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Urban Transportation for Livable Delhi

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Abstract

Drawing on his long experience in strategic positions relating to transport planning in various planning agencies, the author elaborates the reasons for many transport planning problems the citizens of Delhi and the NCR are facing today. History of planning and design as practiced in what he calls the 'grid locked metropolis' appears to have contributed to the rise of transport planning problems. It is also argued that the automobile seems to drive the metropolis rather than the commuting needs of the people living in the metropolis. Identification of Delhi continuously perpetuates transport planning problems. One of the suggestions made is that the functional aspects of road networks that crisscross Delhi need to be critically examined to separate city bound and through traffic. It is also suggested that integrated transport and traffic management techniques should be adopted along with radical organizational changes.

1. INTRODUCTION

One of the consequences of urbanization has been the need to transport people, goods and services to from and within cities. Cities exist because they create wealth and transportation is the cornerstone of cities' ability to create wealth. No city can function efficiently without its passenger and goods transport system. Transportation also exerts a profound influence on the quality of life as well as economic vitality of the city. Urban transport for people today has come to be dominated by the private car, and urban sprawl has made the ownership and use of car essential for suburban residents.

When I first came to Delhi in the mid-1950s private car was still an oddity. Bicycle dominated the mode of individual transport. Other modes of transportation were by city bus provided by Gwalior and Northern India Transport Company, motor-cycle rickshaw as these were popularly called phatis, tongas (horse drawn carriages), cycle rickshaws, and the electric trolley bus and tram, which operated only in Old Delhi Area. As late as 1963, tram was an important mode of public transport in Chandni Chowk. Trams linked important destinations, meandering smoothly through Sadar Bazar, Fountain or Hauz Qazi, Town Hall and Lal Kuan. In 1958, the GNT renamed Delhi Transport Service or DTS was handed over to Municipal Corporation of Delhi. At present the DTC is operated by the Government of the National Capital Territory of Delhi. The DTC buses had long waiting periods and most commuters preferred not waiting for the buses, and took to bicycles. In 1957 there were 147,000 bicycles on Delhi's roads. It was a most favored vehicle, especially for short distances, and became popular

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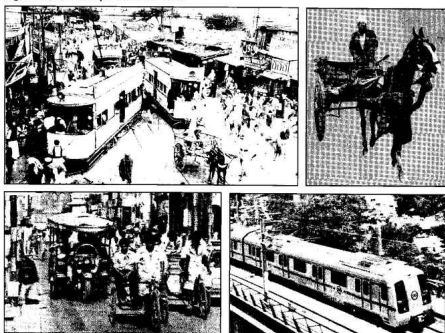
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Fig. 1 : Urban Transportation in Delhi



Trams plying in the crowded Chandni Chowk area; the cycle rickshaw and tonga was popular in the city and now Metro.

amongst government officials, who lived near the Central Secretariat. Traffic was relatively light, speeds were low, and night driving was not very heavy. Delhi then was primarily an administrative city.

Delhi, a product of long historic evolution and served only by some simple form of transportation, is now threatened with disintegration by the onslaught of millions of cars and motorcycles, for which it was never designed. The state and local government failed to provide proper infrastructure, create awareness and enforce traffic laws to meet needs of proliferating traffic. Drivers callously flout traffic rules and regulations with impunity. Traffic police tries to enforce traffic discipline.

Delhi's urban form has changed considerably over the years. These changes have proceeded at an irregular rate, especially during periods of massive urban

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growth. The structure created in the past and needs of the present Delhi conflict. One of the most dramatic and surely one of the most frustrating of the conflicts has manifested itself in the problem of movement of people, goods and services. Delhi today with its central area jammed and ringed by evermore crowded highways leads to Gurgaon and Noida.

Urban transportation has emerged as one of the major challenges facing the national capital. Motorized traffic is probably the most serious single problem affecting the future of Delhi. It has been responsible for much else that adversely affects Delhi's urban environment. The environmental damage has manifested in air pollution, accidents, visual intrusion and invasion of urban spaces affecting the aesthetic quality of the capital. Total dependence on cars, has led to endless traffic jams, eroding pedestrian street-life, and mounting parking woes.

Allowing unlimited use of private cars without solving the resulting congestion by controlling the use of cars and offering attractive alternatives has inevitably led to deterioration of Delhi's transport system and its livability. Delhi has become an auto-centric metropolis with urban design, infrastructure and policy making focused on accommodating the car.

Traffic congestion has placed in jeopardy the wellbeing of many people in Delhi and efficiency of many activities. The potential increase in the number of cars is so great that unless drastic measures are taken the conditions are bound to become extremely serious, probably to the point of paralyzing urban life. The condition on Delhi's roads symbolizes the failure to understand urban transportation as a complex system that interacts with the city and that it must be planned comprehensively as an integral component of urban planning. The focus on keeping traffic on the move obscures the basic environmental objectives of urban planning.

Delhi state government as well as the MCD is oblivious to the gravity of the traffic problem resorting to small scale improvements designed to keep traffic on the move. These measures are unlikely to be of lasting benefit because, as we see, they are being rapidly overtaken by rapid increase in traffic. Rising tide of cars and motorbikes on Delhi's roads will not put a stop to itself until it has almost put a stop to the traffic. Many popular short term solutions to traffic and transportation problems when used indiscriminately can become counterproductive in the long term. Growth of traffic has been so prodigious that traffic is strangulating its own circulation. As large a metropolis like Delhi, based on cars and motorcycle transportation, approach gridlock, it has become apparent that a better solution is needed.

2. SYSTEM OF ROADS

Historically Delhi has developed with a strongly marked radial road system with major commercial and work centers placed at the hub of the radials. The radial road system with no alternative routes generated heavy traffic flows, which led

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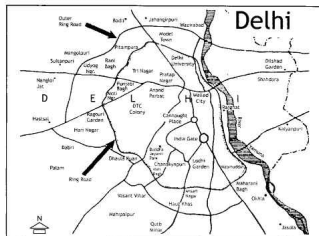


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to the belief that congestion in the central area, was due to all traffic moving on the radials, and that the logical solution was to divert the extraneous traffic round the central urban core. This is how the ring road and the inner ring road came into being. Later, the intermediate and outer ring roads were influenced by the same objective of providing relief to the central area of the national capital. This also happened due to circumferential roads were necessary to link outer suburban areas. The ring-roads concept emerged more by intuition than based on studies of Delhi's urban traffic characteristics. Notwithstanding, today the radial roads and the ring roads form the major traffic arteries.

Delhi metropolis has a myriad of street layouts in its street network. The walled city of Delhi built by the emperor Shah Jahan in the mid-17th century is a medieval organic city. Its street layout looks natural rather than man made. The scale of the walled city of Delhi is small and essentially suited to the pedestrian traffic. The streets vary in width and are rarely straight, winding sinuously throughout the city. Its street pattern was evolved at a time when most movements in the city were made on foot. Even today, there is still a great deal of pedestrian movement, but the situation has changed with the changes in land use from residential to commercial. The built form of Shahjahnabad (the old walled city of Delhi) was shaped by human needs and aspirations. The need was to bring people within walking distance of one another. Buildings paced tightly along narrow streets allowed high density and assured active street life. Today, there is a severe conflict between pedestrians and vehicular traffic in this tightly-packed city of Shahjahnabad.

Fig. 2 : Street Network Delhi



In the early 20th century, the British built New Delhi as the capital of British India. Sir Edwin Lutyen's design of the street layout for the new city contained tree lined boulevards and major streets were laid on the axis of historical monuments creating vistas. The street layout has a geometric order with triangles and hexagons and roundabouts at intersections. Even here the streets were

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designed more for movement of horse carriages than for automobiles. When New Delhi was created, it was planned as a separate entity with the result there was no integration of the road system between New Delhi and Old Delhi. Eventually, both cities have gone far towards coalescing.

In post-independence Delhi, the streets fall apart and exhibit no distinct pattern. Delhi has become unbound and with it our sense of place and home. Today's Delhi metropolis has taken its built form almost entirely from the requirements imposed, the movement and parking of cars and motor bikes.

