Efficient Transportation Planning and System Integration for Healthy Environment of Large Cities

Raman Parti and Surjit S Katoch

***Abstract*—**Our increasingly urbanized civilization must pay attention to its cities, which are growing in size and complexity. One of the major challenges of our time is how to ensure that cities have operationally and economically efficient services, which enhance their environment, their social and cultural values. Cities have always been centers of human activities. The founding, shaping, and growth of human agglomerations throughout history have been products of complex interactions of many forces. One major force has always been transportation. Tremendous progress in transportation technology has been achieved during the last century. The great impact that the transportation developments have had on modern civilization is also evident: the intensive urbanization that has taken place in all countries would not have been possible without modern transportation systems. In light of this abundance of technologies, it appears paradoxical that today many cities suffer from serious transportation and environmental problems. The problems include poor quality of service (low speed, reliability, comfort, safety, etc.), lack of adequate transportation for some population groups, financial problems, and, often the most serious one, strong negative impacts of urban transportation systems on cities and their environments. This paper deals with a holistic approach for efficient Transportation planning and system integration for better and healthy environment of large cities.

***Keywords*—**Transportation Planning, System Integration, Environment, Energy efficient cities.

I. Introduction

THE founding, shaping, and growth of human agglomerations throughout history have been products of complex interactions of many forces. One major force has always been transportation. A review of historic developments will show how long-distance transportation had a major role in determining the locations of cities; how their size has been influenced by both long-distance as well as local, intra-urban transportation; and how the latter has affected the urban form (shape of urban area and its basic transportation network) and urban structure (distribution of land uses and population densities).

Tremendous progress in transportation technology has been achieved during the last century. The great impact that the transportation developments have had on modern civilization is also evident: the intensive urbanization that has taken place in all countries would not have been possible without modern transportation systems. In light of this abundance of technologies, it appears paradoxical that today many cities suffer from serious transportation problems. The problems include poor quality of service (low speed, reliability, comfort, safety, etc.), lack of adequate transportation for some population groups, financial problems, and, often the most serious one, strong negative impacts of urban transportation systems on cities and their environments.

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These problems are mostly consequences of various deficiencies in planning, financing, and organization of urban transportation, rather than technological failures. Although the historical developments clearly show that there is a strong interdependence between quality and type of transportation service on one side, and urban form, size, and character on the other, city governments have often failed to understand the role of transportation. A particular important problem has been to allocate proper roles to different transport modes. Because of this inadequate understanding, often weak public leadership, and low ability to implement plans, public transportation in many cities has been seriously neglected, regulation of auto travel has been so inadequate that the great potential mobility of this mode is often defeated by congestion, while pedestrians have little pleasure, or even safety, while walking in many urban areas.

Urban transport is an important component of the urban infrastructure system. A good urban transport system will increase productivity, enhance efficiency, ensure competition, and promote urban economy. It will also facilitate social interactions, provide people with accessibility to opportunities, safeguard environment, set directions and pattern of land use development, and ensure quality of life. The impacts of a poor urban transport are manifested in terms of congestion, delays, pollution, accidents, high-energy consumption, low productivity of resources, community severance, and inadequate access to services.

II. Urban Transport And Land Use Pattern

Most metropolitan cities in India prepared Master Plans in the 1960s. These were patterned along the following themes:

1. Demographic projections and decisions on the level at which the population shall be contained.
2. Allocation of population to various zones depending on existing density level, infrastructure capacity and future density levels.
3. Land-use zoning to achieve the desired allocation of population and activities in various zones as projected.
4. Large scale acquisition of land with a view to ensuring planned development.

The planning framework as adopted in the preparation of Master Plans has not been found to be commensurate with ground realities. The net effect of the inadequacies of the planning process has been that majority of urban growth has long taken place outside the formal planning process. Informal

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TABLE I
VEHICLE COUNT IN MAJOR INDIAN CITIES –PRIVATE AND PUBLIC

City	Year	Two and Three Wheelers (1)	Cars (2)	All private Transport (1+2)	Public Transport (Buses)	Ratio of Private and Public
Bangalore	1985	207,585	58,971	2,66,556	3,812	69.93
	2002	12,48,272	2,59,001	15,07,273	10,077	149.58
Chennai	1985	1,28,238	55,529	1,83,767	2,945	62.40
	2002	10,33,401	2,50,080	12,83,481	4,541	282.64
Mumbai	1985	1,99,689	2,36,189	7,75,844	13,522	57.34
	2002	10,00,389	5,47,224	32,55,477	47,578	68.42
Delhi	1985	6,09,081	1,66,263	4,35,875	22,506	19.37
	2002	22,65,955	9,89,522	15,47,613	20,716	74.70
Kolkata	1985	165,524	1,77,736	3,43,260	15,736	21.81
	2002	494,759	3,80,079	8,74,838	28,923	30.25

