FINANCING TRANSPORTATION IN FISCALLY CONSTRAINED TIMES: TRANSPORTATION STRATEGIES FOR MUMBAI, INDIA.

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SUMMARY
The strategy detailed in this paper proposes to build on the current strengths of the existing transportation network, optimize its utilization, convert the threats into opportunities and shun the temptation to make Mumbai look like Shanghai or Singapore by taking up grandiose projects like trans-harbor sea links, elevated light rail or ‘Sky bus’ projects. In fiscally constrained times, the only alternative is to OPTIMIZE available infrastructure to; double the capacity of suburban trains with double decker coaches and bus service by dedicated bus lanes that can transform into light rail tracks in future; restrict entry of private cars in the city by area licensing, and prohibit cars 2 days a week; initiate ‘Park & Ride’ schemes at rail stations and bus depots, facilitate pedestrians and two wheelers for the east-west traffic, construct elevated pedestrian walkways as extensions of the foot over bridges at rail stations; provide a satellite air terminal in south Mumbai; reconsider construction of the Trans-Harbour link bridge using the investment instead for creation of employment opportunities on the mainland and construct a ‘calm sea channel’ along the west coast instead of the west island expressway, to facilitate plying of ferries all the year round.

Mumbai, Capital of Maharashtra State. India.
- Area 438 Sq.Km. (Municipal Corporation of Greater Mumbai limits)
- International Airport: Chatrapati Shivaji (formerly Sahar) International Airport.
- Domestic Air terminal: Santacruz Airport in Santacruz, a suburb of Mumbai.
- Railway: Churchgate Terminus (for suburban trains) and Mumbai Central (for trunk routes) on Western Railway (WR) and Chatrapati Shivaji Terminus (CST-formerly Victoria Terminus) for suburban and Long distance trains on Central Railway (CR). The suburban railway runs over 300 route km on WR & CR
- Coastal Length 140 km. Ferry service (except in monsoon, between mid June- mid September) connects to the mainland on the West coast of India across the Thane creek.

Mumbai, over the last few decades, has emerged as the financial and commercial capital of India. It has an area of 438 sq. km and an estimated population of 12.9 m. in 2004. The urban growth has spread beyond the boundaries of Municipal Corporation of Greater Mumbai (MCGB) to form Mumbai Metropolitan Region (MMR). MMR has an area of 4354 sq. km and a population of about 18 m. in 2001 which is expected to grow to 22.5 m. in 2011.
MMR generates about 5% of national GDP and contributes to over one third of India's tax revenues. Mumbai has a unique distinction of satisfying 88% of its peak period travel demand through public transport, mainly suburban trains and buses. Of the remaining 12% peak travel demand, 5% is met by taxis and 7% by private vehicles. Although these proportions are estimated to remain more or less same until 2011 (with public transport share falling marginally from 88% to 85%), the number of public transport trips in the peak period are estimated to rise substantially.

TRANSPORTATION

Transportation in Mumbai is a major problem, especially due to the geography of the city. It is an island city. There is a large concentration of commercial and administrative functions at the southern tip of the island due to the fact that during the British rule the fort was located there which has, over the years, developed into a modern Central Business District. The only highways in Mumbai are the East and West Express Highways that run north/south along the eastern and western coasts of the island. The city's system was modeled after the London transportation system with the exception of the Underground Metro.

Types of Transportation in Mumbai

The largest and the only public bus transport system is the ‘BEST’ (Brihanmumbai Electric Supply and Transport) bus system with about 3380 buses. The road network consists of 1431 kilometers of thoroughfares which handle an average of 4.5 million passenger trips per day. However, the most used mode of transportation is rail. The main trunk rail routes follow the same paths of the express highways and terminate at Chatrapati Shivaji Terminus (Victoria Terminus) on the east and Bombay Central Station on the west, the suburban route continuing south up to Churchgate station. In addition there are private cars, buses, about 45,000 taxis and over 38,000 ‘Autorikshaws’ (three wheelers) in the suburbs excluding the island city where these are prohibited.

History

Not only was the Mumbai transportation system modeled after the London system, it was pretty much developed in conjunction with it. As London developed a system, Mumbai would receive it approximately five years later. Tram
service in Mumbai began in 1870. It remained until the 1950s when the government felt that the trams were becoming obsolete even though their passenger carrying capacity was 50% greater than buses, they were more energy efficient, cleaner and could be easily modernized.

However, a government sponsored study concluded that buses would be more effective. The last tram ran in 1964. This was perhaps the first blow to transportation development in Mumbai. The second came in 1974 with the abolition of the trolley bus. The trolley ran on electricity, was quiet and was able to follow routes that the large diesel buses could not run on. After the termination of these two systems, no new transportation system was introduced in Mumbai.