Most of the major thoroughfares in Delhi pass through built-up areas. The conflict between Delhi metropolis and motorized traffic stems from the physical structure of the metropolis. The manner in which buildings and roads are put together is basically unsuitable for motor traffic. The car has exerted a strong influence towards changing the form of Delhi metropolis by encouraging outward spread and sprawl. Access to the large majority of buildings fronting on main thoroughfares is gained directly from the thoroughfares, thereby obstructing the smooth flow of traffic. To further compound the problem, local government as well as planning authority has been permitting high density commercial buildings along the thoroughfares oblivious of the fact that this would generate more traffic leading to traffic jams. There is no clearly defined road hierarchy and much of the traffic congestion on these roads is due to making the same road perform multiple functions at once.

Under present conditions many problems of road transportation have become far more complex and dealing with today's complexities is a matter for traffic and transportation engineers who specialize in traffic operations and not the generic civil engineers of the Public Works Department who do not give any consideration to traffic factors in road planning and design. Nature and extent of such consideration has quite naturally changed greatly, especially because motor vehicle volumes have begun to be large and speeds have increased substantially.

Calls for organizational changes in the Government of National Capital Territory of Delhi as well as the Municipal Corporation are becoming louder. It is necessary to break away from the pattern of roads that are undifferentiated except as to width. Most of the roads in the network are built as ordinary city streets. There is inherent conflict between carrying of large volumes of through traffic and local traffic, thereby reducing the efficiency of the major roads.

For improving traffic movement in Delhi, it is necessary to develop a road system that will provide required access to buildings abutting the road and at the same time enable vehicular traffic to move swiftly and safely. In the well planned road system, each road has to be designed to serve its specialized function. The road system consists of major roads and minor roads, which serve different functions. The primary task of a major road, like the Ring Road or Mathura Road



is to carry through traffic from one part of Delhi to another. Whereas the minor roads provide access to abutting buildings, and also function as distributor or collector roads. There are certain aspects of road planning that merits special consideration. They include road intersections, pedestrian crossings, walkways and bicycle paths.

In Delhi most of the roads and intersections are sore spots. They limit traffic capacity of roads and are the locus of most of road accidents. Poorly designed intersections put a restraint on safe and smooth flow of traffic on major arteries. Traffic capacity of a road is no greater than traffic capacity of its intersection. Therefore, the intersection design or its traffic geometrics have to take into consideration the multi-directional interchange of vehicles at an intersection. Intersection design must provide for the channelization of left and right turning traffic as well as for traffic moving ahead. In the absence of channelization there is traffic scramble at the intersections in Delhi leading to delays and accidents. A fundamental requisite of a safe intersection is adequate vision clearance so that drivers of vehicles approaching the intersection have an uninterrupted view in all directions before he enters it.

There is a point beyond which it is not technically or economically feasible to increase the capacity of a road. When this stage is reached to bring about a solution to traffic problems, intensity of use of abutting property must be controlled so as to prevent generation of more traffic than a road can carry. Zoning and development control is the most effective tool for the accomplishment of this objective both by controls over density and by requirement for the provision of off street parking.

Increasing population of the Trans - Yamuna area of Delhi along with Ghaziabad and Noida has put pressure on bridges over the river. There are just 12 bridges over the stretch of 22.00 km as shown in Fig.3. Compare with 33 bridges on the 20 km stretch along the Thames River in London. Fortunately, there is a proposal to build more bridges to bring the average to one bridge for every 1.5 km of the stretch along the Yamuna. About 80 percent of the traffic on Nizamuddin Bridge during the morning rush hours is from outside Delhi.

In order to decongest Delhi's main roads, three Urban Extension Roads or UER are to be constructed as proposed in the Delhi Master Plan, 2021. These roads will serve as bypasses. The first Urban Extension Road will connect Wazirabad Bypass to NH1, NH10 and NH8. The second UER will connect Wazirabad Bypass to NH1, NH10, NH8 and NH2. The third UER will provide connectivity from Wazirabad Bypass to NH1 and NH10 as shown in Fig.4. Construction of these bypass roads will not only improve connectivity but also take traffic load off Delhi's arterial roads. The three UERs will serve as direct links from Mahipalpur to Rohini, Rohtak Road and Narela.

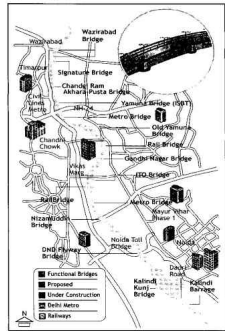
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Fig. 3 : Ways to Cross the River Yamuna



However, since the major work and commercial centers of Delhi are located within the area circumscribed by the Ring Road and since the proposed Urban Extension Roads are primarily meant to divert the traffic extraneous to Delhi, there still remains the problem of improving accessibility to the major work and commercial centers, which at present is extremely poor and time consuming. Master Plan for Delhi, 2021 has not addressed this problem knowing fully well that the volume of traffic destined to work and commercial centers is far more than the volume of extraneous traffic. Vitality of Delhi metropolis is dependent upon the adequacy and efficiency of its roads and traffic systems. Therefore, creation of a system capable of coping with demands of modern traffic must be recognized.

3. GRID LOCKED METROPOLIS

Economic prosperity has created increasing movement of people, goods and services in Delhi. One of the most ominous warnings is the alarming increase in traffic congestion caused by cars, motorcycles and scooters.

The personal vehicle culture has been fuelled by state government's failure to provide a viable public transportation option. Urban sprawl has made ownership and use of cars and motorcycles almost essential for suburban residents. Phenomenal growth of traffic in a short span of time has created unprecedented traffic congestion and delays to the extent of thwarting the very benefit of car use.

Daily motor vehicle trips have risen from 4.5 million in 1981 to 11.8 million in 2001 and are estimated to increase to about 28 million by the year 2021 when Delhi's population is expected to be 25 million people. Between 2002-2003 and 2009-2010, surge of motor vehicles on Delhi's roads has been led by cars and motorcycles. In the seven year period the number of cars has risen phenomenally, by 65 percent from 1,214,700 to 2,013,700 whereas the number of motorcycles has gone up by 61 percent. Car ownership in Delhi has been growing from less than one in 10 people to one in 3 at present. Delhi has become an auto-centric metropolis with the least sustainable urban form because of exorbitant energy

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consumed by the transport system that dominates car use. Between 2003 and 2009, the number of motor vehicles per kilometer road has gone up from 128 to 191. This despite the fact that the total available road space has increased from 30,698 lane km in 2006 to 31,373 lane kilometer in 2009. This increase has been offset by an explosive 52 percent increase in the number of motor vehicles that occupy these roads. More than 300,000 motor vehicles are added every year and as a result the length of road space available per 1,000 vehicles is dipping steadily. It shrank from about 8.5 km/per 1,000 vehicles in 2008.

Overstrained road capacity is further reduced by encroachments on the roads by on-street parking of vehicles, poorly designed intersections and heterogeneity of traffic. There are some 10 modes of transport plying on Delhi's roads. Phenomenal increase in number of motor vehicles, speed and mileage not only have resulted in a shocking rise in toll of deaths, injuries and property damage, but also the growth of traffic has been so prodigious that traffic is strangulating its own circulation. Traffic congestion is literally choking the life in Delhi at the risk of paralyzing it. Congestion on Delhi's roads is bad and getting worse at an alarming rate. Not only does congestion cut transportation operating efficiency, it is also costly. Overcrowded roads waste time and energy, generate pollution, harm human health and damage the economy.

Motor vehicles have been responsible for much else that adversely affects Delhi's urban environment. Environmental damage has manifested in visual intrusion and invasion of urban space, for traffic circulation and parking, which has affected the aesthetic quality of the national capital. Motorized traffic has dramatically transformed Delhi's urban landscape into an immense 'automobile slum'.

The state of the traffic is perhaps the most serious single problem affecting the lives of the people in Delhi. Delhiites leave their homes in their cars very early in the day and take much longer to reach their destinations. As Delhi keeps expanding and roads get more crowded, motorists face longer commutes. This contributes to stress, often expressed as road rage. Angry army of humans and a bewildering variety of motor vehicles battle for space on right of way. Persons, who are polite and considerate in dealing with others, become highly aggressive once behind the wheel of the car often resulting in road rage. It is changing the way Delhiites live as they spend more time living in cars and less time in their homes and family. The car has virtually reduced mobility, while at the same time saddling the metropolis with a host of dilemmas.

