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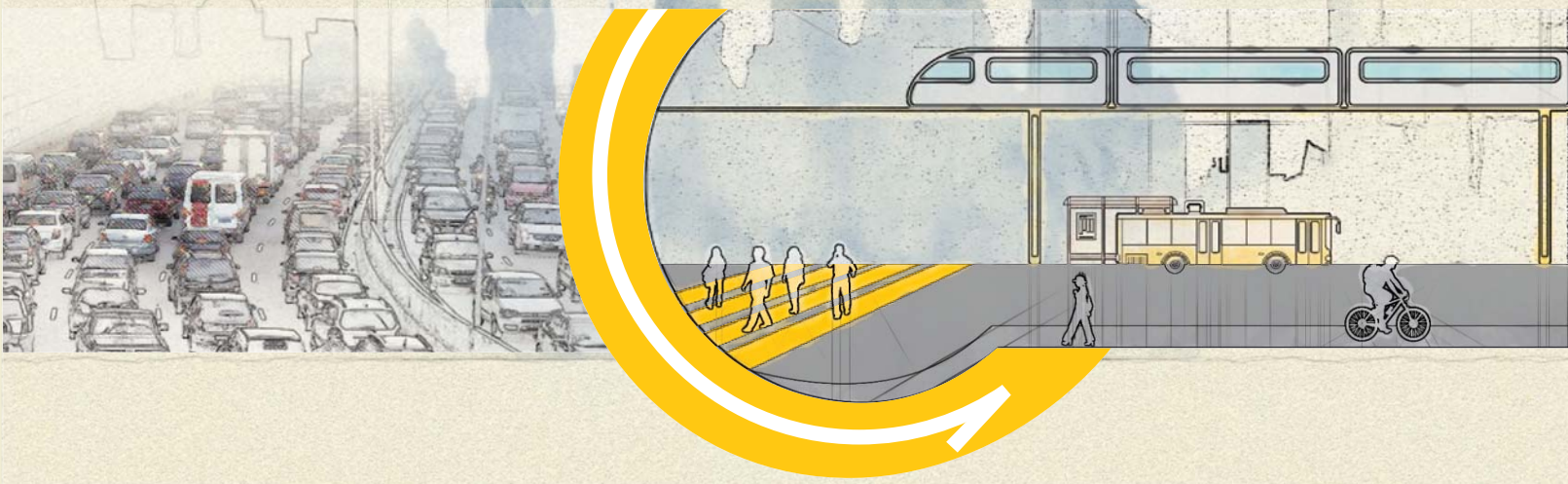
The Urban World

Quarterly Publication

Transforming Urban Transport in India



Regional Centre for Urban and Environmental Studies
All India Institute of Local Self-Government, Mumbai

RCUES
Mumbai

Regional Centre for Urban & Environmental Studies (RCUES), Mumbai

(Fully supported by Ministry of Housing and Urban Affairs, Government of India)

Established in 1926, the All India Institute of Local Self Government (AIILSG), India is a premier autonomous research and training institution in India. The Institute was recognized as an Educational Institution by Government of Maharashtra in the year 1971. The Institute offers several regular training courses in urban development management and municipal administration, which are recognized by the Government of India and several State Governments in India.

In the year 1968, the Ministry of Housing and Urban Affairs (MoHUA), earlier Ministry of Urban Development), Government of India (GoI) established the Regional Centre for Urban & Environmental Studies (RCUES) at AIILSG, Mumbai to undertake urban policy research, technical advisory services, and building work capabilities of municipal officials and elected members from the States of Goa, Gujarat, Maharashtra, Rajasthan and UTs of Diu, Daman, Dadra & Nagar Haveli. The Ministry of Housing and Urban Affairs (MoHUA), Government of India added States of Assam and Tripura from February, 2012 and Lakshadweep from August 2017 to the domain of RCUES of AIILSG, Mumbai. The RCUES is supported by the MoHUA, Government of India. The MoHUA, Government of India has formed National Review and Monitoring Committee for RCUES under the chairmanship of the Secretary, MoHUA, Government of India. The Principal Secretary, Urban Development Department, Government of Maharashtra is the ex-officio Chairperson of the Advisory Committee of the RCUES, Mumbai, which is constituted by MoHUA, Government of India.

The RCUES was recognized by the Ministry of Urban Development, Government of India as a National Training Institute (NTI) to undertake capacity building of project functionary, municipal officials, and municipal elected members under the earlier urban poverty alleviation programme-UBSP. The RCUES was also recognized as a Nodal Resource Centre on SJSRY (NRCS) and Nodal Resource Centre (NRC) for RAY by Ministry of Housing and Urban Poverty Alleviation, Government of India.

The AIILSG, Mumbai houses the Solid Waste Management (SWM) Cell backed by the Government of Maharashtra for capacity building of municipal bodies and provide technical advisory services to ULBs in the State. The Water Supply & Sanitation Department (WSSD), Government of Maharashtra (GoM) established Change Management Unit (CMU) in AIILSG, Mumbai from 13th January, 2010 to 30th June, 2014 and also selected AIILSG, Mumbai as a Nodal Agency in preparation of City Sanitation Plans for 19 Municipal Corporations and 15 A Class Municipal Councils in Maharashtra State, under the assistance of Ministry of Urban Development, Government of India. The WSSD, GoM also established Waste Management & Research Centre in AIILSG, Mumbai, supported by Government of Maharashtra and MMRDA.

In August, 2013 Ministry of Urban Development, Government of India empanelled the AIILSG, Mumbai as Agency for providing technical support to the Cities / Towns of States / Urban Local Bodies (ULBs) in the field of Water Supply and Sanitation, Sewerage and Drainage systems.

In July 2015, Ministry of Urban Development, Government of India empanelled the RCUES & AIILSG, Mumbai an Agency for technical support in Municipal Solid Waste Management under Swachh Bharat Mission (SBM) programmes.

In February, 2016, Ministry of Housing and Urban Poverty Alleviation, Government of India empanelled the RCUES of AIILSG, Mumbai for conducting training and capacity building programme for experts of SMMU, CMMUs, COs, Key Officials and other stakeholders of the State and Urban Local Bodies (ULB) level under Deendayal Antyodaya Yojana – National Urban Livelihoods Mission (DAY – NULM).

In December, 2017, AIILSG has been empanelled as a training entity regarding implementation of new Integrated Capacity Building Programmes (ICBP) under Urban Missions, viz. Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission (SBM), Smart Cities Mission (SCM), National Urban Livelihoods Mission (NULM), Housing for All (HFA), Pradhan Mantri Awas Yojana (PMAY) and Heritage City Development and Augmentation Yojana (HRIDAY) for Elected Representatives and Municipal Functionaries.

At present, RCUES and AIILSG, Mumbai is involved in providing capacity building, research and technical support to number of State Governments and ULBs for implementing various urban development missions and programmes launched by the GoI.

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(April - June, 2018)

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Editorial

Driving urban mobility in the right direction

Urban mobility is a key determinant of the quality of life of citizens. Efficient public transport enables city-dwellers, especially the weaker sections, to access livelihoods, education, healthcare, recreation and so on. For example, lack of affordable transportation may deny better livelihood options forcing them to settle for sub-optimal choices closer home.

However, urban mobility is a stubborn challenge faced by cities. Several factors are leading to this crisis like situation in cities from London to Paris to Mumbai. Increasing choices of private vehicles from a range of cars to two-wheelers, greater affordability driven by financing options especially in the developing world, and new hail-a-cab apps on the one hand; and declining role of public transport (mainly buses) on the other, are some.

The increasing numbers of vehicle on roads is taking its toll in several ways. Congestion, road accidents and poor air quality are some of the more serious ones. Building more and wider roads, more flyovers, viaducts and so on have all encouraged more private transport (cars and 2-wheelers), increasing the numbers of vehicles on the roads with more accidents, and worse air quality. The share of 2-wheelers in vehicles registered in the State of Maharashtra grew from 28 percent as of March 1971 to 73 percent as of March 2016. During the same period the share of buses fell from 2.93 to 0.47 percent. Lower costs of using 2-wheelers (compared to bus fares), point-to-point connectivity and zero wait times contribute to the shift to 2-wheelers. At the same time city bus services are faced with precarious finances with even large ones suffering big deficits. Any attempt to raise fares is met with declining ridership and further drop in revenues.

Efficient public transport could however, remain bus-centred. Consider that in Mumbai, buses occupy just 6 percent of road space while moving over 40 percent of commuters. Cars and 2-wheelers on the other hand, occupy a total of over 80 percent of road space to move the same number of people. For other reasons too; buses can be purchased almost off-the-shelf, the infrastructure to run them, viz., roads – is readily available and buses offer great flexibility – increasing or reducing services on a route at will, changing routes to meet special demands like festivals, etc. Special attention is needed to improve last-mile connectivity, especially in the case of metro and suburban trains – could be shared IPT, electric and non-motorised transport.

In the business-as-usual scenario, urban mobility will soon turn into chaos. Measures will have to be put in place to encourage use of public transport and discourage use of private transport. To start with look at the parking charges! Charges in Mumbai, having among the highest real estate prices in the world, are absurdly low or even free. Parking fees in all our cities

Editorial

need to reflect the true value of precious public spaces. To make public bus services more viable for yet affordable for users, such increased parking fees could be passed on to the city bus operator. A cess on every litre of auto fuel sold could discourage use of private vehicles. This cess, passed on to the bus service operator, could improve viability while keeping fares low.

In addition to such fiscal interventions, we need other measures. For example reserving roads around important centres like railway stations only for city buses and non-motorised transport would encourage their use. The most preferred road between two points could be reserved for pedestrians, cyclists and buses to discourage motorized private transport.

These and several other bold measures would be required if we are to put in place efficient, affordable, equitable and sustainable urban mobility in our cities. We need to do it before it is too late.

In this issue of The Urban World we carry papers on several aspects relating to this complex issue of urban mobility. We trust these will serve to generate lively and meaningful debate on the subject.

Investment Criteria for Sustainable Transport Infrastructure- With Examples from Mumbai

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Traffic Analyst, Mumbai Environmental Social Network.

We need a lot of infrastructure in India – both hard and soft and in several sectors of economy and regions – from irrigation for farming to drinking water, sanitation, hospitals, schools and colleges, judiciary and administrative system, waste & scrap management. Transport infrastructure consists of civic works such as roads, bridges, highway systems, bus depots, railways tracks, stations, ports & airports plus hardware such as rail coaches, engines, signaling systems. Buses for public utilities, metro coaches – also called as rolling stocks for new lines or increased numbers and/or replacements for existing operating systems. During the last 25 years, investment - especially in hard infrastructure has increased manifolds as compared to previous the 45 years. However, there are still significant gaps in many areas. For the hard infrastructure, besides funds, land has become very critical. It is one of the most finite natural resources especially when infrastructure development has to compete with agriculture, housing and industrial as well as commercial needs. Unlike in China, land in India, is not owned by the government and hence there are many delicate issues. When you "open the economy" you also have to pay the price for land in line with "price which market discovers!"