PROBLEMS

A population of about 15 million in MMR generated total peak hour passenger trips of 21,54,860 in 1993. Out of these, 88% were performed by public transport, 7% by private vehicles and 5% by taxis. In 2011 a population of nearly 22.5 million is projected to generate peak hour trips of about 32,60,431. Out of these 85% may be by public transport, 9% by private vehicles and 6% by Taxis.

Due to its linear configuration, traveling distances are more in Mumbai. The average distance traveled per passenger of mass transportation is 6 kilometers, nearly one-third the length of the island city of Mumbai. Because of the overcrowding on the mass transit system, many people are switching to personal transport such as scooters or mopeds. This further aggravates the pollution problem that Mumbai faces. Non-transportation uses of roads, such as squatting, slums and pavement hawking have further reduced the inadequate carrying capacity of the road and rail system vis-a-vis the demand. There is very little scope to widen the right of way of rail tracks or the roads to increase their motor vehicle carrying capacity.

Any increase in the widths of roads or the rail tracks will necessitate dislocation of a large commercial and residential land use and population. Apart from the socio-economic hardships of such an action and the remote possibility of its acceptance by politicians who are the decision makers, it will involve large fiscal investment the magnitude of which may be beyond the capabilities of the local or state governments. On the basis of the investment costs estimated for rehabilitation and resettlement of the hutments located on a small stretch of the suburban rail track on the ‘Harbour’ line, included in the ‘Mumbai Urban Transport Project (MUTP)’ currently under implementation with financial assistance from the World Bank (described briefly later in this article), the fiscal cost of such a project could be anything between Rs. 8000m. –16000m. (US $ 160 m. –320 m.) at current prices.

In view of these physical and fiscal constraints to the public transportation systems in Mumbai, highly imaginative, economical and cost effective options and approaches are needed that can increase the carrying capacity of the
existing rail and road transport network. Instead, the authorities concerned seem to be pursuing the adoption of high capital cost ‘global’ (glamorous?) solutions like; underground rail, overhead light rail nicknamed ‘Sky Buses’, grade separation of roads and limited entry expressways that can help only the 7% of passenger trips undertaken by private vehicles. Imaginative approaches like double decker rail coaches with dual loading-discharging platforms, and regulatory approaches like restriction on entry of private vehicles by area licensing, car pooling, dedicated bus lanes and re introduction of trams or surface light rail systems have not received the attention they merit. Unfortunately, this has strengthened the people’s perception that local or state governments are interested in taking up very high capital cost projects that have a propensity to generate large ‘kick-backs’ for those in power and any benefit that may accrue to the common man is accidental or incidental!

PUBLIC TRANSPORTATION: CURRENT SCENARIO

Rail Transport
Mumbai is served by two zonal railways; the western railway (WR) and central railway (CR). At present, the fast corridors on Central Railway as well as Western Railway are shared for long distance (Main line) and freight trains. The suburban railway services, which are in fact metropolitan services in view of the frequency and short distances between stations, carry close to 6.1 million passengers per day. The western corridor of the suburban system, starting at Churchgate-the southern tip of Mumbai goes up to Virar a distance of 60 km. The Eastern corridor starting from the Victoria Terminus (Chatrapati Shivaji Terminus-CST) extends up to Kasara, a distance of 67 km. A branch of this Eastern corridor, popularly known as the ‘Harbour Line’ crosses the Thane creek and turns to south east to extend up to terminate at Panvel (39 km) on the mainland via New-Mumbai.
The two corridors (local and through) on Western Railway run northwards from Churchgate, the terminus (for local corridor) and the southern most station of the city and from Mumbai Central for through trains. Churchgate is home to the Western Railway headquarters. The suburban rail route runs almost parallel to the west coast up to Virar (60 km). This corridor is popularly referred to as 'Western Line'. Two corridors (one local and other through) on Central Railway run from Chatrapati Shivaji Terminus (CST—formerly Victoria Terminus) The suburban rail route runs up to Kasara (67 km). This corridor is popularly referred to as the 'Central Line'.
Mumbai suburban rail system has the highest passenger density in the World. More than half of the total daily passenger trips on Indian Railways are performed on Mumbai Suburban Railway system. The system, in spite of heavy demands on it, has provided an efficient and reliable service. However, overcrowding has grown to such an extent that up to 4,700 passengers travel by a 9-car train during peak hours, as against the rated carrying capacity of 1,700! This has resulted in, a dense crush load of 14 – 16 passengers per square metre of floor space!