Each vehicle wastes on an average 1.6 liters of petrol in traffic jams amounting to a total wastage of 30 lakh liters of fuel. Daily, Rs.10 crore worth of petrol is consumed by the Delhiites, and with 15 per cent Government subsidy on petrol and diesel, the waste is Rs.1.5 crore for the Government. Cars idling at 600 city's traffic signals, burn Rs.1, 000 crore worth of fuel per year. Traffic jams consume

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90 minutes of commuter time. Congestion costs Rs.3, 000 to Rs.4, 000 crore per year. Loss of man-hours and productivity runs into thousands of crore of rupees.

Motor vehicles are a major source of nitrogen oxide and volatile organic compounds, which interact to form ground level ozone and of microscopic particulate matter. These are the key components of air pollution in Delhi. The neglected aspect of urban transportation is the air quality inside cars, a place where some Delhiites spend quite a bit of time. Levels of benzene, carbon monoxide and nitrogen dioxide may be much higher inside the vehicle, especially in congested and slow moving traffic conditions such as those found in Delhi.

4. ESSENCE OF THE PROBLEM

Layout of road network in Delhi is not suitable for reasonably clear, uninterrupted movement of motor vehicles. In the crisscross layout of urban roads, there are intersections at very frequent intervals each of which is an obstruction to the flow of traffic because of right-hand turns, which cause so much delay.

- Kerb-side car parking and encroachments on roads reduces the capacity of the road.
- Permitting higher density redevelopment on piecemeal basis in both residential and commercial areas without increasing road capacity and off-street parking facilities to accommodate the traffic generated as a result of rebuilding.
- Heterogeneity of traffic including cars, motorcycles, auto-rickshaws, bicycles, buses, trucks driving cheek-by-jowl competing for road space.
- Blatant disregard for traffic laws and road courtesy by drivers of different vehicles not only endangers safety but also creates chaos.
- Numerous flyovers built at exorbitant costs have further aggravated traffic jams.

Traffic conditions as we see on Delhi's roads symbolize the failure to understand urban transport as a complex system that interacts with the urban structure of Delhi, and that it must be planned comprehensively as an integral part of urban planning process.

Master Plan for Delhi, 2021 has failed to address the problem of traffic and transportation in its proper perspective. The plan has a policy on the use of land implicit in the land use plan but lacks a comprehensive policy on urban transportation for the national capital. Indeed, a retrograde urban planning that separates land use planning from transportation planning. Without the policy framework, Delhi's multiple agencies resort to ad-hoc measures directed at finding spot solutions for reducing congestion that succeed only in shifting congestion from one area of Delhi to another. Piecemeal amelioration cannot ever be the answer to what is a very complicated and vexed problem.

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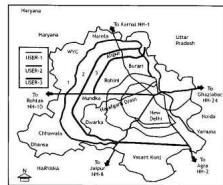
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Government of the National Capital Territory of Delhi sees traffic problem merely as one of keeping motor vehicles moving by building flyovers and elevated roads. This myopic view of fighting traffic congestion by improving traffic flow is an irrational decision. Trying to cure traffic congestion by adding more capacity is like trying to cure obesity by loosening your belt. It creates conditions that crowd out all other modes of transportation leading to a growth in car use that road capacity expansion can never keep up with. Traffic increases to fill in the available spaces. A better option is to develop Delhi metropolis on a more human scale, which is conducive to mass transportation, cycling and walking.

Fig. 4 : Decongesting Delhi



A solution to problem of increasing traffic congestion lies in reducing volume of travel by individual modes rather than in increasing the supply side like building numerous flyovers at exorbitant cost. Government of the NCT of Delhi is trying to solve the problem of too many cars on too few lanes by building more roads only to find that each new road or a flyover has attracted more traffic. Flyovers symbolize enthronement of the car, which 70 percent Delhiites do not possess. These car oriented projects have destroyed sections of Delhi, wiping out streets and urbanism in their wake. Peter Wolf in 'The Future of the City' states that to redesign cities to accommodate the car is to redesign cities out of existence.

Our short term vision blinds us to the consequences of our actions. In the process we are mortgaging the future of the national capital Delhi for the present doing what is expedient rather than what is necessary. Are we not progressively sacrificing all the special values of the national capital to the function of automobile? State government needs to stop and think long and hard before resorting to ad-hoc measures for resolving traffic and transportation problems. Neither MLAs of the state nor the MCD councilors have shown any interest in correcting the fundamental anomaly of favoring private cars over mass public transport.

4.1 Traffic Safety in Residential and Shopping Precincts

The single most important element affecting traffic in Delhi's residential areas is the pattern of the street layout, a form of development, which seems as though it were specially designed to produce adverse effects on traffic movement. The street pattern that one sees in Delhi's residential areas is a by product of parceling of land for plots. The street system is not at all designed for safe and efficient movement of vehicular and pedestrian traffic generated by residential areas.

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Few decades ago very few people owned cars. Today many residents have cars or motorcycles. These changes have resulted in a continuous movement of motor vehicles. There are no sidewalks for pedestrians as cars are parked on both sides of the narrow streets creating traffic hazards for people walking in the neighborhood. Moreover, since the main roads on the periphery of residential areas have become congested, drivers seek alternative routes through residential areas and further aggravate traffic chaos. Residential areas must be protected from flow of extraneous traffic and cross-filtration by drivers seeking short cuts. Vehicular traffic has become a major source of nuisance and hazard to the residents and visitors alike. To add to it in the piecemeal redevelopment in residential areas high density buildings have been permitted knowing that it would generate more traffic on the streets that do not have the capacity and result in traffic snarls.

Street system in residential areas, which is a home for the residents, must provide for the ease, convenience and safety with which they and the visitors move about in the neighborhood by various modes of transport including walking. Besides moving traffic, the streets provide channels for light and ventilation, and space for utilities like water and sewage pipes, electricity, gas, TV Cables, and telephone. All these factors must be taken into consideration in the design of a street layout. In Delhi's residential neighborhoods preference is given to vehicular traffic thereby undermining residential livability. The use of street as setting for social interaction has often been compromised if not prevented by the emphasis on motorized accessibility. Pedestrian network must be integrated with the street layout. Pedestrian facilities are footpaths along streets and some exclusive pedestrian and bicycle paths to interconnect parks, schools and shops.

Substandard residential development that has taken place in Delhi is indicative of the lack of subdivision standards and law to regulate subdivision of land for residential purposes similar to the building bye-laws, which regulate building activities in Delhi. Sanctioning authorities need to set environmental standards for design of residential areas with built in traffic safety and put in place subdivision layout laws to regulate development of residential areas. Design and layout of residential street system has enormous impact on the way our neighborhoods look, feel and work for us. Local or access street to dwellings must be considered more a part of the neighborhood environment than a transportation system.

Residential neighborhoods should have a hierarchical street system. Residential streets on which dwellings are located are the lowest in the hierarchy, and should be designed with a certain curvature or indirectness so as to discourage through traffic and at the same time produce a departure from the usually monotonous rectangular pattern. Staggered cross-streets, dead-end streets and cul-de-sacs contribute largely to safety. In a hierarchical street system, categorization of roads and streets, there must be used for separation of arterial through



traffic network from local ones and clear separation between pedestrians and car traffic.

4.2 Markets and Shopping Centers

Design of markets and shopping centers in Delhi has been conceived without reference to the exigencies of the motor age or future traffic. Nowhere is there the separation of pedestrian precincts from vehicular traffic nor are there any off-street parking facilities. There is a severe conflict between pedestrians and motor vehicles throughout the tightly packed markets and shopping centers in Delhi. It is most marked at points where the main pedestrian movement cross heavy traffic flows on roads on which markets and shopping centers abut. Furthermore, with the present level of car parking most of the road space is taken up by cars and motorcycles.

Entry and exit to markets and shopping centers is invariably direct from major thoroughfares. Conflict between traffic and environment is most pronounced on roads fronting markets and shopping centers where pedestrian activity is the greatest. Important factors to be considered in the design of markets and shopping centers are about providing pedestrians with a pleasant walking precinct insulated from traffic, provide off-street parking facilities and provide entry and exit from access road parallel to major road fronting markets and shopping centers. However, Delhi's market and shopping centers are located and designed with blatant disregard for pedestrian safety. Separation of pedestrians and motor vehicles is nonexistent.

5. TRANSPORTATION SYSTEM MANAGEMENT

Next several years promise to be one of growing traffic congestion, financial crunch, dwindling energy resources, and mobility problem for a majority of the people in Delhi. As an immediate measure greater attention should be given to optimizing the existing capacity for traffic, and of developing a viable mass transportation system. Unfortunately, not much thought is being given for realizing the advantage of making optimum use of available facilities through traffic engineering inputs, streamlining Delhi's bus transport system, and by introducing road pricing policy techniques.

