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DEVELOPING MASS TRANSIT SYSTEM FOR AN ENVIRONMENT FRIENDLY COMMUTING SYSTEM - GO PUBLIC GO GREEN

G. Balamurugan[1], J. Praveen Paul[2] and S. Gopi[3]
Department of Management Studies, Mepco Schlenk Engineering College, India
E-mail: [1]sgbalan@yahoo.com, [2]jpraveenpaul@yahoo.com, [3]gopeee.s@gmail.com

Abstract

Personal transport currently accounts for 25–30% of global CO_2 emissions, increase in the pollution level, enormous demand for fuel and in turn a drastic increase in the external balances of the country. It also adds to the domestic inflationary pressures. The main objective of this study is to reduce the carbon emission in Tamil Nadu by increasing the utilization of the mass transit vehicles and by reducing the usage of personal vehicles. The numbers of mass transit vehicles, personal vehicles, per kilometer vehicle density, total length of the road were considered as the major factors for the study. A simulation was conducted to estimate the level of carbon emission and fuel consumption of both the personal as well as mass transit vehicles for a per kilometer usage in a district of Tamil Nadu in India. In the simulation process, different scenarios were assessed to determine the efficient and less carbon emitting commuting system and the results show that a meager 10% shift of commuters from personal vehicles to mass transit vehicles can result in huge carbon reduction. These simulations provide a supporting guideline to both the transport corporation and the pollution control board for creating a better commuting system and cleaner environment in Tamil Nadu.

Keywords:

Mass Transit System, Personal Vehicles, Carbon Emission, Fuel Consumption, Eco Friendly, National Savings

1. INTRODUCTION

India, being thickly populated country with a population density of 1.27 Billion in 2014, faces a lot of challenges in satisfying the needs of transport requirements of its people [1]. The post liberalized period of the past two decades has witnessed a multifold growth in the personal vehicle sales in India [2] which might have had its own advantages on one side of its economic perspective. At the same time, the rapid growth in personal vehicle density in Indian cities has brought in its wake, a range of serious socioeconomic impacts [3]. This has left the people with more congestion on roads, increase in the pollution level, enormous demand for fuel and in turn reflected on the external balances of the country and also on the domestic inflationary pressures. This can be addressed only by suitable transport policy changes by any country facing similar environmental and economic problems [4], [5], [6].

On contrary to the growth of personal vehicles or Personal Transport System (PeTS), the Public Vehicles/Mass Road Transit System (MTS) has not grown to the extent what it is required to be [7]. This study attempts to support the growth of MTS in India for a better environment in addition to the greater benefits on personal savings, and of course gross national savings.

The MTS in the Tamil Nadu takes two forms such as sixty seater capacity buses (MTSb) and twenty five seater mini buses (MTSm). Usually PeTS is for a single commuter.

Interventions to reduce the use of personal vehicles and increasing the use of public transport can better the health prospects of the people [8] [9] and the basic principle of this study is "Go Public Go Green". Other studies have also emphasized the same in different perspectives [4], [10]. For explaining this concept, a sample district, namely, Virudhunagar in Tamil Nadu State of India was taken and analyzed. Tamil Nadu is considered to be the Detroit (Chennai) of India, where almost all leading multinational automobile companies have their production centers.

Transport using personal vehicles currently accounts for around 25–30% of global CO_2 emissions [11] and for creating a better solution for this environmental problem, an attempt has been made to find out the effect of the tradeoff between the MTS and the PeTS on the carbon emission level in specific and other resulting economic advantages in general [12]. The data on the growth of MTS in terms of number of vehicles (buses operated by the Government and Private) for the period of 15years (2000-2014) in Tamil Nadu, reveal that it has an average growth of 1.6% per year. Contrary to this, the growth of personal vehicles (motor bikes, scooters and mopeds) was at an average of 11% annually. As on March 2014, the number of vehicles under MTS stood at 28,196 whereas the personal vehicles stood at 15,14,635 [7]. The MTS vehicles recorded a negative growth for about five years among the ten year period. The personal vehicles have touched a maximum growth of even 13% at times. This imbalanced growth between MTS and PeTS needs to be studied in the context of carbon emission, as all these vehicles have a direct impact on the environment as well as the health of the people.