But even if we restrict ourselves to straight forward funding needs of transport sector, there are a lot of problem areas-conceptual as well as practical. The most critical one being the fact that the beneficiaries of the infrastructure are not the ones who make investment decisions. An important criterion for infrastructure projects is the investment per passenger trip in a day (per road lane/rail tracks, buses or cars). This is based on treating investment as an input and a passenger trip as an output. This is a basic and somewhat crude criterion but it allows a comparison of efficiency in basic input/output ratios for various uses of space and various modes with a common output denominator. Currently, output is defined in most cases as passenger car units per day. Optimum modal share, environmental & ecological sustainability, value of time saving are the other criteria which are often ignored.

Value of time saving vs modal share to justify an investment in a new road, link, flyover project

Typically, at least in India, government makes the investment decisions for infrastructure with some idea of what benefits will accrue to the economy and society as a whole (or at least that's what is expected) – not necessarily any direct financial returns. Typically, social benefits are added to the direct financial returns such as saving in fuel, transit time. But it is possible that we may be using faulty concepts of social benefits. For example, benefit of many road projects are considered time saving of vehicles and value of time saved of those who travel in them. Obviously, the value of time, in terms of income/hour of people who travel in cars unlike people who walk or travel

in buses would not count for much. But saving in cost and time, which only public transport makes possible and affordable, has great social benefits and also reduction in emission per person km. Quite often, the time saved by new links is a half truth. New link (or flyover) reduces the travel time in the beginning. But over the period, it attracts more motorists to buy vehicles or take out the parked vehicles at home due to time saving and thus traffic increases, traffic jam returns and the whole benefit washes away- can even turn negative as a high collateral cost of traffic jams and emissions in the area beyond the direct impact area. The feasibility report prepared at the time of initiation, does not take into account this experience. Nobody evaluates past performance of such projects before repeating similar logic for new car-centric projects.

It is important in a space starved city to enumerate the number of people and give full weight to the modal mix before undertaking road widening, flyover building or developing new link. Is it possible for us to consider what is the current share of public transport (i.e. buses) and non motorized transport i.e. bicycles and pedestrians rather than considering only vehicles, in reality mostly cars.

Earlier (i.e. at least from 2006 when we started traffic count by streets, we found that **share of passengers in public and non motorized transport** taken together used to be in the **range of 20 to 30% for various roads**). As can be seen from the following table, all the new projects implemented in Mumbai during last decade have contributed significantly to reduce the share of public transport directly and drastically to levels below 10% and the spread effects of these links also impact in a similar fashion and hence we see a huge increase in traffic jams while the number of passenger trips have only marginally increased but

Project name	Year of startup	Length (km)	Total trips/day	Investment		%share of public transport
				Total (Rs.cr)	per pass. Trip-rs.lakh	
Bandra Worli sea link	2009	6.5	58000	1600	**2.76**	**< 1%**
Jogeshwari Vikhroli link rd-JVLR	2007	10.6	256,000	400	0.15	**12%**
Eastern freeway	2012	12	70,000	1400	**2.00**	**< 1%**
Santa Cruz Chembur link rd-SCLR	2014	6.5	200,000	600	0.30	**< 8%**
Coastal Road	2022	31	300,000	15,000	**5.00**	5%
Metro I	2014	11	380,000	4100	1.08	100%
WEH Bus Priority-proposed but not taken	2019	22	250,000	100	0.04	100%

their shift from low intensive buses to land intensive private vehicles.

As can be seen from the table above, **the shares of public transport** for all the new road projects completed during last 10 years ranges **between 12% to 1%**. Further, investment per passenger trip in a day is as high as Rs.5 lakhs per trip on coastal road, whereas it was only Rs. 1.08 lakhs for Metro I. The costs of JVLR and SCLR are much lower as they were existing roads which were widened/modified. However, when the share of public transport is very low as in the case of Eastern Freeway, the investment/passenger trip is very high. Needless to say that when the share of public transport is low, the emission per trip is bound to be

high. It is unfortunate that bus priority was not even considered as an alternative for Coastal Road when it is superior to it on all counts except that it entails a migration from private transport to buses, which will increase share of buses at least fourfold to beyond 20%, by reducing the travel time for buses by 70-80%. Further, there is even less clarity regarding the impact on the environment which has now become a critical and urgent issue. But it gets mostly lip service rather than making a decisive impact on choice (which is most glaring in the choice of Coastal Road which has virtually no environmental or economic merit for most passengers). Climate change is no more just a futuristic idea. It will affect a vulnerable India in the near future – as early as 4 to 8 years! Further, a lot of emerging disruptive technologies have potential to make large investments with long gestation period obsolete in the next few years.

The emerging trends in technologies will impact modal shift in transportation & more

Hyper loop, electric cars and medium speed rail freight corridors are some of the technologies that may affect investments in high cost diesel guzzling expressways. Electric buses will affect not only auto fuel based cars but even diesel using buses. Driverless cars will radically affect ownership and parking of cars in developed and disciplined countries but we need not fear a large scale application of this technology in the foreseeable future. These are some of the real possibilities for the coming decade. In fact, extensive use of internet is already providing an edge to rail transport which is fuel, space and emission efficient compared to roads. Railways consume less than 1/5th quantity of fuel/ton km or per passenger km. Car based private transport is a particularly energy, emission and space inefficient mode. The space element is being recognized as very critical for the growing population in already congested cities. It is unfortunate that most of the highway projects actually encourage increase in the emission/ton km and per person km! Even aircrafts consume more energy and thus more emission inefficient as compared to rail for intercity travel. For intra city travel, pedal assist electric bicycles can emerge as a game changer as it can also manage to run on solar charged batteries.

Rationalization in long distance intercity /region traffic

Share of railways in carriage of freight is steadily going down in the last few decades. Share of railways in freight has gone down from 75% in 1950s to 33% now. Even now in USA, railways dominate freight business. In India, early shift from railways to roads was quite understandable as the movement to and from rail stations was confusing and delaying for wagons from and to ports and to the final destination from the origin. But with rapid improvements in paper work thanks to computers and internet, great progress has been made at least between the port and the rail wagons.

Golden quadrilateral rail freight corridor can reduce freight & emission loads on highways

GQFC has 6 dedicated freight corridors. Ludhiana (Punjab)– to Dankuni (West Bengal)-1760km and Dadri in U.P to JNPT in Mumbai – 1468 km are being implemented. Funding for the remaining 4 was approved in January 2018. The rail tracks linking four largest Metro cities of Delhi, Mumbai, Chennai & Kolkata and two diagonals North – South dedicated freight corridor (Delhi-Chennai) and East-West dedicated freight corridor (Kolkata-Mumbai). These carry 55% of the Indian Railways freight traffic over a total 10,122 km route length. Total investment is likely to be Rs.20 Trillion (US$300 Bn). Still the time by rail is very high compared to road thanks also partly due to improvement in highways and poor development in freight rail corridor which can offer cost and time reduction in a big way. But the growth of this powerful tool has been rather slow and it appears to

be on the back burner. One doesn't hear of the progress on Ludhiana – to Dankuni (W. Bengal) & Dadri in U.P. to JNPT in Mumbai freight corridors which promise movement of freight trains at every 15 minutes in each direction at great reduction in time would lead to substantial saving in cost and time.

Long Distance Rail Freight corridor vs Mumbai Nagpur Samruddhi Mahamarg

The government of Maharashtra has planned an ambitious 4+4 expressway between Mumbai and Nagpur In addition to existing 3+3 highways. This new project of 700km expressway and the proposed Krishi Samruddhi Kendra will cost Rs.46000 crore. The work is expected to start soon after completing the land acquisition. In the light of above, comparison between an expressway and the rail corridor is necessary. Rail corridor will substantially transfer freight from existing highways making way for high speed buses and reduce even the most unwarranted contribution to emission from private cars and perhaps we can avoid investing in the new Mahamarg. This tilt to buses from cars can be facilitated by tolls only on cars and not on buses. This will make it possible to run more (and faster) passenger trains on existing track if we convert the railways to medium speed network substantially reducing the need for incremental lands either for rails or roads. In any case, each rail track can carry at least twice the number of passengers or goods at 50% reduced time. Further it can reduce overall fuel consumption by upto 50% (and consequently the emission loads).

As a matter of fact, rail corridor of two lines should require much less land than 4+4 lane expressways. Normally one rail track requires the same space as one lane on the expressway (except at stations and rail yards) and with medium speed, network of railways will carry more traffic per track as compared to a road lane. Further, once we primarily put most of the long distance freight on the freight corridor and use modern hi speed buses, the pressure on expressway should reduce. This will also lead to a substantial reduction in need for multi lane expressways which generate and invite more traffic from space and emission inefficient private vehicles. If we provide for this factor in the tolls, we can have overall sustainable, comfortable and hi speed transport of people and freight. More of such dedicated corridors need to be developed in a speedy manner using the criteria of economic and emission efficiency taken together. The end to end logistics solutions can bring a major revolution in transport in India. We need to know modal share of cars and buses on various expressways and if we take a holistic view, we should focus much more on freight corridors rather than expressways and toll reforms so that freight and people can be carried more efficiently, with lower overall fuel consumption, emissions and time.

Evaluation of mobility alternatives in a western corridor between Andheri & Borivali

Number of projects have been undertaken for rapidly worsening traffic congestion on North-South corridor in western suburbs such as between Bandra to Virar or more particularly between Andheri to Borivali. To reduce the traffic congestion on this corridor is a major challenge and that is sought to be met by:

1. Coastal Road,

2. Metro 2A and Metro 7 (right on top of WEH)

3. Further western railway is also planning to add one or two extra lines as well as reduce the headway from 3.2 mins to 2.5 mins & also add 3 AC coaches to every train to convert them into 15 coach trains.

