Bus Rapid Transit System for Mumbai

Introduction

- The current bus transit system in Mumbai is catering about 4.5 million commuters per day, which is about 40% of the total commuters in the Mumbai city
- The average speed of bus -ordinary routes is 12 Km/Hr. **Limited Routes ,16 Km/Hr**.
- The total fleet -3,380 buses. The capacity per bus is 74. some routes 90.
- buses share the lane with other vehicles which affects their speed, capacity, reliability, and quality of service
- The slow speeds result in large waiting times at the bus stops, reduces the reliability of the system, hence people are shifting to other modes of transport and contributing to congestion on the roads.

Need for Study

- Queuing of buses in normal traffic in congested city roads.
- Increased time of travel, decrease in service, comfort and quality.
- Increase in number of private vehicular traffic.

Concerns

- HCBS -to increasing ridership that contributes to relieving traffic congestion.
- Separate lane allocation - needs extra space for one lane on the road, due to lack of space on the existing roads, it is important to justify the provision of separate lane for buses.

BRTS

Definition

- It incorporates most of the high-quality aspects of metro systems without the high investments
- It uses available space on arterial roads of cities with dedicated busways.
- It utilizes modern technologies for optimizing flow, passenger movement, ticketing, bus scheduling, and traffic signal priority.

Some Characteristics of BRT

- Exclusive Travel-Ways for buses
- Modern Buses
- Rapid boarding and alighting (efficient DISPERSAL)
- Efficient fare collection (Contact-less cards)
- Comfortable and efficient shelters and stations
- Advanced Traveler Information System (ATIS)
- Automatic tracking of buses
- Efficient fleet management
- Optimized schedules and routes

BRTS for Mumbai Scenario

- Demand oriented – stated preference
- 30 mts wide road [JNNURM Norms]
- Capacity (PAX) per lane at 60 dispatches and 70 passengers = 4200 PPHPD.
- For **5.5m lane** capacity = 60*3.5 =210PCU
  = 120*60 =12600 PAX
- Capacity Enhancement = 3*2 (for articulated buses)
  = 5 to 6 times

- Reduction in capacity with 1.5 lanes on either side = 2000*1.5

  = 3000(PCU's)* 1.2 Pvt Veh occupency

  = 3600
- Net gain = 4200
- % gain = **50% in terms of PAX**

  = 200% in terms of articulated buses.

Assumptions

- All cars with occupancy=1.2
- But its proportion 20% in the total traffic mix
- Physically segregated
- Treatment at junctions [Sion-Dadar BRT Lane with mixing at Matunga circle]
- Passengers dispersal
- Station Spacing 0.5kms Bagota ,Mumbai 1.0-1.5 kms
- Cost of real BRTS won't be not less than LRT with total segregation, passengers safe dispersal, with elevators and lifts at some places
- Sustainability – Pollution may increase unless ETB
  - or but decreases with more fuel efficient pvt

Bogota, Columbia BRT

Case Study: TransMilenio, Developed for Bogota,Colombia

What is TransMilenio?

- A High Capacity – Low Cost Bus Rapid Transit System in Bogota, Columbia.
- Started in December 2000.
- By April 2002, **it moved 650,000 pass/day in 38 Km busways, 62 stations,470 articulated buses and 300 feeder buses operating 125 Km routes.**

Need for TransMilenio

- Transport system in Bogota **does not provide a sound basis for competitiveness, quality of life and sustainability**.
- Long trips with 1hour and 10 minutes and a speed of 10 Kmph.
- High Pollution and Accidents
- Now with **mobility strategy, increase in NMT trips and restricts automobile use.**