Mumbai’s suburban rail system is perhaps the most complex, densely loaded and intensively utilized system in the world. Spread over 302 route km, it operates on 1500 V DC power supply from overhead catenary. The suburban services are run by electric multiple units (EMUs). 184 rakes (train sets) of 9-car and 12-car composition are utilized to run 2067 train services to carry 6.1 million passengers per day.

Given the geographical spread of the population and location of business areas, the rail network will continue to be the principal mode of mass transport in Mumbai. To enable the Mumbai Suburban Railway to meet the demands of the ever-growing passenger traffic, Ministry of Railways and the Government of Maharashtra established MRVC - Mumbai Railway Vikas Corporation Ltd (MRVC Ltd), a public sector unit of Govt. of India under Ministry of Railways (MOR) and incorporated it in 2003 with the equity capital shared in the ratio of 51:49 between Ministry of Railways and Government of Maharashtra to implement the Rail Component of an integrated rail-cum-road urban transport project called Mumbai Urban Transport Project (MUTP). The cost of the Rail Component of the project is to be shared equally by Ministry of Railways and Government of Maharashtra.

Public Road Transport

Bus services in the city are provided by Brihanmumbai Electric Supply & Transport (BEST), with over 3000 buses, which cater to 4.5 million passenger trips per day, of which approximately 60% are connected with rail journeys. The road network in Mumbai is predominantly radiating from the southern tip of the island and comprises three main corridors - Western Express Highway, Eastern Express Highway, and the Eastern corridor to New Mumbai across the creek. Although termed 'expressways', the roads are essentially arterial roads.

The BEST runs a large fleet of buses covering the entire city limits as well as linking the neighbouring district of Thane. There are two types of buses, the single decker and the double decker. The entire fleet of the BEST’s about 3380 buses carry 4.5 million passengers on 335 routes. Buses are parked at 25 Depots spread over the city. In addition to the buses, the BEST also runs ferries across creeks in the northern reaches of the city. It is also one of the few public service provider in India to ply air-conditioned buses.

Private Road Transport

The last two decades saw significant increase in private vehicle ownership. The population growth in MMR in 1981-91 was about 3% p.a. whereas the vehicular growth was 8.81% p.a. Private vehicle registration increased by 3.45 times between 1976 and 1991 (from 1,08,146 to 6,35,172 vehicles). Private vehicles registration in MMR in 2011 is expected to be more than double the 1991 level (1,35,6,498 vehicles). Number of vehicles per 1000 persons in MMR is expected to increase from 44 in 1991 to 61.1 in 2011. Private vehicles are thus expected to grow at a rate of 4.95 percent per annum as against the population growth rate of 2.19 per cent per annum.

The number of registered vehicles in MMR grew from 521,000 in 1985 to 821,000 in 1991. Private cars grew from 173,000 to 366,000 in 1991 and the number is expected to double in 2011. Number of taxis (cabs) has grown to about 45000 in 2004. About 300 motorized vehicles are registered every month by the Regional Transport Authority. In addition to the private cars, and Taxis, in the suburbs of Mumbai (excluding the island city) about 38,000 three wheeler ‘Autorikshaws’ are on the road. Each carry 3 passengers excluding the driver. The entry and plying of goods/ transport vehicles is restricted to night time only in the Island city and during certain restricted hours in the suburbs. In addition, there are private buses which ply on contract basis and carry school children and a limited number of white collared workers to their work places in Factories or offices.

In the distant suburbs a large number of trips are performed by motorized and non-motorized two-wheelers like mopeds, scooters and bi-cycles. These can be very effectively integrated in the total transport system of Mumbai and the load on public transport- particularly from residential areas to the suburban railway nodes- can be reduced
substantially if adequate parking can be provided at the railway stations and bus depots. Unfortunately, this has not been adequately provided for in the station area improvement schemes (SATIS) being drawn up as part of MUTP.

**INTERVENTIONS BY MMRDA**

The traveling conditions, transport infrastructure, road traffic congestion, air quality, and institutional framework were considered as some of the major issues which required urgent attention in order to improve the transport sector management in Mumbai. Road transport is a major contributor of air pollution and noise in an urban environment. Noise levels along the roads in Mumbai have been found to be in the range of 65dB(A) and 85 dB(A). Both vehicular pollution and noise in Greater Mumbai have become a cause of concern. (Urban Air Quality Management Strategy in Asia, Greater Mumbai Report, World Bank Technical Paper No. 381 3)

MMRDA therefore prepared a "Comprehensive Transport Strategy (CTS)" in 1994, providing a strategic framework for the transport sector of MMR. Various strategic transport options identified under the CTS study included projects, such as, flyovers (grade separated roads), ROBs (rail over bridges), Pedestrian subways and Station Area Traffic Improvements Schemes.