Delhi needs to put in place transportation system management processes aimed at making optimum use of existing road network and integration of mass transportation run by the DTC, Delhi Metro Rail Corporation and the suburban railways.

Transport Management System implies that we view all elements of Delhi's transportation, public and private, as part of a single system, organized and operated with appropriate traffic regulations and road pricing policy. The approach would be to combine the pricing of car use and parking with preferential use of



roads by the DTC buses, and control over car use during rush hours. TSM action consists of measures designed to obtain better use of road space. To achieve that a traffic operation plan for increasing capacity and safety needs to be formulated. Effective operation of existing roads in Delhi is highly important to gain a maximum fluidity of traffic and safety. This involves utilization to the best advantage of the existing road network through application of control measures such as speed control, turning regulations, establishment of one way street system, routing of category of traffic, stop regulations at intersections on which there are no traffic signals, and parking regulations. Localized structural changes will be required such as road widening, elimination of bottlenecks, intersection improvements, pedestrian facilities and removal of encroachments on roads and sidewalks.

Enforcement of traffic laws and education of persons 'behind the wheel' is sine-quanon of the traffic operations plan. To improve traffic conditions structural changes are needed to increase traffic capacity. The capacity of a road with frequent intersections is governed largely by layout and capacity of its intersections, and furthermore these intersections are most serious accident points in dealing with the problem of congestion and accidents. By confining movements of vehicles to definite lanes, and channelization avoids or reduces disorder arising from conflicting movements. Proper channelization of traffic at irregular or complex intersections accomplishes its purpose by simplifying the intersection problem with which drivers are confronted at the channelized intersection. The problem of intersection redesign through the application of channelizing principles divides itself naturally into three major classes of requirements dealing with the human factors, traffic factors, and physical factors of layout and arrangement.

Turning movements, both to the right and left, are an important cause of conflict, accidents, and delays at intersections. At signalized and non-signalized intersections right turns interfere with traffic from the opposite direction with pedestrians. Left turns generally speaking are much less disturbing to traffic flow but do interfere with pedestrian movement. Therefore, in intersection design traffic geometrics have to take into consideration the multi-directional interchanges of vehicles at an intersection. Intersection design must provide for channelizing the left and right turning traffic as well as for traffic moving ahead. In the absence of channelization, there is traffic-scramble leading to delays.

Traffic police must be well organized to exercise the three primary functions. First, traffic police should afford a directing and expediting service to traffic at those points where unusual situation exist for confusion and traffic friction. Second, traffic police has an important function of education and prevention of accidents. Third function of traffic police is the punitive function. Police must be equipped to apprehend and bring to punishment those who violate traffic laws



meant for public safety. Traffic education is imperative for improving road user behavior backed by strict enforcement of traffic laws that would change driver attitude and driving ethics especially through supervision of road users.

5.1 Congestion Pricing

With chronic traffic congestion in Delhi, spiraling out of control, it is imperative to restrict car usage as a measure for reducing congestion, in a constrained urban space in the metropolis. People driving private cars, do not bear costs commensurate with the increment of costs that their use imposes. People using private cars, consider the costs to themselves, of the time, petrol, and car depreciation, but do not consider the costs, loss of time they impose on every other driver. They do not consider the congestion on road they all create. The solution to this problem is to charge drivers of private cars, for the full cost of their commute, in terms of a fee that charges drivers for the impact their cars impose on the rest of the road.

Building more roads is not the answer to eliminate traffic delays, but congestion pricing will. Both London and Singapore adopted congestion pricing charging motorists for driving in central business district. Both these cities saw traffic drop significantly keeping the cities traffic-jam free. Charging cars the extra cost incurred by the city to provide them with road capacity during rush hours is one way to bring about a more equitable use of road space. Those driving their cars on congested roads during rush hours are costing Delhi much more than they pay in any form of taxes. Establishing car restricted zones in Connaught Place and Chandni Chowk where cars operate so inefficiently due to congestion, and converting them for pedestrians and bicycles, would be a little loss for the motorists and a boom to pedestrians.

For road pricing to be effective requires improvement in mass transportation. It will have to be made an attractive alternative to travel by individual modes. It has to be a service which demonstrably competes with private mode in terms of efficiency, comfort and above all reliability. Reducing congestion benefits everyone. It saves fuel, spares the environment, reduces accidents, saves time, and lowers cost of transportation.

With the present day volume of traffic to handle traffic operations requires resolution of a wide range of engineering problems that will have to be solved to cope with proliferating traffic both in the adaptation of existing roads to their most effective use, and in the design and construction of new major facilities. This means that the maximum possible service will be demanded of traffic engineering. To meet and satisfy this demand will necessitate establishment of traffic engineering unit. Traffic functions should occupy a major position in the Municipal Corporation of Delhi since the problems of traffic congestion and accidents have assumed staggering proportions. Traffic engineering is devoted to



the study and improvement of traffic performance of road networks. Its purpose is to achieve efficient, free and rapid flow of traffic, and at the same time to prevent accidents and casualties. Its methods include regulation and control, planning and geometric design.

Through the studied use of traffic characteristics, traffic operation improvements are achieved by effective application of regulatory methods to existing facilities, and by proper planning and design of the construction of new facilities. It is the factual studies of traffic operations that provide the foundation for intelligent development of ways and means to improve traffic performance. In traffic, as in other areas of public activity, the best techniques and plans will not bring about satisfactory solutions without developing an adequate structure as a basis of operation in the Municipal Corporation of Delhi.

Traffic function cuts across the established duties of many agencies in Delhi. The objective of traffic administration is to coordinate the varied activities having both a direct and indirect influence on traffic planning, construction, and operations, and at the same time it will be required of all appropriate departments and agencies to assume responsibility for traffic functions which come within their framework.

The operational characteristics of motorized transportation are the basic reasons for all road and highway requirements. Such characteristics determine the need for divided highways, intersection geometry, road widening, traffic regulations, traffic signals, warning, directional and regulation signs, pavement marking, parking facilities, and all the other structural and control facilities for road travel.

6. URBAN TRANSPORTATION

Urban transport for people in Delhi consists of individual modes such as cars, motorcycles, scooters and bicycles; mass public transport provided by the DTC Bus Service, metro service by the Delhi Metro Rail Corporation and commuter suburban train services provided by the Northern Railways, and for hire transport by auto-rickshaws, cycle rickshaws and taxis. As many as 70 percent of Delhiites neither own nor have the use of private vehicle for their daily trips, and must through necessity use public transport.

Many others are so located that the use of public transport is a practical impossibility, and the use of private vehicle car, motorcycle, scooter and bicycles becomes a necessity. But many if not most of the Delhiites wishing to go to work, shop, transact business or for other purposes have a choice of means of travel. And for commuters the choice too often is not attractive means but which offers the least inconvenience.

Choice of public transport by DTC, DMRC and suburban train means following a fixed route, and perhaps walking few kilometers to the bus stop, metro station



or train station. It often means waiting for the bus. It means commuting standing part or the entire lengthy journey. Often transfers are required. However, in its favor public transport offers cheap fares, freedom from annoyance of driving in traffic jams. Choice of private car, motorcycles and scooters usually means driving in traffic with delays caused by traffic snarls. It also means strain of guarding against accidents. But its most serious drawback is the necessity of finding a parking place.

It is a sad commentary on urban life in Delhi that too often the disadvantages of either mode of travel outweigh the advantages. Decision as to which mode to be used, too often rests not upon a positive desire to obtain the benefits of the one but to avoid the more undesirable features of the other. It is a negative not a positive choice. Until we reach a position in which a majority of Delhi's residents can make a choice on positive grounds, we have not solved the urban transportation problem in Delhi.

A transport system must be measured against the area of land it occupies. Studies have shown cars occupy up-to 20 times more land space than the rail based transport for the same capacity of passengers, before any allowance is made for car parking. Car needs much more space than buses or elevated metro-lines, or walking and cycling. A moderate size car occupies a space about 100 sq. feet. Cars not only use space while moving but also need space for parking i.e. about 120 sq feet per car. Walking takes up only 9 sq feet of space for a pedestrian. Cars are most space intensive form of urban transport, and have forced cities to expand into suburban sprawl. A third of Delhi's land is devoted to serving the car inclusive of roads, parking lots and service stations. The amount of space an urban transport system absorbs has a critical effect on urban form.