Virudhunagar district is one of the most populated districts in Tamil Nadu with eight talukas and a population density of 413/km^2 [13]. Transportation plays a vital role in the economic growth of the people in this district since most of them work for daily wages [13]. 17,51,548 is the total population of the Virudhunagar district of which 42% of them are using personal vehicles for their daily commute [13]. Based on the above mentioned factors Virudhunagar district is considered to be suitable for the study.

2. METHODOLOGY OF THE STUDY

It has been presumed that more of public services rather than private services in priority areas would definitely contribute to the well-being of an economy. It is predicted that in sub urban areas, the introduction of additional MTS vehicles than the PeTS vehicles would reduce the carbon emission to an appreciable level. It is also assumed that, considering the requirement and convenience of the people, if more number of mass transport vehicles is introduced by the transport corporations, commuters

using personal vehicles would switch over to the MTS vehicles. The Propositions thus formulated are,

1. The carbon emission from the PeTS Vehicles can be reduced by increasing both MTSb and MTSm by 10% and thereby reducing the use of PeTS proportionally
2. The carbon emission from the PeTS Vehicles can be reduced by increasing only the MTSb by 10% and keeping the number of MTSm vehicle as constant and thereby reducing the use of PeTS proportionally
3. The carbon emission from the PeTS Vehicles can be reduced by increasing only the MTSm by 10% and keeping the number MTSb vehicle as constant thereby reducing the use of PeTS proportionally

To test the above propositions, a mathematical model has been formulated to simulate the Level of Carbon Emission (LoCE), in corporating the conditions mentioned in the aforesaid propositions and the simulation model is presented as Eq.(1). The density of personal vehicles and the public transit vehicles in Virudhunagar district, and the fuel consumption of these vehicles for a kilometer were considered from the present vehicular numbers and emission standards [14]. The coefficient of carbon emission addition by various types of MTS and PeTS are given in Eq.(2), Eq.(3) and Eq.(4).

$$L0CE = \left(CoE_B \times N_{MTSb}\right) + \left(CoE_M \times N_{MTSm}\right) + \left(CoE_p \times N_{peTS}\right) \quad (1)$$

$$CoE_B = \frac{CO_{Bav}}{n_{PB}} \quad (2)$$

$$CoE_M = \frac{CO_{Mav}}{n_{PM}} \quad (3)$$

$$CoE_P = \frac{CO_{Pav}}{n_{PP}} \quad (4)$$

where,

$LoCE$ = Level of carbon emission added to the environment on road for a kilometer operation of vehicle in terms of grams per passenger served

CoE_B = Coefficient of carbon emission addition by MTS vehicles (Buses) per passenger served for a kilometer travel

CoE_M = Coefficient of carbon emission addition by MTS vehicles (Mini Buses) per passenger served for a kilometer travel

CoE_P = Coefficient of carbon emission addition by PeTS vehicles (Motor bikes, Scooters and Mopeds) per passenger served for a kilometer travel

N_{MTSb} = Number of Buses in Operation

N_{MTSm} = Number of Mini Buses in Operation

N_{PeTS} = Number of Motor bikes, Scooters and Mopeds in Operation

CO_{Bav} = Average CO emission from MTS vehicle (Buses)/kilometer operation

CO_{Mav} = Average CO emission from MTS vehicle (Mini Buses)/kilometer operation

CO_{Pav} = Average CO emission from PeTS vehicle (Motor bikes, Scooters and Mopeds)/Kilometer

n_{PB} = Number of passengers accommodated/served under full capacity operation of MTS vehicle (Buses)

n_{PM} = Number of passengers accommodated/served under full capacity operation of MTS vehicle(Minibuses)

n_{PP} = Number of passenger accommodated/served through PeTS vehicles (Motor bikes, Scooters and Mopeds)