**RAIL**

Mumbai suburban rail improvement Project initiated by MMRDA included:
- buying a new type of RAKE but not adding to the capacity of each train,
- provision of additional two railway lines over a length of 16 kms. on the central Central Railway and about 15 kms. on Western Railway adding marginally to the capacity,
- DC To AC Traction conversion involving provision of 18 DC sub- stations (5 on Western Railway and 13 on Central Railway) in place of existing 69 DC sub-stations for better power supply and improved signaling. This will not add to the passenger carrying capacity.
- 12 coach rake operations (instead of 9) adding about 33% to the passenger carrying capacity.

In June 2004, government approval was given for a 13 station elevated light rail line between Versova on the west coast to Ghatkopar on the Central Railway line. The Rs 9703 m. (US $194.06 m.) project envisages a 14 km long totally elevated rail network with 13 stations including 2 stations at the domestic and international airports.

**ROAD**

A road bridge (West Island Expressway) along the west cost through the open sea linking Bandra with Worli at a cost of Rs.20000 m. (US$ 400m).
- A 6 lane trans-harbour link bridge connecting southern tip of the city to the main land at a cost of Rs. 1,20,000 m. (US $ 2400m.)

Road widening and expansion projects include, adding of one lane to the width of 2 east-west link roads to a length of about 16km.adding 4 more ROBs for better road communication across the rail lines,

Public bus transport struggles through Mumbai Roads at snail pace-6 to 14 km. per hour

Private buses and cars speed away on the Mumbai-Pune Expressway

an Area Traffic Control system (ACT) to improve the traffic flows, for the Island City of Mumbai by computer controlled traffic signal system, and central control room facility.

a number of pedestrian grade separation measures on major corridors in the Island City and suburbs, and
Station Area Traffic Improvement Scheme (SATIS) at seven suburban rail stations.

MSRDC (Maharashtra State Road Development Corporation) had originally planned to construct about 50 flyovers, in the city out of which 33 have been constructed, and the rest are at various stages of planning. The flyovers have been mainly constructed or planned on highways of MMR - Western Express Highway, Eastern Express Highway, and Panvel- Sion highway to facilitate uninterrupted flow of traffic in and out of Greater Mumbai. In addition, a number of flyovers are planned or are at different stages of construction in the Island City, to relieve extreme traffic congestion at the intersections. **Except a few, the flyovers were not part of any of the strategic transport options identified by the CTS study.** The decision to construct these flyovers therefore was prompted by considerations other than technical. Even if these were to be constructed on sound technical grounds, the result would be to benefit only the private car traffic that caters to only 5% of the total passenger trips in the city.

The ten key representative projects, which are estimated to cost over Rs. 2,00,000 m.(US $ 4000m.) include: Mumbai Trans Harbour Link, Mumbai Underground Metro, Bandra – Kurla Rail Link, Shivaji Terminus to Churchgate Underground Rail Link, Light Rail Transit, Skybus, Worli to Nariman Point Sea Link, Western Relief Road, Anik Panjarpole Link and Water Passenger Terminals. In addition, the expenditure for repairs and maintenance of city roads and bridges, and augmentation of bus fleet is estimated at over Rs. 12000m. (US $ 240m.) per year.

Two major road projects costing over Rs.140,000m. (US $ 2800 m.) which may not benefit the common man are, a road-cum-rail bridge across the Thane creek linking the southern tip of the island city to the mainland south of Nhava-Sheva port presently estimated to cost around Rs. 120,000 m. (US $ 2400 m.) and the west island expressway bridge between Bandra and Worli estimated to cost Rs.20,000m.(US $ 400m.). It (see map below) completely ‘closes’ the Mahim-Dadar bay and has been fiercely opposed by both the environmentalists and the fishermen of the area. Its construction is pursued perhaps more for its ‘Golden Gate’(San Francisco, USA) like “visionary” appeal than for facilitating vehicular traffic on the western road artery.
Passenger Water Transport (PWT) along the West Coast of Mumbai

The project envisages construction of terminal and operation facilities at five locations namely Borivali, Versova, Juhu, Bandra and Nariman Point, and operation of vessels (catamaran/hovercraft) on Build, Own, Operate and Transfer Basis (BOOT) for a concession period of thirty years.