DTC buses are by far the most economical users of road space in terms of passengers carried as one bus can be used in place of 60 cars. Mass transportation by bus with far less acreage in roadbeds and right-of-way can deliver at least ten times more passengers per hour than the car. Buses constitute just one percent of the total vehicles on road, and yet carry over 50 percent of the commuters. By the year 2021, the number of daily trips by mass transport is estimated to be 224 lakh of which only 45 lakh or 20 percent will be carried out by Delhi Metro. Because mass transportation by bus is most effective in economic utilization of road space, major emphasis should be placed upon its value in reducing traffic congestion and on making the service bus provides more attractive to as large a segment of Delhi's population as possible. Mass transportation service by DTC must be of extremely high quality with frequent service, on-time performance, efficient route system, comfortable coaches, easy to use, and assured personal safety are essential.

However, under present conditions the DTC buses have to compete with cars, motorcycles and auto-rickshaws for right-of-way. Since buses have frequent



stops for loading and unloading of passengers, their average speed is very much lower than of the cars and motor cycles. It is only when high priority is given to DTC bus service, can it achieve better speed than cars. The DTC has to decide to make bus service faster than cars and motorcycles by allocating street space for buses in designated lanes and then to bicycles in separate tracks and lastly for cars and motorcycles. More efforts are required to be made before Delhiites leave their cars and motorcycles and take to bus without facing inconvenience.

Europeans, for instance, have put the car in its place by refusing to let it dominate the development process and overshadow other forms of transportation. Delhi must build a world class mass transit system, and carry out measures to discourage cars. Make mass transit cheaper and convenient and driving by car expensive and difficult. Make mass transit available to people who have been left behind by the car culture. Particularly people who are too poor to own a car or even motorcycle, too old or too young to drive should be looked after by improving mass transport systems. Collin Buchanan's report on 'Traffic in Towns' categorically states that 'cities can only be made to function efficiently and provide a decent environment for living, is by giving a new dynamic role to mass transportation, that is environment friendly'.

Master Plan for Delhi, 2021 has estimated that by year 2021 about 80 percent of the 224 lakh trips per day will be performed by mass transportation. How it is that Government of the National Capital Territory of Delhi has been devising a transportation structure for Delhi on the basis that nearly all trips are to be made by cars.

Unless, mass transportation has a precedence over the individual modes of transport, parts of Delhi metropolis, which are already destroyed to make way for the increasing traffic of cars and motorcycles, will be further pulled down in an attempt to get rid of traffic congestion only to find that congestion still remains while the aesthetic character of the national capital gets destroyed. Delhi has been declared by UNESCO as the heritage city. Delhi has great historic and social value neither of which should be compromised to provide unlimited travel by car. Let us not mortgage the future of the national capital for expediencies of the present.

Until the end of 20th century DTC bus service was the sole mass transportation system in Delhi. Today the national capital has rapid transit in the form of Delhi Metro, which is owned and operated jointly by Government of the NCT of Delhi and central government. Work on the construction of the Metro began in 2002. By 2010 in a period of 8 years the Metro has covered a lot of ground. Starting with an 8.5 km stretch from Shahdara to Tis Hazari, it has completed a length of 152 km covering North, South, East, West, North-West, South-West and South-East Delhi; Airport and Huda City Center in Gurgaon, and Noida City Center in the NCR.



Delhi Metro network is partly underground and partly elevated. It is a capital intensive rapid transit system as compared to DTC bus transport. The cost of underground is about Rs.280 crore per km while the elevated is Rs.125 crore per kilometer, less than half the cost of underground. That is why 80 percent of the metro rail is elevated. By the year 2021, Delhi Metro is expected to carry 108 lakh passengers daily on 414 km track across Delhi and beyond. About 60 percent of the urban area of Delhi will be within 15 minutes walking distance from metro stations. The remaining 40 percent of the area could come within easy access and connectivity with metro stations through 'Metro Link' special feed service by bus.

High level of safety and comfort plus savings on time is surely the main reason commuters are shifting from other modes of transport to the metro. It is faster to take a metro than to slog through the traffic snarls. However the metro requires a much bigger boost because networks and connectivity are inadequate at the present moment. Delhi Metro has to be made the backbone of the transport system in Delhi and cities around Delhi. The DTC must realign its routes to encourage people to use metro by providing feeder services to metro stations. Unfortunately no off-street parking facilities are provided at metro stations for 'park and ride' passengers, resulting in kerb-side parking of cars and auto-rickshaws adding to the traffic jams.

Due to effective traffic management in the Tokyo-Yokohama urban agglomeration of over 27 million inhabitants, although it is very crowded, still it works fairly well and does not suffer from the worst traffic problems afflicting Delhi. The reason being most people in Tokyo take public transport to work. Tokyo has the world's best subway and rail systems and people use it intensively. During the British colonial rule they built a railway network nationwide including commuter rail system in Mumbai, Kolkata and Chennai. State government in Delhi is investing in improving facilities for car while ignoring rail for commuters.

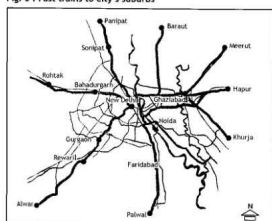
For given investment, Delhi's railway system and Delhi Metro provide greater capacity than road based bus transport system. Origins and destinations are located in densely populated areas that generate enough ridership to justify the capital investment and operational costs. The greatest benefit of railway based urban transportation, to serve Delhi as well as the NCR, is that it builds on and improves what we already have in place i.e. the ring railway and the five radial railway lines that converge on Delhi to serve the regional commuter traffic.

However, there is a need to augment suburban train network by building new lines and increasing the frequency of suburban trains. At present rail network is already overburdened with long distance traffic. There is no space for augmenting suburban rail service on the existing tracks. There is a proposal to have dedicated

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Fig. 5 : Fast trains to city's suburbs



tracks for regional rapid transit system. Northern Railways is planning to put in place suburban rail projects by providing fast mass connectivity to the towns in UP, Haryana and Rajasthan in the NCR (Fig.5). Proposed NCR Transport Corporation will be responsible for the development of integrated multi modal transportation including commuter rail and feeder services in the NCR.

6.1 Balanced Urban Transport System

To be considered efficient, urban transport system must provide service to all areas of the Delhi metropolis. It must be available to all groups of people, and it must provide easy access to work places, central business districts, train stations, airports, interstate bus terminal, education centers and markets and shopping centers. It must satisfy travel volume requirements, satisfy performance (speed, safety, reliability and comfort), reasonable cost, provide facilities and services that are efficiently incorporated with a human-oriented urban environment, and stimulate creation of desirable urban development and forms.

No single mode of transport can satisfy diverse needs of Delhites. Delhites make travel choices based on their individual needs. Travel needs vary substantially by location, time and distance, and other characteristics as well as by income category of the traveler. These diverse needs are met by walking, cycling, car, motorbikes or scooters, city bus service, Delhi Metro, suburban train, auto-rickshaw, and taxis. They vary greatly in comfort, speed and reliability. Each type of transport has its special use, and a good transportation policy for Delhi must seek to improve each type and make the most of it.

Therefore, a comprehensive transportation plan must be put in place to coordinate the individual choices into an efficient inter-modal transportation system to utilize the benefits of diversity provided by a combination of modes. Each mode must be planned separately and then integrated with other modes through an iterative planning and design process. Coordination of modes must be both at operation level as well as at planning level. Implementation of integrated inter-modal transportation system will reduce car use and improve its alternatives in order to achieve required balance of transportation modes.

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Advantages of putting in place an integrated inter-modal system of transport in the national capital is that it would result in economically efficient, socially integrated and environmentally livable metropolis. Other advantage of multi-modal system is that it requires lower investment and operating costs, and that every person has mobility.

Cities known for their livability and efficient transportation have high degree of inter-modal coordination. They tend to have coordinated financing of different modes as well as land use planning that integrates transportation. Delhi, a regional mega-city of over 16 million people, for the built-environment of this scale, to function efficiently and satisfy emerging needs, we must collaborate on all fronts to join our personalized pattern of car travel with fixed planned corridors of public mass transportation. Delhi Metro, city bus service and suburban train must work so seamlessly to create a singular system of urban mobility.