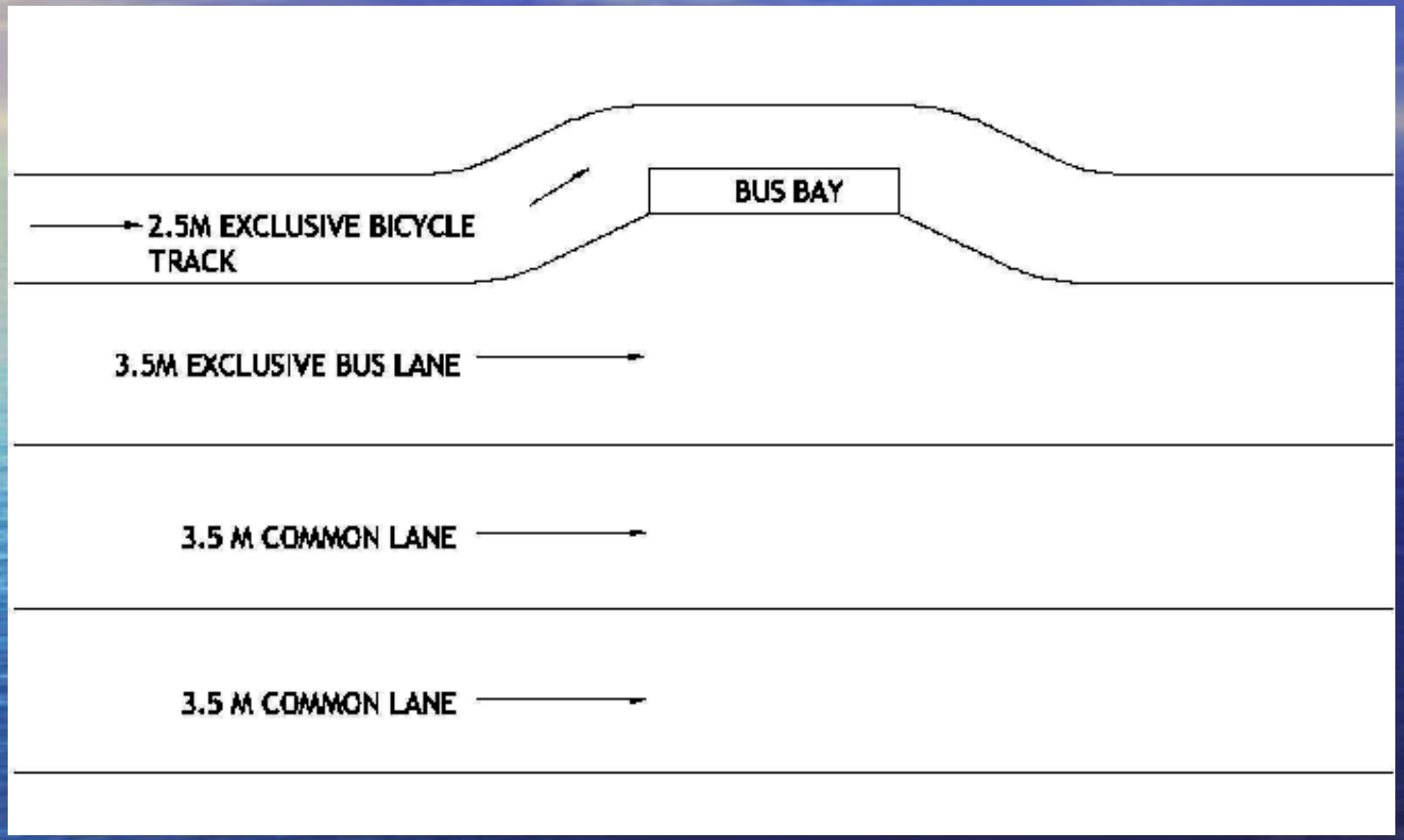
- 16% trips with private vehicles that uses 95% space.
- **Mumbai 6-8% pvt use 24-32 % road space**
- Insufficient road maintenance.

Solutions

- Exclusive busways and feeder system.
- Increase bicycle use from 0.5 to 4%.
- Auto restriction

Results

- Speed increased from 10 Kmph to 15 Kmph in Peak period
- **Bikeways, sidewalks and pedestrian malls recovered a great deal of space previously invaded by private vehicles.**
- **Increase in non-motorized travel (bicycle utilization close to 4%) (www.sinmicarroenbogota.com)**



Layout of Bicycle track and exclusive bus lane at bus stop

BRT for Mumbai

Potential corridors

- Western Express Highway - 27.3km
- Eastern Express Highway - 28.4 km
- LBS Marg - 22.2 km
- SV Marg - 22.5km
- Jogeshvari – Vikhroli Link Road
- Santacruz – Chembur Link Road.

BRT Stations

Spacing & Location:

HCBS stations often are tied to major activity centers such as malls, or business parks

- Spacing depends on the mode of arrival of passengers to the stations

Main Arrival Mode	Spacing (Kms)
Pedestrians	0.4 – 0.5
Bus	0.8 – 1.6
Automobile	3.2

Physical Advancement of the Mobility Strategy

Program	Units	1998	1999	2000
Bikeway Construction	Km	2.0	**17.0**	1.5
Busway Construction	Lane – Km	**16.0**	**36.5**	2.8

Source: IDU

Lessons Learnt

- Need to act simultaneously in several transportation subsystems to achieve integral and land use planning.
- Set up of task forces allowed institutional coordination and fast execution of processes.
- Seek financial sustainability of each initiative such as fuel taxes, property value capture, tolls, privatizations.
- Provision of services in Private sector.