THE RESULTS OF INTERVENTION SO FAR:

However, all these schemes are unlikely to make any significant impact on the traffic and transport situation. All the measures taken by the authorities so far in the name of improving rail and road traffic in Mumbai may result in:

- Very little augmentation in the carrying capacity of the rail network which carries 88% of passenger traffic.
- No augmentation of the passenger carrying capacity of the bus transport.
- No facilities to the motorized/non motorized two wheeler users for the East-West traffic.
- No encouragement to the bi-cycle users or Pedestrians for reducing the load on public transport.
- No reduction in the number of private cars entering the major work centres in the southern parts of the city.
- No adequate parking provision at rail/bus nodes to encourage “Park & Ride” and use public transport.

TRANSPORTATION STRATEGY: PROPOSALS

1. **Double the carrying capacity of suburban trains by having double decker coaches** with the current or dual loading/discharge platforms at all stations at a marginal cost.

2. **Double the carrying capacity of the bus service by creating dedicated bus lanes** which will accelerate the speed of bus travel and facilitate greater frequency of services by only a marginal increase in the number of buses on roads as the shorter journey time may facilitate higher number of trips by the same number of buses.

3. **Convert the dedicated bus lanes into light rail tracks in due course** to further add to the passenger carrying capacity of the roads.

4. **Restrict entry of private cars in certain parts of the city by area licensing**, prohibit use of cars on designated days (at least 2 per week), allow plying of cars with odd/ even numbers only on alternate days to reduce the car traffic on the roads in the city, facilitating frequent and faster bus service.

5. **Provide adequate parking area at the suburban rail stations and the bus depots** to encourage use of public transport and motorized and non-motorized two wheelers for the east-west transport and from the residential areas to the suburban rail stations considerably reducing load on the bus service and reducing congestion.

6. **Construct elevated pedestrian walkways as extensions of the foot over bridges at the suburban rail stations** to reduce the load on the east-west bus service between residential areas and the suburban rail stations.

7. **Provide a Satellite air terminal in south Mumbai with helicopter service to Mumbai International Airport at Sahar** to eliminate car traffic to and from the airport to south of Mumbai.

8. **Reconsider construction of the Trans-Harbour link bridge project**. It will only aggravate the traffic congestion in the southern tip of the city by pouring in more traffic from the mainland. Instead, the projected cost of this venture estimated at Rs.12000 m. (US $ 2400 m.) can used to create employment opportunities on the mainland in the Navi Mumbai (New Bombay) area and provide subsidy to high traffic generating land uses in the Mumbai city to shift to the main land.

9. **Create a ‘calm sea channel’ along the cost from Bandra to Worli for use by traditional ferries all the year round by creating a submersible wall in the sea along the coast at 30% of the cost of the proposed west island expressway between Bandra and Worli over a bridge through the sea along the coast**.
PROPOSED TRANSPORTATION STRATEGY: DETAILS

1. **Double the carrying capacity of suburban trains by having double decker coaches** with the current or dual loading/discharge platforms at all stations at a marginal cost.

Presently both the Western and Central Railways operate on a network route of 302 kilometres. The rakes designed for a load of 1700 passengers carry over 4700 commuters in dense crush load conditions. The Central Railway and Western Railway runs about 1100 and 1000 trains, respectively, with each train carrying about 4700 passengers during the rush hour. In a fiscal constraint times, the least cost alternative that achieves desired objective has to be chosen. Can the passenger carrying capacity be doubled employing double decker coaches for the trains at a lesser cost than adding one more rail track and running necessary number of trains on it? The economics is in favour of running double decker trains.

According to estimates prepared by the MRVC the cost of laying a new single track suburban rail line would be around Rs. 101.53 m. (US $ 2.02 m.) per km.; exclusive of rolling stock and operation and management cost which is estimated at Rs. 4.0 m. (US $ 0.8 m.) per year. The cost of a new rake (9 coaches) with improved design would be Rs. 182.72 m. (US $ 3.65 m.) A double decker coach rake may cost around 30% more (wheel base and Catenary remaining the same) that is about Rs. 237.53. (US $ 4.75 m)/ rake. The Western railway’s suburban route from Churchgate to Virar, is 60 km. long. For dual loading and discharge (if required), a platform will have to be created at the upper level. The level of this platform will be almost at the roof of the presently existing platforms along the tracks within the railway station precincts. Hence what would be

![Double Decker coaches currently used on trunk routes of Indian Railways](image)

required is to replace the existing roofs over the platforms with a concrete slab for the boarding and alighting of passengers at the upper level and raise the existing roof over that. This can be done by encasing the present steel
columns supporting the present platform roof by cement concrete and laying a concrete slab for the upper level platform floor. This will entail least disturbance to the operation of the trains. The steel columns designed in 1940s normally had a factor of safety of 4 and will be able to support the upper level platform slab. However, for costing purposes, even if it is assumed that a concrete slab about 180 mts. (US $ 0.01m) per platform. For the 28 Stations on this route the total cost of platform construction may be Rs. 162.4m. (US$ 3.24m.).