Source: Economic and Political Weekly (Feb 11-17, 2006)

residential and business premises and developments increasingly dominate urban areas. In most of the cities, where half or more of a city's population and many of its economic activities are located in "illegal" or informal settlements, urban planners still rely on traditional master-planning approaches with their role restricted to servicing the minority, high income residents. However, this process along with rising land prices have led to mixed land use patterns and have successfully curbed the number and lengths of primarily non-work related trips by motorized modes.

Initially, Town centre supermarkets took the place of street corner grocers. Later, out-of-town hyper-markets began to replace supermarkets. With the decline of local shopping, more and more people have to use or even acquire a car compulsorily. Moreover, out of town leisure parks, Business parks and schools all involve more travels. In the next decade, India and china are going to show the highest growth in personal vehicles. It is definitely going to put enormous pressure on our society in several ways in terms of fuel consumption, environmental quality, road safety etc. Table I shows the vehicle count (Public and Private) in major Indian cities. If this growth is allowed unchecked in an unprecedented manner, it may have a disastrous effect, particularly on our large and metro cities. It is posing a challenge for the planners of Third world Cities due to complex interplay of several forces. It would require a Holistic Planning instead of any piece-meal approach to solve such a problem.

Such a situation may call for a two-pronged approach – simultaneously (i) Demand management & (ii) Supply management. While the "demand side management" would comprise keeping demand and aspirations for mobility within a reasonable limit through land use planning, policy tools etc., "supply side Management" would comprise policy and techniques for moving maximum number of persons in a safe, comfortable and speedy manner taking a minimum toll on environment and passenger's purse. Here, an efficient public transport plays a significant role.

III. URBAN PUBLIC TRANSPORT

Urban public transportation, commonly known as "transit", has been properly refereed to as the "lifeblood of cities". Neglected in some countries during the period of rapid growth in auto ownership, its role has now been recognized as essential for achieving physically attractive, economically sound, and energy efficient cities. Most large cities in developing countries suffer very seriously from poor mobility, pollution, noise, accidents, and economic waste caused by chronic traffic congestion. This condition is often a consequence of the failure to ensure an acceptable level of transit service through separation of this mode from other traffic. It also results from the lack of a comprehensive transportation policy that would either provide adequate facilities, or control demand through regulatory and pricing measures, rather than allow chronic congestion.

The massive growth in population coupled with stepping up of commercial, economic and administrative activities and also the expansion of geographical area, leads to conversion of walk trips into vehicular trips. The trip rates and the trip lengths increase and the final result is a heavy volume of traffic. As the city size grows, vehicular trips get concentrated on particular sections and the routes and the travel mode changes from cycles, two wheelers and intermediate public transport modes to a bigger unit like a bus. With a further increase in city size and traffic volume, the need arises for a high capacity mode like an intra-urban rail service. How much of that increase goes to transit modes depends on auto-ownership level, transit L/S, and policies toward the two systems.

As cities grow in size, the number of vehicular trips on road system goes up. The only solution to congestion relief and provision of service with adequate capacity and quality is through creation of separate, independent transit rights-of-way. Although partial and temporary separations can be achieved through provision of various types of bus lanes, the most effective permanent solution is to construct light rail transit (LRT) and rapid rail transit (RRT) systems. This necessitates a pragmatic policy shift to discourage private modes and encourage public transport once the level of traffic along any travel corridor in one direction exceeds 20,000 persons per hour. Introduction of a rail based mass rapid transit system is called for. Mass rapid transit systems are capital intensive and have long gestation period. It has been observed that in developed countries, planning for mass transit system starts when city population size exceeds 1 million; the system is in position by the time the city population is 2 to 3 million and once the population exceeds 4 million or so, planned extensions to the Mass Rapid Transit (MRT) Systems is vigorously taken up. In developing countries including India, because of paucity of funds planning and implementation of rail based mass rapid transit systems has been lagging far behind the requirements.

