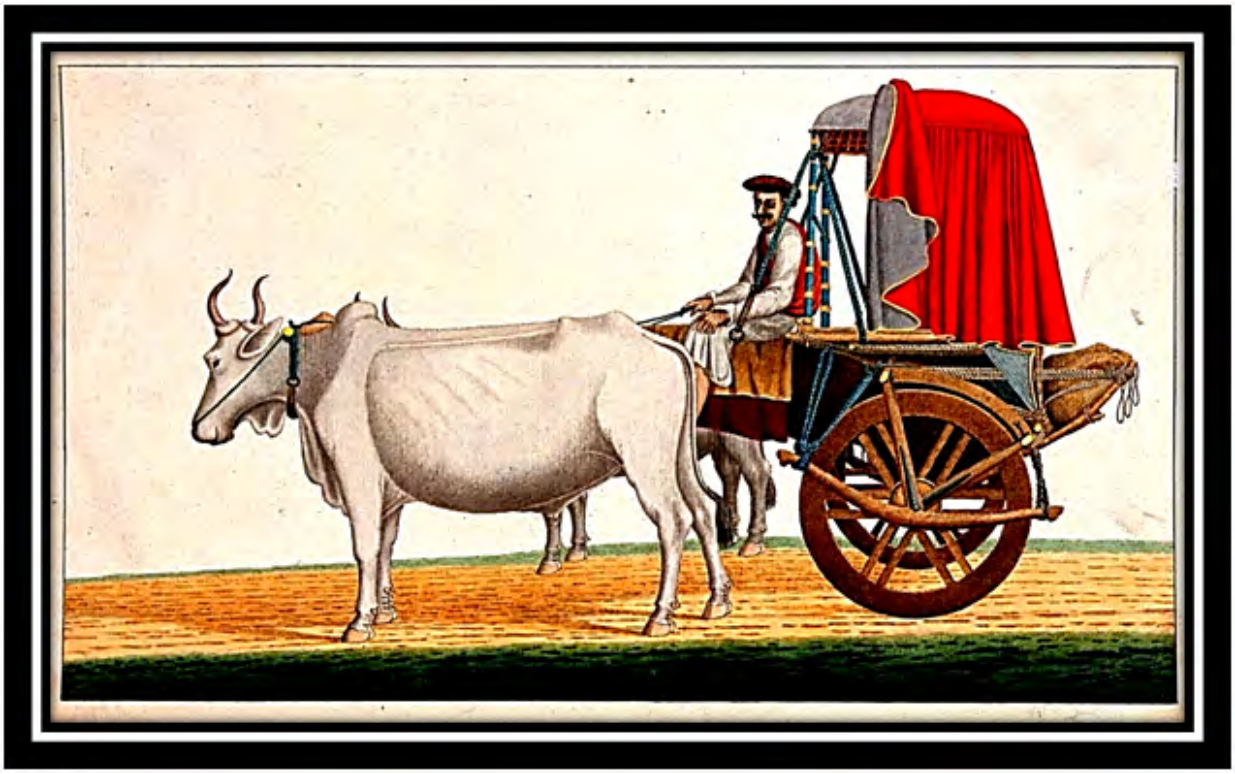
Urban, suburban, interurban and regional public TRANSPORT TECHNOLOGIES improving the Economy and the Living Standards of the Population in India



Once upon a Time Transport in India

Feature Article in Pictures
by Dr. Frank Wingler, February 2020

ANNEXURE: Picture Gallery of Indian Metro Rail in Operation

Urban, suburban, interurban and regional public TRANSPORT TECHNOLOGIES improving the Economy of India and the Living Standards of the Population

"*Incredible India*" is the slogan of the Indian Ministry for Tourism. The often chaotic traffic situation in India is "incredible" for those, who cannot see the hidden rules behind the traffic chaos.

Feature Article in Pictures
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ANNEXURE: Picture Gallery of Indian Metro Rail in Operation

Chaotic Traffic in India

A Mix of "Para Transit Modes", Buses, On-Demand Mini-Buses and Rickshaws, Hand pulled Carts, Delivery Goods Transport, individual private Cars, Bikes, Bike-Rickshaws and Pedestrians fighting for a Tournament through clogged Streets

I. PREFACE/INTRODUCTION

Traffic congestion has increased dramatically in India. Congestion and the associated **Slow Urban Mobility** can have a huge adverse impact on both the quality of life and the economy. Are all cities in India congested or just some of them? Are Delhi and Mumbai less or more congested than, say, Patna and Varanasi? Are mobility and congestion different within cities across the centre and periphery, and at different times of the day? What does the future hold? – see: **Ejaz Ghani** :***India's Urban Mobility and Congestion Problem;*** 01. Oct. 2018, 01:06 AM IST:

Slowest top 10 cities

Rank	City	State
1	Kolkata	West Bengal
2	Bangalore	Karnataka
3	Hyderabad	Andhra Pradesh
4	Mumbai	Maharashtra
5	Varanasi	Uttar Pradesh
6	Patna	Bihar
7	Delhi	Delhi
8	Bhagalpur	Bihar
9	Bihar Sharif	Bihar
10	Chennai	Tamil Nadu

Fastest top 10 cities

Rank	City	State
1	Ranipet	Tamil Nadu
2	Srinagar	Jammu and Kashmir
3	Kayamkulam	Kerala
4	Jammu	Jammu and Kashmir
5	Thrissur	Kerala
6	Palakkad	Kerala
7	Chandigarh	Chandigarh
8	Alwar	Rajasthan
9	Thoothukkudi	Tamil Nadu
10	Panipat	Haryana

The State of Urban Mobility in Indian Cities

"*URBAN MOBILITY*" in India`s Mega Cities

Chaotic Traffic in Chandni Chowk, Delhi | PTI

While the majority of Indian citizens still live in rural areas, last estimated at 70 percent of the total population — cities in India are also growing, with the number of inhabitants currently in the hundreds of millions. By 2030, India will see the rise of some 68 urban sprawls, each with a population of more than one million; the entire continent of Europe only has 35. It is indisputable that cities are the engines of economic growth. To realise the full potential of its economy and demography, India must not only look to increase its rate of urbanisation but also enhance the quality of life in existing cities. Today, Indian cities are characterised by increasing levels of congestion, pollution, road fatalities and inequity in access. To build inclusive, safer, and more sustainable cities of tomorrow, technology will play a decisive role in identifying mobility gaps and transforming existing transportation services.

The discussion around **Urban Mobility** in India stands transformed today for two reasons. First, technology has enabled real-time analysis of public transportation

routes and traffic patterns, that was previously not possible. Second, public sector agencies have now begun to encourage the use of public transportation through new mobility business models such as on-demand and multimodal trip-planning applications. This is the reflection of a global trend, where governments and businesses are exploring mobility solutions through **Multimodal Transportation** — where users will have the option of seamlessly integrating services like public transportation and ride-sharing, instead of having to choose one over the other. **Integrated Payment Systems** such as London's Oyster and Singapore's EZ-Link allow users to opt for different modes of public transportation through a single smartcard. These solutions, however, cannot be realised through the efforts of any one entity alone. **Integration** will require collaborative efforts by a diverse set of stakeholders: Among them, central and state governments, transit agencies, infrastructure developers, transportation service providers, and data scientists.

With escalating chaotic situation of public transport and with demands caused by rapid urbanisation in India, innovative multimodal transport solutions and methods are being evolved and borrowed from other countries.

Urban transport in most Indian cities is under heavy strain, and has negatively affected the quality of life of urban population (Verma 2010). Facilities of mass transit in the cities are utterly insufficient for providing fast, comfortable and convenient travel. This has resulted in heavy shift of commuter patronage from mass transit to private or personal transport, and as a consequence there is huge increase in personal vehicle ownership. The resultant effects are, increased traffic congestion and transport-borne pollution, heavy fuel consumption, poor level of service to the commuters, etc. Still, million plus cities generates more travel demands, which is not fully met by private modes of transport, as a consequence mass rapid transit system becomes mandatory for such cities, to provide better, advanced, efficient and quality transit services. Many steps are being taken by the Indian Government to promote sustainable urban transport. "Multimodal Integration" and "Seamless Integration with other Modes of Transport" have become an official Strategy; see: In Conversation with Mr. Pankaj Kumar Bansal, I.A.S. on Features of Chennai Metro in Rail Analysis, April 11, 2019 Interviews; and Tejas Rawal et al.: ***INTEGRATED MULTI-MODAL TRANSPORT IN INDIA;*** Changing Spectrum of Human Settlements and Planning Education ISBN 978-93-5053-361-1l (Portfolio 6, Metro Newsletter 82, http://www.drwingler.com. See also: ***Preparing for the Future of Urban Mobility in India – Meeting Urban Mobility Challenges*** by Madhulika Srikumar in Special Report No. 37, Observer Research Foundation, July 11th, 2017.

With Population Numbers growing and an Increase in private Vehicle Use, India currently experiences major Road Congestion on a daily Basis

I**t is national policy to easy the often chaotic traffic in Indian Cities by deploying modern, world class standard modes of urban, suburban, interurban and regional public transport. It is part of India` strategic planning and regime. The government looks to make sustainable urban transport a priority. Aim is to improve the Economy and the Living Standards of the People/Population by developing Urban Transport Infrastructure with for URBAN MOBILITY as a SERVICE (MaaS) IN INDIA boosting the socio-economic development for building a strong and prosperous Indian Nation.**

In a move to recognise and act upon urban mobility issues, in 2006 the Federal Government of India introduced the National Urban Transport Policy (NUTP), setting the policy framework for providing sustainable mobility for the future. In 2015 the government unveiled its new plan to upgrade 100 cities into 'smart cities' and to 'renew' 500 cities; see also ***NEW TOWNS OF INDIA***; Posted by: Jatin Patel - on November 19, 2013 ; Urban News Digest.

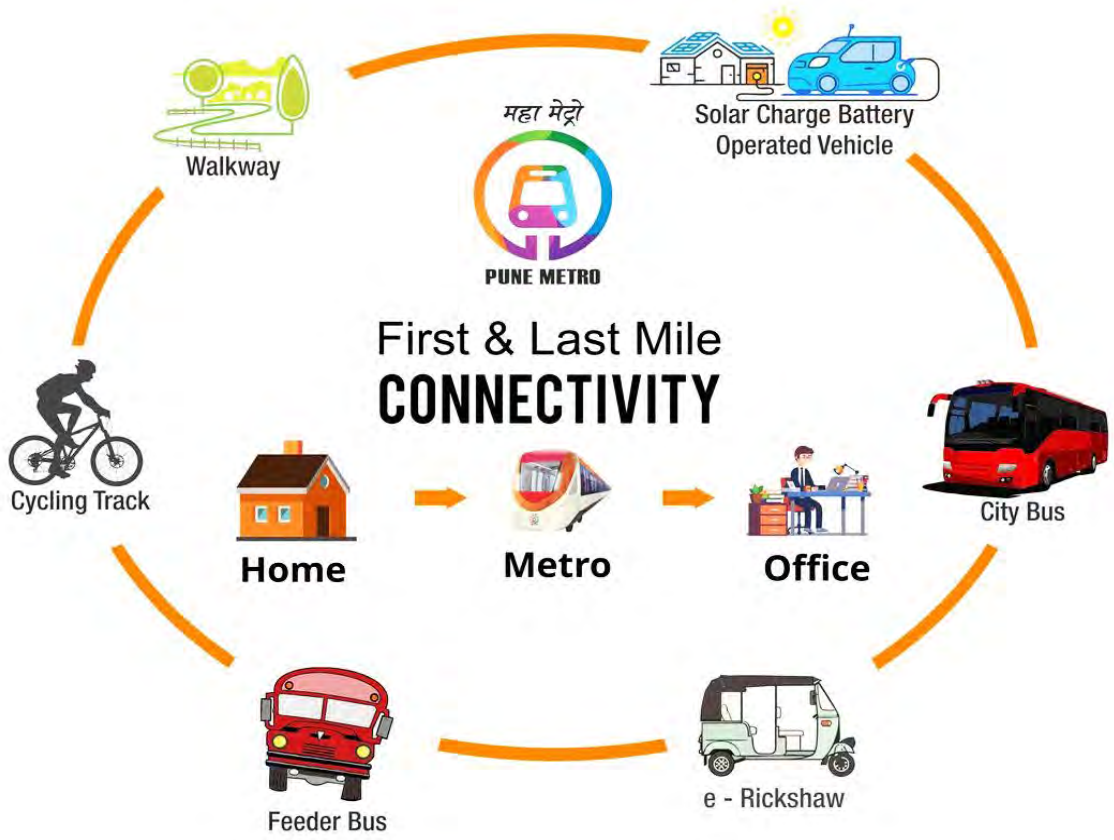
The governmental Transport Orientated Development (TOD) objective is to improve URBAN MOBILITY IN INDIA. Managing the Urbanization Process is likely to be the single biggest Challenge, that will confront Policymakers in India over the next Decade. While public Transport should be able to match the demand, they also need to be self-sustaining in Terms of Revenue.

The fast paced implementation of **METRO RAIL** in several mega cities has become a main constituent within the Governmental Transport and Traffic Policy for urban development. **METRO RAIL** has become in several cities the main backbone or "lifeline" for **URBAN MOBILITY IN INDIA** as a Service boosting socio-economic development. The rapid success with Metro Rail is owed to the fact, that India has imported the technology from abroad.

Metro Rail is an expensive asset. Once built, it must be easy accessible and optimally utilized**.**

However, **METRO RAIL** in India serves mostly only certain corridors. To make **METRO RAIL** viable and to operate economically, it needs affiliated supplements, complements and accessories. **FEEDER SYSTEMS** and multimodal **CONNECTIVTY HUBS** link **METRO RAIL** with the other modes of transport: Railway, Commuter Rail, Light Rail Transits, Bus Rapid Transit, Water Metro, Ropeway and Para-Transits,

that cover wider areas. First- and Last-Mile connectivity enlarging the catchment area for commuters; see Vinodh Shah: ***The Government of India shifts Focus to last Mile Connectivity in Metro Cities,*** Urban Transport News, 23.10.19.



In Delhi 54 % of the City`s Population lives up to 1 km in reach of the next Metro-Rail Station by walkability. In Mumbai the percentage is only 9 % of the dwellers, that could reach a Metro Station within a distance of 1 km.

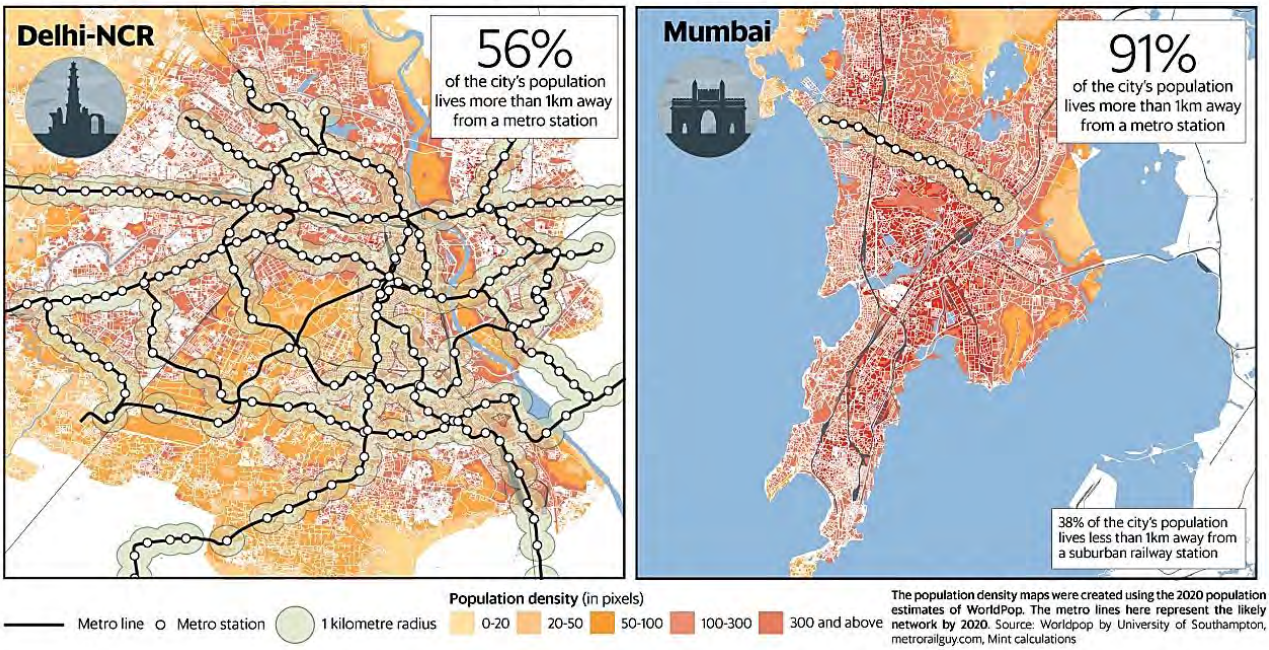
Some other world metropolis like London, Paris, Berlin has a denser Metro Rail network. Zurich has a dense city tram network with a maximum walking distance of 300 m to any next halt or station.

