Carpooling: A Step To Reduce Congestion

(A Case Study of Delhi)

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***Abstract*— As is the trend worldwide, India is undergoing rapid urbanization. This means not only that more people than ever before will be living and working in cities, but also that more people and more goods will be making more and longer trips in urban areas. The costs of increasing dependence on cars is resulting in expensive road building and maintenance, clogged and congested roads, high levels of energy consumption along with its economic and environmental costs, worsening air and noise pollution, traffic accidents and social inequities that arise when the poor find transportation services increasingly unaffordable.**

The most widely used mode of conveyance of public transport in Delhi is "buses". Thus buses form a backbone of the transportation system in Delhi and serve about half of the travel demand while it constitutes less than 1 % of the total vehicle fleet of Delhi. In spite of this, it does not receive any preferential treatment in terms of traffic management, dedicated lanes, and better upkeep/ maintenance of vehicles resulting in that common man who can afford even slightly is shifting from buses to their own vehicles. It may be two-wheelers or four wheelers or even bicycles because of which the number of vehicles on the roads are increasing which is leading to further lowering of speed, congestion, increase in pollution level etc.

Strategies to combat these problems would include reducing the emissions per vehicle kilometer traveled and the total number of kilometers traveled. Road congestion may be reduced by the use of good public transport management, traffic management and car pools etc. In this paper, we have conducted a survey based on a structured questionnaire for carpooling. *By the analysis of the data collected, we found that if there is no carpooling, the amount required for 968316 Kilolitre petrol for 1289231 cars is Rs. 4213.14crores per annum while by carpooling, this amount reduces to Rs. 4213.14-1310.98 =2902.16 crores. Thus, a revenue of Rs. 1310.98 crores can be saved by saving 301307 Kilolitre petrol by carpooling in Delhi.*

***Index Terms*—Carpooling, Public Transportation System, Congestion, Motor Vehicles.**

I. INTRODUCTION

Delhi, the capital of India is facing an acute transport management problem. This primary problem leads to many more secondary problems such as air pollution, high-energy consumption, congestion, loss of productivity, increase in death accident rates etc. An increase in activity of day-to-day life has deteriorated the quality of life in the city. These activities are directly related to motorization. It is not just the population that has increased but, it is also the number of vehicles and their utilization that has increased at a much more higher rate. Delhi ranks third among other Indian cities in population. The total number of vehicles in Delhi (27.0 lacs) was more than number of vehicles in cities of Mumbai (7.24 lacs), Calcutta (5.61 lacs) and Chennai (8.12 lacs) put together during 1995 (see [8]). It is unfortunate that mobility in Delhi is inevitable. There are various reasons for this, the most important of them being the physical characteristics of the city, inadequate public transportation system and the structure of the city.

In the absence of an efficient public transportation system in urban areas, there has been an increasing trend towards more and more ownership and utilization of personalized motor vehicles to commute which is not only more energy intensive and polluting, but also more expensive to the economy.

While on the other hand, the vehicle mix in urban areas has aggravated the problem of congestion and air pollution. With growing traffic congestion, thousands of disappointed drivers in the urban areas are finding that rush hour traffic is slowing to a crawl which in turn leads to higher oil consumption and emissions that are poisoning the urban areas.

II. TRAFFIC CONGESTION IN DELHI

The greatest transportation difficulties are experienced while commuting between home and work place. The separation of housing from employment centers together with the rapid expansion of the urban area has created a pendulum movement between home and work that accounts for a larger volume of traffic.

Traffic congestion is a major problem for the transportation professionals in India. Most of the cities are suffering from medium to high level of traffic congestion. In some major cities the growth of private vehicle usage has increased at a faster rate. The roads are becoming congested at a fast rate.

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There has been no serious attempt to quantify the growth of congestion in different cities in India. The growing congestion problem has forced the urban development authorities, especially in metropolitan cities, to make serious efforts for finding tools and techniques for mitigation of congestion. Studies carried out by [1], [2], [5], [7] and [8] addressed the several issues of traffic congestion problem and emphasized the need for a thorough understanding of congestion behaviour of Indian roads under mixed traffic conditions. The problem of urban traffic congestion has already come to an acute stage for major cities in India like Delhi, and the problem is further growing at a fast rate. Therefore, there is an urgent need to understand the congestion behaviour and address the policy issues for mitigation of urban roads congestion.

Congestion varies depending on the volume of traffic, number of lanes available for traffic, width of carriageway, type of road (i.e. divided or undivided), pedestrian activities and on-street parking. The level of congestion can be significantly different depending on the combination and level of presence of all these influences. Understanding of these influences can be achieved by applying different Mathematical Models on a large number of operating variables/ conditions.