Only three cities, namely, Kolkata, Mumbai and Chennai have intra-urban rail facility. Delhi has a nominal service but an MRTS project is in hand. Other metropolitan cities

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including those having a population of around 5 million do not have a high capacity rail system to serve urban commuters. What is most disturbing, however is that several metropolitan cities with a population of 2 to 3 million, do not have even a properly organized public bus transport system. Kanpur, Jaipur and Lucknow are glaring examples in this category.

IV. Sustainable Transportation

The strategy for sustainability has been chalked out by the European Union as follows:

- Revitalize the railways and other alternatives to road haulage
- Get freight traffic to switch from roads to alternative transport forms, especially rail, but also short-sea and inland waterways.
- Encourage travelers to go by rail rather than air for short journeys (< 400 kms)
- Promote alternatives that combine transport modes for both passengers and freight traffic
- Make users of transport system pay more directly for the infrastructure and facilities they use.
- Reduce pollution and the sources of pollution, and increase safety and security.

In most European countries, cycling is steadily increasing. In Holland, for example, all roads within their city limits have cycleways. Even in 60's, Delhi had a separate cycle track which is still badly needed toady. Roads in Chandigarh city have well laid cycle/rickshaw tracks along the roads. A cycle track for non-motorised vehicles has been contemplated on the western flank of foreshore road, Howrah. Today, construction of road and road widening in Europe is largely confined to suburbs and regions where land is cheap to acquire. In Europiean cities, attempts to alleviate traffic congestion through building more roads or road widening now have largely ceased, because of high land values and opposition from public. Some traffic Engineers too now accept that widening only brings in more traffic.

V. Holistic Approach To Traffic Management And Pollution Control

Aims of comprehensive Traffic Management are:

(i) Relief of congestion
(ii) Accident Reduction
(iii) Improving operation, Integration and usage of Public Transport
(iv) Improvement of the environment

In managing vehicular traffic in urban areas the first principle is to remove, if possible, through traffic from central areas either by constructing bypass or ring road. Cities across Europe have started to introduce a range of policy measures like:

- Charges and taxes to encourage travel choices that are economically anf environmentally sound
- Encouraging people to switch from private to public transport- provided the latter can offer fast, comfortable and cheap services
- Supporting the use of cleaner vehicles, as in the case of gas fuelled buses and vehicles using eco-friendly technology.

The traffic management measures in Table II show some proposed actions and their probable results.

The main administrative actions taken by the government to reduce the amount of pollution generated by motor vehicles include:

- Mandatory pollution checking (CO emission at idling) of vehicles every three months
- Fitting of catalytic converters on cars and emissions norms comparable with Euro-II
- Strict emission norms for two wheelers and availability of petrol premixed with lubricating oils at filling stations.
- Availability of lead free petrol in the city along with reductions in sulphur content in fuels
- Phasing out of buses and taxies more than 15 years old.

Supreme court directions requiring all buses and three wheeled taxies to use CNG fuel in Delhi.

TABLE II
TRAFFIC MANAGEMENT MEASURES

S.No.	*Measure*	*Congestion Relief*	*Improving Public Transport*	*Accident Reduction*	*Environment Improvement*
1	*One Way streets*	*P*	*P*	*S*	*S*
2	*Tidal flow*	*P*		*S*	*S*
3	*Junction Improvement*	*P*	*P*	*P*	*S*
4	*Traffic signs*	*P*		*P*	
5	*Pavement Marking*	*P*		*P*	
6	*Street Lighting*			*P*	*S*
7	*Traffic Restraint*	*P*	*P*	*S*	*S*
8	*Parking*	*P*	*S*	*S*	*P*
9	*Bus Priority*	*S*	*P*		
10	*Integrating Para Transit*	*S*	*P*		
11	*Pedstrian/Cyclist- facilities*			*P*	*S*
12	*Car sharing*	*P*	*S*	*S*	*S*
13	*Staggering Work hours*	*P*	*S*	*S*	*S*

P – Primary effect S- Secondary effect

(Source: "Europe at a crossroads- the need for sustainable transport", publication office, European Union)

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VI. Energy Efficiency And Environmental Friendliness Of Different Modes Of Transport

In view of the huge energy crisis looming large over the country, energy efficiency and demand side management have started playing a key role. From the point of view of national economy, with increase in haulage per unit transport cost become relatively cheaper in railways as compared to the road transport as calculated by Railway Board and world Bank study team. So far as fuel consumption is concerned, as calculated by Transport policy committee (1980), the share of electricity is 2 percent, that of coal is 17 percent and oil is 81 percent in the transport sector. The energy efficiencies of different modes of transport are shown in Table III.