In Mumbai and Chennai **Commuter Rail** with local trains play a significant role for **Urban Mobility**. **Commuter Rail has a far higher transport capacity and runs faster than Metro Rail!**

Bangalore plans to increase the Commuter Rail Network by 148 km with 57 Stations.

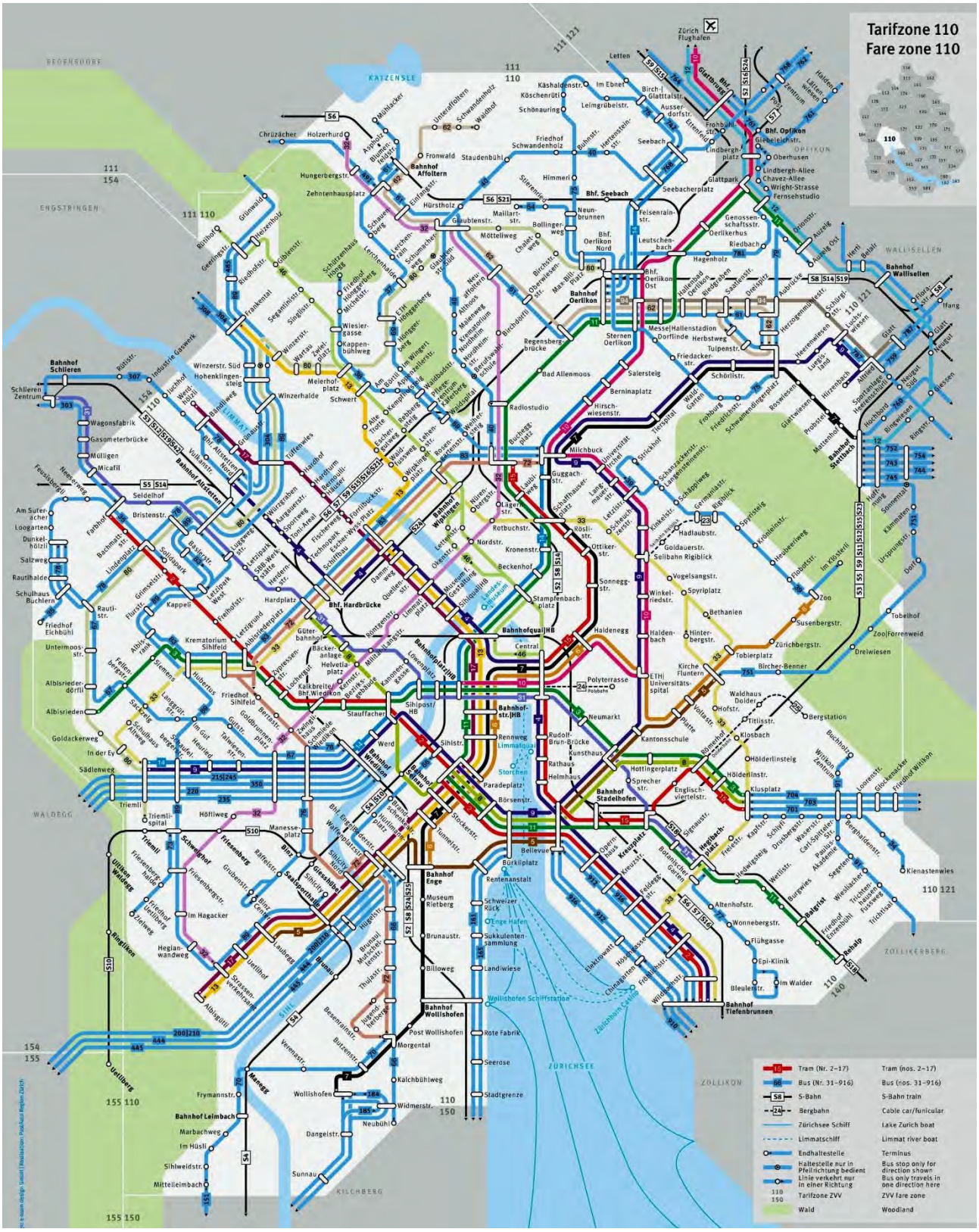
Chart 1a

India's biggest metropolitan cities are a contrast in terms of metro access



The population density maps were created using the 2020 population estimates of WorldPop. The metro lines here represent the likely network by 2020. Source: Worldpop by University of Southampton, metrorailguy.com, Mint calculations

Map of dense Public Transport Coverage by Underground in London



Zurich City Transport Map; Maximum walking Distance to any next Halt or Station is 300 m. Zurich has decided not to dig Underground for Metro Rail but to provide a dense integrated Network of City Tram, Commuter Rail, City Bus and Water Transport

Dens**e** Network of City Trams on Meter Gauge in Zurich, Switzerland

“METROLITE”, **“METRO ON TYRES”**, **“METRO NEO”, “WATER METRO”, aerial “ROPEWAY”, “METRINO”/”SKYTRAN” and “FEEDER/SHUTTLE SERVICES”** are the new envisaged affiliated modes, that will supplement **METRO RAIL FOR URBAN MOBILITY IN INDIA**, and that have to be integrated in the traffic and transport schemes through **CONNECTIVITY HUBS**.

METRO RAIL as an **INTEGRAL** together with the other integrated modes of urban, suburban, interurban and regional public transport shape **URBAN MOBILITY IN INDIA.**

However those modes do not solve the problems caused by Delivery Goods Transport in congested cities.

The solution to this challenge has been largely centered on metro rail networks, which have had a mixed record across cities so far. Currently, there are **639 km of Metro Rail in 13 cities, with more than half of it in Delhi (373 km)** and several hundred kilometers being proposed, approved, under planning or under construction in 22 more cities.

Map of Urban Transport Systems in India

II. URBAN MOBILITY as a SERVICE, MaaS

Urban Mobility is a Service for the economic wellbeing of India with its population. A central principle of integrated **Urban Mobility** is the need or collaboration between modes instead of competition. Technology can only support seamless intermodal journeys if the barriers to integration are removed. Like many aspects of smart cities, this is a matter of public policy and not something, that can be left to the market to regulate.

While the term ***SMART CITIES*** (which are also emerging in India) might interfere notions of hidden forces controlling even the minutest aspects of daily life, the concept is less like

a science fiction movie and more finding a balance between technology, governance and the needs of people and business.

The ability of local governments and other stakeholders to develop robust smart cities strategies will be crucial in addressing the future challenges facing the world`s growing urban population.

Mobility as a Service, MaaS, is gaining ground around the world, and already offers a flexible approach to enhancing traditional public transport provision in several cities. MaaS can be defined as the integration of different transport modes into a single service accessible on demand. Users can plan and pay for the whole door-to-door journey based on what and how much they use.

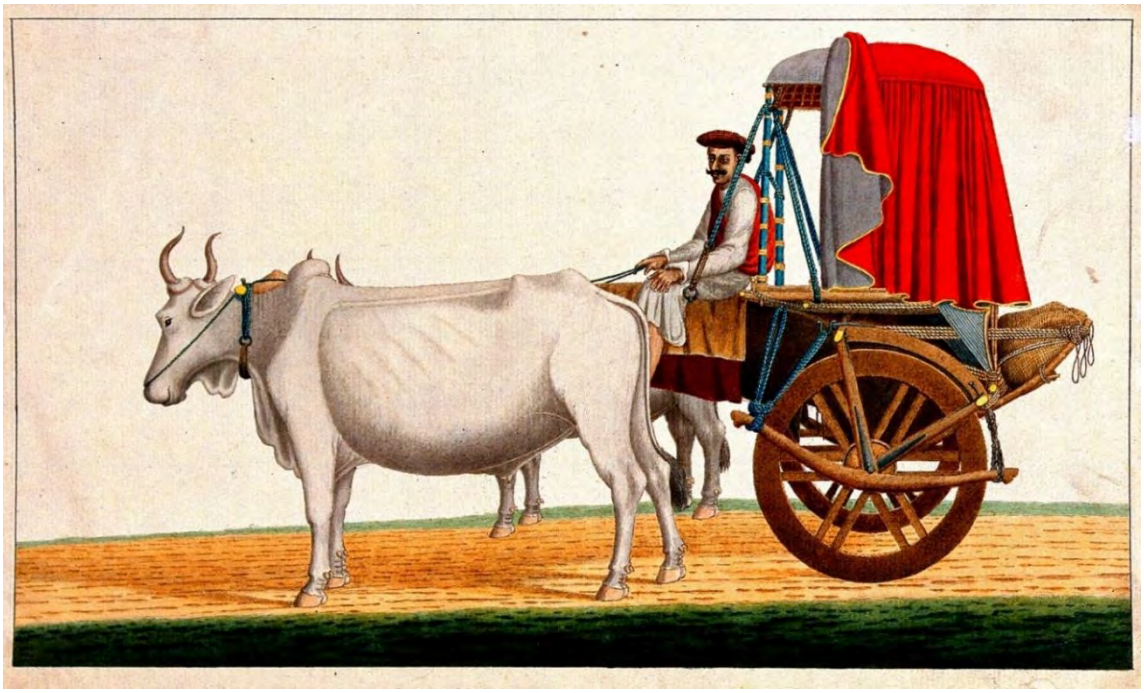
The **MaaS Concep**t brings together route planning, real-time vehicle data, ticketing and payments across transport modes. Such a multimodal offering could encourage people to make fewer journeys by private car, helping to reduce traffic congestion. But while this approach can lead to a seamless experience for passengers, it is about more than simply offering multiple modes. Embedded payment and ticketing represent a fundamental part of enabling public transport within MaaS, and must not be forgotten

See: ***Reshaping Urban Mobility for the Metropolis of the Future - Central Principles of integrated Urban Mobility as a Service (MaaS);*** International Railway Journal, February 2019, page 40.

See also ***Rapid Strides in Urban Transport & Mobility*** from the Desk of Maniging Editor; Metro RAIL News, November 2019:

With rapid urbanization, the pressure is mounting on the public transport system from the people living in cities and towns across the country. Mass Rapid Transport System, MRTS has emerged as one of the most effective means of mobility for the citizens in tier-1 and tier-2 cities and Metro has been a major player.
Metro Projects have not only added to connectivity, it has reduced the travel time and hence enhanced the ease of living substantially in the urban areas. It has also led to creation of direct and indirect employment opportunities. It is expected that with the expansion of Metros in the cities, local and intercity travel will be easier, mobility and connectivity will be enhanced giving a fillip to local business as well.

III. CHALLENGE TO PROVIDE AFFORDABLE TRANSPORT FOR THE MASS OF LOW INCOME POPULATION; Para-Transit Services and Connectivity; Freight and Goods Transport in Urban Environment – the unsolved Problems



Privileged Mode of Transport once upon a Time

Cities across the world are racing to cope with rapid uncontrolled urbanisation. As quoted by United Nations, 54% of the world's population lives in urban areas, a number that is expected to increase to 66% by 2050. This dramatic rise in urban population necessitates reshaping the real estate landscape across the globe through **Transit-Oriented Developments (TOD)**.

TOD is a remedy for growing cities in the Asian region, which to date have been characterised as unsustainable, car-dependent and transit-poor urban sprawl. TODs are seen as the road to sustainable growth. Cities now see transit as an investment for the future and realise its capability to promote economic development, enhance real estate value and increase favorable labour access. A key aspect that developers need to focus on is creating a TOD that is not just easy to manage but enhances place making and ensures the right balance between transit, residential, retail, commercial and spaces for activities within the area. TODs should enable residents to live, play and work in the same area, making cities livable. It is also important to integrate walkability in the TOD system. This includes convenient pedestrian connections and accessibility to a variety of transit stations and nearby neighborhoods. This indirectly helps create sustainable cities. A seamless integration between transits, the surrounding mixed-use development and residential areas are crucial in creating a world class TOD.

Growth opportunities of a country are linked to the mobility of people, to the transport facilities for goods/freight and information.

Managing the urbanization process is likely to be the single biggest challenge, that will confront policymakers in India over the next decade

However, India is still far away of being a ***"developed country".*** The challenge is to provide also public transport for a reasonable prize to the mass of low income population. The majority of the population still belongs to the ***"low income"*** groups.

Metro Rail is by no means the sole remedy for India's transportation problems, as some technocrats might suspect.

Metro Rail is expensive and a high capital investment intensive and mode of public transport. The roadway has to be co-financed with the tickets. For the Mumbai Metro Rail project it is estimated that average cost of these projects is INR 4.54 billion (454 crore rupees) per km. Buses, Para-Transits and On-Demand-Transport Modes need lower investment costs and can use existing roadways.

Despite the rapid deployment of **Metro Rail** in India, most cities will have large shares of their population away from a rapid mode of transit for the foreseeable future (see: ***India's public Transport Challenge;*** Metro Rail News, October 2019).

If the cost of a transport service is not affordable, the commuter will be constrained to shift to a cheaper mode, overlooking the comfort parameter like that of **Metro Rail**.

Intermediate Para-Transit Services (IPT) are cheap and flexible and not fixed to certain routes. IPT is mostly the backbone of public transport in cities with low income population around the world. **Intermediate Para-Transit Services** have to be incorporated into the strategic planning for Indian cities; see ***INTEGRATING PARATRANSIT SYSTEMS IN INDIA*** Madhu.S Centre for Public Policy Research, Kochi, Kerala; Urban Mobility India Conference 2013; http://www.civitas.in, http://www.cppr.in.

From the Ojek (motorcycle-taxis) in Indonesia and the shared Song Thaew in Thailand to the ubiquitous rickshaws whether manual, electric or CNG across India, those para-transit modes play a critical role in urban mobility.

Para-Transits are mostly self-organizing. PT works well, if proper infrastructure, roads, parking space, adequate pick up/ drop areas/points and connectivity hubs are available. Para-Transit has to be integrated into urban transport and traffic schemes.

Heavily used On-Demand Minibus Transport in India

Regulation is anathema to politicians, who worry about employment and votes. Yet, the economic returns of a well-researched, professionally executed para-transit policy with soft regulation may work in everyone's favour. Passenger surveys could easily determine a base demand level for para-transit modes. This will allow a minimum number of these modes to be licensed in each station or administrative zone. Incremental licenses could be granted over time allowing some flexibility for latent market forces. Other innovative

models are also possible (see*: **First and Last Mile Connectivity: Overcoming a stumbling Block; India*** by Jhanavi J.; Metro Rail News, October 2019, page 61).

Existing Roads heavily used by a Mix of (Intermediate) Para-Transit (IPT)-Services, Buses, Taxis, Bikes and Delivery Vans/Lorries/Trucks in Mumbai

Existing Roads heavily used by a Mix of (Intermediate) Para-Transit (IPT)-Services, Buses, Taxis, Bikes, Delivery Vans/Lorries and Good Trucks in Jaipur

"Taking "Alwar" Share Taxi for a Ride"; IPT in Rajasthan

For low income population **Intermediate Para-Transit (IPT) Services**, which run on demand on not fixed routes, are more affordable. For a large proportion of town dwellers, **Metro Rail** remains still unaffordable. IPT provide also job opportunities. IPT has to be integrated in Transport strategies for better life in better cities.

In Mumbai the population and the distribution logistic depend heavily on subsidized **Commuter-Rail**, the so-called "locals". **Commuter Rail runs faster, runs more frequent and has a far higher transport capacity than Metro Rail**! In Mumbai, it caters to almost 80 percent of citizen trips. It is the cheapest mode of city travel anywhere in the world! So, who minds if one has to travel in 'super dense crush load' scenario than in either a first class or a second class compartment?

Mumbai`s Local Commuter Trains, the subsidised Life-Line of Mumbai, also for low Income Population

Affordable and eco-friendly IPT School Transport I

Affordable and eco-friendly IPT School Transport II

21st Century Common Men`s Para-Transport in Calcutta

The Government has to offer also for the low income population affordable public transport. This is now well understood in India. Authorities are looking for more economical and less capital investment intensive solutions as **"METROLITE**", **"METRO ON TYRES"**, **"METRO NEO", "WATER METRO", aerial "ROPEWAY" and "FEEDER/SHUTTLE SERVICES".**

IIIa. Flow of Goods and Warehouse Supply in India`s Cities – **the** unsolved Problem

Rickshaw Transport in Delhi

While Indian cities have taken steps to promote public transport to discourage the use of cars, relatively little has been done to facilitate the flow of delivery goods and warehouse supply in urban areas. **METRO RAIL does not solve this problem**

This unsolved traffic problem in many Indian Cities is caused by delivery, freight, cargo and goods transport and ware distribution without a solution in sight. Trucks and good carriers clog up city roads.