Between Churchgate and Virar, a distance of 60 km., running of 1000 trains requires about 100 rakes (900 coaches @ 9 coaches per rake/train). At Rs.182.72m./rake the cost would be Rs. 18272 m. (US $ 365.44 m.). Thus the total cost of running 100 rakes/day by laying a new track for 60 km. would be Rs. 24363.80 m. (US $ 487.27 m.). As against this, the cost of new platforms and 50 rakes (equivalent to normal 100 rakes) of double decker trains would be Rs. 12038.90m. (US $ 240.77m.) which is a little over 50% of the cost of laying new tracks, not counting additional operating costs for the new track.

Thus, double decker trains even with dual loading/discharge platforms constructed at upper level can be run at almost 1/2 the cost of laying a new rail track and will double the carrying capacity of a train or reduce the current level of congestion by 100%. Of the 9 coaches at the lower level, 3 can be reserved for women, 2 for First Class passengers, 1 for the famous ‘Dabbawalas’ (lunch carriers) of Mumbai, 1 for the school students and physically disadvantaged and 2 for the non-‘Pass holders’. All the coaches at the upper level (80% standee only) can be totally reserved for ‘Pass holders’ who travel regularly at specific time of the day and are generally bound for the final destination of the train.

2 **Double the carrying capacity of the bus service by creating dedicated bus lanes** which will accelerate the speed of bus travel and facilitate greater frequency of services by only a marginal increase in the number of buses on roads; as the shorter journey time may facilitate higher number of trips by the same number of buses.

3 **Convert the dedicated bus lanes into light rail tracks in due course** to further add to the passenger carrying capacity of the roads.

4 **Restrict entry of private cars in certain parts of the city by area licensing**, prohibit use of cars on designated days (at least 2 per week), allow plying of cars with odd/ even numbers only on alternate days to reduce the car traffic on the roads in the city, facilitating frequent and faster bus service.

Creation of dedicated bus lanes on the north south trunk routes will mean reduced road width for plying private vehicles like cars and taxicabs. This can overcome by reducing the use of private cars by,

- allowing plying of cars with odd and even numbers on alternate days;
- prohibiting use of cars in the island city area two days in a week;
- permitting use of cars only if there are more than 3 passengers per car;
- area licensing for entry into specific areas of the city.

These measures will release road space for creation of dedicated bus lanes. A dedicated bus lane can almost double the speed of travel of buses, (presently the average speed of buses on the north-south arteries is 14-16 km./hour and as low as 6 km./hour in congested residential areas on the east- west bus routes) shortening the journey time by at least 40% (since stoppage time will be constant). This will mean a greater turnover time for a bus increasing its total passenger carrying capacity by at least 40% in a day and increasing the revenue which can be used to ply additional buses on the same route. The frequency of buses will be greatly increased, congestion reduced, working as an incentive to the car owners to travel by public bus transport. Introduction of air conditioned buses on these routes will further attract the car owners. In due course of time these dedicated bus lanes can be converted for light rail tracks as is prevalent in many cities of the world. The restrictions on the use of cars should not be considered Utopian as has been demonstrated by such measures already implemented in Bogota, Columbia by its famed Mayor Mr. Enrique Penelosa.
5 Provide adequate parking area at the suburban rail stations and the bus depots to encourage use of public transport and motorized and non-motorized two wheelers for the east-west transport and from the residential areas to the suburban rail stations considerably reducing load on the bus service and reducing congestion.

6 Construct elevated pedestrian walkways as extensions of the foot over bridges at the suburban rail stations to reduce the load on the east-west bus service between residential areas and the suburban rail stations.

The linear configuration of Mumbai is often cited as the reason for the long journeys to work, especially as work centres are mostly concentrated in the south. On the contrary, if right measures and decisions are taken, this linear development of residential areas on either side of the two north-south rail-road spines, can be a great boon to fast and comfortable journey to work by adopting the concept of ‘Park & Ride’!

Most residential development in the city is within 1 km. distance from the two rail transport spines. If the carrying capacity of the rail-road spines is doubled by measures discussed earlier, facilitating the east-west journeys to the railway stations from the residential areas will further help solve the transport problems in the city.

