expenditure etc.

- It has been identified in the study that there has been a problem of linkage among the various technologies in the transport sector. There is a need for further examination in this regard in order to understand and analyse the problem of linkage among the various technologies.

Appendix I (a)

Motor Vehicle Population in Delhi

(In Numbers)

Types of vehicles	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
Cars &Jeeps	398479	440166	477783	522264	575762	633802	705923	765470	818962	869820	920723
Two-wheelers	1220640	1317180	1403050	1492201	1617732	1741260	1876053	1991710	2101876	2184581	2230534
Auto Rickshaws	63005	67128	70459	72102	74981	79011	80210	80210	86985	86985	86985
Taxis	10157	10694	11365	11846	12547	13765	15015	16654	17136	17762	18362
Buses	18858	20201	23221	24211	26202	27889	29572	32333	35254	37733	41483
Goods Vehicles	101828	107629	111277	116379	125071	133918	140922	146668	150243	156157	158492
Total	**1812967**	**1932998**	**2097155**	**2239003**	**2432295**	**2629645**	**2847695**	**3033045**	**3210456**	**3353038**	**3456579**

Source: Transport Department, GNCTD cited in Economic Survey of Delhi 2002

Appendix I (b)

Annual Growth Rate of Motor Vehicle

(In Percent)

Types of vehicles	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
Cars &Jeeps	15.45	10.46	8.55	9.30	10.24	10.08	11.38	8.44	6.98	6.21	5.85
Two-wheelers	9.65	7.90	6.52	6.35	8.41	7.64	7.74	6.16	5.53	3.93	2.10
Auto Rickshaws	6.90	6.54	4.96	2.33	3.99	5.37	1.52	0.00	8.45	0.00	0.00
Taxis	5.22	5.29	6.27	4.23	5.92	9.71	9.08	10.92	2.89	3.65	3.38
Buses	5.68	7.12	14.95	4.26	8.22	6.44	6.03	9.34	9.03	7.03	9.94
Goods Vehicles	9.75	5.70	3.39	4.58	7.47	7.07	5.23	4.08	2.44	3.94	1.50
Total	**10.71**	**8.28**	**6.83**	**6.76**	**8.63**	**8.11**	**8.29**	**6.51**	**5.85**	**4.44**	**3.09**

Source: Transport Department, GNCTD cited in Economic Survey of Delhi 2002

Appendix I (c)

Man/Animal Driven Vehicles in Delhi

(In Numbers)

	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Rickshaws	45963	45899	46386	55075	56849	59071	70401
Tongas	867	796	679	613	585	545	497
Rehras	190	205	131	144	70	56	40
Hand Carts	4998	5518	5515	5448	5247	5012	4932
Bullock Carts	442	423	426	430	316	270	280
Cycle, Rickshaw, Trollies	35576	38925	42339	40666	65321	66819	83541
Total	**88036**	**91766**	**95476**	**102376**	**128388**	**131773**	**159691**

Source: Transport Department, GNCTD cited in Economic Survey of Delhi 2002

Appendix II (a)

Diesel Engine

Level of Emission Norms	Technology Options
Euro I	• Retarded injection timing • Open/re-entrant bowl • Intake, exhaust and combustion optimisation • FIP~700-800 bar, low sac injectors • High swirl • Naturally aspirated
Euro II	• Turbocharging • Injection pressure > 800 bar, moderate swirl • High pressure inline / rotary pumps, injection rate control • VO nozzles • Re-entrant combustion chamber • Lub oil consumption control • Inter-cooling (optional depends on specific power) • EGR (may be required for high speed car engine) • Conversion to CNG, catalytic converter
Euro III	• Multi valve • Low swirl - high injection pressure > 120 bar • Rotary pumps, pilot injection rate shaping • Electronic fuel injection • Critical lub oil consumption control • Variable geometry turbocharger (VGT) • Inter-cooling • Oxycat and EGR • CNG/LPG injection • High specific power output • Diesel emulsified fuel, Dimethly Ether (DME) fuel
Euro IV	• Particulate trap • Nox trap • On board Diagnostics (OBD) system • Common rail injection-injection pressure>1600 bar • Fuel Cell • CNG/LPG injection

Source: Interim Report of the Expert Committee in Auto Fuel Policy, Government of India, New Delhi, 2001

Appendix II (b)

SI Engine

Level of Emission Norms	Two/Three-wheelers*		4 Wheelers
	2- Stroke	4- Stroke	4-Stroke
Euro I	• Intake, exhaust and combustion optimisation • Catalytic converter	• 4-Stroke engine technology	• Intake, exhaust, combustion • Carburetor optimisation
Euro II	• Secondary air injection • Catalytic converter • CNG/LPG	• Hot tube • Secondary air injection • CNG/LPG	• Fuel Injection • Catalytic converter • Fixed ERG • Multi-valve • CNG/LPG
Euro III	• Fuel Injection • Catalytic converter	• Fuel Injection • Carburetor + Catalytic converter	• Fuel Injection +Catalytic converter • Variable ERG • Variable Valve timing • Multi-valve • On-Board Diagonostic • CNG/LPG
Euro IV		• Learn burn • Fuel Injection +Catalytic converter	• Direct cylinder injection • Multi-brick catalytic converter • OBD

*** Euro norms are not applicable for 2 / 3 wheelers in India**

Source: Interim Report of the Expert Committee in Auto Fuel Policy, Government of India, New Delhi, 2001

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