Table I shows the Distribution of Population and Vehicles in Delhi during 1971-2001. The figures are given in millions. The table shows that the population increased from 3.65 millions in 1971 to 13.78 millions in 2001 (4 times in three decades approximately) while total number of vehicles from 0.2 million to 3.59 millions in the same period (18 times approximately). The number of Cars & Jeeps increased from .06 million to 0.95 million (16 times approximately) and Motor Cycles & Scooters have grown from .09 million to 2.23 millions (25 times approximately) during the same period. The data also shows that the population of 2-wheelers is approximately two third of the total number of vehicles.

Table I

Distribution of Population and Vehicles in Delhi
(Figures in millions)

	1971	*1976*	*1981*	*1986*	*1991*	*1996*	*2001*
Population	3.65	5	5.73	7.73	9.37	11.45	13.78
Total vehicles	0.2	0.35	0.56	1.08	1.92	2.79	3.59
Cars & Jeeps	0.06	0.09	0.12	0.20	0.42	0.63	0.95
Motor Cycles & Scooter	0.09	0.14	0.36	0.74	1.3	1.7	2.23

Source: Delhi Statistical Handbook (2001)& Transport Department, Delhi

The following Table II shows that Delhi had 19.24 lacs motor vehicle in 1991, which increased to 45.44 lacs in 2005, whereas the number of cars increased from 4.24 lacs to 12.89 lacs during the same period. The annual growth rate of total vehicles in Delhi is 5.3 percent and 4.4 percent growth of cars and jeeps.

Table II

Growth of Total Motor Vehicles and Cars in Delhi

Year	*Total Motor Vehicles (lacs)*	*No. of Cars (lacs)*
1991	19.24	4.24
1993	21.99	5.1
1995	25.76	6.18
1997	30.33	7.66
1999	33.23	8.57
2001	35.89	9.56
2003	39.71	10.96
2005	45.44	12.89

Source: Delhi Statistical Handbook (2001) and Transport Department, Delhi.

It was observed that the growth of motor vehicles on the roads in Delhi follows a linear trend. This linear growth was studied for the year 1991 to 2005. Based on the statistics available, a linear growth curve was fitted for this data. If the variable x denotes the years and the variable y denotes the number of motor vehicles on the roads, then the linear curve that can be fitted into this data is given by

$$y = 1.82\ x - 3599.20$$

Based on this linear equation, the projected figures for the years 2007 till 2025 were calculated. These figures are projected in the Table III. It is obvious from these projections that the vehicles are growing at an alarming rate.

Similarly, the number of cars on the roads of Delhi was studied on a similar pattern and a linear growth curve fitted into this data. The linear growth equation in this case is given by

$$y = 0.60\ x - 1190.66$$

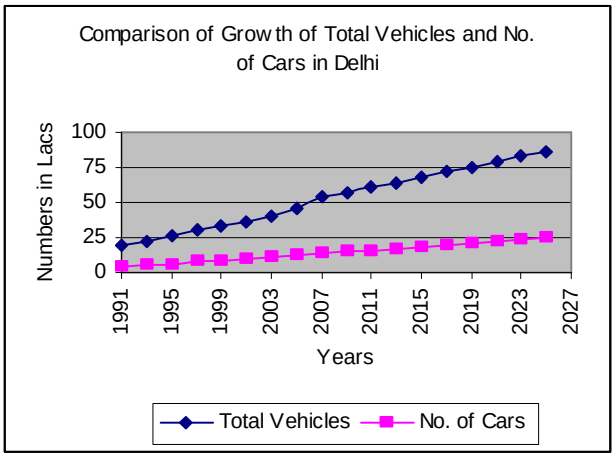
where the variable x represents the years and the variable y represents the number of cars in Delhi. The projected figures for the year 2007 to 2025 are given in the Table III. It can be observed from the above table that the cars will be 24.34 lacs (more than five times) in 2025 as compared to 4.24 lacs in 1991.

The corresponding figures are estimated till the year 2025. It is clear from the Table III that estimated number of total vehicles in Delhi will be 86.3 lacs and number of cars will be 24.34 lacs in 2025.