Following table shows the expansion of capacities by all the above modes in this area which has a width of about 4-5 km(East-West

Capacities-current and under construction

between Andheri & Borivali for all modes - Peak Hr Peak Direction (PHPD)

Link	current	2021 - 22	investment
	no. persons - all modes		rs cr
W E highway (constant for last few years)	15000	15000	
W Rly (1st & 2nd cl)	120000	130000	8000
Metro 2A	0	22000	8000
W Rly AC class (incremental)	0	12000	1200
Metro 7 #	0	18000	7000
Bus priority # - WEH needed but not proposed	0	12000	100
Coastal Road**		25000	16000
Total	**135000**	**234000**	**40300**
Increase in capacity in 4 yrs		**73%**	
Max increase in demand in 4 yrs		**120%**	

- *Current performance of Metro I at PHPD 28000 persons*
- *** BWSL currently has a PHPD of 6000 persons*
- *# Metro 7, AC class on locals & bus priority on WEH together provide a great alternative to coastal road in terms of cost, emissions and effectiveness.*

direction) & length of about 10-12 km in(North South direction)

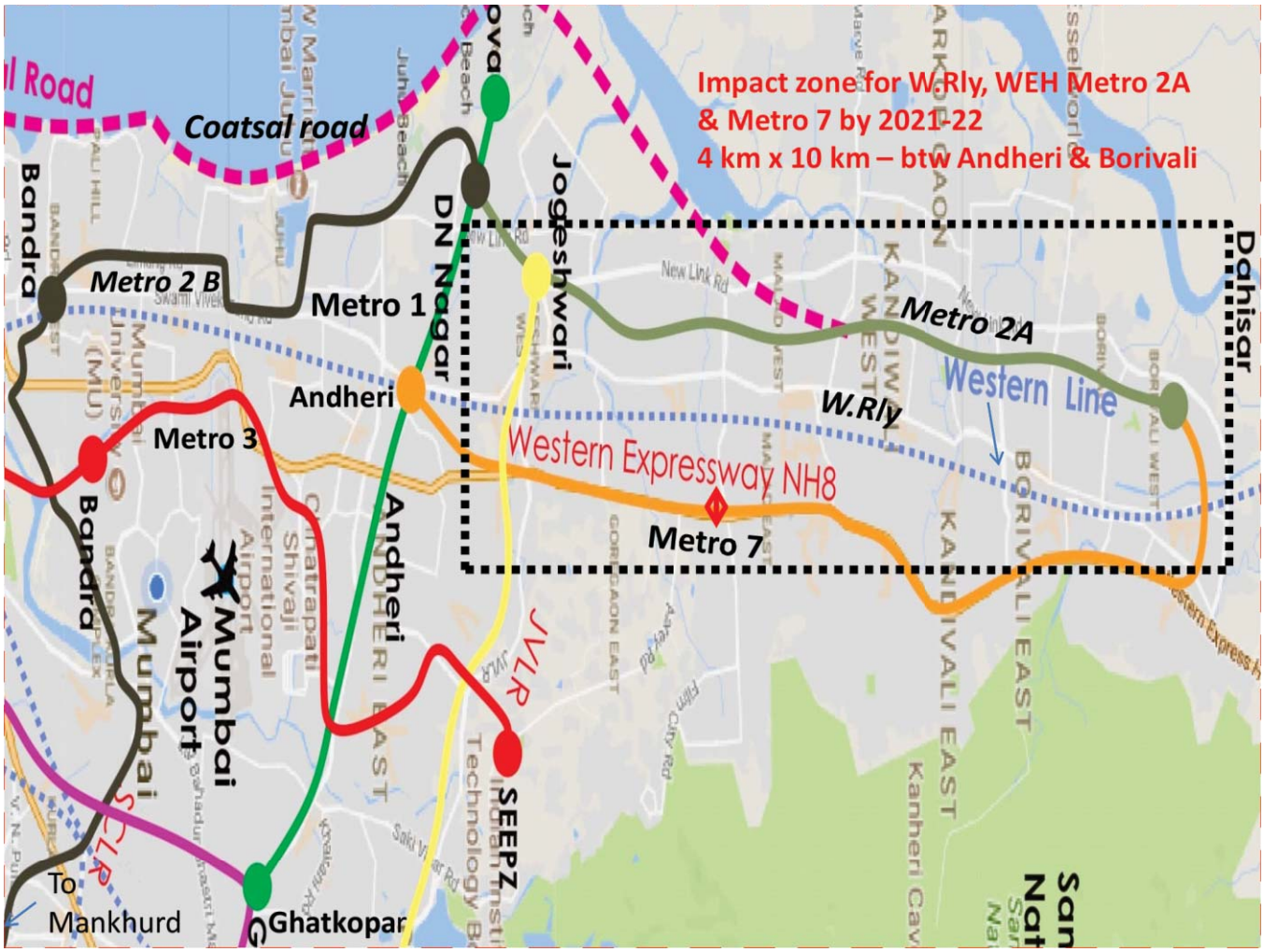
As can be seen from the above table the capacity is being increased by 73% in 4 years. This kind of increase in such a small area has never been made in the past. During the last decade we have observed & felt a rapid increase in congestion, but on a closer look it will be seen that this congestion does not represent increase in number of passengers but a major shift away from buses to private vehicles (2/3 wheelers, cars/taxies). This involved increase in space used per passenger. Traffic counts showed that number of persons using WEH per peak hour has remained the same but the time to cover a given distance has increased considerably of which visual expression is in the form of growing traffic congestion. Even the increase in the trains has been matched to some extent by a decrease in the ridership of buses. Thus overall number of passengers travelling north-south per peak hour has not increased materially. It is certainly under 3-4% p.a. (more likely 1-2%). This should be verified before planning large investments in multiple options such as 3 metro lines, a 4+4 lane coastal road, increase in tracks and reduction in headway for western railway (not to miss elevated rail tracks over existing corridors).

It is a good idea to create large capacity as there is an experience that creation of capacity leads to increase in demand, but whether so much money should be spent on so many options in a small area in a short time. The traffic that will be carried by this metro can be conveniently carried by a bus priority on WEH itself with easy connections to east and west. This could have saved a lot of money (Rs.100 cr vs Rs.8000 cr) and space, because today metro above WEH is consuming equal space as required by bus priority which would have brought the "vehicle restraint" on agenda. This combination of 2 metros and one bus priority together with

expansion capacity on W Railway would have met various objectives of reduction in traffic congestion and emissions and would have distributed traffic in a balanced manner, with substantial saving in investment. A third metro in the same narrow corridor would offer a poor return on investment.

As can be seen from Map 1, existing Bandra Worli sea link which forms the central part of the coastal road carries about 50,000 vehicles/day (no increase in last 9 years) almost totally private cars. The simplistic environmental rationale of the project is that all the cars will travel fast and smooth and will thus reduce emissions than what they incur today due to heavy traffic. It doesn't take into account that all entries and exits to the city will face humongous traffic jams which will be an additional distance to travel and generating substantial emissions as there will be a lot of stop start operations at the connecting points and travel from origin to destination. Besides, it assumes that there will be substantially less traffic jams on existing inland arteries as a lot of car traffic is diverted to the Coastal Road. Again forgetting the past experience that whenever a new link is provided or road is widened or a flyover is provided, its capacity invites "additional traffic "in a fairly short time (unless it is accompanied by vehicle restraint measures, which is an anathema to us)

Map 1



A rigorous "alternatives analysis" would show that a combination of bus priority, increase in Western railway services and metro 2A would more than adequately cover the north-south traffic needs in the western corridor for more than 10 years.

To summarize, for long term inter city transportation through dedicated freight corridors we should dramatically improve the efficiency and time in carrying freight compared to road transport. We should establish criteria such as fuel per ton-km(corollary is emission), average time from origin to destination-hours per 100 km, throughput per road lane and per rail track per hour etc and use them in justifying investments in rail as well as roads. For transport of passengers also we should compare rail & road. With medium speed rail network, its efficiency for carrying passengers by trains for distances longer than 200 km should be superior to road network but for shorter distances and intra-city transport bus network (with right of way wherever possible) would be more efficient as its reach is much wider and investment is much smaller and flexibility is much higher. Metro policy initiated by the central Government which identified thresholds for a metro line for a minimum of 30000 persons per peak hour peak direction (PHPD) and similarly for bus priority, the no. identified was 10000 persons PHPD.

In conclusion, we should circumspect while considering car centric highway projects. There are a lot of negatives about them and full rigorous alternative analysis is a must in those cases. Transport projects should also question the existing and assumed land use for housing, affordable housing, job creating entities – commercial or industrial and possibilities of reducing the need for mobility through use of internet connectivity (for work) & mixed land use. Social mobility and mobility for cultural, social, sports and entertainment purposes should not be discouraged and for such purposes, bicycle and walking mobility will be an important option. These concepts need to be translated into well-defined mathematical criteria and need to be used in a transparent manner for new investments as well as evaluating past investments as needs, trends and technologies keep on changing and we must keep ourselves abreast of these changes.

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Creating Non-Motorized Friendly Cities- Challenges and Way Forward

Ranjit Gadgil,
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1. Introduction

The National Urban Transport Policy (NUTP) of 2006 created a new vision about how to deal with traffic and transportation in cities. The policy came against the background of rapid increase in the numbers of personal motorized vehicles in cities leading to incredible congestion, pollution and a rise in accidental fatalities and injuries, the victims of which were predominantly pedestrians, cyclists and two-wheeler users; so-called Vulnerable Road Users. This increase in the number of vehicles (cars and two-wheelers) was predictable and followed worldwide trends that show a strong correlation between GDP and car ownership (TERI).

Until the advent of the NUTP there was no explicit policy that guided the cities with regard to traffic and transportation and actions were fragmented, uncoordinated, ad hoc and often contradictory. The unwritten "policy" of cities and the public authorities was essentially to try and increase road infrastructure (road widening, new roads, flyovers etc.) and the supply of free and unregulated parking. There was no vision at the city-level for public transport or non-motorized transport. While most larger cities had some semblance of a formal usually bus-based public transport system (either city or State-run city transport services) – which was neither adequate or of good quality – non-motorized transport was completely ignored. As the pressure of motor vehicles increased, roads became increasingly hostile for pedestrians and cyclists – leading to both a drop in their share as well as an increase in accidents.

The NUTP was considered a visionary document and presented a radically different vision, one which questioned the status quo and emphasized the need for cities to focus on improving public transport and non-motorized transport. The tagline for the whole policy was "move people, not vehicles". More importantly the policy shifted the actions of the Central Government and it effectively ensured that all its programs and the nature of its support to cities was in-line with this policy. Thus, we see the NUTP as the basis for both JnNURM and the Smart Cities Mission as well as subsequent policies such as the Transport Oriented Development (TOD) policy and the Metro Policy 2017. Grants to cities under various schemes are tied to compliance with NUTP.

2. The failure of NUTP

A dozen years since the policy came into effect the situation on the ground however remains grim. The fundamental shift one expected has not materialized. Growth of personal vehicles has continued unabated and with it, congestion, pollution and road traffic trauma. While there has been some effort to improve bus-based public transport, the results have been poor. Non-motorized

transport remains a highly neglected aspect of urban transport. There are many reasons for this. Understanding them is critical to finding solutions.

3. Mindset

Urban Transport is essentially a State subject. Transportation budgets, projects and planning is done by cities and State Governments. At this level, despite the NUTP, there has been no shift in the thinking about urban transportation. State and city-level policy-makers are still stuck in the pre-NUTP paradigm, with an almost exclusive focus on movement of vehicles (cars in particular). An overwhelming portion of resources – both budgetary and mind-space – are spent on desperately trying to improve the road infrastructure for the "smoother" movement of traffic – by which one implicitly means cars and two-wheelers. The road infrastructure and traffic management are focussed on trying to ease congestion usually at the cost and to the detriment of the movement and safety of pedestrians, cyclists and public transport users. This attitude of city and state planners and decision-makers means that people who currently walk, cycle or use public transport, find these modes inconvenient or unsafe and choose to shift to personal modes as soon as they are able to do so.

Budget Analysis for 5 cities in India – SUM Net

A 5-city budget analysis carried out by SUM Net India, a coalition of civil society organizations, showed that the bulk of city budgets were being spent on projects that were meant for "motor vehicles" as compared to "NMT" or "Public Transport".