With the expected growth in domestic consumption, urban freight demand is increasing rapidly. Last-mile unit costs are around twice those of long-haul transport because of the high cost of disaggregating shipments for delivery and the effects of congestion.

To improve urban distribution efficiency, coordinated efforts are required from both the public and private sectors. For example, some urban logistics companies are developing offsite consolidation centres for joint distribution. **Freight transport planning in cities should be integrated into the urban transport planning and traffic management process**, which is currently focused in India nearly solely on passenger transport.

Trucks and Good Carriers clog City Roads; an unsolved Traffic Problem in India

Some transport modes are still “archaic”, however suit the circumstances and work:

21st Century Transport of Onions in Karnataka

IV. METRO RAIL FOR URBAN MOBILITY IN INDIA

(a) METRO RAIL IN INDIA,
meeting the demand for Urban Mobility, is a success story for its fast paced legislation, planning, financing, construction and operation; and in the last 14 years has significantly improved **URBAN MOBILITY** and changed the public transport in several Indian cities; see also survey in http://sundarmukherjee.blogspot.com and Metro Newsletter 47 in Portfolio 3 in http://www.drwingler.com.

Artist`s Concept for Ahmedabad MEGA Metro Rail

The **Kolkata** Metro was for 18 years the only Underground Metro Rail in India, opening for commercial services from 1984. It celebrates now its 35th anniversary.

35 Years Kolkata Metro Rail

Only after 18 years, **Delhi** was the second city to get Metro Rail. The construction started in 1998, and the first elevated section (Shahdara – Tis Hazari) on the Red Line opened on 24th December 2002, while the first underground section (Vishwa Vidyalaya – Kashmere Gate) of Yellow Line opened on 20th December 2004. Within only 15 years the network expanded to 343 km serving 250 stations. The system has a mix of underground, at-grade, and elevated stations using both broad-gauge and standard-gauge. Delhi Metro operates with 8 lines over 2,700 trips daily, starting at around 05:00 and ending at 23:30 hrs.

Delhi Metro is a Pioneer in METRO RAIL EXPANSION and a Symbol of the Progress, that India has made in the last decade. The leading eminent personality behind this success story is Mr. E. Sreedharan.

Elattuvalapil Sreedharan is an Indian civil engineer and a retired IES (IRSE) officer popularly known as the "Metro Man". He is credited for changing the face of public transport in India with his leadership in building the Konkan Railway and the Delhi Metro while he served as the managing director of Delhi Metro between 1995 and 2012

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First Bombardier *MOVIA* Metro Car for Delhi Metro Rail arrived February 2009 in India on-Board of Antonov Air-Carrier AN 124-100M

The following charts from Rail Analysis India, 2019, gives an update of the current state-of-affairs for Metro Rail in India`s Cities; see also ANNEXURE with Picture Gallery page 97 :

OPERATIONAL PROJECTS :

AHMEDABAD METRO

Project Description :

Transit type : Ahmedabad Metro
Number of lines : 2
Number of stations : 32
System length : 40.03 km
Track gauge : Standard Gauge
Average speed : 33 km/h
Top speed : 80 km/h

Latest Updates 2019 - 20

Mar 05, 2019 :	Hon'ble Prime Minister of India, Shri Narendra Modi dedicated Ahmedabad Metro Rail Project Phase-1 to the Nation
Feb 26, 2019 :	Metro tunnel from Apparel Park to Kalupur ready
Feb 20, 2019 :	Cabinet approves Ahmedabad Metro Rail Project Phase-2

BANGALORE METRO

Project Description :

Operator : Bangalore Metro Rail Corporation Ltd. (BMRCL)
Operation Start Date: 20 October 2011
Transit type : Rapid transit
Number of stations : 40
Operational System length : 42.3 km
Number of lines : 2 East-west corridor (Purple Line), North-south corridor (Green Line)

Latest Updates 2019 - 20

Mar 19, 2019:	Bangalore Metro gets 44 acres of forest land from Central government
Mar 04, 2019:	Track-laying work was in progress for the extended metro line from Yelachenahalli to Anjanapura under Phase 2
Dec 21, 2018 :	Upcoming underground stations of Bangalore Metro Rail to have Platform Screen Doors

CHENNAI METRO

Project Description :

Operator : Chennai Metro Rail Limited (CMRL)
Operation Start Date: 29 June 2015
Transit type : Rapid transit
Number of stations : 32 operational
System length : 45 km (operational) ; 54.1 km (Phase I and Extension)
Number of lines : 2 (Blue and Green Line)

Latest Updates 2019 - 20

Mar 18, 2019 :	32 Metro Stations awarded with IGBC Platinum Rating
Feb 12, 2019 :	Tamil Nadu Chief Minister seeks Centre's sanction for Chennai Metro phase-2
Feb 11, 2019 :	Rs 2,681 crore allocated for Chennai Metro Rail project

DELHI METRO

Project Description :

Operator : Delhi Metro Rail Corporation Limited (DMRCL)
Operation Start Date: 24 December 2002
Transit type : Rapid transit / Metro
Number of stations : 236, includings 6 Airport Express
System length : 327 Km
Number of lines : 8 colour Lines (Red, Yellow, Blue, Green, Violet, Orange, Pink and Magenta)

Latest Updates 2019 - 20

Mar 25, 2019 :	Uber, Ola to install kiosks at more Metro stations
Mar 18, 2019 :	Delhi Metro to conduct customer satisfaction survey from Mar 18 to Apr 14
Mar 11, 2019 :	300 Metre Pathway opened for switching between Noida Metro Aqua Line and Delhi Metro Blue Line

www.railanalysis.in

Chennai Metro

Bombardier *MOVIA* Metro **Train** for Delhi, India

GURGAON METRO

Project Description :

Operator : Rapid Metro Gurgaon Ltd. (RMGL)**Operation Start Date:** 14 November 2013
Transit type : Rapid transit
Number of stations : 11
System length : 11.7 km
Number of lines : 1
No. of tracks : 2

Latest Updates 2018 - 20

Feb 04, 2019:	DMRC to take over operations of Gurgaon Rapid Metro from Feb 5
Feb 04, 2018:	Introduce Dual Chip Pre-Paid Metro Wallet And Non-Transit Wallet By End-2018
Feb 04, 2018:	Gurgaon Metro Records Punctuality Of 99.88%, Availability Of 99.94%

HYDERABAD METRO

Project Description :

Operator : Hyderabad Metro Rail Ltd. (HMRL)
Operation Start Date: 29 November 2017
Transit type : Rapid transit
Number of stations : 40
System length : 46.5 Km
Number of lines : 2 (Operational) ; 3 (Phase I)
No. of tracks : 2

Latest Updates 2019 - 20

Mar 27, 2019 :	Hyderabad Metro Rail patronage reaches 2.20 lakh
Mar 20, 2019 :	Ameerpet to Hi-Tec City Metro Rail stretch flagged off
Mar 16, 2019 :	CMRS approves Ameerpet-Hitech city route

JAIPUR METRO

Project Description :

Owner : Jaipur Metro Rail Corporation Limited (JMRCL)
Operation Start Date: 3 June 2015
Transit type : Rapid transit
Number of stations : 9 (operational); 22 additional stations (planned)
System length : 9.63 km (operational); 23 km (planned)
Number of lines : 1 (operational); 1 (planned)

Latest Updates 2019 - 20

Mar 23, 2019 :	Jaipur Metro rail to be extended to Ramganj
Jan 08, 2019 :	Jaipur Metro Rail begins operations through Automatic Train Operation (ATO)
Sep 26, 2018 :	An Internal trial run of Metro on Phase-1B conducted

KOCHI METRO

Project Description :

Operator : Kochi Metro Rail Ltd. (KMRL)
Operation Start Date: 03 October 2017
Transit type : Rapid transit
Number of stations : 16
System length : 18.4 km
Number of lines : 3 (1 Operational/under construction, 1 Approved, 1 planned

Latest Updates 2019 - 20

Mar 22, 2019 :	Kochi Metro achieves 2 Crore travellers mark
Feb 23, 2019 :	Land acquisition for Kochi Metro extension gets a boost
Dec 21, 2018 :	Construction of iconic cantilever bridge at Ernakulam South completed

Gurgaon Mass Rapid Transit Metro

Elevated Cantilever Construction over Railway Line at Ernakulum for Kochi Metro

KOLKATA METRO

Project Description :

Operation Start Date : 24 October 1984
Transit type : Rapid transit
Number of stations : 24 Stations (Line 1/ North South Metro)
12 Stations (Line 2/ East West Metro)
12 Stations (Line 3/ Joka - B.B.D. Bagh)
9 Stations (Line 4/Noapara - Barasat)
11 Stations (Line 5/ Baranagar - Barrackpore)
23 Stations (Line 6/ Airport - New Garia)

Latest Updates 2019 - 20

Mar 05, 2019 :	Kolkata Metro's 1st Metro Rake from Overseas arrived in the city
Jan 12, 2019 :	State government allows to resume work on Joka-Esplanade Metro stretch
Dec 08, 2018 :	Railway Board gives nod to begin construction on Airport-Barasat Metro line

LUCKNOW METRO

Project Description :

Operator : Lucknow Metro Rail Corporation (LMRC)
Operation Start Date: September 05, 2017
Transit type : Rapid transit
Number of stations : 8
System length : 8.5 km
Number of lines : 1 (Operational) 1 (Approved) 6+ (Planned)

Latest Updates 2019 - 20

Mar 07, 2019:	Prime Minister Narendra Modi flags off Lucknow Metro's commercial run on the 23-km North-South corridor
Feb 25, 2019:	CMRS Gives Certification To Lucknow Metro Rail Corporation After 3 Day Successful Inspection From CCS Airport To Munshipulia
Feb 19, 2019:	Lucknow Metro Obtains Fire Safety Clearance For All The 13 Metro Stations Of The Balance Section Of The North-South Corridor (Phase-1a)

MUMBAI METRO

Project Description :

Owner : MMRDA, Mumbai Metro One
Operation Start Date: 8 June 2014
Transit type : Rapid transit
Number of stations : 12
System length : 11.4 Km

Latest Updates 2019 - 20

Mar 19, 2019:	Mumbai Metro One launches 2-in-1 travel smart card
Mar 15, 2019:	MMRDA plans Transit Oriented Development (TOD) along Mumbai Metro corridors
Mar 06, 2019:	MMRDA floats tenders for Construction of Metro Bhavan in Aarey

NAGPUR METRO

Project Description :

Transit type : Nagpur Metro
Number of lines : 2
Number of stations: 42
System length : 43 km
Operator : Maharashtra Metro Rail Corporation Limited (MAHA-METRO)

Latest Updates 2019 - 20

Mar 07, 2019 :	Prime Minister Shri Narendra Modi flags off the first phase of Nagpur Metro
Feb 23, 2019 :	MahaMetro Announces Inaugural Fare Structure
Feb 19, 2019 :	RDSO conducts a trial run from Khapri to Congress Nagar Metro stations

www.railanalysis.in

Lucknow Metro –fastest ever Metro Project Execution in India

Artist`s Impression of Nagpur Metro to be Part of India's first four-Layer Transport System

Mumbai Metro Corridor over the Slums

See also: "***Mumbai Metro: Here's all you need to know about the entire City Network"***; Updated: Sep. 13, 2019, 08:46 IST | Rajendra B. Aklekar; mid-day.
The full article of Rajendra B. Aklekar you find also on http://www.drwingler.com in Portfolio 7, free for download under the technical paper:
THE WORLD OF TRANSPORT TECHNOLOGIES; INDIAN AND GLOBAL ACTIVITIES FOR URBAN MOBILITY – METRO-NEWSLETTERS – gathered by Dr. F. A. Wingler, September 2019; published on: May 7, 2019 by Chaminda Weerawarna Category:Metropolitan Transport Schemes.

From Metro Rail, India, 2019:

UNDER - CONSTRUCTION PROJECTS :

NOIDA METRO

Project Description :

Owner : Noida Metro Rail Corporation (NMRC)
Transit type : Rapid transit
Number of lines : 1
Number of stations : 21
Operation will start : December 2018
System length : 29.7 km
Track gauge : 1,435 mm Standard Gauge

Latest Updates 2019 - 20

Mar 27, 2019:	6.45 lakh people used Aqua Line in 2 months
Feb 28, 2019:	Over 3.24 lakh passengers took rides on the Noida-Greater Noida Metro in the first month
Jan 30, 2019:	Over 37,000 passengers avail rides on Noida-Greater Noida Metro in first 3 days

AGRA METRO

Project Description :

Project Name : Agra Metro
Owner : Uttar Pradesh Metro Rail Corporation
Transit type : Rapid transit
Number of lines : 2
Number of stations : 27
System length : 30 km (Phase 1)

Latest Updates 2019 - 20

Mar 08, 2019 :	PM Modi laid foundation stone for Agra Metro Rail Project
Feb 28, 2019 :	The Union Cabinet, chaired by the Prime Minister Narendra Modi has approved Agra Metro Rail Project having two corridors.
Feb 11, 2019 :	State government allocates Rs 175 crore for Metro rail project in Agra

BHOPAL METRO

Project Description :

Project Name : Bhopal Metro
Operator: Madhya Pradesh Metro Rail Co Ltd.
Transit type : Light metro
Number of Corridors : 3 (planned)
Number of stations : 86 (planned)
Track gauge : Standard gauge
System length : 198.95 km (planned)

Latest Updates 2019 - 20

Dec 19, 2018 :	Excavation Work Begins for Metro Rail project in city
Sep 25, 2018 :	State Cabinet Clears Proposal for 500 Million Euros Loan from European Investment Bank (EIB) for Bhopal Metro Project
Aug 21, 2018 :	Dilip Buildcon Bags Rs 247.06 Crore Contract for Bhopal Metro Rail Project, Phase-1

INDORE METRO

Project Description :

Project Name : Indore Metro
Operator : Madhya Pradesh Metro Rail Co Ltd
Transit type : Light metro
Number of lines : 5 (estimated) , 5 (planned)
System length : 94 km (estimated)
Number of stations : 89 (estimated)
Track gauge : Standard Gauge

Latest Updates 2019 - 20

Oct 05, 2018 :	Dilip Buildcon Receives LoA for Bhopal and Indore Metro Rail Project Valued at 476.02 Crore
Sep 21, 2018 :	Dilip Buildcon Declared Lowest Bidder for Indore Metro Rail project, Phase-I
Jul 17, 2018 :	Tender Invited For Construction of Elevated Viaduct & Stations Between ISBT/MR10 Flyover and Mumtaj Bag Colony

KANPUR METRO

Project Description :

Transit type : Kanpur Metro
Number of lines : 2
Number of stations: 42
System length : 43 km
Operator : Maharashtra Metro Rail Corporation Limited (MAHA-METRO)

Latest Updates 2019 - 20

Mar 18, 2019:	Metro rail to promote Transit Oriented Development
Mar 01, 2019:	Metro Projects in Agra and Kanpur approved by Centre
Feb 12, 2019:	Public Investment Board approves Metro rail projects in Patna, Agra, Kanpur

MEERUT METRO

Project Description :

Project Name : Meerut Metro
Transit type : Rapid transit
Number of lines : 2 (Phase 1)
Number of stations : 29 (Planned)
System length : 35 km
Track gauge : Standard gauge
Average speed : 65 km/h
Top speed : 80 km/h

Latest Updates 2019 - 20

Mar 09, 2019 :	Prime Minister Narendra Modi laid the foundation stone for Meerut Metro Service at Sikandarpur in Ghaziabad.
Feb 19, 2019 :	Union cabinet approves India's first regional rail along with metro in Meerut
Sep 06, 2018 :	State Government Sends DPR for Starting Metro Rail in Kanpur, Agra and Meerut to Centre

NAVI MUMBAI METRO

Project Description :

Owner : City and Industrial Development Corporation (CIDCO)
Transit type : Rapid transit
Number of lines : 1
Number of stations : 20
Operation will start : May 2019
System length : 23.40 km (14.54 mi)
Track gauge : Standard gauge

Latest Updates 2019 - 20

Mar 13, 2019:	Two trains for Navi Mumbai Metro reaches Mumbai port
Feb 27, 2019:	CIDCO approved DPR for lines 2 and 3 under the Navi Mumbai Metro Project
Feb 18, 2019:	Work to install the 130-metre truss for the Navi Mumbai Metro over the Panvel-Diva railway line was completed

PATNA METRO

Project Description :

Transit type : Rapid Transit
Number of lines : 2
Number of stations : 23 (planned)
System length : 33 km (planned)
Track gauge : 1,435 mm

Latest Updates 2019 - 20

Feb 18, 2019 :	Prime Minister Narendra Modi lays foundation stone of Patna Metro Rail Project
Feb 14, 2019:	Union Cabinet approves Patna Metro Rail Project at Rs. 13365.7 crore
Feb 08, 2019:	Patna Metro project gets the Public Investment Board's (PIB) nod

UNDER - PLANNING PROJECTS :

PUNE METRO

Project Description :

Project Name : Pune Metro
Operator : Maharashtra Metro Rail Corporation Limited (MAHA-METRO)
Transit type : Rapid Transit
System length : 31.25 km
Number of stations : 30
Track gauge : Standard Gauge

Latest Updates 2019 - 20

Mar 18, 2019 :	PuneMetro work for Reach1 PCMC - Range Hill is in progress at Harris Bridge.
Mar 16, 2019 :	Civil work has started for the first foundation in Mula Mutha river, near Bund Garden for Pune Metro Reach3 Civil Court to Ramwadi.
Mar 16, 2018 :	Four Launching Girders are operational for Reach1 PCMC-Range Hill to achieve proposed timeline of Pune Metro

GUWAHATI METRO

Project Description :

Operator : Guwahati Metro Rail Corporation Limited (GMRC).
Transit type : Rapid Transit Number of lines : 4 (Phase 1)
Number of stations : 54
System length : 61.4 kilometres (planned) Detailed
Project Report: RITES

Project Details :

The Guwahati Metro is a mass rapid transit system proposed for the city of Guwahati, Assam.