To facilitate smooth and fast travel from the residential areas to the suburban rail station, the east-west roads leading to the rail stations need to be improved by,

- restrictions on hawker on these streets during morning and evening peak hours,
- restrictions on vehicular parking on these streets during peak hour traffic,
- creating dedicated bicycle and motorized two wheeler vehicular lanes on these streets,
- providing two wheeler parking at ground level along the rail tracks within the right of way of railway land as this land may not be required for laying of additional rail tracks (the need being fulfilled by deploying double decker coach trains),
- providing multistoried car parks over the railway stations and Bus Depots in the city.
extension and widening of the foot bridges over the rail lines (as depicted in the picture above) at all suburban stations to bridge over the north-south road arteries (parallel to the rail lines) and give a grade separated access to the pedestrians directly from the suburban rail station to the residential area.

These measures will encourage the daily commuters to either walk or use personalized vehicles for their journey to rail stations and make optimal use of the public transport. Such a proposal to ‘Pedestrianize’ the suburban railway precinct area and the streets leading from residential areas to the rail stations is by no means utopian or ‘impracticable’. In Columbia the city of Bogota’, with the initiative of its Mayor Mr. Enrique Penelosa has created over 45 km. of pedestrian and bicycle way through the city in just 3 years!

7 Provide a Satellite air terminal in south Mumbai with helicopter service to Mumbai International Airport at Sahar to eliminate car traffic to and from the airport to south of Mumbai

A major contributor to the traffic on the north-south road arteries in Mumbai is the car and taxicab traffic from the Mumbai International airport. Though the number of vehicles is small, each normally does not carry more than 2 passengers and mostly the cars originate in south Mumbai and go to the airport only to receive the international traveler. A proposal to start an air taxi service has been debated for long. Rather than an air taxi it would be far more convenient and acceptable to the traveler, if the ‘check in’ for the international flight could be arranged at a ‘Satellite terminal’ in the south of Mumbai. Air travelers could check in at this satellite port and be directly ferried to the departure lounge of the international airport.

The present airport at Sahar has already reached its maximum handling capacity and the MMRDA has proposed a new international airport at Mandwa across the thane creek on the mainland directly opposite to and east of the southern tip of Mumbai. Landing at this proposed airport will involve a circuitous road journey of at least 5 hours to reach south of Mumbai (via New Bombay, Thane) Hence, a proposal to link the southern tip of Mumbai to the main land by a road bridge (see map) at a currently estimated cost of Rs. 1,20,000 m.(US $ 2400 m.) has been mooted and is being enthusiastically pursued! Due to the quantum of investment required it may take a long time to have the proposal implemented.

In the mean time, though the present airport at Sahar has already reached its optimal capacity and its augmentation is not feasible without shifting its location, its accessibility with the city needs to be improved. Hence a new proposal of an overhead light rail (estimated to cost Rs.9703m. ie. US $ 194 m.) between Versova on the west coast to Ghatkopar station to the east touching Sahar with a new rail station there on the Central suburban rail line is mooted and global tenders have been invited! The fact that Sahar airport would not be serviceable in another year is lost sight of in the enthusiasm to undertake new and costly projects and turn Mumbai into Shanghai!

What is required is to relocate the international airport in such a way that it is linked to the entire city by existing suburban rail routes and the hinterland by existing trunk routes. The best location for the airport is the triangular area formed by the suburban rail station Thane at its apex to the north, the present road-rail bridge connecting Mankhurd with Vashi in New Mumbai at its base in the south and bounded by Eastern Express highway to the west and Thane –Belapur road to the east (see Mumbai map). This location will give access to south of Mumbai by rail and road, to the north and east by expressways and will have scope for expansion for the next 50 years. The runways can span the creek by bridges so as to cause least disturbance to the ecology of the area and the Air Terminal buildings can be located either on the mainland at Vashi in New Mumbai or at Deonar in Mumbai.

8 Reconsider construction of the Trans-Harbour link bridge project. It will only aggravate the traffic congestion in the southern tip of the city by pouring in more traffic from the mainland. Instead, the projected cost of this venture estimated at Rs.1,20,000 m. (US $ 2400 m.) can be used to create employment opportunities on the mainland in the Navi Mumbai (New Bombay) area and provide subsidy to high traffic generating land uses in the Mumbai city to shift to the main land.
It has been discussed earlier that the Trans-Harbor link was originally proposed to provide a direct access from the proposed new international airport at Mandva, on the main land south of Nhava Sheva port (see map above). As the location of the new airport at Mandva is now fiercely opposed by the local population, the Trans Harbor link has lost its basic purpose. However, the proposal for the link is now being justified on the grounds that it will help development of that area on the main land. What (or whom?) it will actually do is to create a satellite residential community for the ultra rich who will find a serene seaside location for their palatial residences and commute to their business empire in south Mumbai just across the bridge! Once the link is created, migrants from the poorer ‘Konkan’ area will pour into Mumbai easily in search of livelihood.

