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ENVIRONMENTAL IMPACT ON TRANSPORTATION PLANS IN DEVELOPING COUNTRIES (INDIA).

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ABSTRACT

Due to liberalization of the economy and rapid urbanization, the vehicle population in Indian cities is growing rapidly. In India, over the past 50 years, approximately 37.2 million vehicles have been registered and this number may sharply increase further in the future. The growth of vehicles results in an increase in the demand for the energy. The transport sector in India is a major energy-consuming sector. The demand for fuel is likely to increase exponentially over the next few years. The key challenge facing India today , is bottlenecks in energy supply which may prove a constraint for economic growth. Ensuring an adequate supply of fuel to the transport sector should be an immediate concern considering that the transport sector has direct implications for the economy.

Another related problem facing the society today is environmental pollution. An increase in number of vehicles would definitely worsen the air quality in the future. This would result in health problems as well as decrease in visibility during peak hours in Indian cities giving rise to road safety concerns. It makes sense to find environmentally friendly forms of energy to improve the quality of urban life. To preserve the health of the society at large, some major policy decisions need to be implemented in order to control the environmental pollution.

This report attempts to analyze, through a simulation model, the time series data of various modes of transport, their growth, emission levels and fuel consumption per kilometer for three Indian metropolitan cities: Pune, Bangalore and Hyderabad. This would be useful for the policy makers to formulate a socially optimal transport and environmental policy.

INTRODUCTION

Transport is a critical infrastructure for economic and social development. It provides access to markets and materials, influences population distribution and shapes the pace and quality of human life. It involves massive investments, consumes scarce natural resources and has significant environmental implications. The transport demand has been growing over years as well as per capita transport intensity, though it is still well behind the developed countries. The total number of registered motor vehicles in the country shows a steep rise, especially during the last decade. The number has risen from 21.3.74 million in 1991-92 to 37.231 million in 1996-97, recording a huge growth of 74.19. As per estimates of Rail India Technical and Economic Services (RITES), the likely number of vehicles by the year 2010 could reach 147.501 million. It is very interesting to note that much of the growth will be in the personalized modes like two-wheelers, cars and jeeps. The rapid growth in road transport vehicles has lead to an increase in demand for energy.

In addition, pollution levels have risen drastically, resulting in high social costs in the form of health disorders or reduced quality of life. This unbridled demand for energy if unchecked would exhaust all the energy resources leading to utter chaos. In order to bring out the gravity of the situation, it is necessary to quantify not only the demand for energy but also the cost of pollution.

This paper attempts to forecast the vehicular growth based on the time series data and estimate the demand for energy and the ensuing pollution levels for the three cities, Pune, Bangalore and Hyderabad. The Vehicle Air Pollution Information System (VAPIS) model originally developed by the World Bank and redesigned by Harvard University has been used to analyze vehicular emissions and fuel demand for the cities under consideration. Finally, the policy recommendations to reduce the energy demand and air pollution are explained in the last section.

ENERGY DEMAND IN INDIA

The transport sector consumes 23% of commercial energy in the country. The consumption in 94-95 was 65.49 million tones (mt) and the demand is expected to go up to 113 million tones by 2001-02 and 120 million tones by 2005. While indigenous crude production had reached an all-time high of 34.09 million tones in 1989-90, it declined to 32.24 million tones in 1994-95. Domestic production would meet 44% of the demand at the end of the 9^{th} plan, 33% at the end of the 10^{th} plan and only 27% by the year 2010-11.

The transport sector accounts for about 75% of the diesel fuel consumed in India. Imports of crude have risen from 14.6 mt in 1985 to 27 mt in 1994-95 (30.8 mt in 1993-94) and imports of petroleum product have gone from 1.9 mt to 14 mt in the same period .

In India, the petroleum consumption is increasing at a very steep rate from 3.5 Million Metric Tons (MMT) in 1950-51 to 74.7 MMT in 1995-96. The situation is bleak, and the present known stocks may not even last for 10 years at the current rate of consumption. In India, the indigenous production is only 36.31 MMT and is less than 50 per cent of the annual requirement.

India's demand for petroleum products has been rising at a rapid rate. A study shows that the dependability on coal which was about 47 per cent in the year 1960-61 has been reduced to 0.3 per cent in the year 1994-95. The dependability on oil as a fuel increased from 51 per cent in 1960-61 to 97.3 per cent in 1994-95. This increase is due to the growth in large

vehicular population during the above period. The demand on petroleum products increased by two and half times from 30 million tones in 1980-81 to almost 75 million tones in 1995-96. In India, the average per capita consumption of petroleum products is only 90 kg, which is 10 times less than the world average. Current estimates indicate that consumption in India would reach a level of around 155 MMT by 2006-07 A.D.