7. WALKING AND CYCLING AS EFFECTIVE TRANSPORTATION MODE

The oldest form of human transportation is walking. In Delhi pedestrians are a very important factor. As many as 35 percent of the total daily trips in Delhi are made by walking. These include trips to work, shop or transact business.

Planners have ignored the importance of pedestrian traffic to the quality of life in the urban development process. Walking is crucial for livability to which the Delhi Development Authority has not paid much attention, while neglecting urban planning and design at micro scale. Micro-design is urban design of individual areas in Delhi metropolis that often have a major influence on the roles of different modes of travel, particularly on pedestrians in areas like Connaught Place, District Centers, Community Centers, Markets and Shopping Centers, making them more walkable and for people to meet.

Most cities in Europe, in order to enhance social life and livability, encourage pedestrian activities in their central business districts as well as in shopping centers. In Delhi, where a large number of people walk, they remain marginalized. In our entrenchment with the car, we have forgotten how much more efficient and how much more flexible the foot walker is.

Roads in Delhi are inhospitable to pedestrians and lack sidewalks. The entire system has been designed for the convenience of the motorists. At present, it is virtually impossible for people to walk, to navigate freely in the city, thereby imperiling their safety. In terms of fatality toll, pedestrians outnumber drivers of motor vehicles. People walking in Delhi have generally been subjected to relatively little control and provided for very inadequately. There is a great need to construct facilities, which will make it easier for people to walk safely and conveniently.

In the United States of America, a major shift in policy away from auto-centric planning to mandated accommodation of the pedestrians and cyclists in federally supported transportation projects has stimulated numerous pedestrian

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and bicycle policies, plans, and built-projects across the country. Our built environment must support and encourage walking by providing comfort and safety to pedestrians as well as offering visual interest in their journeys through Delhi. It must be made interesting enough socially to make one feel that walking is more than just getting from one place to another. Walkability might be defined as the extent to which built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout Delhi.

One fundamental principle must be maintained that is pedestrians must have precedence over all other road users. Pedestrians must be given priority over vehicular traffic in shopping centers, markets, business districts and other commercial areas that generate pedestrian traffic in large numbers. Walking and cycling are essential ingredients in an integrated, inter-modal transportation system to give travelers transportation options and to provide continuity from home to destination through convenient and accessible links to other modes such as DTC bus, Delhi Metro, and suburban train within a reasonable time-distance of 10 minutes to 20 minutes of walking.

Next to walking is the use of bicycles. Bicycles have several attractions for the user. For one thing he or she is not spending money on fares or fuel. Bicycles provide the user with excellent physical exercise recommended by doctors for strengthening a healthy heart. Bicycles take up relatively little space, create no traffic jams, or pollute the air, and a cyclist is unlikely to cause any damage to pedestrians. On the positive side, the cyclist has advantage over the car driver, being in an unenclosed environment. The cyclist has a non-stop door to door journey, which the car driver spends some time looking for a parking place. He or she can ride through red lights and difficult intersections, and negotiate traffic jams. For the short trips involving several stops for shopping and so on, the cyclist may take little longer than the car but will experience none of the car driver's frustrations.

During the preparation of the first Master Plan for Delhi in the late 1950s, traffic survey enumerated around 7 lakh bicycles in Delhi, which then had a population of less than 2 million people. The cyclists were seen riding on the streets for want of separate bicycle tracks. To cater to such a large volume of bicycles, Master Plan for Delhi, 1981 proposed Express Bicycle Tracks separated from motorized traffic indicating the alignment of tracks on the land use plan. Like many others, this proposal too never got on the ground. In Delhi, both state and local governments have forgotten or ignored this relatively low-tech mobility option. It is about time to improve bicycle facilities and enhance safety by creating city-wide bicycle network of express tracks.

A number of European cities have taken steps to substantially limit automobile traffic in their central areas. Some cities have converted their centers to car free districts limited to bicycles and pedestrians and public transport. There exists a



network known as 'Car Free Cities' based in Brussels of about 60 cities working on these issues. Many of these participating cities are signatories to Copenhagen Declaration whereby a commitment is made to finding ways for reducing the pressure of cars in their cities. Here in Delhi we have produced an urban design for Delhi so hostile to pedestrians and cyclists in order to accommodate the car.

8. PARKING CRISIS

After battling through traffic jams, finding a parking space is even more frustrating. There is scarcely a business and shopping area in Delhi that is not handicapped by a lack of adequate amount of parking facilities. And yet neither state nor local governments in Delhi have found a single and simple solution for the parking problem. With the result, motor vehicles are parked on the road kerbs, thereby reducing traffic carrying capacity of the road to as much as fifty percent.

Delhi's parking woes are now global news. Of the twenty big cities surveyed across the world, Delhi was rated the worst in terms of parking pain. 'Parking index' formulated by the IBM is based on peoples' responses to the time taken for finding a parking space, not finding it, disagreement over parking space, and getting 'challans' for illegal parking. Delhi with a global parking index of 140 tops the list of 20 world cities. Inefficient parking system is a major setback to Delhi's productivity leading to inefficient services. Frustration and pain of looking for parking space has impacted the social behavior of car drivers. Fights over parking have become all too common in the capital. With 70 lakh vehicles and 900 more being added every day, parking space is woefully limited. With the dire need for parking facilities, so apparent in this vast metropolis, it seems incongruous that plans for road and highway improvements for moving motor vehicle are taking shape while little or nothing is done for their parking.

Certainly, roads and highways cannot be effective without adequate parking provisions for motor vehicles they carry. Parking provisions must be integrated with facilities for movement of vehicles. Mere movement does not accomplish the ends of transportation. Motor vehicles have no utility to their owners unless it is possible to park the vehicle once the driver has reached his destination.

Every car in Delhi occupies large amount of space for its movement and storage. It needs a parking space at home, a parking space at place of destination, like employment, business, shopping, and of course a space on the road for movement. It will not occupy all the three or more spaces at once, but nevertheless, spaces have to be there.

Parking requirements for different purposes necessitate different types and operation of facilities. For instance, worker parking is generally all day parking, and must be available at low rates, usually on self-parking basis. Shoppers, usually are short-term parkers, and need to be charged on hourly basis. Those wishing to transact business often park for only a few minutes at a time but often many times a day, and they can be accommodated at the kerb with parking meters.



Local government in Delhi can provide for these different needs by careful selection and development of appropriate sites, and application of rate schedules to encourage desired use. Kerb space reserved for short-term parking to be enforced by parking meters wherever in use have proved their value for effective control of time-limit parking along the kerb. They result in a greater parking turnover, and tend to eliminate the all-day parker.

Eventual step is to prohibit parking in congested areas of Connaught Place, Chandni Chowk, and other congested business districts for a time longer than necessary. But this can only be achieved after adequate off-street parking is provided. However, the space available for off-street parking is limited to cater to increasing demand for parking in already congested business centers. Pressure on available parking spaces can be relieved to the extent that commuters to congested business and commercial areas are persuaded to use mass transportation rather than private mode of travel.

Municipal Corporation of Delhi has not made much progress in providing off-street car parks. Between 2003 and 2007 the MCD announced building of 40 car parks. In 2003, MCD announced construction of 16 automated multilevel car parks and in late 2007, 24 conventional car parks. When parking has assumed crisis proportions, the MCD needs to speed up the construction of car parks announced by it, and at the same time not permit high density redevelopment in Delhi without providing corresponding street capacity and off-street parking.

9. REGIONAL TRANSPORT LINKAGES

A solution to Delhi's transportation problems does not lie just in the National Capital Territory of Delhi alone as it very much depends on the linkages to the towns in Delhi Metropolitan Area as well as in the towns in the National Capital Region. A large number of vehicles come to Delhi and leave the metropolis during peak hours. The highest traffic volume being on the National Highway-24 (Delhi - Ghaziabad) followed by NH-8 (Delhi - Gurgaon). The road from Faridabad i.e. NH-2 is equally choked. This traffic is generated because of jobs and businesses located in the capital. There is a suburban train service operating between Delhi and towns in the NCR for quite sometime. It is grossly inadequate, unreliable and inconvenient because of lack of feeder services from trip-end points.