4. Role of Traffic Police

One of the most retrograde agencies in the transport sector is the Traffic Police. Largely unaware about the new thinking on urban transport, the traffic police continue to remain fixated on "traffic management", by which they mean the smoother flow of vehicular traffic. The traffic police are extremely sensitive to congestion and often face severe pressure from politicians, media and the public whenever there is traffic congestion. The immediate reaction of the traffic police is to push for vehicle-centric solutions such as one-ways, junctions and signal timings optimized for vehicle movement (at the expense of pedestrians), shifting of bus stops, removal and narrowing of footpaths and cycle tracks and stiff opposition to effective solutions such as Bus Rapid Transit (BRT).

5. Fragmented and ad hoc decision making

While NUTP stresses the need for integrated land use and transport planning and has pushed for the creation of Unified Metropolitan Transport Authorities (UMTA) for this to happen, this has been an area where little or no progress has been made. Even at the city-level transport planning and projects are conceived and implemented by various departments/agencies with little understanding about sustainable transportation concepts and coordination. Road departments, PWD, Highways Authorities continue to build and design roads that are totally unsuitable for pedestrians, cyclists and public transport. Traffic departments continue to focus on traffic movement. Land use plans (made by town planners who continue to adhere to outdated and discredited ideas about transport) focus on wider roads and more parking. All these actions encourage the use of personal vehicles, which leads to even more traffic.

6. Making cities NMT friendly

It can be seen from the above exposition that improving non-motorized transport in cities is not just a matter of creating some cycle tracks and footpaths, but fundamental to the re-thinking about urban transport. It also requires a recognition of the forces that act against improvement in NMT and hence a robust response to negate them.

7. Urban Street Design

The most neglected aspect about urban streets is the design and execution of proper footpaths, cycle tracks (where needed) and junctions. Junctions are critical not only for the better movement of vehicular traffic but also need to be designed to be safe. Junctions are points where interaction between vehicles and pedestrians (and cyclists) is inevitable and are thus locations where pedestrians and cyclists are at highest risk.

Urban street edges are complex and often chaotic. Utilities, trees, vendors, pedestrians, parking, bus stops are all jostling for space near the edges. To be NMT friendly the edges need to be designed for all these uses and with enough space to accommodate their needs so that they do not conflict with each other. But this is precisely the space that is utterly neglected. This is where urban street design comes in.

Urban street design requires every street to be designed completely – edge to edge. Special attention is paid to the safe and smooth movement of pedestrians and cyclists. Spaces for various other activities and street elements such as parking, trees and landscaping, hawkers, utilities are very deliberately designed and placed. Design elements that ensure that public streets are disabled-friendly – a requirement by law – are carefully built in. Traffic calming – so that vehicular movement is slowed to appropriate levels – is also achieved through design. At junctions, sightlines are improved, and pedestrian-vehicle conflicts avoided.

8. What is urban street design?

Urban street design is a highly specialized activity and is typically undertaken by multi-disciplinary teams consisting of urban designers (architects who specialize in the design of urban public spaces), transport planners, traffic engineers and stakeholders such as the police. It is an activity based on a common understanding about sustainable transportation principles and the objectives that are articulated for the city or for that locality. Good urban design must necessarily involve the public – after all it is their needs that it must address. It also inevitably requires the balancing of sometimes conflicting requirements. Questions such as how much priority should be given to safety as opposed to reducing congestion must be posed and consensus arrived at. Public representatives play a key role in creating such consensus. This means they too must be aware of and convinced about these concepts. Tools that allow public opinion gathering and consensus building have to be explored and adopted.

9. Urban Street Design in ULBs

Currently urban street design is not a part of the set-up of any ULB. Neither is there any recognition of this critical function within the State Urban Development Departments. No posts for urban designers exist. Another key component for effective street design is awareness about sustainable transport principles. This awareness is required at varying levels. A deeper understanding at the level of administration officials and department heads, including the traffic police and a more general understanding at the level of the public at large and media. Politicians need both an understanding and the ability to steer public opinion and make this a politically acceptable and desirable stand. This awareness will not come about easily. It must be carefully planned and implemented as a project with appropriate allocation of resources. Finally, agencies that are able to conduct effective public-participation will be required and recognized as essential elements for transforming the city in a democratic manner.

Urban Street Design in Pune – showing the way

In 2016 the city of Pune adopted Urban Street Design Guidelines (USDG) that had been drafted specifically for the city, with inputs from various NGOs and public authorities. The Guidelines were made mandatory for all future road works by the Municipal Commissioner. The city also created an Urban Design Cell by hiring 8 Urban Designers to help create designs for streets using the USDG. The city also empanelled 4 Urban Design firms and started work on completely re-designing 100 km of major roads in the city. Some of the re-designed streets are now complete and despite some issues have largely met with positive reactions from people. The city also formally adopted a Pedestrian Policy in 2017, which prioritizes safety and comfort of pedestrians.

10. Comprehensive Bicycle Plans

Cities that are committed to increasing the modal share of cycling must move beyond token measures such as the creation of a few unconnected badly designed cycle tracks or lanes. Cycle awareness programs such as rallies and "cycle to work" initiatives make for good headlines but achieve very little sustainable increase in cycling. Distribution of cycles to the urban poor or school children (especially girls) definitely have a positive impact for the beneficiaries, but again do not achieve measurable impacts on cycling overall.

Cycling has to be seen as an integral part of the transport system of the city, not just a "green" initiative. Cyclists, just like motorists, require a complete network of cycle-safe routes. This may consist of dedicated cycle tracks, cycle lanes or even cycle-safe streets where traffic volumes and speeds are low or controlled. Cyclists require secure parking too. Cycling has often been erroneously seen as just a means of "last mile connectivity". However most urban cyclists use a cycle for the complete trip. Cycling can be an affordable, convenient and quick mode of transport for a very large section of the population. Distances of up to 8 km can be cycled easily by experienced and habitual cyclists if a comfortable, safe, direct and connected city-wide cycle network is in place. Most Indian cities have average commute trip lengths that are less than this distance.

In order to make cycling a prominent component of the urban transport system it is essential that cities have statutory comprehensive bicycle plans. A bicycle department, either stand-alone or as a sub-department of the larger transport department, with dedicated staff and budgets, will be needed to implement and constantly monitor and evaluate the usage of cycles in the city.

Comprehensive Bicycle Plan for Pune

The Pune Municipal Corporation is perhaps the only Municipal Corporation in the country to have a comprehensive bicycle plan. The plan was made with support from the Government of India under its Scheme for Urban Transport by a consortium of bicycle expert agency, urban design firm and public outreach agency. The plan proposes a comprehensive city-wide network of 830 km of cycle tracks, lanes and greenways. It also proposes a bicycle parking plan. The city also created a dedicated bicycle department with an advisory team of cycling experts.

11. Parking Management and Street Vending – critical components for better NMT

While street design will address some aspects of parking and street vending, it has to be recognized that these two street activities have a huge impact on the quality of non-motorized transport. Both activities happen on the edges of streets, where footpaths and cycle tracks (as well as bus stops) exist.

12. On-street Parking

Parking remains a very poorly understood concept in the Indian urban context. Even the NUTP, while being progressive on many fronts, falls short when it comes to parking. Worldwide it has been recognized that providing too much parking will only serve to incentivize the use of personal vehicles; conversely an effective parking management strategy can help to dis-incentivize the use of personal vehicles and create space and opportunities for the promotion of both NMT and public transport. Parking spaces along the edge of streets has to make way for space for NMT in cities that want to promote walking and cycling. Illegal parking has to be effectively curbed. Pricing for on-street parking is critical to reduce parking demand and for the more efficient use of existing parking spaces. This requires that cities must have a parking policy and a parking management plan. Currently the legislation and policy for urban parking is weak and inadequate. Strengthening this will be essential to ensuring better NMT in cities.

13. Street Vending

Street vending has been a contentious issue for decades. While often seen as a conflict between pedestrians and vendors, with both vying for space on footpaths and other walkable areas (such as near railway stations and bus terminals) the root of this conflict lies in the explosion of personal vehicles and the priority that is given to them. Narrow footpaths that are inadequate for even pedestrians, let alone hawkers, are the result of policies that give a lion's share of road space to vehicles. Similarly, space for parking of vehicles almost always gets preference over space for vendors. While parking fees are still not common and vehemently opposed by the public, vendors are often charged a vending fee – either formally or informally. However, street vending and NMT-friendly streets go together. Not only do pedestrians and vendors share a symbiotic relationship – each needs the other – but the presence of street vendors has been acknowledged to make streets safer, especially for women, providing what are called “eyes on the street”. Cities that promote sterile and dead streets will also witness a drop in pedestrian movement. The Street Vendors Act of 2014 enshrines the constitutional right under article 19, of a hawker to vend on streets, as upheld by the Supreme Court. Cities that adopt street design guidelines that incorporate vending areas (if necessary by restricting the space for vehicles and parking) as an integral part of street design, can be said to be truly NMT-friendly.

14. Do we need an NMT Act?

Given the myriad problems faced by pedestrians and cyclists and the lack of any framework that will ensure their safety and right to space on public streets against the onslaught of personal vehicles, the time has perhaps come for State Governments to consider comprehensive legislation for NMT in Urban areas. It so happens that "vehicles other than mechanically propelled vehicles" come under List II ("State List") of the Seventh Schedule of the Constitution and hence the State Legislature has exclusive rights to enact legislation on this matter. Such a legislation could cover pedestrians, cyclists and cycle-rikshaws.

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Impact of Metro on Development of Twin Cities - Case of Kolkata & Howrah

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Abstract

Metro system leads to development impacts all along the transit corridor in and within their influence area, as observed from global experiences. Twin Cities, all over the world, are interdependent on each other for various functional purposes, such as employment, education and businesses. In this context, the importance of intra-urban mass transportation is paramount as it determines the overall urban structure of the settlement. The twin cities Kolkata and Howrah are presently connected by two bridges with an average daily trans-river vehicular movement of over two lakhs (2011) likely to become three lakhs by year 2025. Kolkata has an operational North-South metro corridor (29 km) with an average daily ridership of five lakhs and the proposed East West Metro corridor will be connecting the twin cities (18 km). This proposed East West metro corridor provides an opportunity to influence the future development of the twin cities in a planned manner particularly in Howrah. However, there are no explicit strategy to guide the development of twin city Kolkata and Howrah taking into account the likely impacts of the proposed metro system. This research aims to assess the extent to which Metro system is likely to affect the urban structure of two cities of Kolkata and Howrah in future in terms of transport demand and environment and propose a metro based guided urban development pattern. The study adopted urban structure indices such as Urban Radius, Coefficient of Dispersion of population and employment and the Locality Association Factor to analyse the existing urban structure of the twin cities. Two alternate scenarios of spatial development patterns were developed in terms of population and employment distribution – Scenario 1 based on proposed Development Plan proposals while Scenario 2 was developed by the authors in order to assess impacts on mobility & environment utilizing urban structure indices and its relation with transport demand measures.