Implementation of TransMilenio System

Infrastructure

- Includes **three trunk corridors covering 38 Km and seven feeder zones with routes covering 125 Km**
- System has 4 terminal stations, 4 intermediate stations and 53 stations.
- Additionally, 17 pedestrian overpasses, plazas and sidewalks.
- Total investment was US$213 million, with a local fuel surcharge(46%).

Implementation of TransMilenio System....

Operations

- System started moving with 18,618 passengers.
- Demand grew to 650,000 passengers per weekday in April 2002.
- Maximum **ideal** capacity was 35,000 pass/hr/peak dir.
- **Daily Kilometers per bus have been growing from 216 to 320.**

Implementation of TransMilenio System....

Ticketing

- Started with manual procedures.
- Tests with **intelligent contact-less cards** started.
- Introduction of **multiple-trip electronic card**.
- Daily revenue is around US$300,000.

Impacts

Accidents and Air Pollution

- **With city-wide total integrated transport network and land use planned & with shift to BRT**
- Fatal reduction : 89%
- Reduction in injuries from accidents: 75%
- Collisions reduction: 79%
- Muggings declined:47%
- Pollutant reduction

  Sulphur Dioxide :43%

  Nitrogen Dioxide:18%

Travel Time

- Speeds increased to 26.7%.
- 32% reduction in average trip time for users.

Equal Opportunity Access

- Fully accessible for users with disabilities, elderly, youngsters and pregnant women.

Quality and Consistency

- Poll shows that the system is 49% very good and another 49% good.

For Mumbai SP Survey ??

Affordability

- A trip costs US$ 0.4 which includes capital investment, operation and maintenance of bus fleet and ticketing system etc.

Conclusions

- **Less travel time**

  Exclusive travel ways save about 1-2 minutes per Km traveled

- **Less congestion**

  HCBS reduces congestion significantly at a less cost as compared to grade separator

- **It's as good as grade separated**

- **More capacity**

  Number of bus riders in exclusive bus lane exceeds number of private vehicle users in adjacent lane

- **More safety**

  Separate bus lanes and bicycle tracks reduces conflict and congestion which results in more safety

- **Reduction in fuel consumption and pollution**

- **Improvement in accessibility of transport in the cities**


LET KNOWLEDGE SERVE THE CITY
Thank You!

Integration of Transportation Modes

(Essential Input in Integrated City Growth)

Integration of the Transport System

Integration of existing rail and bus transport along with a sustainable solution

- Twin railway corridor (WR & CR)
- Proposed Metro Railway corridor
- Proposed High Capacity Bus Corridor
- Existing BEST bus routes
- New concept of Sky Bus metro
- Environment friendly Battery Powered Electrical Vehicles
- Battery Powered Vehicle