The base line data used for the simulation are summarized in Table.1 and these data were the major inputs for above mentioned mathematical model which was used to estimate the carbon emission from the PeTS and the MTS (MTSb and MTSm) in Virudhunagar district of Tamil Nadu. The number of personal vehicles like Motor bikes, Scooters and Mopeds in the Virudhunagar district were obtained from the Tamil Nadu state transport authority. The data about the mass transit vehicles like buses and mini buses were obtained from the Tamil state transport corporation. Based on all these data, the average density of vehicles in the Virudhunagar district was estimated. The carbon emission standards were obtained from Central pollution control board of India.

Table.1. Baseline Data of sample district

Total population = 1,942,288[a]	
Number of Personal Vehicles[b]	
Motor Bikes	4,38,956
Scooter	71,739
Mopeds	2,29,735
Total	7,40,430
Number of Public Transit Vehicles[b]	
Buses	1,505
Mini Buses	250
Total	1,755
Average Vehicle Density	
Total Length of Road[b]	4,841km
Average Personal vehicle Density/km	153
Carbon Emission Standard[c]	
Public transit	2.1gm/km
Personal Vehicle	1gm/km

[a][14] [b][15] [c][16]

3. RESULTS AND DISCUSSION

The simulations for the propositions were conducted and the results on the carbon emission and the fuel consumption in Virudhunagar district are presented in Table.2. The assumption of the simulation is that when one MTSb vehicle is increased, sixty PeTS users switch over to that MTSb and when one MTSm vehicle is increased, twenty five PeTS users switch over to that MTSm.

The outcome of the Simulation 1 shows that 9677.615gm/km of Carbon emission can be reduced and 261litre/km petroleum products can be conserved by increasing the MTSb and MTSm by 10%. In the Simulation 2, 9024.7325gm/km of Carbon emission can be reduced and 244litre/km of petroleum products can be conserved. In Simulation 3, by increasing MTSm only, carbon emission can be reduced by 572gm/km and 17litre/km of fuel can be saved.

Table.2. Simulation and results of replacing personal vehicle by Public mass transit

Simulations	Carbon Reduction/ Person/km(gm)	Total Fuel Savings/km(litre)	Total Carbon reduction for serving the same number of passengers/km(gm)	Travel Cost Reduction/km(Rs)
Simulation 1[a]	0.011	261	9677.615	19,873
Simulation 2[b]	0.010	244	9024.7325	18,529
Simulation 3[c]	0.0007	17	622.9	1,282

[a] Propositions 1:increasing both MTSb and MTSm by 10% and reducing PeTS proportionally
[b] Propositions 2:increasingonly the MTSb 10% and reducing PeTS proportionally
[c] Propositions 3:increasingonly the MTSm 10%and reducing PeTS proportionally

From the above results it can be seen that when both MTSb and MTSm are increased, the results are better. The set propositions have confirmed empirically and the results are found to be environmentally and economically encouraging. The inferences are just for a kilometer operation of these vehicles in a small district of a state. If the same is extrapolated for the situations in the whole state of Tamil Nadu and for entire India, definitely the results will be much more encouraging. But, for this to happen, there is a need for suitable policy measures on the related issues by the Government and a little awareness on the part of the commuters too. Thus there is a wide scope for the further research on this study of "Go Public Go Green". The other benefits of personal savings, fuel consumption and health issues can also be explored further.

4. CONCLUSION

Based on the model postulated in the study, it is evident that enhancing the Public transport system is the answer to the environmental problems created by the proliferation of personal vehicles. This could also be a solution to the ever increasing demand for energy source, health issues of the people, and an opportunity for personal savings and national savings. There is a clear indication of unlimited benefits of "Go Public" as the passenger transport policy for any country which adopts the related propositions in the study.

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