Keywords: *Mass Rapid Transit, Transit Oriented Development, Urban Radius, Locality Association Factor, GHG emission*

1.1 Research Need

Rapid developments are taking place along the MRTS corridors in their influence area of the cities Kolkata and Howrah. However, there has been no study/research to analyse the impact of the Metro on the Twin City or policy to increase the metro impacts, or guide the development of twin city Kolkata and Howrah. The Metro can act as a catalyst for guided urban development and can help in inducing growth and development in Howrah to keep pace with Kolkata.

Major changes in terms of land use, structure, density and built form if managed in a timely process, can result in an integrated development of Kolkata and Howrah. The need of the study thus

lies in the understanding the intensity of the impact of mass rapid transit on the development of the twin cities of Kolkata and Howrah and thereby proposes a planned strategy to manage development.

1.2 Objectives

1. To review impact of metro on development patterns of cities in general and twin-cities in particular.

2. To assess the existing spatial structure, landuse/land value, mass transport system characteristics, for case cities, Kolkata & Howrah and view various policy initiatives in case cities.

3. To assess/analyze the existing landuse-transport system and travel patterns of commuters on select Metro stations and transport nodes at Howrah.

4. To estimate the likely impacts of proposed metro rail corridor between twin cities (on landuse pattern, socio economic activity, mobility) under alternate scenarios.

5. To propose strategies for mass transit supported guided urban development in the case of twin cities.

2.1 Definition : Twin Cities

Twin cities are a special case of two cities or urban centres that are founded in close geographic proximity and then grow into each other over time, losing most of their mutual buffer zone.

2.2 Lessons Learnt: Landuse Transport Integration

As there are very few examples of Twin cities, hence 3 international case cities of London, Singapore and Copenhagen were studied and the following lessons were learnt:

While allocation of land uses impact demand for travel as people need to access different activities, transport infrastructure adds to the attractiveness of a location by improving accessibility and leads to change in land values. The concept of land use transport integration is based on the nature of interaction between spatial and transport development. Integrating land use and transport thus involves two simultaneous mutually supportive processes :

i. Organizing the physical form and land use pattern of a city such that travel demand, trip lengths and travel times are minimized, while accessibility, comfort and efficiency are maximized.

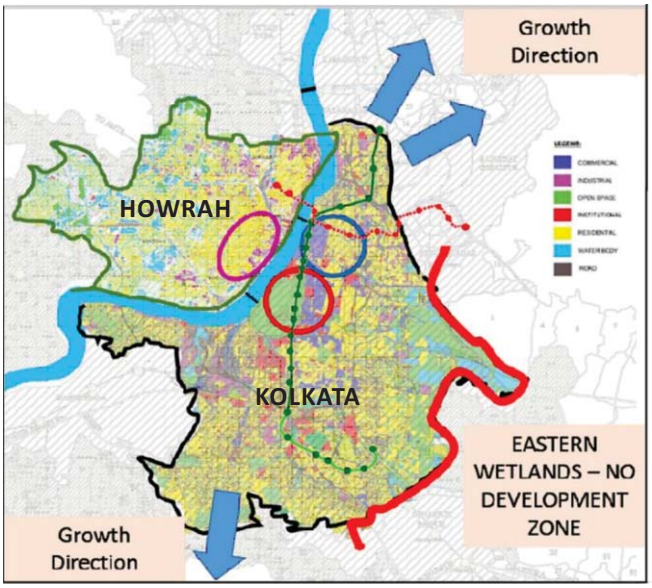
ii. Organizing all systems of transportation from pedestrian pathways to mass transit systems such that they integrate well with each other and enable the harmonious establishment of land uses around them, in the process generating a city form that is sustainable (R.Cervero, 1995).

3.1 Existing Character of Kolkata & Howrah

3.1.1 Physical Characteristics

The Kolkata Metropolitan Area (K.M.A) is spread over 1,886.67 sq.km and comprises 3 municipal corporations. Kolkata Municipal Corporation (KMC) has an area of 185 sq.km. Howrah city stretches along the west bank of the river Hooghly and has area of 64.55 sq.km. Both the cities have grown linearly along the river Hooghly on the land along the river and its slope away from the river. The wetlands in the east and the river Hooghly have forced the city to grow in the North South direction.

Figure 3.1 Physical extents of Kolkata and Howrah *(Source: KMDA)*



3.1.2 Demographic Characteristics

According to 2011 Census, Kolkata Municipal Corporation had a population of 44.96 lakhs distributed over 144 wards, Howrah Municipal Corporation had a population of 13.62 lakhs in 2011, distributed over 66 wards. The population of KMC area is expected to be 45.4 lakhs in the year 2021 as per Kolkata Metropolitan Development Authority (KMDA) estimates. The population of HMC area is estimated to be 14.60 lakhs in the year 2021.

3.1.3 Travel Characteristics

K.M.A grew in the north-south direction as the railway track and the river running north -south acted as a physical hindrance to the development of road infrastructure in the east west direction. Howrah Bridge and Vidyasagar Setu, connects the two cities and Howrah Station serves as the terminal for two railway zones of India. It acts as a regional gateway to both Kolkata & Howrah. Between Howrah and Kolkata, there are ferry services available for easy movement of trans-river passengers. The ferry services cater to about 3 lakh passengers daily. (CMP Kolkata, 2008). The Metro Rail System operates between Dum Dum and Tollyganj and carries about 5 lakh passengers on an average weekday (Metro Rail Kolkata, 2015). The bus system is being operated by various Government and Private bodies. Buses carry about 32 lakh passengers daily in the Kolkata Area. Presently 200 trams are in active service and carry about 1.8 lakh passengers on an average weekday. (CMP Kolkata, 2008).

Kolkata has about 9 lakh-registered vehicles, of which the public transport / IPT modes include 16,000 buses, 25,000 taxis and 8,000 auto rickshaws. In Howrah the number of registered motor vehicles has increased from 49,000 in 1993-94 to about 1.0 lakh in 2004.

3.1.4 Metro Profile

The North-South Metro was the first metro introduced in India, initially operational for a stretch of 16.45 km between Dum-Dum and Tollygunj and later extended to New Garia in the South, and Noapara in the north (12.55 km). It carries 5 lakh passengers a day, from the northern fringes to the southern suburbs in 49 minutes. The East-West Metro project is proposed to connect Kolkata with Howrah planned from Salt Lake Sector-V in the east to Howrah Maidan in the west. The East-West alignment goes through a very densely populated corridor with connection to Howrah and Sealdah Stations acting as feeder systems to the metro. At Central metro station, the operational N-S metro and the E-W metro line crosses each other. The proposed length is 14.67 km (8.9 km underground and 5.77 km elevated).

3.1.5 Travel Demand

KMC, HMC, Salt Lake and New Town are estimated to grow from 6.5 million in 2011 to 11.2 million in 2021. The number of passengers having both origin and destination along the proposed metro corridor is 51,000.

4.1 Database Collection

To study the impacts of metro on the overall development of the city through the spatial transformation, various primary surveys were undertaken.

4.2 Primary Surveys

Primary land use survey was undertaken along the existing Operational North South Metro Corridor, using reconnaissance survey techniques. Real Estate agent survey was undertaken both on the Operational North-South metro corridor as well as the proposed East West metro corridors to understand the influence zone of the metro on land value. Metro user survey was undertaken on the Operational North-South metro corridor in order to understand the travel characteristics of the people and to estimate the travel demand on the metro in comparison with other public transport modes. Potential User survey was undertaken as well on the proposed East West metro corridors (at select locations) to estimate the travel demand on the proposed corridor

5.1 Landuse Characteristics of Case Cities

Kolkata, apart from the planned area, i.e. present CBD and adjacent area, has expanded organically. This organic growth resulted in unplanned demand based land uses except for the central planned area of Kolkata. Howrah, mostly has mixed residential area and like most old unplanned cities, the central part of Howrah is densely populated. Landuse distribution of both cities is shown in Table 5.1.

5.2 Landuse Characteristics along Metro Stations (Operational N-S Line)

A large number of studies have taken place attempting to describe the underlying relationship between increasing accessibility and changes in land use patterns of an area. The possible impact of the introduction of a new track, or the extension of its existing infrastructure can have on the land use system has been studied based on the operational North South Corridor in Kolkata. This study further analysed the impact of metro on land use and land value through a series of primary surveys conducted along the operational metro corridor of Kolkata.

Table 5.1 Landuse Distribution in Kolkata and Howrah *(Source: KMDA)*

	Land use Categories	Kolkata	Howrah
		Land Use area in sq.km (Percentage to Total Area)	Land Use area in sq.km (Percentage to Total Area)
1	Residential	106.86(57.76)	27.80(53.73)
2	Commercial	115.72(8.5)	1.54(2.98)
3	Industrial	7.12(3.85)	4.17(8.06)
4	Institutional	8.12(4.39)	0.96(1.86)
5	Roads, Railways and Transport	16.39(8.86)	5.46(10.54)
6	Water bodies	9.93(5.37)	3.88(7.5)
7	Parks & Playgrounds	20.85(11.27)	3.52(6.80)
9	Agriculture	0(0)	0.91(1.76)
10	Open/unused	0(0)	3.50(6.77)
	Total	**85.0(100)**	**51.74(100)**

5.2.1 Spatial change in Land use along Metro Corridor

In 1985, when the metro was introduced between Esplanade to Bhowanipore, the prominent land uses along the metro spine had been commercial and institutional. The metro was further extended to the North and South. Tendency towards land use densification has proliferated since the initial speculation of the Metro. In 2010, The North- South corridor was further extended till New Garia, which was then a new addition to the Kolkata city, predominantly a vacant area. The Temporal change in Landuse along the existing operational Corridor has been studied with the help of the Landuse drawings from 1995, 2005 and from the Primary landuse survey along the Metro stations in 2015.

The salient findings are as followed:

- The land use change was observed at the most recent extension of the North-South Metro, operational from 2009. The change is most prominent around the New Garia (terminal station).
- Land use impact had occurred after 2005 in the southern extension of the Metro corridor due to speculative changes in the market.
- Metro's impact has been observed in terms of conversion of bungalows to apartments, residential landuse to mixed use or commercial land use and new development on open and vacant land.
- Land parcels have been amalgamated to take leverage of permissible higher development opportunities in terms of FSI and building heights.
- Land use densification has emerged in terms of increased building heights.
- Due to increased demand of commercial and retail spaces, land scarcity for horizontal expansion and favorable development opportunities, buildings have grown vertically in the Central and southern part of the metro route.
- Higher usage of FSI in the immediate vicinity of the metro station.

5.3 Land-Value Characteristics Along Metro Stations

Changes in the land use and an increase in FSI are also observed along the metro corridor, which results in densification along the entire metro route. The influence of a metro line can be seen up to 1 kilometer away and the most influence is exerted within a 500 meter walking distance of a station. The influence decreases as the distance from the station increases. As per estimates, the market value of properties increases by more than 50 percent over the existing values after the launch of the metro system. This increase depends upon the location, influence, land use and overall market appeal.