Stage In Project
Planning

Project Cost
Estimated Cost for the project is Rs 18,020 Crore.

GWALIOR METRO

Project Description :

Transit type : Rapid transit
Operator : Madhya Pradesh Metro Rail Company Limited.
Number of lines : 3 (Proposed)
Number of stations : 100 (Projected) System length : 105 Km
Detailed Project Report: RITES

Project Details :

Greater Gwalior Metro Rail is a proposed rapid transit system for the city of Gwalior, Madhya Pradesh in India. The project was announced by state Chief Minister Shivraj Singh Chauhan on October 17, 2014.

The survey has been started.

Stage In Project
Planning

KOZHIKODE LIGHT METRO

Project Description :

Transit type : Light Metro Rail System
Number of lines : 1 (Phase I)
Number of stations : 22 (Phase I)
System length: 44 km (Phase I)
Track gauge : 1,435 mm standard gauge
Operator : Kerala Rapid Transit Corporation Limited

Project Details :

Kozhikode Light Metro is a proposed mass rapid transport system (MRTS) for the city of Kozhikode (Calicut), in India.

Stage In Project
Planning

Project Cost
Around Rs 2500 crore.

LUDHIANA METRO

Project Description :

Operator : Ludhiana Metro Rail Corporation Transit
type : Rapid transit
Number of lines : 2 (Phase 1)
Number of stations : 27
Operation will start : Postponed
System length : 28.83 kilometres (planned) Track
gauge : 1,435 mm Standard Gauge

Project Details :

Ludhiana Metro is a proposed rapid transit system for the city of Ludhiana, Punjab. This project is under Public-Private Partnership (PPP) or Build Operate Transfer (BOT) model.

Stage In Project
Planning

Project Cost
Rs 10,300 crore

SRINAGAR METRO

Project Description :

Owner : Srinagar Development Authority Transit
type : Rapid transit
Number of lines : 2
Number of Stations : 18 (estimated)
System length : 54 km

Project Details :

The Srinagar Metro is a rapid transit proposed for the city of Srinagar capital of Jammu and Kashmir, in India.

Stage In Project
Planning

Project Cost
Estimated Cost for the project is Rs 15881 Crore.

SURAT METRO

Project Description :

Nodal Agency till SPV is formed : Gujarat Metro Rail Corporation Limited
Locale : Surat, Gujarat
Transit type : Rapid transit
Number of lines : 2
Number of stations : 37
System length : 40.35 km

Project Details :

Surat Metro is a rapid transit rail system for the city of Surat, Gujrat, India.

Stage In Project
Planning

Project Cost
Rs 12,800 crores

THIRUVANANTHAPURAM LIGHT METRO

Project Description :

Operator: Kerala Rapid Transit Corp. Ltd. Transit
Type : Light Metro Rail System
Number of lines : 1
Number of stations : 19
System length : 22.20 km
Average speed : 40 km/h

Project Details :

Thiruvananthapuram Light Metro Rail is a proposed Metro rail system in the city of Thiruvananthapuram, the capital of the Indian state of Kerala.

Stage In Project
Planning

Project Cost
Rs 4,219 crore (Estimated)

www.railanalysis.in

UTTARAKHAND METRO

Project Description :

Transit type : Rapid Transit System
Locale : Dehradun, Uttarakhand, India System
Length: 70 km
Phases: 2

Project Details :

Uttarakhand Metro is a Rapid Transit System. This Project will connect to Dehradun, Rishikesh and Haridwar

Stage In Project
Planning

Detailed Project Report
DMRC

VIJAYAWADA METRO

Project Description :

Operator : Amaravati Metro Rail Corporation (AMRC)
Transit type : Rapid transit
Number of lines : 3 (planned)
Number of stations : 25
System length : 40 km
Track gauge : 1,435 mm Standard Gauge

Project Details :

The Vijayawada Metro Rail is a proposed rapid transit system for the city of Vijayawada in Andhra Pradesh, India.

Stage In Project
Planning

Project Cost
Rs 6,769 crore

VISAKHAPATNAM METRO

Project Description :

Transit type : Rapid transit
Number of lines : 3
Number of stations : 38
Operation will start : 2024 System
length : 42.5 km

Project Details :

Visakhapatnam Metro Rail is a proposed rapid transit system for the city of Visakhapatnam in Andhra Pradesh, India.

Stage In Project
Planning

Project Cost
Rs 8,300 crore

VARANASI METRO

Project Description :

Owner : Varanasi Development Authority
Transit type : Rapid transit
Number of lines : 2 (proposed)
Number of stations : 26 (proposed)
System length : 29.235 km
Track gauge : 1,435 mm Standard Gauge

Project Details :

The Varanasi Metro is a rapid transit proposed for the city of Varanasi, Uttar Pradesh, India.

Stage In Project
Planning

Project Cost
Rs. 17,227 Crores

www.railanalysis.in

The Metro Rail Installations in India are controlled by **COMMUNICATION BASED TRAIN CONTROL, CBTC,** technology, which will allow also Driverless automated Operation, ATO. Providers are ALSTOM with the system "***URBALIS®"***, Bombardier with the System "***CITYFLO 650®***" and Thales with the system ***"SelTrec®***". The RRTS regional semi-high speed corridors (see: **Chapter IVb.**) will use the European Train Control System, **ETCS**, Level 2; see: Metro Newsletter No. 91 in

Portfolio 7, http://www.drwingler.com. and cover story in METRO RAIL NEWS INDIA, November 2019, page 17.

Communication Based Train Control, CBTC**,** Movement Authority

Driving with **European Train Controly System,** ETCS Cab-Signalling

For the case of a Calamity when running underground, the Front- and Rear Cars have a Detrainment door to evacuate people:

Emergency Detrainment on Delhi Yellow Line after Breake Down, May 2019

The following Picture Gallery gives an impression on the heavy construction works for Metro Rail:

Construction Works of Trajectory for Hyderabad Metro

Connecting Delhi Blues Line to Yellow Line with Plinth Beams

A View on Hyderabad Metro Rail elevated Line Construction with Segment Elements in Progress

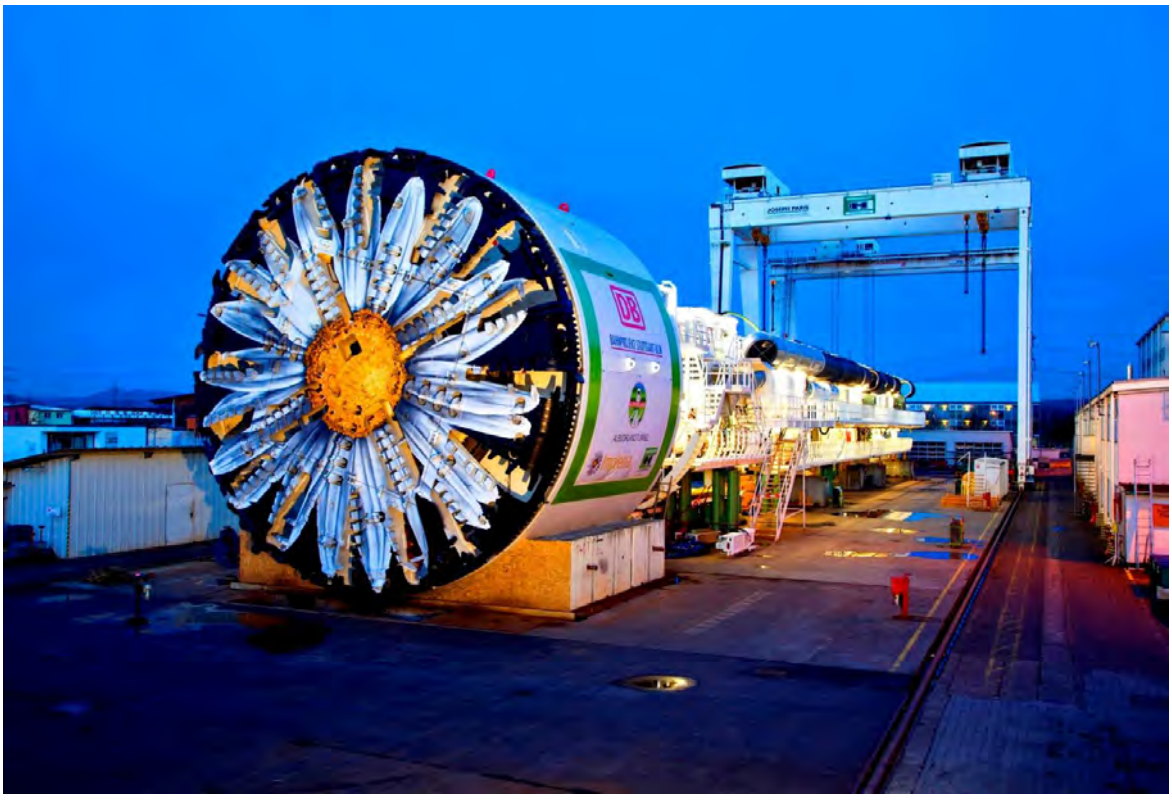
Constructing elevated Right-of Way Track with Segment Elements

Bridge Construction for Hyderabad Metro

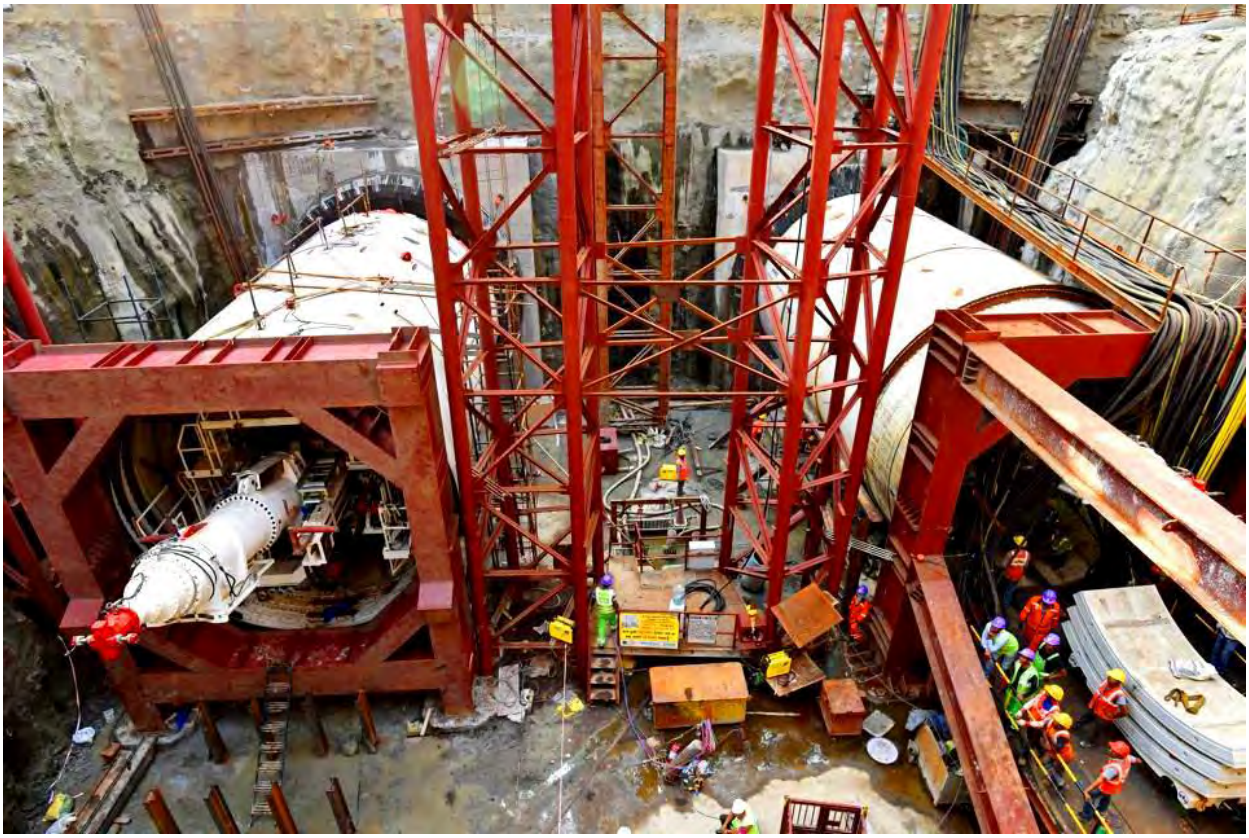
Underground Cut-and-Cover Metro Tunnel Construction

Cut and Cover Soft Ground Tunnel Construction with Side-Flange Freeze Stabilization by WSP (formerly: William Sale Partnership) Group

For the construction of underground sections latest state-of-the-art tunnel boring machines are used, which significantly accelerates the construction.



Tunnel Bore Machine build by Kirchheimer; Switzerland



Twin Tunnel Boring for Mumbai Metro Rail

Successful Breakthrough with Austria based Tunnel-Boring Machine TERRATEC TBM at Mumbai

Lowering TBM in Shaft in Mumbai

The Methodology of choice for tunnelling in soft ground is the cut and cover method with freeze stabilisation of the flanges. At Kolkata the mistake has been made to bore a metro tunnel in wet alluvial strata with a boring machine with the result, that on 31st August 2019 a water slurry flushed into the tunnel and houses only 14 m above collapsed. About 52 houses at Bow Bazar, Durga Pituri and Saytra Para lanes, developed cracks, and 70 families had to be evacuated in the apprehension of further cave-ins. The condition of a dozen of houses is quite bad. 27 of them have now to be demolished.

Another building, the second one on Bowbazar Street in central Kolkata, came crumbling down on September 3th, 2019. The first house collapsed on August 31th, 2019 night following the boring for the 16.6 km of East-West flank of the Metro.

Another Building collapses in Kolkata Bowbazar due to Metro Tunnel Boring in Alluvial Water containing Strata

This has not been the only mishaps during Metro Underground Construction in soft ground**:** On Monday 19-11-19, a building located on Mahim (West)'s LJ Road has tilted to one side and developed cracks. This had reportedly happened due to construction work at the Colaba-Seepz-Metro-3. Another Building in Mumbai Mahim tilted on 18-11-19 due to Metro Construction in soft ground, making several families and inhabitants homeless without proper compensation.

Comment*: For an Non-Indian expert it is "incredible", that Kolkata Metro Rail Corporation (KMRC) took the risk in boring a metro tunnel with a boring machine only 14 m below a densely built bazar area through water containing soft ground alluvial strata.*

There had been no contingency plan for an emergency management in the eventually that building and surrounding structures above the tunnel might subside, crack or crumble down.

Risk is the product of the probability of a bad unwanted event to happen and the impact this bad event might have.

In case of the Kolkata tunnel boring the risk had been high.

With the tunnel boring instead of making use of cut-and-cover methodology, obviously one looked for a cheaper but more risky but way. Before starting the tunnelling the area should have been cleared from houses, and the metro tunnel should have been constructed in an open shaft as a cut-and-cover construction with freeze stabilization of the side walls. Under the prevailing circumstances and water containing soft soil conditions, the cut-and-cover method with side walls stabilization by ground freezing or grouted pipe spilling would have been the less risky method of choice or preferred technology.