Energy Demand in Urban Transport

The urban transport (UT) sector is a major consumer of energy accounting for about 20% of the total energy consumed in the transport sector . The energy consumption in the UT sector depends to a large extent on the modal split as well as traffic characteristics viz., mixing of slow and fast traffic, congestion levels, average cruising speeds, frequencies of stopping and starting of vehicles, road surface and profile, driving habits etc.

AUTOMOBILE POLLUTION IN INDIA

Air pollution generally means unacceptable levels of pollutants emitted from vehicles such as Carbon Monoxide (CO), Hydro Carbons (HC), Nitrogen oxides (NOx), Suplur Dioxide (SO2) and particulates present in the air.
Pollution in Indian cities is getting deadlier. Nearly 51,800 people were estimated to have died in 1995 because of lung and cardiovascular diseases linked to pollution in 36 Indian cities. (Study conducted by the Center for Science and Environment, New Delhi). This phenomenal increase in actual and projected traffic and the concomitant growth in the number of vehicles have not only led to congested roads and higher accidents in urban areas but also exposed the environment and the society to the baneful effects of vehicular pollution. Two-wheelers and cars are said to be the principal contributors to vehicular pollution, accounting for nearly 90% of total emission loads
At present, pollution caused by vehicle emissions account for a plethora of diseases in human beings and is now considered as one of the most potent threats to human health. Air quality in urban areas in particular has reached a new low due to proliferation of all types of vehicles in towns and cities. In urban areas, the effect of automotive pollutants on ambient air quality tends to be more pronounced than their emission shares on a regional or global basis. As motor vehicles emit contaminants in close proximity to the breathing zone of people, they not only pose a greater health risk but are frequently a source of public annoyance.
Environmentalists commonly agree that in spite of so many rules framed by the Central Government of India as well as the State Governments to control emissions, the current level of automobile pollution in the mega cities of India is much beyond tolerable limits.
Hence there is a need to estimate and forecast the energy demand and emission levels based on the past data available. It is in this context that an attempt has been made to study the vehicular growth, the energy demand and emission levels of three Indian cities ie., Pune, Bangalore and Hyderabad.

Vehicular Growth

A time series analysis of two-wheelers shows a significant growth rate of more than 20% in 1985 and 1986 which was reduced to 16% in 1990. During the period 1991 to 1995, the average growth rate was around 6% and significantly shot up to 16.5% in 1996. This high increase in the growth of two-wheelers indicates the lack or inefficiency of the public transport system. The analysis of auto rickshaws shows that initially there was a growth rate of 11% up to the 1980s, which then stabilized around 9% between 1980 and 1987. From 1991 onwards the increase in growth rate was significant at 15%. The taxi has played a less important role in the transport system of Pune city. The public transport in Pune experienced a growth of 4.3% in 1972 and from then onwards, there was a small and unsteady growth. This growth varied between 1.3% and 18.7% from 1972 to 1996. The goods vehicles have shown a steady growth of around 5% from 1985 onwards.

Estimated Energy Demand

At present, auto rickshaws are the top consumers of fuel amounting to 63.2 million litres/year followed by two- wheelers with 58.8 million litres/year.
The petrol consumption will increase 2.9 times by the year 2010, whereas the diesel requirement will increase by 1.8 times. If the same trend continues, the petrol consumption will be 9.3 times the present level by 2020. This increase in demand of petrol can be attributed to the high rate of growth of petrol driven personalized modes.

Estimated Vehicular Emissions

Projected emission levels in Pune for the years 2001, 2010, 2020 and 2025 have been calculated. The highest CO emissions came from two-wheelers, amounting to 36.1 tones/day, followed by auto rickshaws and cars. NOx emission analysis shows that the buses are more dominant with 9.72 tonnes/day than trucks with 9.5 tones/day. Emissions of hydrocarbons by two-wheelers and auto rickshaws are higher. The current levels (2001) are 19.2 and 18.4 tonnes/day respectively.

DATA ANALYSIS: BANGALORE

In 1991 the population of Bangalore city was 4.09 million and during 1981-91, the decadal growth in population was 40%. At present the city has an unofficial population of 6.0 million with a decadal growth rate of 46%. The modal split analysis of Bangalore city in the year 2001 clearly indicates the dominance of two-wheelers followed by cars and auto rickshaws.

Vehicular Growth

The time series analysis of Bangalore data shows that there was a high rate of growth of vehicles in the 1970s and medium growth in the 1980s, which stabilised at 10% in the 1990s. This high rate of growth in two-wheelers indicates the lack or inefficiency of the public transport system. Although there was a high rate of growth of auto rickshaws during the 1970s,this growth rate decreased in 1980s. An increase in growth for auto rickshaws can be observed from 1988. Taxis have played an insignificant role in the Bangalore city transport. The buses in Bangalore city show the lowest growth rate of 1.3% in 1983. Until 1994, there was hardly any growth in this category. A significant growth rate of around 9% can be seen from 1995 onwards. There is an unsteady growth in goods vehicles varying from 0 to 17%.