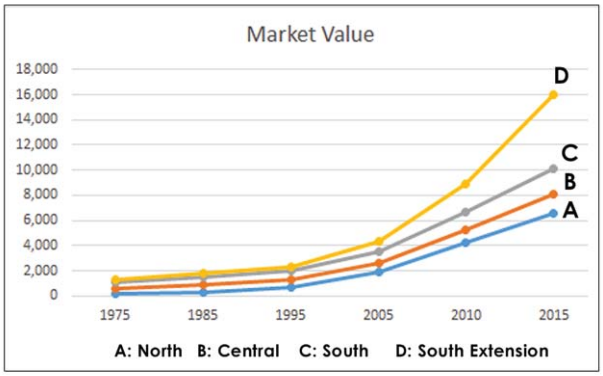
This study tries to build a relation among accessibility benefits, impact on proximate land use and land value gains. The value appreciation varies from place to place influenced by various parameters. The impact on Land Value is based on the following:

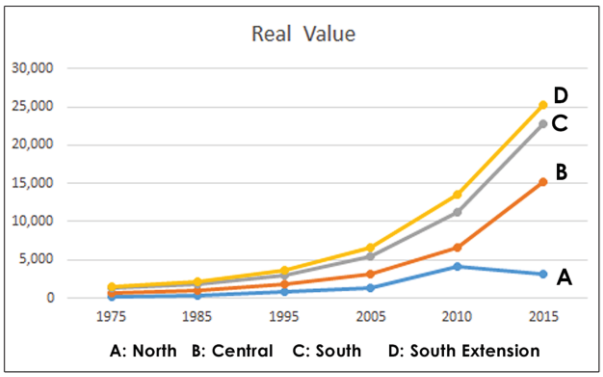
a) Land Value Increment as a function of time
b) Land values as a function of distance from the metro station

5.3.1 Temporal change in Land Value along North South Metro Corridor (1975-2015)

A significant growth in land values have been observed over the period of time from 1975 to 2015. Land value price escalations are very area specific, and based on the extension of the Metro Corridor as shown in figure 5.3.

Figure 5.3: Temporal Changes in Land Value in Metro Zones : North, Central South, South Extension *(Source: Primary Survey)*





Salient Findings are noted as below:

- Four distinct zones emerged based on land value, based on land-use and distance from the CBD and time of introduction of the Metro.
- Real estate prices escalate based on certain slabs like the North, Central, South and later South Extension.
- The extension of the NS line brought about rapid appreciation of the real estate value in the southern most area of Kolkata.
- The land value change is observed at the most recent extension of the North-South Metro, operational from 2009. The change is most prominent around the New Garia (terminal station) region.
- During the full period CAGR is 15%- 17%.
- A constant rise is observed in land price in the proximate areas during all the project stages.
- Land values are inversely related to the distance of land parcels from the metro station.

5.3.2 Influence Zone of the Metro within Catchment

Primary real estate survey was undertaken in the 1.5 km radius of the metro stations to determine the influence zone of the metro on land value. Predominant landuse along the metro corridor is residential and commercial. A landuse-wise comparative study of the land values in the influence zone of the Metro was conducted and the following observations were made:

- Value of land was found to be maximum within the 1.5 km catchment of the metro, decaying with distance from the metro corridor.
- There was a 150% increase in residential real estate value in the metro catchment from 2005-2015 in the most recent extension on the North-South metro corridor.
- Along the proposed East West metro corridor, there has been a speculative increase in the prices of residential and commercial real estate to almost 3 times higher than the price in 2010.

6. Urban Structure Measures

The location of spatial development has a fundamental influence on travel patterns. At the same time, the location and characteristics of major transport infrastructure impacts the allocation of landuses. Urban Structure Indices are simple qualified measures to express the interaction of spatial distribution of people and jobs and their changes over time. It is derived from the cumulative population distribution from the centre

of a city. It can be used as a tool for assessing alternate plans of population and jobs distributions in a quantified manner.

6.1 Urban Radius

The radial accumulation of people and breaking point at the fringe of the urban area is reflected in human behavior in urban areas, especially in the spatial distribution of vehicle kilometers of travel. Hence, they are useful for the first approximation estimation of the distribution of people, as well as for defining the edge of the urban area a quantified way. It is based on the assumption that city is symmetrical around its center.

6.2 Factor of Locality Association

It expresses the degree of similarity or difference between different distributions such as population and jobs. The LA factor is expressed as:

$$LA\ factor = [100 - \Sigma(Xi - Yi)]/2$$

Where, Xi = % of first group in zone i , Yi = % of second group in zone i. The value of LA factor range from 0.0 to 100.0. A high value indicates a high degree of association between the two groups and vice versa.

6.3 Coefficient of Dispersion

As the population in an urban area shift over time, their spatial distribution can become either more concentrated towards city center or more dispersed away from it. A measure of such change is the coefficient of concentration or dispersion, which is defined in the following manner:

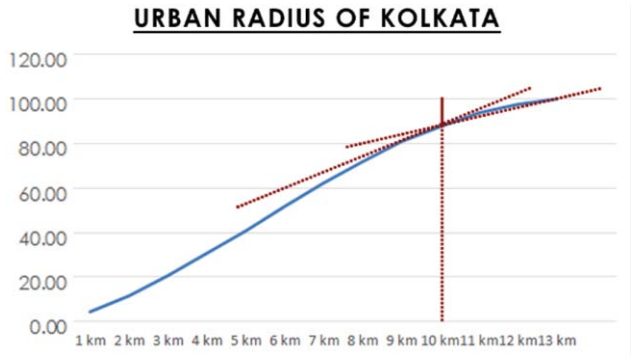
$$C.O.D = \Sigma|Xi - Yi|2 \; ; \quad 0 < A < 100$$

A low value expresses an even distribution of population over the area while a high value expresses an unequal distribution.

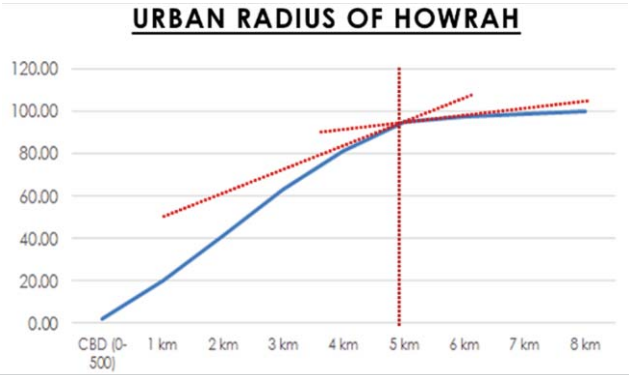
6.4 Application of Urban Structure Measures in Case Cities Kolkata & Howrah

The Urban Structures of both cities have been calculated by after calculating the population accumulation in concentric rings over both cities, a line graph of cumulative population is plotted from the CBD as shown in figure 6.1. The distance from the CBD to the point where the curve changes its slope is called the Urban Radius. So the urban radius of Kolkata is 10 Km, as shown in figure 6.1. The Coefficient of Dispersion along with the LA Factor for Kolkata and Howrah is calculated based on the population and Employment distribution from the East West Metro DPR by RITES (2008).

Figure 6.1 Urban Structure Indicators for Kolkata and Howrah 2011



Urban Radius = 10 km	COD of Population = 6.71
LA factor = 89.25	COD of Employment = 15.19

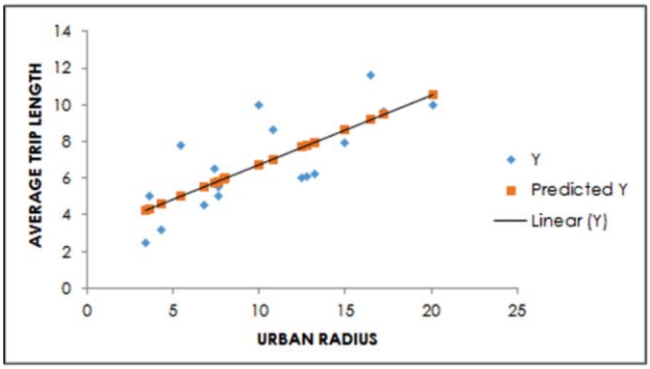


Urban Radius = 5 km	COD of Population = 13.46
LA factor = 87.75	COD of Employment = 16.00

6.5 Regression Analysis between Urban Radius & Average Trip Length (ATL)

A regression analysis was performed based on the Urban Radius of 20 Indian cities with their Average Trip Lengths, in order to derive an equation between the two (SPA, 2013).

Figure 6.2 Relation Between Urban Radius & ATL from 20 cities Model



$Y=0.6715x + 3.62$

$R^2= 0.7466$

6.6 Validation of the Relation

For the purpose of the study, the relation between urban radius and Average Trip Lengths developed in the 2013 study helps in estimating the future growth and travel demand of settlements. It facilitates a quantitative analysis of future growth trends to manage development accordingly. Thus, the relation between Urban Radius and ATL was further estimated in cases of Howrah and Kolkata. The Urban Radius and Average Trip Length of Kolkata is known, 10 km. Hence by substituting the value of 'y' in the equation we can determine 'x' = Urban Radius

Kolkata
ATL of Kolkata =10 km 10 = 0.671 x + 3.62 x = 9.75 km ~ 10 KM

Howrah
ATL of Howrah = 5 km 5 = 0.671 x + 3.62 x = 5.69 km ~ 5 KM

Hence the equation can be adopted for assessing the Urban Radius for Howrah.

7. Development of Alternate Scenarios

7.1 Background

Two alternate scenarios were developed for the year 2021 for Kolkata and Howrah. Each development scenario is based on the distribution of population and jobs along the Metro corridor, and influences the urban structure of the city. Each scenario has then been evaluated on the basis of its potential impact on Mobility and Environment Indicators, based on the transport demand and Greenhouse Gas (GHG) emissions.

The two development scenarios are:

1. **Vision Plan-2025 Scenario (Development Plan)**

2. **Metro as Catalyst for Guided Development Scenario**

7.2 Planning Forecast

The population forecast for Kolkata and Howrah is adopted from Vision 2025, for the horizon year 2021. The employment projections for the horizon year 2021 have been adopted from the DPR for Metro East West prepared by RITES, in 2008.

7.3 Scenario 1 (Development Plan)

7.3.1 Assumptions

1. It has been assumed that development and population distribution will happen according

to the Vision 2025 strategies document. Population and area of planning divisions are taken from the Vision Plan 2025.

2. The population projections have been adopted as per the Vision Plan 2025, for the horizon year 2021.

3. The employment data been adopted from the East West Metro DPR (2008), for the year 2021 based on the population projections of the Vision Plan 2025.