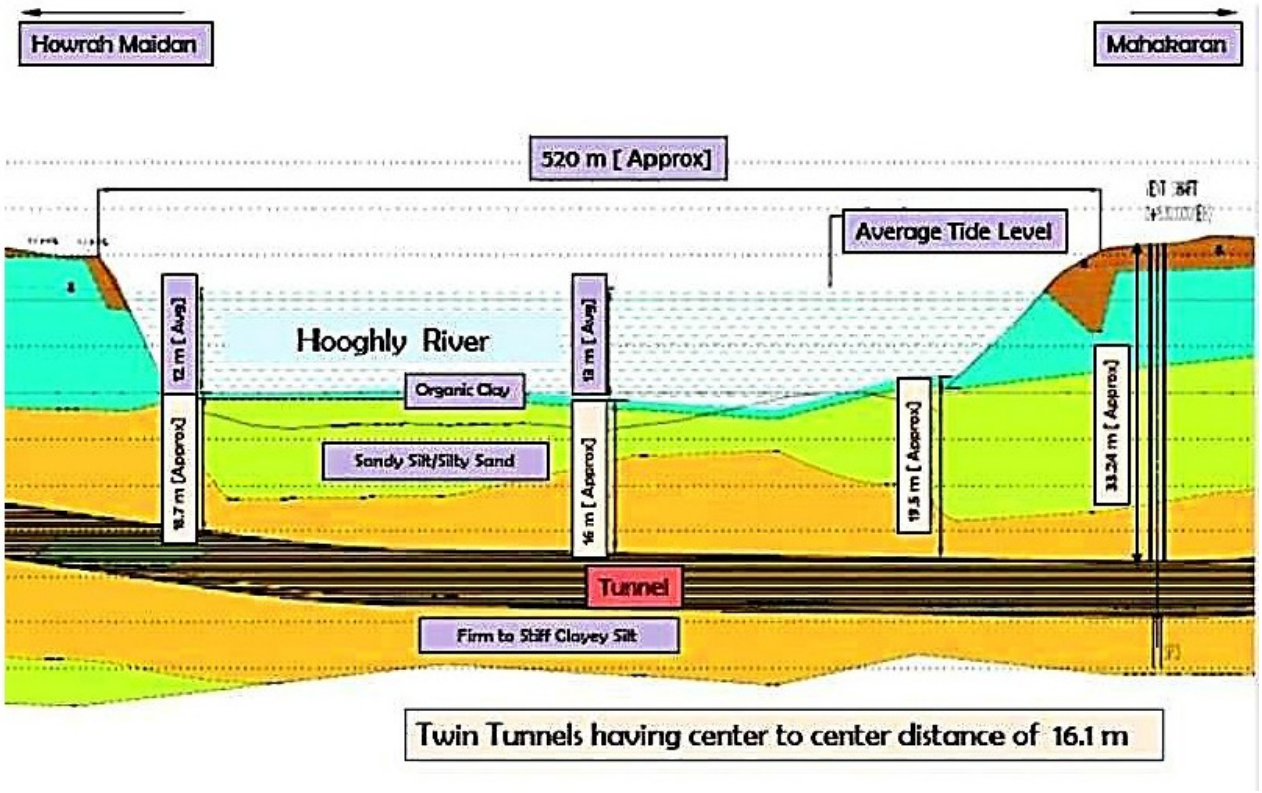
The bad result proofs, that the unfavourable methodology had been implemented. But now it is too late. The area has now anyway to be vacated from building structures. The affected dwellers of the Bazaar area are now the suffering victims, which got deprived of livelihood and property without any hope of proper compensation under a situation, which could have been easily foreseen.

The legal procedure is in favor of the party, which planned, organized and executed this risky technical adventure. The victims are the losers.

The planners are making a fundamental mistake:

It is a FUNDAMENTAL AND BASIC KNOWLEDGE in SAFETY AND RISK MANAGEMENT:

"What did not hap*pen in the past is more l****ikely to happen in the future!"***
*"From the NON-OCCURANCE of a bad and unwanted event one cannot make any prediction for the future or regard an organisation as safe****!"***



B**ored 550 m Tunnel under Hooghly River for Kolkata East West Metro**

(b) MASS RAPID RAIL TRANSIT, MRRT: Delhi–Ghaziabad-Meerut Regional Rapid; NCRTC/RRTS Semi-High Speed Transit Corridors

Artist`s Concept for Regional Semi-High Speed Rail Car for NCRTC Rapid Transit; Delhi–Ghaziabad-Meerut Regional Rapid, NCRTC/RRTS, Transit Corridor Semi-High Speed EMU

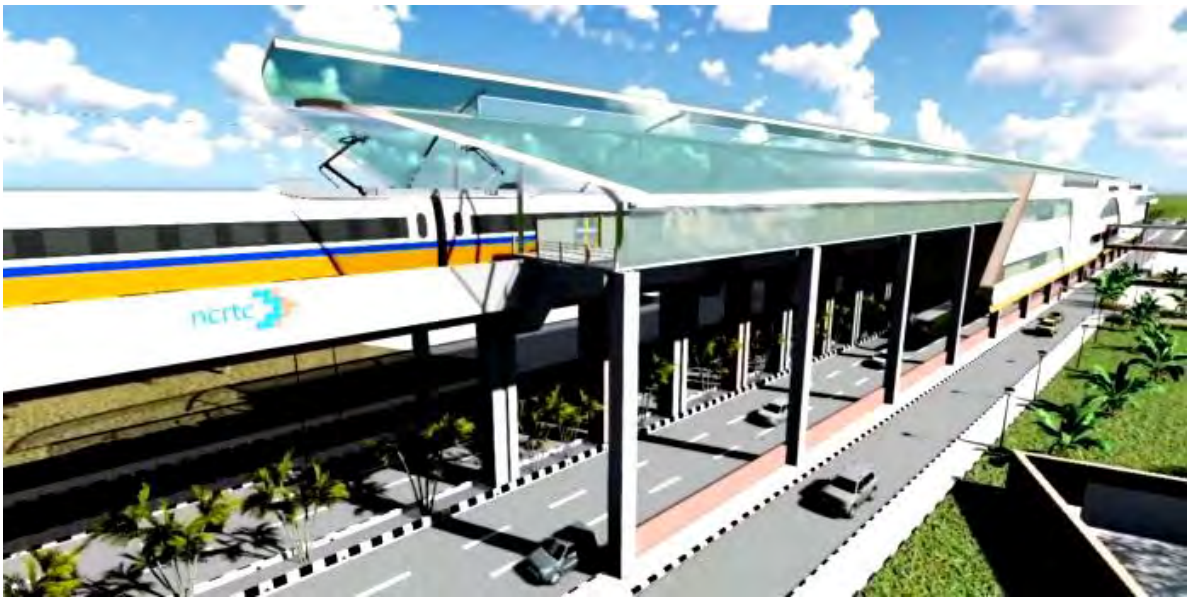
The Delhi–Ghaziabad-Meerut Regional Rapid Transit System (Delhi–Meerut RRTS) is an 82 km long and under-construction regional semi-high speed rail corridor connecting

Delhi-Ghaziabad-Meerut. It is one of the three rapid-rail corridors planned under Phase-I of Regional Rapid Transport System (RRTS) project of National Capital Region Transport Corporation (NCRTC). With maximum speed of 160 kmph (99.42 mph), the distance between Delhi and Meerut will be covered in around 62 Min. (1.03 h).The project is estimated to cost ₹30,274 crore (US$ 4.4 billion) and is expected to start operations by 2025. The corridor would be beneficial for the development of the region and help connect the large number of townships and centres of economic activity that are already planned along this corridor. The entire route is designed for a maximum speed of 180 kmph (111.85 mph) and the operating speed will be 160 kmph (99.42 mph). The average speed (including all the stops) will come around 100 kmph (62.14 mph).

As rails, UIC 60/60E–1/60KG 1080 Grade Head Hardened Rails Class-A conforming to IRS T-12-2009 are envisaged.

The Delhi-Meerut corridor starts from Sarai Kale Khan Station in Delhi. The corridor will pass through areas of Delhi, Ghaziabad and Meerut, terminating at Modipuram in Meerut.

Hazrat Nizamuddin Sarai Kale Khan will also become a transit hub with the presence of Hazrat Nizamuddin metro station with Sarai Kale Khan ISBT and the Hazrat Nizamuddin railway station in vicinity; source Wikipedia.



Delhi-Meerut Regional Rapid Transport System, RRTS, Station Design;
(Image: Ayesa)

Proposed RRTS Corridors in India:

S.no	RRTS Corridors
Prioritised Corridors Identified for execution	
1.	Delhi- Sonipat- Panipat: 111 km
2.	Delhi - Ghaziabad -Meerut: 90 km
3.	Delhi- Gurgaon - Rewari- Alwar : 180 km
For Second Phase	
4.	Delhi- Faridabad -Ballabgarh -Palwa
5.	Ghazlabad- Khurja
6.	Delhi - Bahadurgarh - Rohtak
7.	Ghaziabad - Hapur
8.	Delhi-Shahadra - Baraut

V. STRADDLE BEAM METRO RAIL ON CONCRETE TRAJECTORY

The first successful experimental Straddle-Beam Mono-Rail was the ***"ALWEG EINSCHIENENBAHN"*** in the outskirt of Cologne in Germany, operated until 1967 by Krupp; Later it had been further developed together with Hitachi for the Walt Disney Park in Bay Laky near Orlando in Florida, USA, starting operating in 1971.

ALWEG was a transportation company known for pioneering straddle-beam mono-rails. Alweg was founded by Swedish industrial magnate Dr. Axel Lennart Wenner-Gren in January 1953 as **Alweg-Forschung, GmbH** (Alweg Research Corporation), based in Fühlingen in the outskirt of Cologne, Germany. The company was an outgrowth of the **Verkehrsbahn-Studiengesellschaft** (Transit Railway Study Group), which had already presented its first mono-rail designs and prototypes in the previous year. The Alweg name is an acronym of Dr. Wenner-Gren's name (**A**xel **L**ennart **WE**nner-**G**ren).

First successful operating experimental Concrete Straddle Beam Mono-Rail at Fühlingen **until 1967**, Cologne, Germany

The **Mumbai Mono-Rail,** opened to traffic in February 2014, is the India's first mono-rail transport. Larsen and Toubro, along with the Malaysian partners Scomi Sutra Engineering Bhd, Malaysia, were awarded the ₹24.6 billion (US$360 million) contract to build and operate the monorail until 2029. Because of insufficient economic performance it has become under scrutiny. It will be probably India`s first and last Straddle Beam Monorail on a heavy concrete trajectory.

Mumbai Mono-Rail

Route Map of Mumbai Monorail; Blue: Phase I, Red: Phase

Emergency Passenger Evacuation by the Fire Brigade after Breake Down in March 2015

Mumbai Mono-Rail 5 Point Turnout at Depot

Mono-Rail, Mumbai; India

Mumbai Mono-Rail Station Bhakti Park

VI. MEDIUM CAPACITY SYSTEMS (MCS), OTHER THAN METRO RAIL, FEASABLE FOR INDIA

A Medium-Capacity System (**MCS**) is a transport system with a capacity less than typical heavy-rail rapid transit. It is also known as **Light Metro** or **Light Rapid Transit.** Such technologies might be feasible for smaller towns in India with less ridership and for evolving smart cities from the drawing board. They are also discussed as Feeders for Metro Rail in India.

Mumbai operates 19 km of elevated **Straddle Beam Mono Rail**. Kochi has a **Water Metro**, and for Dehradun, Shimla, Darjeeling, Dharamshala, Tsomgo Lake in Tsomgo, East Sikkim and Varanasi **Gondola Aerial Ropeway Metro** is envisaged. In 12 tourist places shorter scenic Ropeways are already in operation. Further Ropeway locations for local public transport under evaluation include Elephanta Caves, Mumbai, Maharashtra; Kanyakumari in Tamil Nadu; Langolceiraoching-Marjing Ching, and Sendra to Thanga, Chaoba Ching, Loktak in Manipur; Bermpark-Bhawani Island in Andhra Pradesh; Vasco da Gama to Dona Paula in Goa; and in Kochi. For Urban Mobility in Chandigarh, an area with less town-dweller than in the Indian mega cities, a light Monorail of Swiss ***INTAMIN*** Technology, running on a right-of-way Steel Beam Guide-Way, is in discussion. For smaller Cities in India with less ridership-demand as well as a supplement for **Metro Rail** in Delhi ***"METROLIGHT***" or "***METROLITE"*** of a more cost-effective Light Rail Transit Technology than Metro Rail Technology is in discussion. Kolkata has preserved its City Street Tramway for modernization. Hubli in Karnataka and Amritsar in Punjab will go for a right-of-way dedicated bus lane for Bus Rapid Transit, BRT. Pune is a forerunner in providing a BRT

public transport with shelter stations. Guided autonomous bus technology is in India envisaged. Eco-friendly hybrid bus propulsion by electricity, stored in batteries are under trial. Perhaps Hydrogen-Fuel Cell technology might also come to India. Amritsar is thinking to install an autonomous on-Demand PodCar People Mover between Railway Station and the Golden Temple.

Last- and First-Mile Connectivity provided by UBER car sharing, electric bicycle rickshaws, electric three-wheeler rickshaws, electric scooters are on trial in several cities.

(1) INTEGRATED MULTIMODAL URBAN MOBILITY SOLUTIONS FOR PUBLIC TRANSPORT, IT

Multimodal Connectivity Hubs are on the way to come. Hubs help to cut down unnecessary travel time. Turning Metro Stations into Activity Hubs creates new job opportunities:

Artist`s Impression for an Indian multimodal Public Transport Connectivity Hub

Artist`s Impression for Surat Multi Modal Connectivity Hub

Artist`s Impression for Gandhinagar Railway Station cum Connectivity Hub

India is going to follow global samples for successful **INTEGRATED MULTIMODAL URBAN MOBILITY SOLUTIONS FOR PUBLIC TRANSPORT, IT.**

The objective is to make Kochi the first city in the country, where the entire public transport system: The metro, the buses, the boats, the auto-rickshaws and the taxies work together as a seamless integrated system; with a common timetable, common ticketing and centralised `command and control'.

At Indore the interesting factors about corridors is that they will be having multimodal integration with railway stations as well as BRTS stations, and also they will have feeder network of bus services, intermediate public transport and non-motorised transport:

Envisaged Indore and Bhopal METRO as an integrated multi-modal urban and suburban public Transport System

Global shining samples for integrated and multimodal public urban, suburban, interurban and regional transport solutions we can find in Istanbul (Turkey), Helsinki (Finland), London (UK), Paris (France), Berlin (Germany), Stockholm (Sweden), Zurich (Switzerland), Madrid (Spain), Mexico (Mexico), Madrid (Spain), Toronto (Canada) and Portland (USA):

Portland USA "BUS AND BYKE"

Germany is ranked as the best country for sustainable mobility, followed by the Netherlands, Sweden, the UK and France. The only non-European country in the top 10 is Japan, in seventh place. The worst-performing country is Libya, followed by the Central African Republic and Yemen.

(2) LIGHT RAIL TRANSITS

Around the globe, light rail systems, or also so-called ***"LIGHT RAIL TRANSITS***", LRT, have become increasingly popular in recent years due to their lower capital costs and increased reliability and flexibility compared with heavy rail systems.

In Central European countries, LRT/city trams remained operating since hundred years uninterrupted as the backbone for urban, suburban interurban and regional public transport, operating on meter gauge and as well on standard gauge or even on narrow gauge.

In recent decades, LRT had a remarkable comeback in many countries around the world. Even in low income countries, new LRT transport had been installed. Tramways have come to cities in North and South America, Europe, Asia and Australia/New Zeeland, which never have seen a tramway before. Even Jerusalem, Algeria, Lahore and Rèunion, the French Indian Ocean Island, are installing new LRT tram systems.

Be it the tram in the classical sense or the suburban and interurban railways, that combine features of underground railways and trams, the global future of urban transport is on the rail with Light Rail Transits. While the construction and running of underground or elevated systems incur a huge cost, tram and light rail transit systems can be constructed and integrated into the cityscape at a comparatively lower cost.

Global Activities with Trams and Light Rail Transits; Source: Plasser&Theurer

Light Metro Rail (LMR), Light Rail Transit (LRT) or Light Rapid Transit (LRT) are now regarded as feasible for India. LMR/LRT/LRT as so-called "METROLITE" had been suggested as a cost effective mobility solution in planned corridors and subdivisions of Bangalore, in Chennai to run on Tambaram-Velachery Corridor in Delhi for the Rithala-Narela corridor and for Jammu and Srinagar; see also page 56. Light Rapid Transit is envisaged to connect Dehradun, Rishikesh, and Haridwar.

Animation of Light Metro Rail, **LRT**/LMR, for India`s Cities **as a more Cost effective Solution**

Artist`s **Concept** for Mauritius and Delhi Phase IV LRT Projects

Light Metro Rail, LMR, Light Rail Transit (LRT) or Light Rapid Transit (LRT) technologies operate with Light Rail Vehicles (LRV). Those are Tram Trains/Light Rail Transits, which can run in urban region as well on Streets as City Trams, elevated as Right-of-Way Trams or Underground as Metro and suburban and interurban on dedicated rail tracks or interoperable on governmental main railway lines as commuter rail or regional intercity trains from city to city centres. The invest costs for LMR are less, the diversity is higher and adjustment to local conditions and environment is more flexible; see F. Wingler: ***From the 1832 Horse pulled Tramway to 21th Century Light Rail Transit/Light Metro Rail – a short History of the Evolution in Pictures;*** free for download from http://www.drwingler.com. See also ***Rail based Light Mass Transit, LRV/LRT, for METROLIGHT - more viable! India***; by **Kanika Verma**; Metro Rail News; 05/08/2019.