Due to development of towns in the NCR, there is an urgent need to strengthen available rail service capacity along the tracks, and provide dedicated electrified corridors, automatic signalling facilities, additional suburban station, rolling stock and power supply, and integrate the suburban rail system with Ring Railway and Delhi Metro. Ring Railway carries less than one percent of the commuter load. The main hurdle is limited capacity in the northern stretch of the Ring. Inadequate feeder service, and lack of integration with radial railway lines. There is no scope for improving capacity in the northern stretch i.e. between Tilak Bridge and New Delhi Station, but it is possible to augment capacity in the southern stretch. The NCR Planning Board has recommended Suburban Railway Development Projects to provide fast mass transit connectivity to the Ring Towns of Ghaziabad, Meerut

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and Bulandshahr in UP; Sonapat, Gurgaon, Faridabad and Rohtak in Haryana, and Alwar in Rajasthan. These towns are identified as major contributors to Delhi's increasing migrant population. The mass transit connectivity will also serve as a catalyst for the development of these Ring Towns within the NCR fostering their growth. Promoting regional growth is a way to relieve population congestion in Delhi, enable middle and working class families to move to better homes in less crowded neighborhoods.

The suburban rail system has a capacity to carry from 40,000 to 60,000 people per hour along a single route. Whereas highways using far more space cannot move more than 4,000 to 6,000 cars with an average occupancy of more than one and half passengers. The National Capital Region is home to nearly 40 million people. In recent years, significant social and economic changes have occupied the region. These changes have created demand for travel, which the present transportation system must meet. The National Capital Region is at the center of railway network for passengers and freight traffic. There are five radial railway lines and the Ring Railway, which are significantly tied to the NCR's transportation requirements both intra and interstate. The National Capital Region is also at the center of national highway network. There are five radial national highways and the concentric ring roads.

To cope up with the travel demand, there is a proposal for creating two orbital railway corridors. The outer corridor will have a length of 300 km and will connect Panipat, Rohtak, Rewari, Palwal, Khurja, Hapur and Meerut. The inner corridor will connect Sonapat, Sampla, Jhajjar, Gurgaon, Faridabad and Dadri. There is also, a proposal for separate expressways to connect Panipat, Rewari, Rohtak, Palwal, Meerut and Bhagpath and for Ghaziabad there is the Hapur Link. The Western peripheral expressway (Kundli, Manesar-Palwal); Taj Expressway (Greater Noida - Ballia); the Eastern Peripheral Expressway (Kundli - Ghaziabad-Pawal) will also help manage traffic.

Since Delhi is linked to Noida and Gurgaon with Delhi Metro, many car drivers travelling between Noida and Delhi, and Gurgaon and Delhi, have switched on to Delhi Metro on park and ride basis. For those travelers where metro stations are not within walking distance, efficient DTC bus feeder service is imperative. Federal Urban Development Ministry has approved in principle a rail-based regional rapid transit system to provide fast connectivity between Delhi and Meerut, Alwar, and Panipat. Conceived as multi-modal system integrated with Delhi Metro, DTC bus clusters and terminals will not only ease connectivity to distant towns in the NCR but will also ease traffic congestion on roads. These three corridors, Delhi - Ghaziabad - Meerut, Delhi - Gurgaon - Alwar, and Delhi - Sonapat - Panipat need to be executed sooner than 25 years as stipulated by the authorities. It brooks no delay because the population of the NCR is rising at an exponential rate. It shot up by 40 percent to 21.7 million people in the last decade.

A good transportation system supports social, economic and environmental wellbeing of the people in the region. The way we deal today with the issues of

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land development, accessibility, economic vitality, mobility and environmental protection will affect the quality of life for years to come. The provision of good transportation service is expensive and financial resources are limited. It is important therefore to plan future major transportation for the NCR to ensure the best system possible with the financial resources expected to be available.

The United States government enacted Inter modal Surface Transportation Efficiency Act in 1991. The Act requires state and regional authorities to plan comprehensively with appropriate modes of transportation. It calls for a holistic approach to transportation planning. It considers a range of transportation modes, and their impact on natural and built environment. The NCR planning board instead of a piece meal approach to addressing regional transportation planning, problems should formulate a comprehensive regional transportation plan for providing an integrated and coordinated multi modal transportation system. The NCR Board should create a system that maintains accessibility and includes a variety of mobility options, which serve the needs of residents and businesses in the National Capital Region. With significant support to all modes of travel, such as, BUS, Delhi Metro, Suburban Rail, Cars, Motorcycles, will improve regional mobility and accessibility.

Regional Transportation Plan will be a long range guide for major investments in NCR's multi modal transportation system. Agencies such as Delhi Transport Corporation, DMRC, Northern Railways and the Public Works Department responsible for operating and maintaining the transport system will have to develop their own plans and programmes within the framework of the Regional Transportation Plan, which will recommend major projects, systems, policies and strategies designed to maintain existing infrastructure and meet future travel demands.

Changes in regional development have contributed to a rapid growth in suburban to suburban trips in the NCR. At the same time the demand for the suburbs to city trips has remained strong. This combination of travel pattern has added a new dimension to the challenge of serving regional travel needs. In addition to a shift in travel pattern, the individual choice of modes in the NCR has continued to be limited and use of car has grown dramatically. A sound transportation system must respond to significant changes in the NCR including changing commuting pattern and residential development.

Adjustments or changes to regional transportation system are to be made through a well-defined planning process. Transportation by its very nature is multi-jurisdictional and its issues need to be discussed at a regional level. The NCR Planning Board needs to establish planning processes that involve local, state and central governments in the formulation of the regional transportation plan.

Given the size and the complexity of NCR, the regional transportation plan cannot adequately address the many local issues and concerns that affect specific towns



throughout the NCR. The regional planning processes must recognize the impact of regional travel pattern and transport improvements in these small areas.

Planning processes must involve the states of Haryana, UP and Rajasthan as well as the locally elected and appointed officials, and professional staff from many units of local governments, regional and local transport providers such as, Railways, DMRC, DTC, planners and residents, and representatives of businesses.

10. RELATIONSHIP BETWEEN LAND USE AND TRANSPORTATION

Planning urban highways and local transportation systems is a specialized field. Nevertheless, it is an integral part of urban planning. It is not possible to plan proper transportation routes and facilities until the pattern of land uses to be served are known. That is why traffic and transportation have to be seen as a part of the comprehensive scope of urban and regional planning. Urban planning on the other hand should not be empirical without any vision for the future. We have to make up our minds about what kind of Delhi we want to live and work in, and design the transportation systems to serve the indicated needs. Unfortunately we have not demonstrated this in our urban planning processes. Delhi Development Authority's approach to urban planning is based on the preparation of land use plan for controlling the use to which land in Urban Delhi can be put through development control measures. While formulating land use plan, the functional relationship between land use and transportation is not taken into consideration. A dismal failure to link transportation planning with land use is exhibited by the DDA.

Delhi Development Authority has not entirely faced up to the problem of traffic and transportation in Delhi, which explains, Master Plan for Delhi, 2021, has a land use policy but no corresponding policy on urban traffic and transportation. Urban planning is concerned not only with the way in which land shall be used but also with the problem of movement of persons and goods, which arise because people in Delhi as in any other city live and work on the land. The Master Plan must relate the provisions of the plan as a whole to policies for the movement of people and goods, and for the management and control of road traffic, and for maintaining a balance between public and private transport.

Urban transportation has to be analyzed in terms of its underlying causes, the need for movement of people, goods and services, within the Metropolis of Delhi. These movements are manifestation of organized system of urban activities, which are land based. Different kinds of activities based on land, generate different types and amount of traffic. Traffic is thus, a function of land use. Land uses create and determine traffic demands.

Vitality of the metropolis of Delhi is very much dependent upon the adequacy and efficiency of its roads and traffic systems. The creation of a system capable of coping with the demands of modern traffic must be recognized as a primary feature in a comprehensive urban planning programme, which hitherto have not been done in our urban planning processes. The task ahead is staggering



because traffic problems are developing much more rapidly than the techniques for their resolution. Even while improvements, such as the numerous flyovers being built at exorbitant costs are in process, the problem continues to grow beyond calculation.

Traditionally, transportation planning begins with the existing land use pattern or a postulated future one, and identifies the resulting transportation needs and effects. The new requirements call for analyzing the reverse relationship that is a recognition that land use pattern is not given but rather is at least partially the result of accessibility created by the transportation system. Analyzing land use effects of transportation is a difficult and complex task. Present attempts are general and rely on inexact methods. Improving the ability to address this factor calls for new planning techniques.