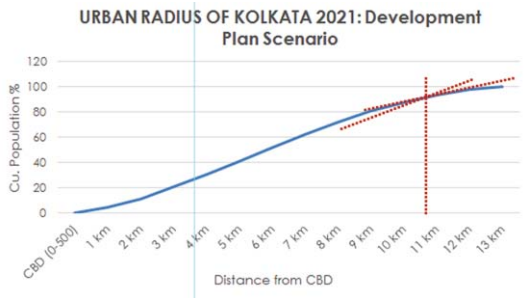
4. The population densities have not been altered, and it is assumed that the population will grow in a trend based curve, and the density will grow proportionately in the wards.

5. The distribution of population and employment determine the urban structure measures and its subsequent impact on mobility and environment.

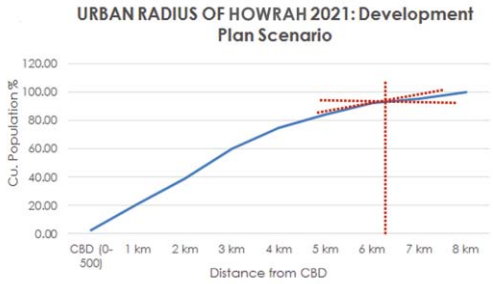
7.3.2 Assessment of Urban Measure Indicators for Scenario 1

Based on the forecast, population and employment distribution of both the cities of Kolkata and Howrah are calculated ring wise and as per the Development Plan Scenario, urban structure indicators are deduced as shown in figure 7.1.

Figure 7.1 Urban Structure Measures for Kolkata and Howrah 2021 (Scenario 1)



Urban Radius = 10.5 km **COD of Population = 6.38**
LA factor = 90.69 **COD of Employment = 13.94**



Urban Radius = 6.5 km **COD of Population = 5.48**
LA factor = 87.54 **COD of Employment = 17.94**

7.4 Scenario 2

7.4.1 Assumptions

1. The North South operational Metro Corridor has been studied based on the following parameters:

   a) Landuse Mix
   b) Density (Population, Employment)
   c) Real Estate Value
   d) Ridership

2. The study based on the above parameters helps to determine the development induced due to the operational North-South Metro in the catchment zone with respect to that of the Kolkata city, for 2011 and horizon year 2021, in order to project the same relation for E-W Metro to Howrah.

3. The population projections are adopted as per Vision Plan 2025, for the horizon year 2021. However, the population is restructured along the East West metro catchment based on the potential for redensification and infill.

4. The subsequent urban structure is measured along with its impact on mobility and environment.

7.4.2 Assessment of Urban Measure Indicators for Scenario 2

The Table 7.1 shows the relation between the North South Metro Corridor catchment to the

City of Kolkata, based Urban Structure indicators such Population, Population Density, Employment density and Mobility Indicators such as Average Trip Length, Per capita Trip Rate, Passenger Km, and Cost per Km. The ratio that is derived is used to estimate the relation of Howrah city to the East West corridor catchment based Urban Structure indicators such Population, Population Density, Employment density and Mobility Indicators such as Average Trip Length, Per capita Trip Rate, Passenger Km, and Cost per Km as shown in Table 7.2. This is done in order to project the estimated impact of the metro on the city of Howrah and to calculate the urban structure indicators for the cities.

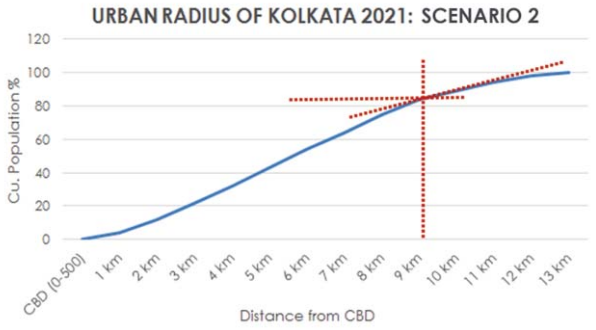
Table 7.1 North South Metro: Kolkata City Relation

	North South Catchment	Kolkata	Ratio
City Profile			
Population 2011 (in lakh)	2.75	46	0.06
Population Density 2011 (in ppHa)	350	231.49	1.5
Employee Density 2011 Employee/Ha)	300	210	1.42
Travel Characteristics			
Average Trip Length (km)	10.5	10	1.05
Average Trip Time (in Minutes)	20	25	0.8
Per Capita Trip Rate	1.4	1.58	0.8
Passenger Km	45.83	138.87	0.33
Cost per Km	5	4.5	1.1

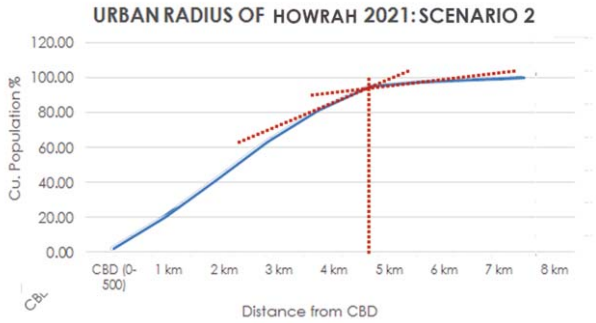
Table 7.2 East West Metro: Howrah Relation

	Howrah City 2011	Howrah City 2021	East West Catchment 2021
City Profile			
Population (in lakh)	13.62	14.2	0.71
Population Density (in ppHa)	195	210	292.5
Employee Density Employee/Ha)	165	185	234.3
Travel Characteristics			
Average Trip Length (km)	6.5	7	7.0875
Average Trip Time	25	30	20
Passenger Km	101.2	109.84	36.25
Cost per Km	6	7	8

Figure 7.2 Urban Structure Measures for Kolkata and Howrah 2021 (Scenario 2)



Urban Radius = 9.5 km **COD of Population = 12.29**
LA factor = 92.34 **COD of Employment = 7.66**



Urban Radius = 5 km **COD of Population = 11.34**
LA factor = 91.34 **COD of Employment = 7.89**

7.4.3 Restructuring along the Metro Corridor

From the study of the Urban Structure of cities, the population and employment distribution of Kolkata and Howrah have been studied both at the city level as well as the metro catchment level. The population and employment has been restructured along the corridor based on potential for redensification and infill. The density ranges are based on:

A) Availability of land in the study area.
B) Locational factors such as land value

7.5 Comparison of the Alternate Scenarios

Urban Structure analysis of Kolkata and Howrah reveals that Scenario 2 has better impacts on cities, as shown in Table 7.3.

Table 7.3 Urban Structure Analysis of Kolkata & Howrah, based on Alternate Scenarios 2011, and 2021 (Estimated)

Measures	Existing Urban Structure Measures 2011		Scenario 1 (2021)		Scenario 2 (2021)	
	Kolkata	Howrah	Kolkata	Howrah	Kolkata	Howrah
Urban Radius (In km)	10	5	10.5	6.5	9.5	5
LA Factor	89.9	87.5	90.69	87.54	92.34	91.34
COD Population	6.71	13.46	6.38	6.48	12.29	11.34
COD Employment	15.91	16	13.94	17.94	7.66	7.89

Table 7.4 Mobility and Environment Impacts in Alternate Scenarios

Impact Parameters	Existing 2011		Scenario 1 (2021)		Scenario 2 (2021)	
Mobility Parameters	**Kolkata**	**Howrah**	**Kolkata**	**Howrah**	**Kolkata**	**Howrah**
Average Trip Length	10	6.75	10.5	7	9.5	5
Modal Share	Bus:44% Metro:12.4%	Bus:49% Metro: -	Bus:42% Metro:16.4%	Bus:45% Metro:11.4%	Bus:40% Metro:18%	Bus:42% Metro:20%
Vehicle km	45.9	24.56	45.63	26.84	44.8	23.56
Environmental Impacts						
Emissions	323	215	305	195	296	150

Mobility Pattern can be rapidly analyzed through Urban Structure Analysis, by the use of the Regression Analysis between ATL and Urban Radius of a city. Alternate Development Scenarios have been estimated to show the following impacts, as observed in Table 7.4.

8.1 Conclusions

From the study, we can conclude that Metro has the potential to induce and guide development in urban areas. The existing operational North South Corridor has resulted in the following impacts:

- Change of vacant/residential land use to commercial/mixed land use
- Increase in real estate value within the influence zone of 1.5 km (catchment) of the metro
- Increase in population density within catchment of the metro

Urban Structure Measures are an useful tool for analysis of spatial distribution of population & jobs and its impact on mobility and environment.

8.2 Recommendations

1. There is a need to revisit the VISION 2025 development proposals for:
   a) Population and employment distribution along the proposed East-West Corridor
   b) Consequently developing Kolkata & Howrah in a compact manner to check sprawl
2. There is a need to develop activity nodes and growth centres along the proposed metro station at Howrah and Sector V with a potential to generate employment of around 1.5 lakhs for the horizon year 2021.

3. There is need for restructuring the density pattern along the East-West Corridor.

4. There is a need to plan for last mile connectivity around the transit stations for seamless mobility interchange.

8.3 Areas of Further Research

1. To assess the carrying capacity of proposed development with respect to traffic and infrastructure along the East-West Corridor to estimate the financial viability of the development project.

2. To evolve Development Control Regulation (DCR) and a planning standard for likely transit centric development along the metro corridor.

3. Restructuring population along the transit corridor reduces the Urban Radius, which follows the concept of a density decay curve for development which is most preferred for a compact form.

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Role of Metro Rail in Sustainable Urban Development, Kochi

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Study Brief

The millennium decade has provided an economic boom triggered by rapid urbanization worldwide. It is estimated that about 7 out 10 Indians would live in urban areas by 2050. Also cities are considered as the engines of economic growth, currently they contribute to 58 % of the country's Gross Domestic Product (GDP) which is expected to go up to 70% by 2030. The growth of urban areas has outpaced the conventional planning provisions which calls for a relook into the process and adopt sustainable planning approach to these areas. Through Sustainable Urban Development (SUD), the use of urban resources are optimized to carry out the services hence reserving it for the future needs of the city.

One of the intrinsic parts of SUD is mobility, which outlines the need to strengthen Public Transportation (PT). The congestion in areas which are not addressed through the existing PT infrastructure is now serviced by high speed, safe and reliable Metro Rail systems. As more Tier II cities are now going for metro rail infrastructure in addition to the large metropolitan cities, it creates a need to relook at their likely implications on the urban development. The National Urban Transport Policy, 2014 has envisioned the need to "Integrate the Metro rail systems with the Land use plans of the cities". It is perceived that such an effort would result in compact development of the city concentrated along the Metro corridor which consequently reduces the vehicular emissions, energy consumption and land savings. This paper summarizes a research study which aims to evolve an integrated sustainable strategy for Kochi by studying the role of the Metro Rail on its development.

Kochi Metro Rail

Kochi, the commercial capital of Kerala and also the largest urban agglomeration in the state availed the Metro rail as a remedy for its traffic congestion only after its draft Development Plan 2031 was prepared. The city generally referred under the Greater Cochin Development Authority (GCDA) area of 630 sq.km has a population of 2.2 million. The Development Plan is prepared for the Kochi City Region having an area of 370 sq.km and a population of 1.1 million. The Kochi Metro spans over 25 km and has 22 transit stations in its initial phase. The study uses indicators to measure sustainability under spatial development (population density & land use distribution) and mobility framework (Average Trip Length, Per Capita Trip Rate & Modal Share). The existing status of Kochi is studied w.r.t. the cities of the same size having a metro and also those not having a metro system, based on these indicators. It is then compared with the sustainable benchmarks and the Development Plan proposals to infer the likely implications of the Metro.