Kolkata City Tram survived in India to be now upgraded

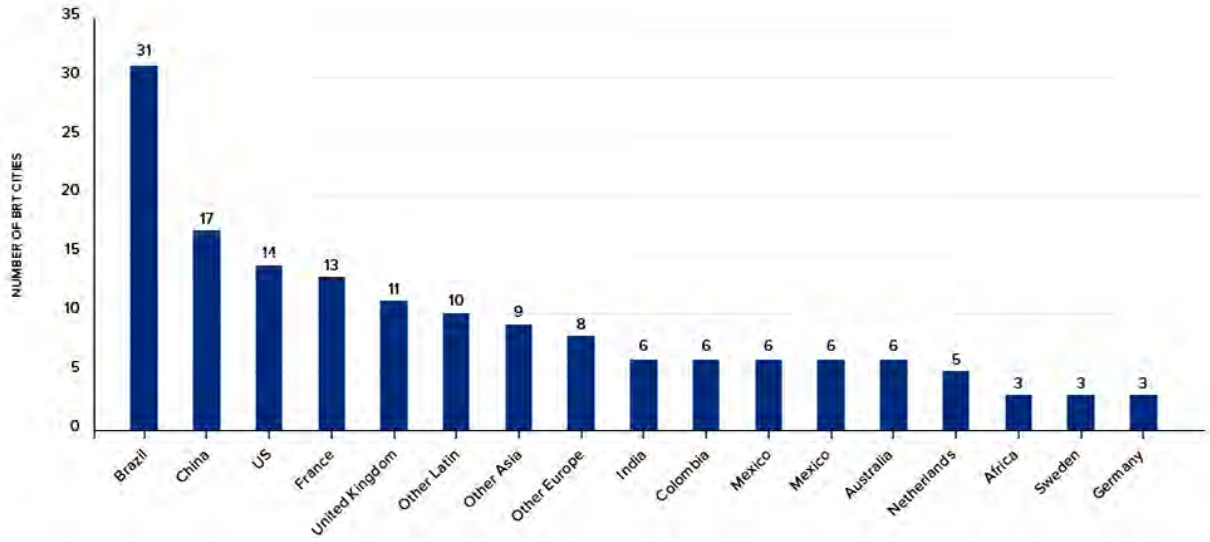
To boost public transport in Tier-II and Tier-III cities, the Indian Central Government is planning to bring the Mass Transport System **Light Rail Transit (Light Rail Transit, LRT, METROLIGHT/METROLITE).** Arguments for the Government are that Light Rail Transits are more cost effective and more flexible. The Vehicles (LRV) can negotiate tighter curvatures and need less massive stations. In most German cities as awell in several other European countries and as well in Canada, Ottawa, LRT handles most of the local public transport running underground, on streets, on reserved or dedicated lanes on Metro Rail, Commuter Rail as well on Main Line Rail Tracks. LRT/Metrolite works also as **Metro Feeder**.
Jammu, Srinagar and Amaravati will get Light Metro Rail, LMR, in next four to five years. For Delhi, Noida, Bangalore and Chennai LRT is proposed as a supplement or compliment to Metro Rail:

Artist`s **Concept** for **Jammu** LRT

RITES prepared a comprehensive public Transport Platform Plan with Light Metro Rail, Ropeway, Waterway Metro and Road Transport for Varanasi; see: Urban Transport News 26/07/2019; Portfolio 6, Metro Newsletter 82, http://www.drwingler.com.

(2) SMART AND INNOVATIVE RUBBER TYRED ROAD BUS RAPID TRANSIT (BRT) TECHNOLOGIES

BRT Systems have gained popularity worldwide as a cost-effective alternative to far more expensive urban Metro-Rail investments. High-quality bus-based systems also better serve the low-density settlement patterns of many suburban markets and small-to-medium size cities due to the inherent flexibility advantages of **rubber-tyre systems** – the same vehicle that provides speedy line-haul services on a dedicated bus-lane or reserved bus-way can morph into a feeder vehicle, collecting and distributing customers on local streets; see: 20th ACEA Scientific Group Advisory Board, Robert Cervero, University of California, Berkeley, USA, December 2013:



Number of Cities with BRT Systems by national and regional Settings, 2013

Buses are a popular and convenient mode of transportation in Indian cities. More than 1.6 million buses are registered in India, and the public bus sector operates 170,000 buses carrying roughly 70 million people per day. However, bus transportation has not been able to cater to the growing travel demand. There are only 30,000 buses serving the city areas, out of which approximately 3,500 buses are operated under a public-private partnership agreement. All bus operators are incurring huge losses and do not have funds for the capital investment needed to procure new vehicles and technology. The average age of the fleet ranges from two years to 11.8 years for state bus transport undertakings.

The recent **'Policy Road Map for City Bus Systems in India'** study identified that most of the city's bus operators are still lagging behind in the implementation of an IT system. The survey revealed that nine out of 12 cities have implemented a vehicle tracking system and 11 out of 12 have implemented electronic ticketing machines (ETMs). However, no cities have yet implemented 'planning and scheduling' or 'depot management' systems; with the majority using manual systems for such operations. The availability of real-time information is equally important for commuters to plan their journey. In the absence of good quality data, commuters aren't able to obtain accurate service information. However, there are some third party mobile app providers that provide offline information to users such as *Trafi* and *Moovit*.

The Federal Government has unveiled an ambitious project to replace all public bus transport fleets with hybrid technology. The government launched the full indigenous retro-fitted electric bus, converting existing conventional fuel buses into electric buses, developed by KPIT Technologies and Central Institute of Road Transport (CIRT).

A main hindrance to the adoption of new technology is the financial implication and capital cost. The average cost of a hybrid bus in India is around INR 23 million (US$ 375,000), compared to INR 9 million (US$ 150,000) for a premium diesel bus. In order to incentivise the operators to procure electric and hybrid buses, the federal government has launched the 'Faster Adoption & Manufacturing of Electric and Hybrid Vehicle (FAME)' scheme to provide a subsidy of INR 6.1 million (US$ 100,000) for electric and hybrid buses.

Currently Navi Mumbai Municipal Transport (NMMT) has procured five **hybrid city buses** from Volvo and MMRDA has procured **25 hybrid buses** from Tata Motors. There are currently no fully electric buses in commercial operation. BYD has completed a pilot in Bangalore (2014) and Delhi (2016) to demonstrate electric bus technology.

For **Nasik, Nagpur and Warangal (Telanga) a Metro *"NEO"* Project** with Rubber-tyred AC electric Coaches on dedicated and elevated corridors had been submitted. Covering a distance of 32 km at Nasik, the rubber-tyred AC electric coaches with a capacity to carry around 300 passengers will run on two elevated corridors. In addition to the two elevated corridors, covering a distance of 24 km, the battery-powered feeder buses will also run on two feeder routes. The both type of transport systems will cover almost 90% of the city; see also METRO RAIL NEWS, November/December 2019:

Animation for Nasik`**s "***METRO NEO***"** Rubber tired electric Light Vehicle Project on dedicated Corridor

The cost of civil construction, as well as the cost of rolling stock can be substantially reduced if the same elevated kind of structure as for **Metro Rail** is used for introducing **Bus Transit**, having its own 'right-of-way" or reserved line. '**Elevated Bus Rapid Transit'** is the panacea for all ills of urban transport in India. Air-conditioned buses on elevated roads can easily clock an average speed of more than 40 kmph at a frequency of less than a minute. It can reach a level of 18,000 passengers per hour peak direction easily and will be a cost-effective solution. Moreover, on narrower internal roads, as the width of the carriageway would be required only for a single bus passage, a looped one-way elevated bus-only mode of transit can effectively overcome the incontrovertible **'last-mile connectivity'** problem. A win-win situation for all stakeholders; see: Opinion: There is Need for Revision of Urban Transport in a smart India; by Anushka Khare, 23/10/2018; Urban Transport News.

Animation of electric Metro Bus on reserved Corridor for innovative METRO NEO **MRTS** Project**s** for Nashik City**, Nagpur and Warangal**, India

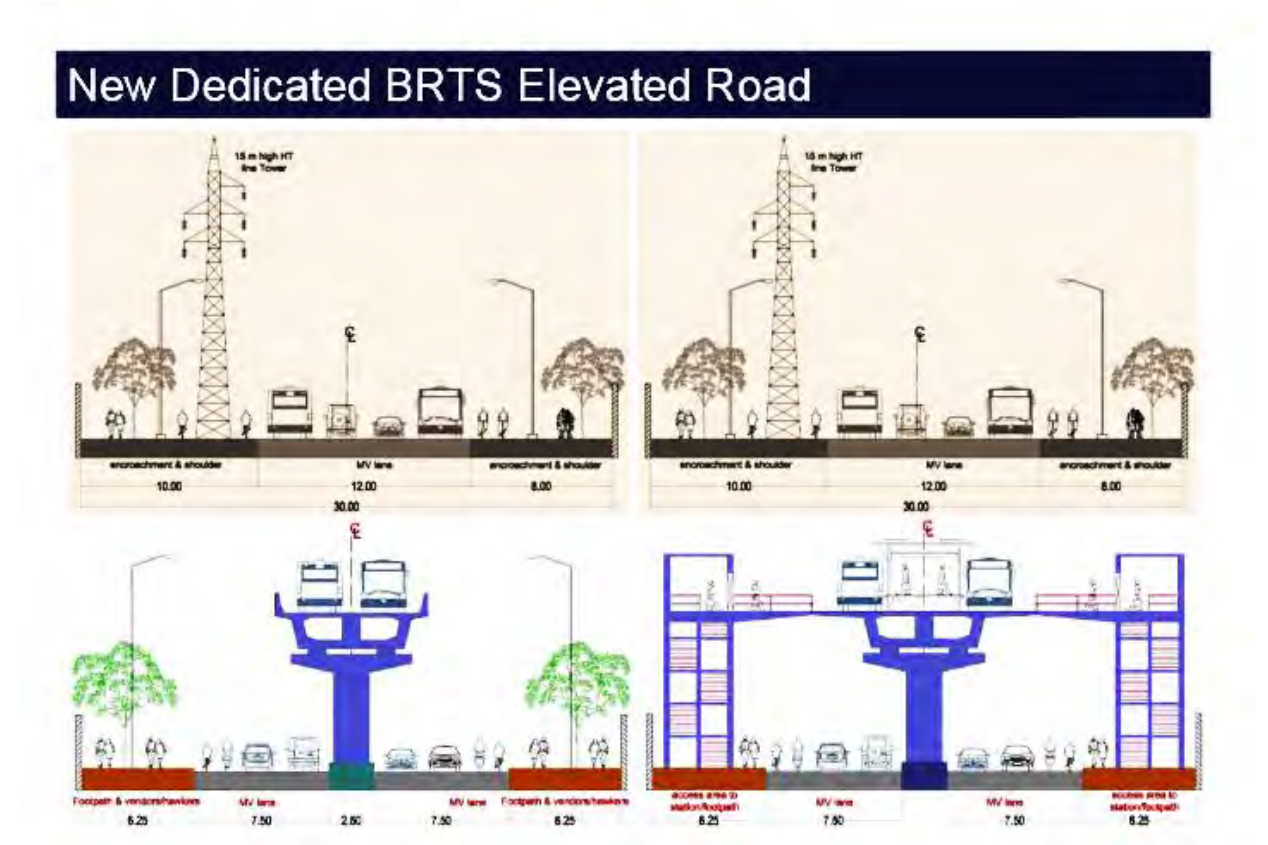
Artist`s Impression for Overhead Electric Feeding when running on reserved Corridors

"METRO ON TYRES" will become an economical and flexible transport technology in India. It can run and operate on existing roads, on dedicated and reserved lanes at grade or elevated, it can run driverless on guide rollways (proposed for Hyderabad). The propulsion technologies are ecofriendly with Diesel-electric, electric, with lithium battery and/or supercapacitor electric storage, or even with hydrogen-fuel cells. Electricity can be fed by overhead catenary trolley-bus technology, also for battery in-motion charging, latter also at fix-point charging stations from overhead or from bottom by ground level recharging technology. Those technologies are now far developed and worldwide in use.

See also the Project for Right-of-Way elevated guided Bus Rapid Transit in Hyderabad, BRT; Urban Transport News 26/07/2019; Portfolio 6, Metro Newsletter 82, http://www.drwingler.com.

Driverless BRT on Guide Roll-Way at Adelaide, Australia; proposed for Hyderabad

Amritsar Bus Rapid Transit System on reserved and dedicated corridors , BRTS Dream Project takes Shape; see Harkirat Singh and Usmeet Kaur in: Hindustan Times PUNJAB Updated: Feb 15, 2016 09:48 IST:



Animation: The Future of urban, suburban and interurban Mobility in Punjab`s Cities with Right-of-Way dedicated Bus Rapid Transit (BRTS) Lanes

Amritsar dedicated Right-of-Way Bus Corridor Lane

(2a) ELECTRIC BUSES

The year 2019 has witnessed a greater action in the space of electric buses. Department of Heavy Industries (DHI), Government of India sanctioned INR 4.37 billion (US$ 67 million) for the procurement of electric buses, e-taxis and e-autos in December 2017. The department has selected **11 cities with one million-plus population** for the procurement of 390 electric buses, and is providing funds to the tune of INR 10 million (US$ 150,000) per bus.

The department has sanctioned 40 buses for every city under the pilot project, except 15 buses each for Guwahati and Jammu. However, BMTC (Bengaluru Metropolitan Transport Corporation) in Bengaluru is considering 150 buses and TSRTC (Telangana State Road Transport Corporation) in Hyderabad has decided to take 100 buses. 10 out of 11 cities floated the tender within 15 days, except Delhi which is planning to procure 700 e-buses separately from state budget. Interestingly, all 10 cities completed the tender within one month and received good response from the industry.

Bengaluru was the first City in the Country to conduct Trial Runs of e-Buses; Photo by Ramesh NG/Wikimedia Commons

Kurla Bandra Diesel-electric Hybrid Bus

Overhead Charging Point for Electric Bus in Delhi

Proposed electric Bus for Gurgaon

(2b) SHUTTL-APP BASED OFFICE BUS

Shuttle-App based Office BUS is an alternate Solution for corporate Employees Transit and enlarges catchment areas of Metro Rail; see Mannat Batra; Urban Transport News; 12/07/2019. It is an on-demand chartered bus system in certain commercial areas of smart cities. It is India's topmost and largest office commute app. It is the systematised and much-improved version of chartered bus services. It is curated on technology and data. The routes, pick-up points, and time slots are designed on the basis of customer feedback and the discoverability of these routes is solved through the consumer app:

Shuttl App Office Bus

(3) AUTOMATED PODCAR PEOPLE MOVER **for Amritsar and Haridwar;** see also Paragraph 6, page 74 and 89 on Mobility by Cable, aerial Tramway, suspended Monorail APM and Bottom Cablelliner.

Rubber tyred self-driving automated Pod Cars are poised to transform Amritsar City`s Streetscape and Skyline; published by by Jim Witkin December 16th, 2011:

DCA Design International Limited. A Rendering of the Pod-Car APM System, over the Streets of Amritsar, India

ULTra Fairwood, an engineering company in India, announced that it reached an agreement with the Punjab Government to build a **Personal Rapid Transit, PRT,** system in Amritsar, an Indian city of 1.5 million. The system would be based on the pod-car

technology of ULTra Global PRT, which recently completed a proof-of-concept at Heathrow Airport in London.

DCA Design International Limited

Amritsar is the host of as many as 500,000 Sikh pilgrims on major holidays who visit the Golden Temple. Prompted by concerns about exhaust fumes damaging the building's facade, which was built in the early 17th century, the government has banned nonessential motor vehicle traffic within a one- to two-kilometer radius of the shrine. Pilgrims consequently must walk or hire pedal-powered rickshaws to reach the temple. Mr. Brown expects the electric-power pod-car system to accommodate up to 35 percent of these visitors.

With private investment, ULTra Fairwood will design and build the system for the Punjab government and operate it as a concession under a 30-year agreement. Fairwood would license the pod-car technology from ULTra Global PRT in a franchise-style agreement, according to Mr. Brown. His company, which is based in Britain, would receive payment for consulting services, which he estimated at £2 million, or roughly $3.1 million, over the next two years. ULTra Global would also receive an estimated £5.4 million over the 30-year concession agreement, representing a share of the fares collected. He declined to disclose the projected costs to build and operate the system, but he estimated that the system would recoup its costs to investors after five years of operation.
Pod Cars public transport is also envisaged for the Pilgrim Town of Haridwar.