Nevertheless, the Master Plan for Delhi should be supplemented by a transportation plan, which would be part of the statutory submission. Preparation of a transportation plan would enforce the much needed integration of land use planning and transportation planning. Long run solution of transportation problems is planning, guidance and control of change in the pattern of land use in the interest of efficiency like alternative land use development pattern that reduce travel demand. Also removing from areas of traffic congestion establishments not functionally required to be in Delhi, and by separating land uses that generate conflicting or mutually antagonistic kinds of traffic.

See how the peculiar land use pattern, and the sub-urbanization of Delhi has helped create constant traffic grid locks. The two fundamental issues in urban planning are environment and transportation. Environment has precedence over transportation because the ultimate goal of urban planning is to improve living conditions. Therefore, urban transportation is too important to be viewed solely as a means of moving people, goods and services. Instead, it should be considered as a means of designing a more satisfying urban environment in Delhi. In the process, urban mobility would be well served. Because, much that would be done to improve the urban environment would also help improve transportation.

Singapore, for instance, made transportation the framework around which urban development took place. Limited access roads provided transport to suburbs. It also combined housing, workplace, schools and shopping in clustered development to help stem the tide of traffic. Landscaped highways in Singapore proclaim the dual role of transportation in urban setting to move traffic and also help create a satisfying urban environment. Urban transportation is a basic element of the livable city.

11. EPILOGUE

In the course of past five decades, a number of traffic and transportation planning studies were undertaken for metropolitan Delhi and the National Capital Region. In 2001, Government of the National Capital Territory of Delhi and Ministry of



Environment, Government of India, sponsored a study on integrated transport and traffic management with Japanese funding through the World Bank. One of the findings of these studies brought about the metro rapid transit for Delhi.

Practically, all these studies emphasized the urgent need to strengthen the existing institutional set up, and to plan, implement, coordinate, fund and monitor an integrated urban transport system. These studies also recommended the establishment of a unified Metropolitan Transport Authority.

According to the Report, the factors causing deterioration in the transport system of metropolitan Delhi are multi - agency planning and implementation, inter-agency interests and conflicts, lack of a strong will to improve the public transport system, lack of land use - transport integration, and above all, a non-existent public transport culture. The study presents future directions to provide, promote and ensure safe, economic and efficient movement of all categories of passengers and goods in an integrated multi - modal transportation system.

Many of these recommendations made in these reports are yet to see the light of day. Few years ago, the Minister of Indian Railways, while presenting the Annual Railway Budget in the Parliament had this to say 'when there is money there is Railway, when there is no money, there is survey'.

Mounting traffic grid locks on Delhi's streets leading to delays constitute serious threats to the continued economic health of the metropolis. Potential increase in the number of cars and motorcycles is so great that unless some action is taken to alleviate the traffic problems, the conditions are bound to get extremely serious in the coming years, to the point of paralyzing urban life in the national capital.

In view of the complexity of urban transportation and traffic problem, Government of the National Capital Territory of Delhi and Municipal Corporation of Delhi must eschew piecemeal and ad-hoc measures, and instead adopt a more comprehensive and systems approach for grappling with traffic and transportation problem as recommended by the experts through studies undertaken at the behest of state government.

It is time state government took charge of Delhi's traffic and transportation or risk further traffic grid locks and chaos, making Delhi's central business and work areas, less easily accessible and their value as focal point for the life of Delhiites getting seriously damaged. Economic losses arising from traffic congestion and delays will mount, road safety will be seriously impaired, and the pressure of growing car and motor bike traffic and parked vehicles will increasingly damage Delhi's urban environment. Vigorous action is needed if we are to emerge victorious from revolution in urban transportation through which we are passing. It is rather unfortunate that state government has been rebuilding Delhi for cars rather than for people. Entrenchment of the car has plagued Delhi by ill-planned changes that are anti-city in character. Instead of trying to force the fabric of



Delhi to fit the car, state government must devise means of transportation to fit the metropolis. The bottom line is a dire need for an urban transportation policy with a holistic approach for addressing problems of traffic and transportation.

In Delhi, no other phase of urban services is handled by so many different agencies as traffic and transportation, and no other phase receives as little attention in scientific and traffic engineering planning. Activities related to improving traffic operations are conducted with rudimentary and peripheral knowledge of the techniques of traffic engineering. To execute works of the kind and scale of measures required to modernize traffic operations and provide efficient mass transportation in the capital. There is an urgent need to put in place, under a single command, an organization for planning, coordinating, budgeting, programming and phasing of projects for modernization of traffic operations to improve road capacity, and safety, and for creating integrated inter modal mass transportation system.

Until the essential institutions are created as recommended in the studies, most of the traffic and transportation planning will be empirical and blundering. So what prevents Government of the NCT of Delhi from establishing Metropolitan Transport Authority? Neither Government of the NCT of Delhi nor Municipal Corporation of Delhi has the necessary apparatus to deal effectively with Delhi's traffic and public mass transport. This perhaps is the key reason why they have not been able to address the problem, which has assumed crisis proportions. The present administrative structure is archaic, and to maintain the status quo would be an anachronism.

While traffic continues to choke Delhi's roads and nettle commuters almost wherever they seem to turn, there is growing public frustration with traffic grid locks, grossly inadequate off-street parking, and eroding pedestrian safety. Delhites certainly must wonder how much longer they will have to endure before Government of the National Capital Territory of Delhi and Municipal Corporation of Delhi take some effective steps and act to alleviate the problem.

To bring about relief, it is imperative to modernize traffic operation for optimizing road capacity and safety by drawing up a Traffic Operations Plan. Delhi can only be made to function efficiently with a decent environment for living by giving a new dynamic role to mass transportation. Mass transport carriers operating in Delhi including Delhi Transport Corporation, Delhi Metro Rail Corporation, and Suburban Commuter Railways. Rapid transit provided by Delhi Metro has enabled Delhites to speedily transact business as well as access their work places and leisure options. However, networks and connectivity are inadequate. To make mass transport easily accessible and available to everyone in Delhi, it is imperative to integrate the three separate modes, DTC Bus, Delhi Metro and Suburban Train operated by three different agencies, and form an integrated intermodal transportation system under a single command.

In Delhi since more than one mode of transport is used, it is clear that some planned coordination between transport systems is necessary. Coordination can

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best be achieved through statutory Master Plan for Delhi. Master Plan for Delhi has to be supplemented by a Transportation Plan. The main movement needs of passengers and goods that are likely to arise in the future have to be assessed, and indicated how these are to be shared by various modes of transport including private car.

People walking, and riding bicycles is so ubiquitous in the vast spread out of Delhi where neither the pedestrian nor the cyclist is free from traffic hazards who has to contend with motor traffic. Thus walking and cycling as a means of travel is integral to urban transport system in Delhi. Therefore, it is imperative to provide pleasant pedestrian walkways, and express bicycle tracks separated from motor traffic.

The psyche and the behavior of the person behind the wheel is one of the crucial factors in Delhi's chaotic traffic. The reckless driving with blatant disregard for traffic laws, angry army of humans and a bewildering variety of vehicular traffic, battle for space and the right of way. Delhi Traffic Police needs further training for discharging their obligatory duties of enforcing traffic laws. When Traffic Police are unable to enforce traffic laws on a sustained basis, disrespect for law and order on the road grows process of law breaks down, and anarchy reigns high. Delhi Traffic Police function with old knowledge of traffic operations and traffic laws. When the traffic problem in Delhi has assumed crisis proportions, Traffic Police are conspicuous by their absence at places, where they are most needed. Traffic education is sine-qua-non for bettering road user behavior, backed by strict enforcement of traffic laws that would change driver attitudes and driving ethics.

Delhi Traffic Police under existing traffic conditions cannot continue to function with archaic approach to traffic control and enforcement of traffic laws. Delhi metropolis needs a more sophisticated traffic policing system designed to deal with the nature of traffic in Delhi. Such a system cannot be part of the Delhi Police, which deals with crime and maintenance of overall law and order. A separate cadre for Traffic Police has to be created, who is well trained for the task they are required to perform. Traffic Police should be under the administrative control of Government of the National Capital Territory of Delhi.

Urban traffic and transportation crisis in Delhi cannot be ameliorated without significant changes in policies, planning, and peoples' travel habits. Delhites, on the other hand will not change their travel pattern and driving habits until they understand and appreciate that the changes could result in a reduction of transportation costs not only for themselves but also for Government of the National Capital Territory of Delhi.

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