Table III

Estimated Growth of Total Motor Vehicles and Cars in Delhi

Year	*Total Motor Vehicles (lacs)*	*No. of Cars (lacs)*
2007	53.54	13.54
2009	57.18	14.74
2011	60.82	15.94
2013	64.46	17.14
2015	68.1	18.34
2017	71.74	19.54
2019	75.38	20.74
2021	79.02	21.94
2023	82.66	23.14
2025	86.3	24.34



The above graph of the Tables II and III highlights the fact that the growth of motor vehicles is much more as compared to the growth of cars. This factor on one hand indicates that the problem of transportation and problems due to transportation can be accounted primarily to all motor vehicles other than cars. But, on the other hand, it gives an indication of increasing density of cars. This is the major cause of the increasing traffic congestion, reduction in vehicular speed and car parking problems in the commercial as well as residential colonies in Delhi.

In Delhi, the phenomenal increase in motorization has resulted in deteriorating quality of life in the city. Motorization 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 motorization is not simply a result of population size. Several other factors determine the motorization level in the city. High levels of motorization are manifested in increasing number of vehicles and their utilization.

As environmental awareness grows, people are becoming increasingly concerned about the pollution caused by motor cars. At the same time, congestion is slowly bringing traffic to a halt in the major cities.

The idea behind travel demand reduction is to reduce congestion by decreasing the number of vehicle trips on the existing road network, as opposed to expanding the road network. Travel demand reduction focuses on maximizing the movement of people, not vehicles, within the transportation system. This can be done by increasing the number of persons in a vehicle, or by influencing the time of travel.

The high occupancy vehicle lanes and congestion pricing may be started to reduce congestion and air pollution problems. Among other strategies that can be considered to reduce travel demand to employment centers at peak commute time are carpooling, vanpooling, staggered work hours, compressed work weeks.

III. CARPOOLING

Car-pooling is the sharing of rides in a private vehicle among two or more individuals. It involves the use of one person's private or company vehicle to carry one or more fellow passengers.

Carpooling is the easiest and most common ridesharing arrangement. It usually consists two to four persons commuting in a vehicle. Sometimes carpoolers share driving, and other responsibilities. In other cases, one person does all the driving and is reimbursed for mileage by his or her riders. The carpool driver may pick up passengers from their home or the passenger may find a way to get to the driver's home at a specified time or they may meet at a particular location.

Car-pooling defined as an effort by drivers of motor cars who agree to take turn to share rides from places of residence to places of employment. As the definition implies, car-pooling therefore refers only to the exercises carried out by the owners and drivers of private motor cars. For example, if two persons A and B would like to car pool, they must first be owners and drivers of cars. They will then organize among themselves as to who is to drive on which day or which route to follow, and so forth. Preferably, A and B would alternate driving on a daily or weekly basis, or on any other basis they prefer. There will not be any charges or fees involved.

Excluded from the definition are those who ride share but do not own a motor car; and those who own motor cars ride share regularly but did not share driving. In these two cases, payment of fees are usually involved.

If a car owner drives alone to work every day and spends approx. Rs. 5392 including fuel, maintenance and parking etc. It is assumed that on an average, he travels 40 kilometer per day. If he shares the car with three carpoolers who have their own car and drive to the same workplace. Then each of them can save Rs. 4044 per month of the total spent on commuting to the work place. All the four carpoolers have to bring their own car for a week in a month and drive themselves with other three carpoolers.

IV. CAR-POOLING FOR DELHI

In order to conserve fuel, decrease traffic congestion during rush hours and enhance the use of existing highways and parking facilities in Delhi, carpooling is required. The

Government should encourage the use of car pools in urban areas by means of programmes, which include funding of car pool demonstration projects, and the encouragement of local authorities to establish schemes by various means including distribution of information.

The ridesharing will only increase significantly if there exist clear incentives to the participants. The most important incentives to ride-sharing appears in practice is reserved road space and parking space, and the absence of a convenient alternative mode e.g. where there is no adequate public transport services. The reservation of road space for high occupancy vehicles is therefore essential.

The ridesharing programme will reduce the vehicle miles traveled by single occupancy vehicles. To make car-pooling attractive:

- There must be clear incentives e.g. preferential parking spaces;
- The personal touch is an important element in any car sharing matching service;
- Efforts for ride sharing should be concentrated within recognized groups, rather than spread across the community. New pools can be largely formed with participants have a clear similarity with each other;
- The employer of an organization plays an important role in promoting and making the carpool a success;
- A pool may be formed by one or more than one employer in a particular commercial complex which is equally important as the official matching service;
- If the schemes are to succeed, an efficient and dynamic leadership is necessary;
- To make car pooling an attractive proposition, there must be a substantial increase instead of gradual increase in the price of petrol;

V. Data Analysis

As on December 31, 2005, the total number of vehicles in Delhi are 45,44,223 out of which the Cars are 12,89,231.