DCA Design International Limited: The Pods would accommodate up to 35 Percent of the Sikh Pilgrims who visit Amritsar on major Holidays

(4) SMART AND INNOVATIVE FIRST- AND LAST-MILE CONNECTIVITY AND FEEDER-TRANSPORT

The Chennai Metro Rail Limited (CMRL) has launched a **feeder service cab** at a flat rate of Rs. 10 to enable metro users to travel between the stations and their residences:

Chennai Metro Rail launches Feeder Service Cabs

E-Scooter Renting Service of Delhi Metro Rail Corporation

Electric Vehicle Mobility Mission Plan:

Push for e-Mobility in Indian Cities

Government of National Capital Territory of Delhi released it draft ***Electric Vehicle Policy 2018***. Delhi is facing major issues with air and noise pollution. Adoption of Electric Vehicles ('EVs') for road transport will contributes to better air quality, reduced noise pollution, enhanced energy security and reduced greenhouse gas emissions. Delhi has become the seventh state in the country to launch its own EV policy, following Karnataka, Kerala, Telangana, Maharashtra, Andhra Pradesh and Uttar Pradesh.

In 2013, Government of India launched a National Electric Mobility Mission Plan 2020. Under the mission plan, the Scheme for Faster Adoption and Manufacturing of (Hybrid&) Electric Vehicles in India ('FAME India') was launched in March, 2015 for two years as Phase-I, which has subsequently been extended up to 31 March, 2019. Despite Central and State government incentives, pure electric vehicle penetration currently (i.e., in 2017) remains quite low in India, about 0.1% for cars, ~0.2% for 2 wheelers and practically nil for commercial vehicles. This is mainly because of high capital cost, non-availability of charging stations and lack of supply. – Source UITP.

With the aims to promote green mobility in the state, Uttar Pradesh Government has recently launched new Electric Vehicle and Mobility Policy 2019. Electric Vehicles are widely gaining market across the globe. Due to high pressure and fast depletion of fossil fuels, electric mobility has become necessary to reduce the impact of transportation on the environment and climate change. The recent Paris Agreement enforced in November 2016 provides to limit Carbon dioxide emissions to control global warming and threats of climate change. Electrification of the automotive industry aims at achieving the set objectives by decarbonizing the transport system.

Battery operated e-Bike Rickshaw

Mahindra Electric and SmartE signed MoU to transform Last-Mile Connectivity

The Indian automobile industry is one of the largest growing industry in the world, and the sector promises further growth in manufacturing sector driving the country's economic growth. Since presently the automobile industry largely contributes to pollution, the government is promoting electric mobility towards this:

Smart E-Rickshaw flagged off by LG Anil Baijal in Delhi Metro

The year 2019 has witnessed a greater action in the space of electric buses. Department of Heavy Industries (DHI), Government of India sanctioned INR 4.37 billion (US$ 67 million) for the procurement of electric buses, e-taxis and e-autos in December 2017. The department has selected **11 cities with one million-plus population** for the procurement of 390 electric buses, and is providing funds to the tune of INR 10 million (US$ 150,000) per bus.

(5) WATER METRO

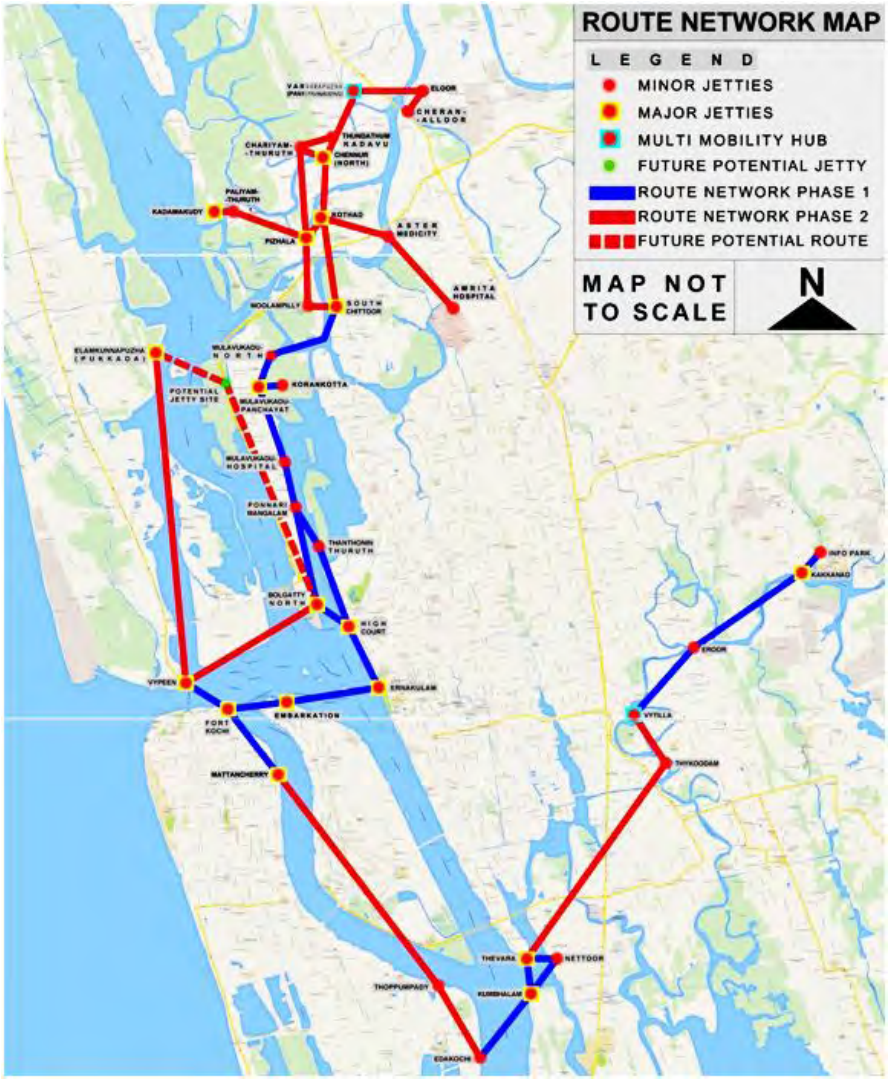
An unique Project is the Kochi Water Metro Project:

Jetty for Kochi Water Metro

Kochi is the first city in India to have achieved water transport to be integrated as a feeder service to the metro.

It is also for the first time in India that such a significant level of investment is being brought in for improving water transport. The Water Metro Project would be a reality by 2020.

The proposed project envisages the development of 16 identified routes connecting 38 jetties across 10 island communities across a 76 km route network. The identified routes and jetties are represented in the following figure:



The project intends to bring in a fleet of 78 fast, fuel efficient, air-conditioned ferries plying to 38 jetties, 18 of which will be developed as main boat hubs, while the remaining 20 will be minor jetties for transit services. More than 100,000 islanders are expected to benefit from the Water Metro, complete with modern watercrafts.

The boats would be 24 m long and have a capacity of 100 passengers. The boats will be powered using an electric propulsion system equipped with high-quality Lithium Titanium Oxide batteries, For emergency purposes and for achieving top speed, the propulsion system of boats shall also be connected through a hybrid system using power from diesel generators," the release said.

Kochi Water Metro Project is an integral link in the perceived Urban Metropolitan Transportation Model for Kochi, wherein the **Metro Rail**, land feeder services, marked pavements for cycle and pedestrian movement and water metro would be integrated to ease the traffic congestion and reduce the pollution in the city.

The **waterborne transport** network is the ideal solution for Kochi in order to integrate all of its inhabitants on the various islands into an efficient transport system. The outer islands will be closely linked to the mainland, giving them easier access to employment opportunities, schools and health services.

Artist`s Impression of Kochi Water Metro Mobility Hub

The project is unique since it introduces an integrated water transport system, whose schedule and route network will be aligned with the new metro and bus lines. Tickets are valid for the entire transport system and are designed to be affordable for the poorer population as well.

(6) **Public Transport with aerial Ropeway (*"URBAN MOBILITY BY CABLE"*), aerial Tramway and suspended APM Monorail as Personal Rapid Transit (PRT) - Options for densely populated Indian Cities like Varanasi or Cities with difficult Terrain like Shimla, Dharamshala and Dehradun**

Animation of Dehradun Aerial Metro; by F.A. Wingler

Rope Grip of Detachable Circulating Monocable Ropeway, DCMR

Minister for Road Transport, Shipping and Water Resources Nitin Gadkari has said that the country needs futuristic technology for developing its transport sector: “Ropeways and Cable-Cars are Future of public Transport in India”.

India may soon have a brand new set of ropeways across select inaccessible regions of the North-East, Andhra Pradesh, Tamil Nadu, Kerala, Goa, and Maharashtra. The plan comes about as the government realises that these aerial cable-cars can do much more than serve tourists and adventure-seekers, and ropeways can actually become the crucial last mile connectors in tough terrain.

RITES has been given the responsibility of the survey for a ropeway transport system in Varanasi. Operation of cable car or ropeway as a public transport is a brand new project for India. At the moment, the ropeway is used only in tourism here and in most mountainous areas. If the cable car is operating as an alternative transport in Varanasi, then it will be a big deal, and if successful, it will be considered in other cities too. See Krishtina D'Silva**:** ***After rejecting Varanasi Metro Project, Govt. plans to run Ropeways in the City; Urban*** Transport News.

Public Transport with Ropeway is envisaged for Shimla, Dharamshala and Dehradun.

Public Transport with Ropeways is popular in Bolivia; see: “Mi Teleférico”, Cablecar Metro in Bolivia; Bolivia; Sustainable Urban Development and Mobility with Cablecar Metro; Metro Newsletter 67 in Portfolio 5, http://www.drwingle.com:

Boarding Aerial Cable Car in Laz Paz, Bolivia

Travelling with "Mi-Teleferico" in Laz Paz, Bolivia
Urban Mobility with Metro Cable Car, "Mi Teleférico**"** in Las Paz; Bolivia

Ropeways are integral Parts for Urban Mobility in several cities around the world, for example in Istanbul, Madrid, Singapore. For Cologne in Germany a 30 km public transport system with ropeway is in discussion.

An interesting innovative and futuristic proposal has been made for Varanasi with an Automated People Mover (APM) as a Hybrid of suspended Monorail and cable pulled Ropeway; see following Artist Conception:

Innovative projects in India deal with smart Pod-Taxi suspended Monorail systems as Personal Rapid Transit, PRT. Six states in the country are in talks for pod taxis project in their regions. These include Rajasthan, Maharashtra, Kerala, Haryana, Uttarakhand and Bihar:

Artist`s Conception for Reliance "SKYTRAN" - a Personal Rapid Transit, PRT, in Business Centres and Techno Parks

Artist Conception for "METRINO“ - Metropolitan Individual System of Transportation on Elevated Rail, "*MISTER*": Suspended Monorail Pod Taxi Personal Rapid Transit, PRT

VII. MAKE IN INDIA

(a) Metro Coaches – **‘Make in India’**

The industry has covered the long way in last 15 years from being an importer of metro coaches to become exporter of coaches to other countries. 90% of the coaches supplied to Delhi metro are manufactured in India and also maiden consignment of six metro coaches made in Bombardier facility were shipped to Queensland and Sydney Metros in Australia in January 2016. Bombardier Transportation will export a total of 450 metro coaches over a period of two-and-a-half year. Further, India will also be exporting 521 bogie frames to Brazil for Sao Paulo Monorail.

ALSTOM has delivered the last of the 25 trainsets for Kochi Metro, by rolling out the 100th ‘Make-in-India’ metro trainset from its **manufacturing facility in Sricity, Andhra Pradesh**. Kochi operates a 100% ‘Make-in-India’ metro fleet entirely custom-built at the flagship manufacturing facility at Sricity:

ALSTOM Metro Train-Set for Kochi Metro

The Metro-Sets for Sydney Metro's newest service – the fully automated North West Line train connecting Tallawong to Chatswood – have been made by Alstom in India in its SriCity manufacturing plant.

The Modern Coach Factory (MCF), Rae Bareilly has floated a Rs 150 crore tender to buy technology and expertise to produce railways' first 'Make in India' international standard coaches for metro trains by 2021, according to sources. Sources said, the MCF, last week, floated tender for transfer of technology for design, development, manufacturing, testing and maintenance of aluminium body passenger coaches for metro trains.

(b) Manufacturing Units in India; source UITP

The capital costs of Metro coaches in India are substantially lower than the rest of the world. The capital cost of a coach is around INR 89.4 million (US$ 1.35 million) in India, the cost in Vancouver is INR 160.8 million (US$ 2.5 million) and in San Francisco is INR 151.3 million (US$ 2.30 million). Three Metro coach manufacturing units have already been established in India:

Name of the Company	**Facility at**	**Year of Establishment**
Bombardier Transportation	Savli near Vododara (Gujarat)	2008
Bharat Earth Movers Limited (BEML)	Bengaluru (Karnataka)	2015
Alstom Transport	Sricity near Chennai (Tamil Nadu)	2010
Tiragarh Firema	Kolkata	1908

China Railway Rolling Stock Corp (CRRC) is planning to setup its manufacturing unit in the Multi-modal International Cargo Hub and Airport at Nagpur (MIHAN).

The existing numbers of coaches supplied or ordered for various metro project is as follows:

Metro Rail Project	Rolling Stock Suppliers	Coaches
Delhi Metro (Broad Gauge)	Consortium of Hyundai, Mitsubishi & MELCO/ Bombardier / BEML	1232
Delhi Metro (Standard Gauge)	BEML	164
Bangalore Metro	BEML-led consortium with Mitsubishi & Hyundai	150
Mumbai Metro	CSR Nanjing (China)	64
Jaipur Metro	BEML	40
Kolkata Metro	CNR Dalian (A subsidiary of CRRC)	112
Chennai Metro	Alstom	168
Gurgaon Metro	CSR Zhuzhou (A subsidiary of CRRC)	36
Hyderabad Metro	Hyundai -Rotem	171
Lucknow Metro	Alstom Transport	80
Kochi Metro	Alstom Transport	75
Nagpur Metro	CRRC	69
Navi Mumbai Metro	CSR Zhuzhou (A subsidiary of CRRC)	12
Noida Metro	CRRC	76
Pune Metro	Titagarh Firema	102

(c) Future Demand

As per industry estimates, there will be a demand of 2000 metro trains in India in the next 5 years (2015-2020). The Delhi Metro currently operates with a fleet of 227 train sets comprising of 128 six coach, 58 eight coach and 41 four coach trains across all its corridors. A total of 924 coaches have been ordered for the forthcoming phase of Delhi Metro including 504 coaches for the new Phase 3 corridors.

Further, new metro systems like Ahmedabad, Vijayawada, Kanpur etc. will release tender in coming months for the procurement of rolling stock.

With the Institute of Metro and Rail Technology (IMRT) India has a first-of-its-kind institution, that aims to be a knowledge leader in Metro and Rail Technology. IMRT has the the objective of producing next-generation 'techno-managers', capable of making crucial decisions using their skills and understanding of the sector. IMRT will breed professional engineers for the rail and metro industry by designing, developing, and delivering high-impact learning programs through education and research institution's strength lies in offering specialized training and education for engineering graduates as well as experienced professionals in the rail and metro space.

VIII. SMART TICKETING

Smart Ticketing has been slow to gain popularity in India. All metro systems have implemented smart ticketing solutions for its ‘closed’ environment; Delhi Metro sells approximately 16,000 smartcards a day and 1.8 million commuters use the card daily. However, the smart ticketing systems are not yet integrated with the bus system. The federal government did make plans to introduce a Smart National Common Mobility Card (NCMC) to enable seamless travel using different modes of transport across the country as well as having retail purchasing benefits. However, the initiative did not take off. In July 2015 the government established a committee to recommend an inter-operable smartcard.

In June 2016 Bengaluru Metropolitan Transport Corporation (BMTC) became the first city in India to launch the Axis Bank BMTC Smart Card – an open loop EMV contactless smartcard. The Bangalore Metro Rail Corporation Ltd. (BMRCL) will implement the 'National Common Mobility Card' at all the 62 stations in the Phase-2, according to reports. The 'One Nation One Card' System, in effect, can be used to make payments for all public transport.

Mumbai is another example for having various modes of public transport including suburban railway lines, metro, buses, taxis and auto-rickshaws. The Mumbai Metropolitan Region Development Authority (MMRDA) has appointed London's Transport for London (TfL) to prepare a detailed plan for an integrated ticketing system in the Mumbai Metropolitan Region. An integrated system is planned to be rolled-out by 2018.

Mumbai will soon become the first city in India to roll out 'One nation One card' system, where commuters can use their normal bank debit card to use any mode of transport.

Nagpur has unveiled with the common Mobility Card ***MAHA-CARD*** a single Payment-Card for metro, buses, feeders, parking, utility and other retail payments.