Integration at 3 levels

- Physical
- Institutional
- Operational

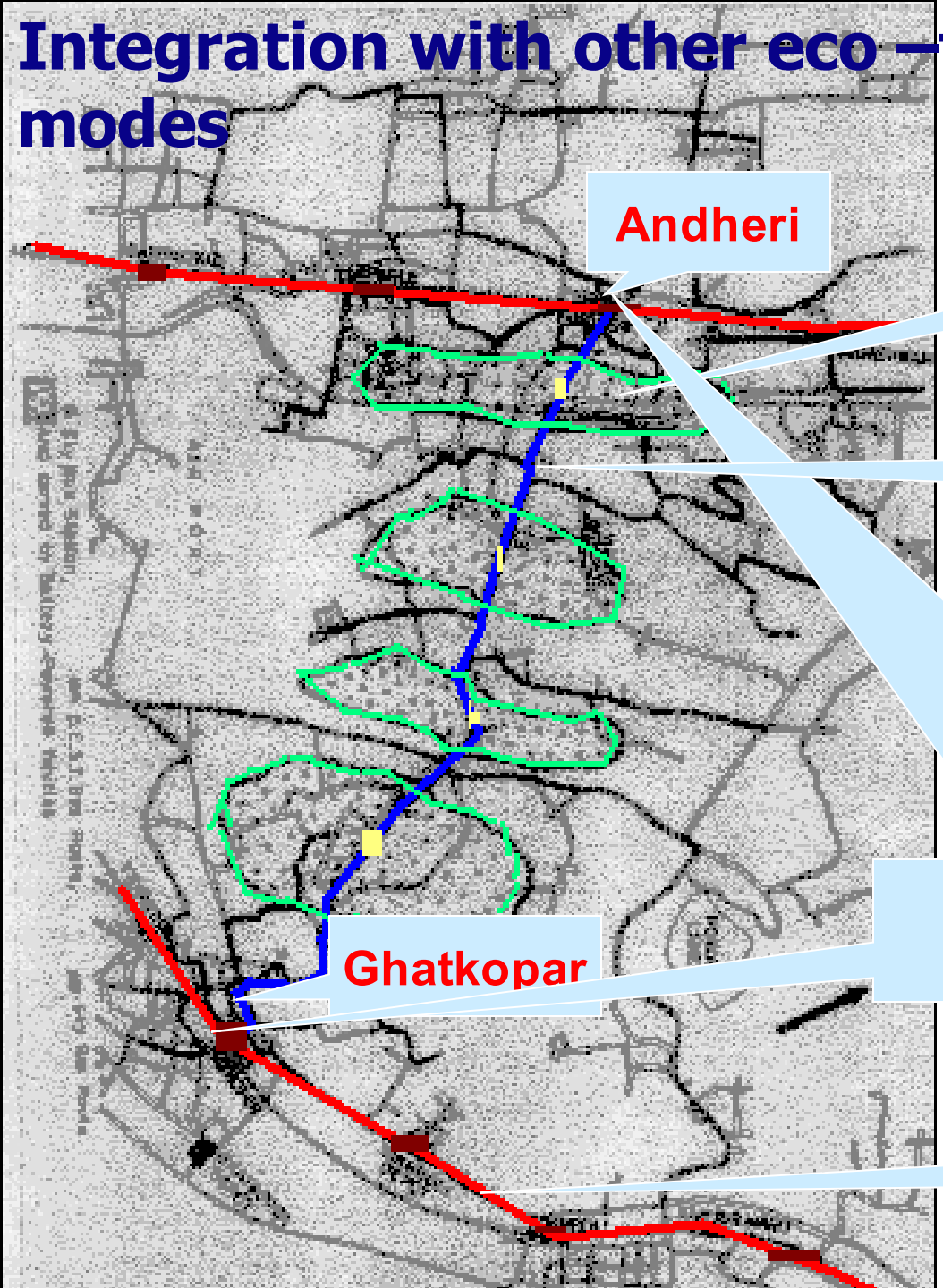
Advantage of the Integration

- Demand is sliced in each mode with route integration

- Proposed integrated systems can
  - drastically reduce the time of travel for the cross railway stations
  - increase the accessibility of the system
  - increase the safety of users
  - reduce the fuel consumption and emissions
  - reduce operation cost and user cost
  - be proved environmentally, economically and socially viable

- Similar approach can be implemented to other growing or mega cities of India

Integration with other eco –friendly mass transit modes



Battery operated Vehicles
Feeder route services

LRT/Sky Bus

Proposed Integration of
ndheri-Ghatkopar route

Bus Network strengthen
neighbour zones movement

Suburban/metro

Proposed Integration in Mumbai

Alternative Fuels for Sustainable city Growth

Alternative Fuels

Definition

- Fuels derived from non – crude oil resources
- e. g. All vehicular fuel other than petrol and diesel
- Example includes CNG, methanol, biodiesel, hydrogen and electricity

Why alternative fuels are important

- Cost effective reduction in harmful emissions
- Better environment
- Reduced health risks

Compressed Natural Gas

- As a transportation fuel, natural gas, a fossil fuel, is compressed
- Compression decreases storage vol. to obtain operating range
- High octane rating hence good spark ignition engine fuel

Disadvantages

- Storage at sub zero temp. needs high insulation materials
- Contributes to Global Warming when released in atmosphere
- Decreased specific power output of vehicles
- Hurts vehicle acceleration due to heavy weight

CNG may be Polluting !!

Most Significant Emissions		HIGHEST → LOWEST
1	NO_X	Diesel baseline ~ Diesel/CRT > CNG
2	Total PM Mass	Diesel baseline >> CNG > Diesel/CRT
3	Total Ultrafine Particle Number*	Diesel baseline > CNG ~ Diesel/CRT
4	Aldehydes**	CNG > Diesel/CRT
5	Mutagenicity	CNG >> Diesel baseline ~ Diesel/CRT
6	PAH Species***	Diesel baseline > CNG > Diesel/CRT
7	NO_2/NO_X	Diesel/CRT >> Diesel baseline ~ CNG
8	CO_2	Diesel/CRT ≥ Diesel baseline > CNG
Other Measured Emissions		
9	Nonmethane Hydrocarbons	CNG >> Diesel baseline > Diesel/CRT
10	Other Toxic Hydrocarbons	CNG > Diesel baseline > Diesel/CRT
11	CO	CNG > Diesel baseline > Diesel/CRT

* The ultrafine particles measured for the CNG bus appear to be smaller relative to the diesel particles.

** Diesel baseline samples invalidated.

*** Excluding naphthalene, due to contamination of sampling media.

Mutagenicity via Modified Ames Assay

Modified Ames Assay Results

Normalized Potency (Rev./µg) for TA98 w/o S9 - CBD