A survey based on a structured questionnaire was conducted. Around 500 respondents were interviewed personally and their viewpoints were brought into focus. By the analysis of the data collected through survey from various locations in Delhi, 28.2% people want carpooling with 1 person, 8.2 % people want with 2 person and 15.4% people want carpooling with 3 persons while 48.2 percent people do not want carpooling. The findings and observations of the respondents can be seen from the following Tables IV and Table V:

Table IV

FINDINGS FROM THE DATA SURVEYED FROM THE RESPONDENTS FOR CARPOOLING

S.No.	OBSERVATIONS	FINDINGS
1	Average mileage of vehicle	15.29 Km/Lt.
2	Average distance traveled by a vehicle per day	39.78 Km
3	Average number of working days per month	24.06 days
4	Average monthly expenditure on a vehicle	Rs. 4065
5	Standard Deviation	1861.2

Table V

RECOMMENDATIONS OF THE RESPONDENTS FOR CARPOOLING

S.No.	RECOMMENDATIONS	YES %age	NO %age
1	Percentage of people who say that Delhi should be less polluted and less congested	97.4	2.6
2	Percentage of people who are sharing carpooling	15.2	84.8
	Percentage of people who want to share carpooling with:		
3	One person	28.2 %	
4	Two persons	8.2 %	
5	Three persons	15.4 %	
6	Percentage of people who are not interested in carpooling	48.2 %	
7	Percentage of people who want to cut down hassle of driving using carpooling	97.4	2.6
8	Percentage of people who say that carpooling will help India to grow by saving of fuel.	83.4	16.6
9	Percentage of people who want carpooling with woman or vice-versa	54.4	45.6
10	Percentage of people who are in favour that carpooling will decrease pollution	81	19
11	Percentage of people who say that carpooling will decrease over-crowding buses	43.8	56.2
12	Percentage of people who are in favour that carpooling will save time	65	35
13	Percentage of people who are in favour that vehicles used for carpooling should be given subsidy at parking lots	77.6	22.4

- As is evident from the above analysis, 97.4 percent people are in favour that Delhi should be less polluted.
- 84.8 percent people are not using carpooling while 15.2 percent people are sharing carpooling.
- 28.2% people are in favour of carpooling with 1 person, 8.2 % people with 2 person and 15.4% people want carpooling with 3 persons while 48.2 percent people do not want to share carpooling.
- 97.4 percent people want to cut down hassle of driving using carpooling while 83.4 percent

people say that carpooling will help India to grow by saving of fuel.

- 54.4 percent people want carpooling with woman or vice-versa and 81 percent people are in favour that carpooling will decrease pollution.
- 56.2 percent people say that carpooling will decrease over-crowding of buses and 65 percent people say that carpooling will save time.
- 77.6 % people are in favour that vehicles used for carpooling should be given subsidy at parking lots.

VI. IMPACT ON REVENUE

Average monthly expenditure on a vehicle	= Rs. 4065
Saving if carpooling is done with 1 person	= Rs. 2033
Saving if carpooling is done with 2 persons	= Rs. 2710
Saving if carpooling is done with 3 persons	= Rs. 3049
People who want carpooling with 1 person	= 28.2 %
People who want carpooling with 2 persons	= 8.2 %
People who want carpooling with 3 persons	= 15.4 %
No. of cars reduced on road if carpooling is done with 1 person	= 181781 cars
No. of cars reduced on road if carpooling is done with 2 persons	= 70478 cars
No. of cars reduced on road if carpooling is done with 3 persons	= 148906 cars
Total no. of cars reduced on road by carpooling	= 181781+70478+148906 = 401165 cars
Average distance traveled by a car per day	= 39.78 Km
Average no. of working days in a month	= 24.06 days
Average distance traveled by a car in one month	= 24.06 x 39.78 Km = 957 Km
Average distance traveled by a car in one year	= 957 x 12 = *11484 Km*
Average mileage of the vehicle	=15.29 Km/Lt.
Petrol required for a car per year	= 11484/15.29 = 751.08 Lt.
Petrol required for 401165 cars per year	= 401165x751.08 Lt. = 301307008 Lt. = 301307 Kilolitre
Saving of amount on petrol per year	= Rs. 301307008 x 43.51 = Rs. 13109867918 = Rs. 1310.98crore
Petrol required for all the cars (1289231), if there is no carpooling	= 12892312 x 751.08 Lt = 968315619 Lt = 968316 Kilolitre
Percentage of saving on petrol by carpooling	= (301307/968316)x100 = 31.12%
Revenue required for fuel for all the cars (1289231), if there is no carpooling	= 1289231x751.08x 43.51 = Rs. 42131412603 = Rs. 4213.14crores

Therefore, if there is no carpooling, the amount required for 968316 Kilolitre petrol for 1289231 cars is Rs. 4213.14crores per annum while by carpooling, this amount reduces to Rs. 4213.14-1310.98 =2902.16 crores. Thus, *a revenue of Rs.* 1310.98 *crores can be saved by saving* 301307 *Kilolitre petrol by carpooling in Delhi*.