Hyderabad Metro introduces QR Code-based e-Ticketing on WhatsApp.

Global payments company Visa announced it had launched specifications for the 'National Common Mobility Cards'. NCMC, also known as 'One Nation, One Card', is an interoperable transport card that can be used for payments across all transit segments including metro, bus, suburban railways, toll, parking, etc..

IX. POTENTIAL USE OF DIGITALISATION AND ARTIFICIAL INTELLIGENCE **, AI,** IN PUBLIC TRANSPORT

The world is increasingly interconnected. Digitization plays an important role, especially in information and communication technology. Data and information are transferred worldwide in seconds within the Internet. Traditional transport systems such as road, rail and shipping are changing in terms of speed and effectiveness. The applications of Digitalisation, Big Data, Artificial Intelligence (AI), Building Information Modelling (BIM), Digital Twins, Enterprise Resource Planning, ERP, and Autonomous Operation (ATO) are rapidly shaping the Technologies for Urban Mobility as a Service (MaaS) and the way Commuters organize and plan their daily journey from A to B.

Digitalisation and Artificial Intelligence help in decission making for increase of transport capacity with shorter headways, for higher efficiency in maintenance, for higher reliability in traffic management and for faster reaction on disturbances .

For applications in public Transport see relevant article in Metro Newsletter 54, March 18th, 2019 Articles; Portfolio 3, and Metro Newsletter 96, Portolio 8 http://www.drwingler.com.

X. OTHER PUBLIC TRANSPORT TECHNOLOGIES FEASABLE FOR URBAN MOBILITY IN INDIA, ESPECIALLY UNDER THE "SMART CITY" POGRAMME, FOR PLANNED COMMUNITIES, TECHNO PARKS AND SPECIAL ECONOMIC ZONES, SEZ

Naya Raipur, a well-planned new Community waiting for innovative Transport Modes

In 2015, India's Prime Minister Narendra Modi created the Smart Cities Mission Program, which is an urban improvement initiative. 100 Indian cities were selected to participate in the project after a competitive process that compared funding with each city's individual ability to comply with the program and reach its goals:

Artist`s Impression of "Smaert City" in India

(1) INTAMIN LIGHT MONORAIL PEOPLE MOVER FOR "*SMART CITIES*", planned Communities and Techno Parks

After Union Home Minister Rajnath Singh put brakes on the much-touted metro rail project for Chandigarh in July 2018, the Chandigarh administration is now planning to have monorail as an alternative mode for mass transport in the city.

Metro shelved, Chandigarh now plans a Light Monorail of Swiss Intamin Technology. According to the proposal, the project will connect the tricity — Chandigarh, Panchkula and Mohali. In the first phase, a 20 km network is proposed.

The Switzerland-based company, **Intamin Transportation Limited**, has given presentation for its Light Monorail, which has the capacity to ferry 10,000 to 12,000 passengers per hour per direction. The cost of construction will be around Rs 2,500 crore, which translates to Rs 125 crore per km. The light-weight track system can be easily incorporated into the existing infrastructure:

Animation for the proposed first Phase Link of Panchkula with Sector-43 ISBT in Chandigarh (Biswajit Debnath/HT); Monorail People Mower with *INTAMIN* Steel-Beam Guideway Technology from Switzerland

INTAMIN (Switzerland) Monorail People Mover Steel-Beam Guideway Technology; Calabar Nigeria

The *INTAMIN* Monorail P30 People Mover of Swiss Technology, running on a Steel-Beam Guideway with inflated Rubber Tires, is a response to demands and requirements of urban transportation authorities and airport operators, for a safe, fast and reliable

transportation technology for **Mobility as a Service, MaaS**, especially in areas, where Metro-Rail will be not feasible.

It is of lighter Structure than that of a Straddle Concrete Beam Monorail. It can be laid underground, at grade and as well on elevated structure. It can negotiate tight curves and steep gradients like a roller coaster.

The system is most suitable for public transportation services in cities and allows city planners an easy implementation of a mass transit system, even into difficult environments. The train is characterized by an innovative design, spacious cabins, convenient for both standing and seated passengers and is equipped with large size door openings for easy and quick passenger access. ***INTAMIN*** People Mover Systems are characterized by route planning flexibility, low construction costs, low operation costs due to the high automation degree and are environmental friendly with virtually no emissions.

The train guiding system combined with a sophisticated automatic train protection and guiding solution, allows for a driverless operation of the trains and optimization of line performance while improving the safety of operation. The high degree of automation makes it also possible to operate the system with a minimum number of staff. State-of-the-art communications systems with on-board passenger information system together with large window areas enhance the environment to a superior level of comfort. The trains travel quietly and quickly to their destinations, offering an efficient transportation method, especially during the rush hour.

INTAMIN Monorail Steel-Beam Guideway for Calabar; Nigeria

The implementation in other Indian Cities of **HEAVY MONO-RAIL** on **CONCRETE STRADDLE BEAM TRAJECTORIES,** the technology used for Mumbai Mono-Rail, has to be regarded as NOT FEASABLE for other Indian Cities. This technology under scrutiny will have no future in India anymore!!

(2) INDUCTION LINEAR MOTOR PROPELLED INNOVIA LIGHT RAPID TRANSIT

Innovia Metro (stylized as **INNOVIA Metro**) is the current name given to an automated rapid transit manufactured by Bombardier Transportation. **Innovia Metro Systems** run on conventional metal rails and pull power from a third rail, but are powered by a linear induction motor that provides traction by pulling on a "fourth rail" placed between the running rails. A new version of the technology being marketed by Bombardier is compatible with standard electric rotary propulsion.

Rapid KL - Kelana Jaya Line; Kuala Lumpur, Malaysia;
Linear Induction Motor towed Light *INNOVIA* Metro

(3) GUIDED RUBBER TYRED LIGHT PEOPLE MOVER ON STEEL ROLLWAYS; See: ***Subways/Metros with Rubber Tires***, written by Alexander Lew Gear; in Metro Newsletter 41 in Portfolio XX, http://www.drwingler.com. and METRO RAIL NEWS, Edition November 2019,

Paris Metro runs parts of his Metro Cars on Rubber Tires, running on Steel Rollways parallel arranged to the railway. The dispatchable tractive effort is higher than with steel wheels on steel rails allowing faster acceleration and deceleration. The bogies are guided with side flanges. The Paris Metro System has as back-up for the case of a deflation by flanged railway steel wheels and steel rails. The track can be used both by rubber wheel as well by steel wheel metro cars. This technology is nowadays worldwide followed by several metros:

Rubber Tyred Bogie of Paris Metro-Rail on Steel Flange Guide Roll-Way with Steel Wheel/Steel Rail Backup

By waving of the railway rails, several Light People Mover systems have been developed. There are flange as well centre mono-rail guided systems mostly used for shorter lines and automatic people movers as shuttle and/or feeder installations; see also F. Wingler: ***MONO-RAIL GUIDED TRANSPORT,*** **p**ublished on: June 22, 2019/July 26, 2019 by Chaminda Weerawarna Category: Metropolitan Transport Schemes; http://www.drwingler.com.

Hiroshima Rapid Transit Co. Rubber-tired Automated Flange Guideway 6 Car Transit Light Metro Trainset on Rollway

Lyon Rubber Tired Light Metro VAL on Flange Roll Guideway; France

(4) Centre Mono-Rail guided People Mover on elevated Rollways; see also F. Wingler: ***MONO-RAIL GUIDED TRANSPORT,*** **p**ublished on: June 22, 2019/July 26, 2019 by Chaminda Weerawarna Category: Metropolitan Transport Schemes; http://www.drwingler.com

Leading global player for centre-rail mono-rail guided automatic driverless people movers (APM) is Bombardier:

Centre Rail guided Bombardier APM automated People Mover on elevated Right-of Way Roll-Way

Bombardier APM 100 People Mover, Frankfurt Airport

Bombardier *INNOVIA* APM Centre Rail guided and Rubber tired Autonomous People Mover on Roll-Guideway, Shanghai

San Francisco INNOVIA APM 100 Air Train; Pict www.mousetroop.com

“Right-of Way” Center-Rail guided and Rubber tyred automated Bus-People-Mover of Los Angeles Airport; USA

Wolmi “Sea Train” on Right-of-WayGuide-Way South Korea

(5) BOTTOM CABLELINERS

The Cable-Liner and Cable-Liner Shuttle is a range of Automated People Mover (APM) products designed by DCC Doppelmayr Cable Car for use at Airports, in City Centers, as intermodal Passenger Transport Connections, Direct Air to Rail Transit (DART), Park and Ride Facilities, Campuses, Resorts and Amusement Parks. They can negotiate steep gradients; see Metro Newsletter 46 in Portfolio 3, http://www.drwingler.com.

The evolution of Doppelmayr, Austria, goes back to the San Francisco, USA, Cable Car from 1877 pulled by a continuously rotating cable embedded in the center of a city-street tram rail track with vignol rails:

Cable-Car San Francisco, USA

CLS Cable-**Train "**Bolivariano**" in** Caracas; Bolivia

Animation of Cable-Liner for Luton Airport, UK, under Construction

(6) LOW SPEED MAGLEV TRAINS FOR URBAN TRANSPORT

Animation of low/medium Speed *BÖGL* Maglev People Mover

German Construction Company Max Bögl launched a new maglev concept: Instead of a high speed application, the company envisages low or medium speed operation over distances up to about 30 km.

Following the demise of Transrapid maglev technology in Germany after Transrapid 08 collided at around 170 kmph with a maintenance vehicle in September 2006, Max Bögl later revisited the concept and decided to explore its potential. The company built a short test guideway in Sengenthal, not far from Nürnberg, with a view to refining the infrastructure, vehicle and control technology.

Speaking to business publication *Handelsblatt*, CEO Stefan Bögl said that 'worldwide there is great potential for the technology' and that the 'market could be worth billions'. The initial target is China, where the company has reportedly found a partner business with a view to building a 3·5 km test installation in Chengdu.

Existing low to medium speed maglev applications include the Linimo light metro originally built to serve the World Expo east of Nagoya in 2005, the Mentougou Line in Beijing, where passenger-carrying tests began in August 2017, and a peoplemover at Incheon Airport in South Korea. When running at scheduled speed it runs maglev-elevated and when running slow it lowers on rubber tires.

(7) SUSPENDED MONORAIL TECHNOLOGIES – feasible for India

(a) Experimental Goa Sky Bus

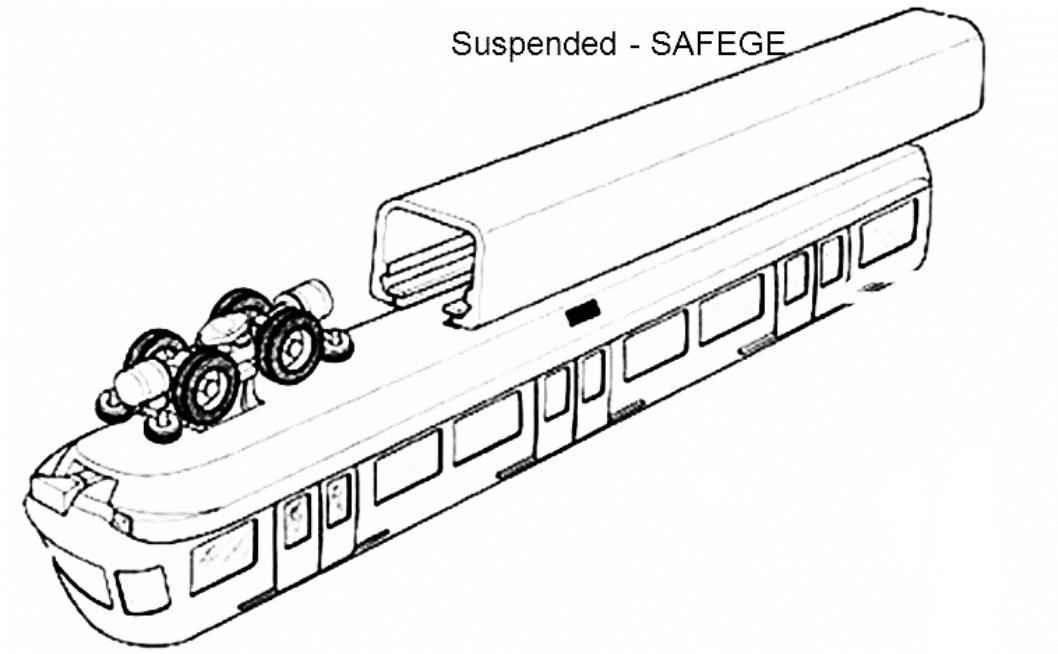
The Goa Skybus Metro was a prototype suspended railway system by Indian technologist B. Rajaram with the Konkan Railway. The system consisted of an elevated concrete trajectory or guideway box, carrying two parallel rails without cross bars and with a railway carriage drive with flanged steel wheels running on the rails. The cars are suspended below in the gap between the two rails

A 1.6 km (1 mi) test track in Madgaon, Goa started trials in 2004, but on 25. September, one employee was killed and three injured in an accident, ending the trial. The test track was supposed to be extended to 10.5 km, but no progress was made after the accident. In 2013, the Konkan Railway scrapped the project. There had been also problems in keeping the trajectory box stable, to keep the gauge with no cross ties and to provide turnouts:

Goa Sky Bus Guideway Trajectory

(b) Suspended Rubber Tired SAFEGE Sky Bus

Other than the Indian two-Rail suspension system the SAFEGE Technology with rubber wheel drives running in a narrow steel trajectory or guideway box on a steel rollway proved to be feasible and dimension stable. It can negotiate steep inclines with a ruling gradient of up to 1 in 10:



SAFEGE Suspension Arrangement

Driverless Düsseldorf SIEMENS Airport Sky Bus People Mover, Germany

The Shonan suspended Monorail in Kamakura System SAFEGE, Japan

CRRC Sifang Suspension Monorail that in Hancheng, China

(c) The Wuppertal Suspension Mono-Rail, Germany

The first and only successful Suspension Mono-Rail in public urban transport with steel wheels running on a steel mono-rail is the so called Wuppertal “Schwebebahn” in Germany, which started operation on1st of March 1901 and serves since up to now as the backbone of the urban public transport. It had been recently refitted with modern cars for autonomous driverless operation controlled by the European Train Control System , ETCS, Level 3, allowing headways of 150 seconds with a max. speed of 80 kmph:

Wuppertal “Schwebebahn” Suspension Steel Monorail

Flanged Steel-Wheel Steel-Rail Suspension Drive

(8) FIRST- AND LAST MILE DRIVERLESS PEOPLE MOVER

With the worldwide evolution of automatic driven cars and buses feeder shuttle-taxis will also run autonomous and driverless. Test vehicles are already in operation. Such automatic people movers are a viable and feasible option for emerging Indian “SMART CITIES” and Special Economid Zones, SEZ, to bring commuters at Metro-, Railway-, Bus-Stations or multimodal connectivity Hubs fro and back to factories, worksides, offices, homes, hotels, hospitals and shopping centres:

German Railway Driverless automatic People Mover (APM) ***“LOKI”*** for First- and last-Mile provided by SIEMENS

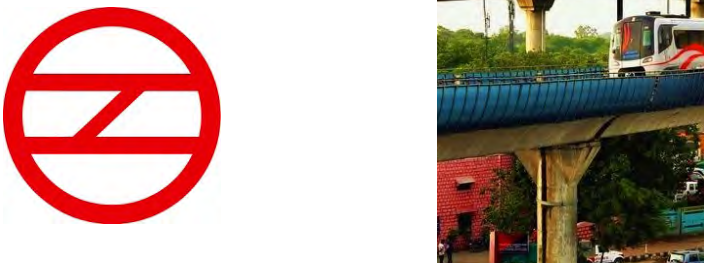
NAVYA autonomous electric Shuttle Bus by Siemens, Seestadt Aspen; Austria

ANNEXURE: Picture Gallery

Indian Metros in Operation cum Logos - Date of Opening Sequence

1. Kolkata Metro
October 24th, 1984
27.22 km

2. Delhi Metro
December 24th, 2002
347.66 km



3. Namma Metro Bangalore
October 20th, 2011
42.30 km

4. Rapid Metro Gurgaon
November 14th, 2013
11.70 km

5. Mumbai Metro
June 8th, 2014
11.40 km

6. Jaipur Metro
June 3rd, 2015
9.63 km

7. Chennai Metro
June 29th, 2015
45.10 km

8. Lucknow Metro
September 05th, 2017
23.70 km

9. Kochi Metro
October 03rd, 2017
27.80 km

10. Hyderabad Metro
November 29th, 2017
56.50 km

11. Noida Metro
January 25th, 2019
29.70 km

12. Nagpur Metro
March 07th, 2019
13.50 km

13. Ahmedabad Metro
March 14th, 2019
6.5 km

14. Pune Metro
sheduled opening June 2020
7 km