Energy Demand

At present, cars in Bangalore are the top consumers of fuel amounting to 133.3 million litres/year followed by auto rickshaws with 116.7 million-liters/ year.
The petrol consumption will increase 2.4 times by the year 2010, whereas the diesel requirement will increase by 1.4 times. If the same trend continues, the petrol consumption will be 10.9 times the present level by 2020. This increase in demand of petrol is because of the high rate of growth of cars and auto rickshaws projected in the future.

Vehicular Emissions

In 2001, the highest CO emissions came from cars, amounting to 68 tonnes/day. According to projections, two-wheelers will have the highest emission levels at 107.03 tonnes/day by 2010 and this domination will continue even in 2020 and 2025 with 187.25 and 254.139 tonnes/day respectively. By 2020, auto rickshaws are also likely to be in second place ahead of cars in this respect. The emission level from auto rickshaws is going to be 243.75 tonnes/day by 2025. The NOx emission analysis shows that trucks are dominant with 21.84 tonnes/day in 2001. The SO2 analysis shows that trucks will emit 1.64 tonnes/day in 2001 and 0.7, 0.4 and 0.29 tonnes/day by 2010, 2020 and 2025 respectively (assuming that emission standards become more stringent in the future). The dominance of trucks can be observed with respect to SO2 emissions. Emissions of hydrocarbons are higher in two-wheelers and auto rickshaws. The current levels (2001) are 37.46 and 32.17 tonnes/day respectively. By the year 2025, these levels are expected to grow up to 66.97 and 80.94 tonnes/day respectively. The total CO emissions by all modes are 208.21 tonnes/day in 2001 and are likely to increase 667.43 tonnes/day by the year 2025.

HYDERABAD DATA ANALYSIS

As per the 1991 census, Hyderabad city had a population of 4.28 million with a decadal growth rate of 67.8%. Currently, Hyderabad has an unofficial population of 5.8 million with a decadal growth rate of 35.5 %. The population growth rate has declined sharply between1991 and 2001The modal split analysis of Hyderabad city clearly indicates the dominance of two-wheelers followed by cars and auto rickshaws.

Vehicular Growth

A time series analysis of two-wheelers shows the highest growth rate of more than 45% in 1986. There was a significant growth rate (22.5%) of two-wheelers from 1972 to 1987, but this was subsequently reduced to 12% in 1990. Between 1990 and 1995 the growth rate was around 8%. Although there is an increase in total registered two-wheelers, there is a steady decline in their growth rate which is a positive sign for the city environment. A similar trend has been seen in cars, auto rickshaws and taxis as well. In the case of buses, although the average growth up to 1985 was around 3%, there was a significant increase after 1985. Since 1995 the average growth rate has been 8%. Contrary to the trend observed in Pune and Bangalore, this city has witnessed a decrease in the growth rate of personalized modes which augurs well for the environment in the future. Presently, two-wheelers in Hyderabad top the petrol consumption with 65.5 million litres/year, while for diesel consumption trucks are the largest users with 97 million litres/ year.

Vehicular Emissions

In 2001 the highest CO emissions came from two-wheelers, amounting to 48.25 tones/day.These are projected to increase up to 55.59, 79.14, and 94.94 tones/day respectively by 2010, 2020, and 2025. The NOx emission analysis shows that trucks are dominant with 12.34 tones/day. The SO2 analysis reveals that trucks are going to emit 0.97 tonnes/day. Emissions of hydrocarbons are mainly contributed by two-wheelers and auto rickshaws. The current levels (2001) are 28.10 and 12.26 tones/day respectively. The total CO emissions by all modes, which are 123.99 tones/day in 2001 would increase to 179.11 tones/day by the year 2025.
Study indicate that cars, which have a share of 12% in passenger kms emit 38.6% of total emissions, whereas buses, which have a 50.7% share in passenger kms are emitting 2.3% of the total emissions. Hence there is a need to promote the Public Transport System.

Comparative Analysis of Three Cities

Analysis of the three cities brings out the following observations:
1. Urban areas (comprising 26% of the total population) contribute nearly 55% of GDP in India. This share is likely to go up in the forthcoming years. More importantly, the unprecedented growth in personalized vehicles in most Indian cities could be attributed to the growth of disposable incomes of the middle and upper middle class coupled with the affordable hire purchase schemes made available by the vehicle manufacturers and finance companies.