TABLE III
COMPARISON OF ENERGY EFFICIENCY OF RAILWAY AND ROADS

S.No	Mode	Energy needed BTU/Tonne Km
1	Electric Train	84.60
2	Diesel train	225.50
3	Steam Train	3576.90
4	Diesel Truck	1587.30

Compared to roads, the railways are about five times more energy-efficient. However, water borne transport is one of the cheapest modes, even cheaper than rail transport which deserves its proper exploitation.

Different environmental parameters can be seen with respect to friendliness of different modes of Transport as given in Table IV.

TABLE IV
ENVIRONMENTAL-FRIENDLINESS OF DIFFERENT MODES OF TRANSPORT

	Air Pollution	Noise	Ugliness	Unsafe
Walking	5	5	5	3
Cycling	5	5	4	2
Car	1	2	2	2
Tram	5	3	3	3
Light rail (LR), Surface	5	3	3	4
Rapid Rail (RR), Surface	5	2	2	4
Rapid Rail (RR),Elevated	5	1-2	2	5
Rapid Rail, Tube	5	5	5	5
Bus, Mixed Traffic	1-2	3	4	3
Bus, Reserved Lane	3	3	4	3

Legend: 1 = very bad, 2 = bad, 3 = average, 4 = good, 5 = very good

VII. Integration Of Different Modes Of Transportation

River and sea-going ferries has a very long history. Sea-going ferries carry railway wagons both with passenger and goods, passenger motor cars, lorries with goods, and motor car trailers. These are combined railway and sea or road and sea means of conveyance which eliminates transshipment of cargo at the junction points of different transport modes. This saves travel and delivery times. Also storage space can be saved. Multi-modal integrated Traffic dispersal system has been envisaged for some railway stations/airports like Dumdum rail junction etc. India is developing country. The transportation demand on road and railway infrastructure is increasing day by day. Rail based transport such as light rail transit (LRT), tram, Mass rapid transit system, monorail etc. deserve higher priority in the national interest in terms of following factors:

- Energy - efficiency
- Passenger – comfort
- Passenger/ Citizen – safety
- Environment - friendliness

Hence, rail transport deserves encouragement – either in isolation or coupled with other modes of transport based on ground reality. However, instead of competing with each other, rail and road transport should take a complimentary role to cater to the needs of public. The objectives of transit integration process include:

(i) Operate all the diverse publicly and privately owned services as though they were part of a single area wide transit system
(ii) Eliminate wasteful duplication and extend tae availability of service
(iii) Benefit from combined planning, purchasing and marketing efforts and joint use of facilities.

Enable the transit user to travel anywhere in the community on a single fare, transferring efficiently and comfortably between different modes and services.

VIII. System Integration Of Different Modes Of Transportation

The efficiency of different modes of transport and main transit facility can be enhanced by system integration. System integration occurs at three levels: Institutional, Operational and Physical.

Institutional integration refers to the creation of an organizational framework within which joint planning and operation of transit services can be carried out. Four types of organizational arrangements named Tariff association, Transit communities, Transit federation and Mergers are considered for implementing transit integration.

Operational integration involves the application of management techniques to optimize the allocation of transit resources and co-ordinate services. The techniques of operational integration include

- Rationalization of redundant services,
- Matching modes to service requirements,
- Unification of fare structure
- Fare discounts
- Co-ordinated public information systems
- Reserved bus lanes and streets
- Development of feeder routes
- Development of co-ordinated schedules
- Parking controls etc.

Development of feeder routes and schedule co-ordination for feeder services is the most important aspect of operational integration.

Physical integration refers to the provision of jointly used facilities and equipment. Techniques of physical transit integration include

(i) Inter-modal terminals
(ii) Transit shelters
(iii) Park-and-ride facilities
(iv) Pedestrian facilities.

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IX. Summary And Conclusions

This paper deals with a holistic approach for efficient Transportation planning and system inegration for better and healthy environment of large cities. Aims of holistic approach for comprehensive Transit panning and system integration are: Relief in congestion on roads of large cities, Accident Reduction, Improving operation, Integration and usage of Public Transport, and Improvement of the environment of large cities. Different environmental parameters like Energy - efficiency, Passenger – comfort, Passenger/ Citizen – safety, Environment - friendliness with respect to different modes of Transport are discussed.

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