Indicator to measure Sustainable Urban Development		Kochi present scenario without Metro	Case Studies of Cities			Kochi Development Plan 2031 for KCR Region, Proposal	Quantitying Sustainability (for a city 2-3 million population)	
			Two Million population		Extensive Metro Rail Networks			
			Without Metro	With Metro				
Spatial	**Population Density**	City (2 million) = 35 PPH	40-60 PPH	50-80 PPH	150-300 PPH	Proposes Gross density of 60 PPH for 1.9 Million, Net Density 100 PPH	60-80 PPH for the city	UIGSC LEED
		Along the Metro (1Km either side) = 50 PPH			250-300 along the corridor	60-100 PPH in the planning units where the Metro rail has influence	125-150 PPH along the corridor	
	Land Use	Residential : 69 %	40-50 %	30-40 %	25-35 %	40 %	25-35 %	URDPFI Guidelines
		Commercial : 1.6 %	4-8 %	5-10 %	5-10 %	4 %	4-7 %	
		PSP : 6.7 %	4-8 %	10-15 %	10-15 %	9 %	8-10 %	
		Industrial : 11 %	5-10 %	nil	nil	10 %	10-20 %	
		Recreational : 0.5 %	5-10 %	15-20 %	20-25 %	7 %	15-20 %	
		Transportation : 6.4 %	8-10 %	10-15 %	10-15 %	7 %	12-16 %	
Mobility	**Modal Spilt**	51 % PT (BUS). 15 % Walk Trips. 15 % IPT	10-20 % PT (bus) Indore 60 %	20-30 % PT (bus) 25-35 % Metro Rail	30-40 % PT BUS 20-40 % Metro Rail 20-30 % Walk trips	KMRL Study, Metro DPR (2035) PT BUS: 28% PT METRO: 30%	Public Transport: 50-60 % *Traffic and Transportation policies and strategies in urban are as, MoUD.*	
	Average Trip Length	8.1 Km	4-5 Km	5-7 Km	10-20 Km: all modes 12-25 Km: Metro	The ATL for Metro rail is estimated to be 9.44 Km	City with ATL > 10 Km, Metro more Suitable, UNEP Study	
	PCTR Per Capital Trip Role	1.02	1.2-1.5	1.3-1.5	1.4-1.7	1.35		

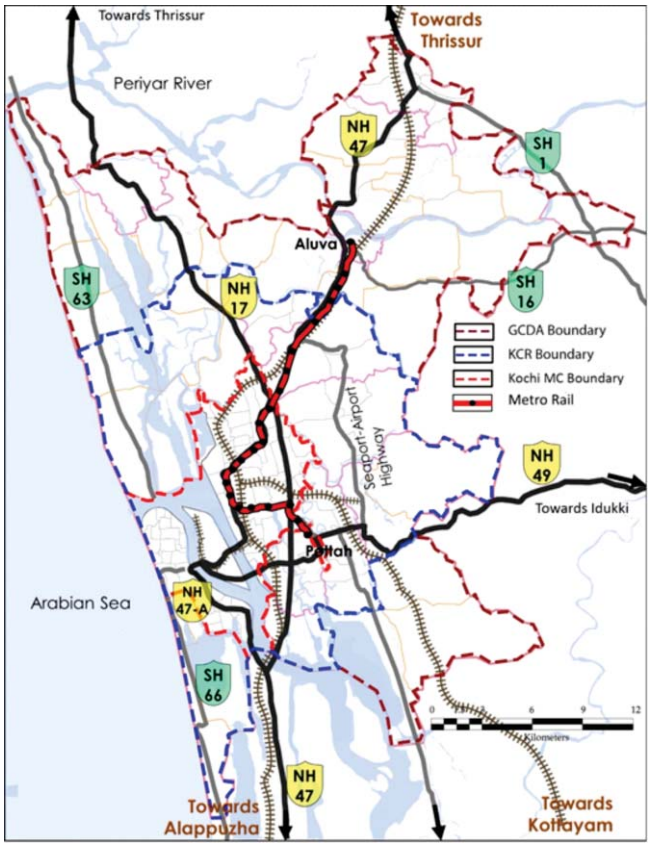
Framework comparing the sustainable indicators of the city with various chosen cases.

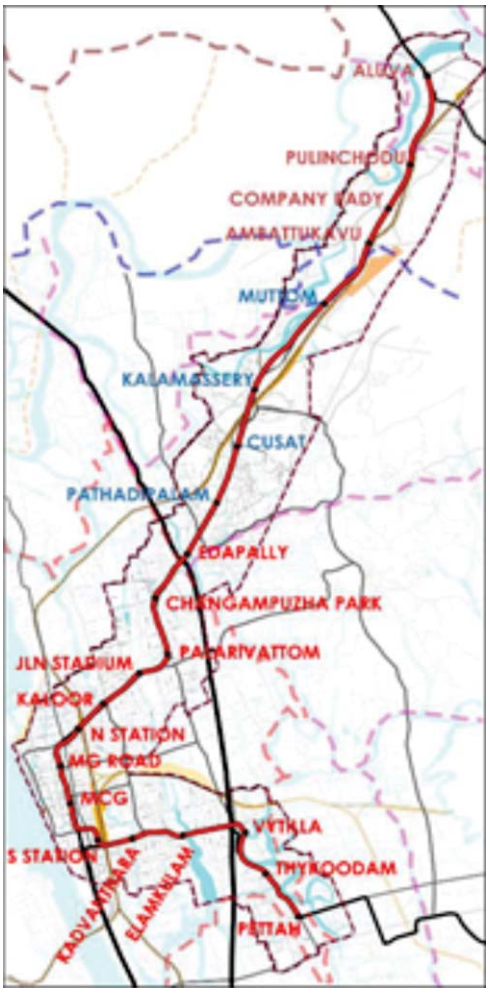
Analysis: Salient Findings

The study was done both at the city level and at the Primary Influence Area (PIA) of the Metro. The city of Kochi is generally referred under the area (630 Sq. Km) of Greater Cochin Development Authority (GCDA) of population 2.24 million. The Development Plan 2031 is prepared for the Kochi City Region (KCR) having 1.17 million population.

The city had an alarming rate of urban area expansion over the past census decade at 82 %, which is twice the national average of the rate at which the ten largest cities of India were growing during the same period. This was profound in the low dense diffused pattern of development of the city and is considered as a primary indicator of sprawling. The density distribution and the land use pattern is set to alter with the advent of the Metro rail, particularly along the corridor.

Figure: Kochi transport network with the Metro rail (source: Kochi Metro DPR)





The PIA was selected considering the average trip length of walk trips in the city i.e. 1 Km circle from each station forming a continuous band. The area is further subjected to spatial analysis namely population density, land use, FSI and building heights and the following observation were made:

- The gross density of the area is 52 PPH, with about 52 % of land under residential usage. There is acute shortage of active recreational spaces.
- The FSI consumed for the residential and commercial uses is 1.27 and the permissible for the same is 2 and 2.5 respectively as per Kerala Municipality Building Rules (KMBR) 2014.
- The average building heights in the area is 1-2 floors with the central Business District (CBD) of MG Road having higher values. The primary influence area was further divided into four stretches based on the characteristics identified in the analysis, in order to study the constraints and potentials for formulating a distinct strategy.

As it was observed that the city as well as PIA has a diffused pattern of low density (30-50 pph.) development with acute shortage of active recreational spaces (<1%). About 40% of the city area is covered by wet land and water bodies thus creating a stress on the urban land. The city had recorded an alarming urban area expansion of 82% during the last decade leading to the sprawl phenomenon. Through the spatial analysis it was observed that the average floor space usage along

the corridor is less than the permissible limits providing further scope for re-densification.

Scenario development & Proposals

The strategies outlined for the primary influence area is facilitated by the re-distribution of Population, Employment and Land use in the area. The Population and Employment densities were developed under different scenarios, further evaluated on the basis of sustainable indicators for the selection of the best alternative. Further the activity density map was developed combining the two, for restructuring the Land Use in the Primary Influence Area.

Population Re-distribution

The potential population to be distributed along the wards in the primary influence area was decided upon by deducing the natural growth rate from the population estimates for the remaining wards as per the Development plan 2031. As per the calculations, 4,02,505 excess population is the potential population to be distributed to the wards in the influence area in addition to the Development Plan projected population of 7,47,778. Thus the total population of the area is 11,50,283 at a gross density of 133 PPH. The distribution was built in three scenarios,

- Scenario 1: Uniform distribution- the excess population distributed uniformly in all wards with proportionate increase.
- Scenario 2: Selective distribution- the excess population distributed to wards less than the Development Plan density.
- Scenario 3: Normalizing distribution- the population is distributed in such a way that the wards have a uniform density in the range 125-150 PPH, which is considered sustainable for the Metro influence area for a city to the size that of Kochi.

Employment Re-distribution

As per the Kochi Metro study, the formal workers employed at major commercial or activity centers in the primary influence area is 18% of the total workforce of the city i.e. 38,641. It is estimated to be 25 % in 2031 with the Metro rail i.e. 99750. The excess 61,109 jobs is the task to be redistributed along the Metro rail through three scenarios.

- Scenario 1: Uniform distribution: the jobs are distributed uniformly at the wards near (300m) all metro stations
- Scenario 2: Selective distribution: Stations were selected based on their commercial viability potential and accessibility.
- Scenario 3: Newer commercial nodes: New stations were identified to lessen the congestion at existing business districts.

Scenario 3 was found to be more sustainable alternative from the evaluation done base on the sustainable indicators chosen for the study. Along with this the vehicular emission and fuel consumption reductions were also compounded. With the scenario 3 of population and employment distribution, there densities were combined to produce the activity density for the Primary influence area, which depicts the intensity of mixed use.

Implication of the Metro Rail

The following implications of the Metro rail on the city clubbed with the density pattern preferred in Scenario 3 were computed:

- **Per Capita Trip Rate:** Improved mobility choices, PCTR set to increase by 10%.
- **Average Trip length:** 20 % reduction in the work trip lengths.

- **Modal share:** The Public Transport share to be 70% from the present 50%, Metro being 33%.
- **Travel Demand:** Private Road Motorized Trips to be reduced.
- **Travel time:** Metro user saves at an average 15 minutes in journey time.
- **Vehicular emissions:** 500 metric ton of CO_2e saved annually.
- **Fuel consumption:** 850 kl of fuel saved a year.
- **Developed land consumption:** By adoption 60 PPH for the GCDA area, 63 sq.km of land saved from put to urban use.
- **Accident rate:** About 100 lives could be saved from road accidents annually
- **City bus productivity:** Enable to perform 2-3 extra trips a day due to improvement in road condition.

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