2. Hyderabad had a controlled growth rate of vehicles compared to the other two cities. The reason for this may be due to a reduction in growth rate of the population n and the market segmentation policies adopted by the State Road Transport Corporation. An analysis of buses, which are being run by the State Road Transport Corporation reveals that Hyderabad has 4.1 buses per million population while it is 2.6 and 3.6 buses per million of population in Pune and Bangalore respectively.
3. Though the population levels in Hyderabad and Bangalore are higher, the decadal growth rate of Pune was the highest with 50.6%. Though the number of vehicles in Bangalore is more in 2001, Pune reaches the top position in 2025. This is mainly because of the high growth rate of personalized modes of transport.
4. The public transport has lower level of emissions per passenger kms in spite of a higher share of passenger kms in all the cities. Therefore it is necessary to promote the public transport system. The analysis of above cities clearly brings out the necessity to control the growth and usage of personalized modes of transport. These control measures may be made in terms of transport and land use planning, technological improvement and effective enforcement in order to provide a safer environment.

TRANSPORTATION MEASURES TO PROVIDE A SAFER ENVIRONMENT

A seemless flow of vehicle movement reduces traffic congestion and consumption of fuel. At the traffic signal points all kinds of vehicles get choked to go first and fast. This keeps vehicles in idling, emitting more pollutants by consuming more fuel. The smoothing of the traffic flow needs proper forecasting. Educational and work trip constitute around 70% of the total trips. By providing proper and punctual public transport, traffic congestion can be reduced. Further this will reduce the use of personalized vehicles. The following steps would help to achieve a sustainable transport system

- Separate lanes for different kinds of vehicles.
- Segregation of slow and fast moving vehicles.
- Diversion of heavy goods vehicles through city bypass roads as these vehicles mostly operate on National and State highways
- Optimization of traffic flows and improvement in traffic management by having area traffic control systems and no-traffic zones
- Removal of road encroachment and regulation of construction activities to ensure a smoother flow of traffic
- Restricted areas for the operation of Intermediate Public Transport modes – Three-wheelers must be operated only as a supplementary or feeder system to the public transport system
- Staggering of industry shift timings as this will reduce traffic congestion (industries and other institutions must be convinced to do this).
- Duration of signaling time should be different at different times of day. Otherwise this would result in unnecessary stoppage of vehicles at signal points.
- Proper city planning is a must to provide a smooth flow of traffic. Urban development authorities must play a key role in this regard.

The above points certainly help not only in reducing the quantity of pollutants, but also fuel consumption.

SUGGESTIONS TO REDUCE VEHICULAR EMISSIONS

Stringent emission regulations and their effective implementation have produced good results in the U.S.A. and Europe. According to the 1992 World Development and Environment Report of the World Bank, emission standards in developing countries are either non-existent or much less stringent than in the European countries. An expert committee was set up by the Government of India, Ministry of Environment and Forests on 16 th May 1991 to propose vehicle emission standards for the years 1992, 1996 and 2000. After detailed discussion on the expert committee report with the concerned agencies, emission standards for 1992, 1996 and 2000 were finalised. However the Indian emission standards are very lax compared to current Euro standards. Hence, there is a need to review the 2000 emission standards of India and make them
more stringent.
In India, the Motor Vehicles Act of 1988 and the Central Motor Vehicle Rules of 1989 have several provisions dealing with pollution from vehicular traffic
Rule 115 (2) of the CMVR 1989 states that every motor vehicle must comply with the following standard:
- Idling CO emission limit for all petrol-fueled four-wheelers shall not exceed 3% by volume
- Idling CO emission limit for all petrol driven two- and three-wheelers shall not exceed 4.5% by volume. Sub rule 3, 4 and 5 of Rule 115 lay down detailed emission standards for diesel driven and petrol driven vehicles. To bring down emissions to an acceptable level there is a need to review the above emission limits which were prescribed ten years ago.

Summary and Conclusions

The estimated growth in vehicles and consequent fossil fuel consumption clearly indicates that air pollution in major cities in India will assume gigantic proportions. For the sustainable growth of these cities in the future, the problem will have to be addressed objectively. Passenger transport needs in Indian cities are satisfied by private modes like two-wheelers and cars because of their flexibility in operation. The approach adopted to forecast vehicular growth, energy demand and pollution levels has highlighted the need to priorities public transport. Since transport is a State subject in India, the respective state Governments will have to develop implementable strategies to promote an acceptable level of public transport and reduce the usage of personalized modes of transport. The comparative analysis of three cities under review proves that Hyderabad, which has a relatively higher level of public transport, has shown the least growth in personalized modes compared to the cities of Pune and Bangalore. Apart from addressing the problem of excessive fuel consumption, it will also lead to a reduction of congestion levels on the limited road system, less vehicular emissions, something essential for the health of Indian society in the long run.

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