The international consultants Mckinsey, in their recent report have noted that “the slow down in economic growth is responsible for deterioration of Mumbai. To achieve 8 to 10% growth, 0.5 m. additional jobs need to be created. This can be done in the high and low end service sector by converting the hinterland of Mumbai into a manufacturing logistics hub”. The estimated cost of Rs. 1,20,000 m. for the Trans Harbor link can be used to create jobs in the mainland area by providing physical infrastructure services for establishment of agro-based, fishing, food canning and similar industries. Subsidy can be given to existing traffic intensive land uses in Mumbai (Whole sale vegetable, Cotton, cloth steel, scrap markets) to shift to the New Mumbai area. Such a measure will achieve the dual purpose of development on the main land and reduce traffic in Mumbai.

The Trans Harbor link should be viewed in the broader perspective of its effect on migration to Mumbai from the under developed hinterland.
Create a ‘calm sea channel’ along the coast from Bandra to Worli for use by traditional ferries all the year round by creating a submersible wall in the sea along the coast at 30% of the cost of the proposed west island expressway between Bandra and Worli over a bridge through the sea along the coast.

The proposed west island expressway linking Bandra with Worli by a bridge through the sea along the west coast is expected to cost around Rs. 20000m. (US$ 400 m.). It will only carry cars and taxicabs or air-conditioned long haul buses. This high speed traffic over the bridge will ultimately have to merge into the existing arterial road from Worli to south of Mumbai and will in fact add to the density of car traffic in that stretch of the road.

A cheaper alternative that will help the common man traveling by public transport would be a Ferry service from Versova to Nariman point with jettys at Juhu, Bandra, Mahim, Dadar, Hajiali, and Chowpaty (see Map of Mumbai).

In the past, many attempts were made to run such ferry services with high-tech. Vehicles like Catamaran and hovercraft. These failed as the service could not be run during monsoon (between mid-June to mid-September) due to the choppy sea along the coast. For a mass transport to be successful, the first requisite is its availability all the year round. To facilitate such a service, at least in the stretch between Bandra and Worli (the two points proposed to be connected by the west island expressway by a bridge at a cost of Rs. 20000 m.) it can be explored if a deep but calm channel along the coast can be created by constructing a submersible wall in almost the same alignment as the bridge (with outlets for small fishing crafts) between these two points to substantially reduce the effect of the tide and choppy sea in the monsoon and facilitate plying of the traditional Ferries. It is a feasible proposition almost like the walls protecting the ships in a harbor. The cost of such a submersible wall may be $1/4$th the cost of the west island expressway bridge.
CONCLUSION

Transportation strategies for urban areas cannot be evolved in isolation. They have to be an integral part of the overall urban development strategy for a city. The economic as well as social costs and benefits of any approach to evolving transportation strategy have to be carefully balanced. Such a task is not easy as the social costs or benefits of a strategy are rarely ‘quantifiable’! An urban development strategy for Mumbai and approaches to its transportation problems can be evolved only in its socio-economic context and constraints. The context is that 54% of its population lives in slums (occupying only 16% of its land), 15% live on sidewalks, 82% of the population has an annual income of less than Rs.30,000 (US $ 600), and all its public institutions like the rail, bus and municipal services as also the state government are either running at a loss or deeply in debt.

The MUTP estimates that the minimum package of measures to marginally improve the situation will cost Rs. 200000 m.(US$ 4000m.) at current prices. All these projects will have to be financed mainly from the surplus revenues of either the State or local municipal government. As against this requirement, the total yearly (2004-2005) budget (deficit)of the state of Maharashtra is only Rs.1,99,833 m.(US $ 3966.6). Its current debt is Rs.8,70,000 m. (US $ 17,400 m.). The servicing of this debt even at a low interest rate of 6.5% will require an amount of Rs.56,550 m. (US $ 1131 m.). It is therefore almost impossible for the state to finance such a large investment.

The Mumbai municipal corporation has a yearly budget of Rs. 33000m. (US $ 660m.). A staggering 82% of this amount is spent on establishment (administrative expenses and salaries). It is there fore left with hardly Rs. 5940m.(US$ 118 m.) for development works. It can hardly be expected to finance a project cost of Us.$ 4000m.!

The strategy detailed in this paper there fore proposes to build on the current strengths of the existing transportation network, optimize its utilization, convert the threats into opportunities and shun the temptation to make Mumbai look like Shanghai or Singapore by taking up grandiose projects like trans- harbor sea links, elevated light rail or ‘Sky bus’ projects. In fiscally constrained times the only prudent alternative is to OPTIMIZE available infrastructure. The proposals for the transportation strategy outlined in this paper attempt just that.

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