VII. ADVANTAGES OF CARPOOLING

- *Reduced Parking Demand*: Parking demand will be reduced by car-pooling
- *Reduce Travel Demand*: The idea behind travel demand reduction is to reduce congestion by decreasing the number of vehicle trips on the existing road network, as opposed to expending road network. Travel demand reduction focuses on maximizing the movement of people, not vehicles, within the transportation system. This can be done by increasing the number of persons in a vehicle, or by influencing the time of travel.
- *Reduced Pollution:* Decreasing the volume of vehicle trips is far less costly than providing new transportation facilities and the decrease in the number of trips will reduce vehicle-generated air pollution.
- *Benefits of Car-Pooling For Individuals*
    - Reduced traveling expenses and the need for second car
    - Improved travel time through use of transit lanes
- *Benefit of car-pooling for the community*
    - Reductions in vehicle emissions
    - Reduction in traffic volumes and congestion
    - Provides an alternative, cost effective choice
    - Improving the environment
- *Benefit for companies that arrange car pooling*
    - Maximizing use of employee parking
    - Encouraging sociability between employees
    - Reducing stress on driving to work
    - Providing staff with a further benefit
    - Improving company image
- *Natural resource conservation:* The resource impacts of automobile production will decline. Cars are environmentally expensive to produce even before they are driven one mile. Car-sharing recognizes this fact by making more use out of fewer vehicles.

- *Social justice*: Transportation access for poor people and wealthy people will become more equal. Poor people will be able to make car trips without becoming car owners.

VIII. Recommendations for the Carpooling Policy

A systematic incremental approach should be adopted in implementing car-pooling in Delhi, beginning with promotional and advertising campaign, route feasibility studies, test project, obtaining institutional support, and so forth. It is realized that the success of this programme depends totally on the support of individuals and institutions. The promotional campaigns, advertisement and the re-education of the general public on the advantages and benefits of car-pooling are of paramount importance.

The Delhi Government should make efforts in initiating and promoting car-pooling. The Government should initiate the carpooling with the following objectives:

- To coordinate the implementation of car-pooling in all Government agencies, Ministries, private companies as well as the general public in Delhi.
- To inform and educate the general public about the advantages and benefits that can be derived from car-pooling.
- To provide the match-making service.

To promote the carpooling, the following alternatives should be enforced:

(a) Only those who car pool (a driver plus a minimum of 2 passenger) will be allocated a parking space without any parking charges. For those who currently enjoy a parking space but do not car pool, these privileges will be taken away unless he/she shows that the driver already has passengers in their cars or is a member like a Chairman, a Director or a Chief General Manager of a company.

(b) All employees allocated with parking spaces will be charged a parking fee except those who car pool. Parking charges will be organized in the following manner:

- Full charges for those who do not car pool.
- Reduced charges for those who drive with other employees.
- No charges for those who car pool.

(c) The staff can be allocated with parking spaces free of charge on certain days. The schedule is as follows:

- Monday, Wednesday and Friday: Cars with the last figure in the number plate showing odd number.
- Tuesday, Thursday and Saturday: Cars with the last figure in the number plate showing even number.

This control measure ensures that each employee gets to use the parking space 3 times a week. Alternative arrangement will have to be made for the other 3 days. Car-pooling is hopefully, an alternative choice. Operationally, this measure will reduce the number of cars driven by half. Hence, the parking demand will be reduced to half.

In addition to that, the following incentives may be given:

1. Strategic location of parking spaces for carpoolers e.g. close to entry/exit points, basement parking, etc.
2. Incentive to Ride Home: This incentive ensures that an employee who car pools will be reimbursed for his/her taxi fare in case of an emergency requiring him/her to rush home or when required to work after normal office hours. To prevent abuse, some control on the number of claims submitted by a pooler is necessary e.g. a maximum of two claim per month, etc. The head of department must certify these claims.
3. Insurance Coverage: Carpoolers are allowed to claim for expenses paid in respect of the personal accident.
4. Premium to the insurance company for the car-poolers should be paid by the employer.
5. In addition to above, carpoolers may be subsidized for their initial car insurance policy.

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