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ABSTRACT

The motivation for this report is to explore whether the Transit Oriented Development (TOD) principles, parameters and components can be applied and adapted in Indian cities with existing large populations and diverse land use patterns before the introduction of metro rail.

Since Transit Oriented Development (TOD) is a recent technique using certain parameters and components to create the desired development density around transit, this report analyzed whether the same parameters and components are being used or are applicable to the areas around well-established and recent transit systems in cities in USA, Europe, Asia, South America and India. Transit oriented policies for these cities were also analyzed.

A case study of Bangalore was done to determine existing population densities in the city and the strategies needed to promote ridership and additional density around the newly introduced metro in Bangalore.

The TOD analysis for the Indian context concluded that at least some or all of the TOD components, Design, Density and Diversity exists in the areas around the transit stations. Although the population densities around the newly introduced transit systems may be adequate for transit ridership, accessibility to transit and multimodal connectivity is lacking.

The proposed transit oriented strategies in India do address new high density development around the transit stations, investing in critical transportation infrastructure and better traffic and transportation management and parking management. Pedestrian safety and convenience are also addressed. The strategies do not address immediate and short term solutions for generating transit ridership and moving people away from private vehicles towards the use of public transportation. Therefore, the proposed strategies may not reduce congestion on an immediate and short term basis. The issue of increasing transit ridership on an ongoing basis is also not addressed.

In order to promote transit ridership, the transit oriented strategies must address land use and transportation and short term and long term solutions. The existence of mature and diverse land uses and densities along the transit stations must be recognized. The report recommends overall, specific and general strategies for promoting transit ridership in Indian cities where new transit systems (metro) are being introduced and which already have a fairly high population (two million+) with fairly high population densities.

CHAPTER 1 - INTRODUCTION

1.1 BACKGROUND

Most Indian metropolitan cities have complex organic growth patterns encompassing many centuries of growth. These cities have old city centers and associated infrastructure that were built before the invention of automobiles and modern transportation systems. These city centers support major economic activities to this day. The Indian cities also typically have diverse neighborhoods, densities and land uses. With the rapid growth in population in the last two decades and the economic boom added by automobile based sub-urbanization, Indian cities have grown in size leading to associated transportation issues of congestion, delays and pollution.

Mass Rail Transport (Transit) Systems (MRTS) can solve many of the transportation issues raised in Indian cities (Sekar & Karuppannan, 2012). Metro rail systems are non-polluting, energy-efficient and superior to other modes because they provide higher carrying capacity, are faster, safer, smoother and occupy less space (DMRC, Pune Metro DPR, 2008).

However, MRTS in India is a relatively new phenomenon. The first rapid transit system in India was the Kolkata Metro, which started in 1984, followed by the Delhi Metro in 2002, the Bangalore Metro in 2011 and the Chennai Mass Rapid Transit System in 2014. (sources: KMRC, DMRC, BMRCL, Chennaimetrorail).

In 2009, it was decided to invest Rs. 2000 billion (US$30.6 billion) on metro rail projects in eight more cities in the following ten years (Times of India, 2009). There is a plan to have metro rail systems in all Indian cities having a population of more than two million This is one of the major recommendations made by the working group on urban transport in the Planning Commission (Times of India, 2011).

Most of the Indian cities were planned much earlier than the introduction of metro rail projects. Therefore, much of the anticipated developmental impact of the metro rail projects are not easily integrated into current Master Plans (Sekar & Karuppannan, 2012). The efficiency of a public transport system is heavily dependent on demand thresholds. The metro systems often attract lower than expected number of passengers, and tend to capture passengers from buses while the shift from cars to the metro remains limited (Hayashi, 2007).

With the above issue of the Indian cities already including a large population and being planned before the introduction of metro rail projects and the issue of the metro systems often attracting lower than expected number of passengers, how will the above two million plus cities that will have future metro systems promote transit ridership?

Transit oriented development (TOD) is one of the recent techniques used to provide the desired development density and connectivity for transit. This report will analyze whether transit oriented development is applicable in the Indian context to achieve the desired development densities and transit ridership.

1.2 MOTIVATION FOR THE REPORT

The motivation for this report is to explore whether the transit oriented development principles can be applied and adapted in Indian cities with existing large populations and diverse land use patterns before the introduction of metro rail.

Since Transit Oriented Development is a recent technique using certain parameters and components to create the desired development density around transit, this report will analyze whether the same parameters and components are being used or are applicable to the areas around well-established and recent transit systems in cities in USA, Europe, Asia, South America and India. A street car system and a suburban rail have also been studied for comparison purposes. Transit oriented policies for these cities will also be analyzed.

Based on the analysis, the report will explore whether transit oriented development parameters and components can be applied to the areas around new metro rail projects in India to achieve the desired development densities and transit ridership.

1.3 SCOPE OF THE REPORT

The following documents have been analyzed for this report:

- Data for Transit Routes and City Data for metropolitan cities in USA, UK, Asia, South America and India
- Literature review for various land use planning, transportation and Transit Oriented Development (TOD) policies and issues.

1.4 METHODOLOGY

The following methodology will be used for this report:

- TOD Review and Analysis for the following cities:
    - USA – New York and Portland
    - UK – London
    - Asia – Hong Kong and Singapore
    - India – New Delhi and Mumbai
    - South America – Sao Paulo
- Literature Review for TOD parameters and policies
- Exploration and Analysis of TOD principles and parameters for the above cities
- Recommendations for TOD principles for the Indian Context

1.5 BENEFECIARIES OF THE REPORT

The beneficiaries of the Report will be:

- Transportation, Town Planning and Regional Agencies like BMRCL, BDA, BBMP, BMRDA. BMTC, DULT, BMRTA, DMRC in Bangalore
- Research Institutions, other Government agencies and the Urban Population

CHAPTER 2 – TRANSIT ORIENTED DEVELOPMENT (TOD)

2.1 WHAT IS TOD?

TOD Definition and Description

The definition of Transit Oriented Development is any development, either macro or micro scale that induces people to prefer the use of public transportation (Definition Source: APTA http://www.apta.com/research/info/briefings/briefing_8.cfm)

Transit Oriented Development is a recent trend in creating vibrant, livable, compact, walk-able communities around or along transit systems to achieve a higher quality life by reducing car dependency. Transit oriented development is considered a major solution for climate change issues because it reduced the need for driving and the burning of fossil fuels by creating dense, walk-able communities around transit (source: http://www.transitorienteddevelopment.org/).

Transit-oriented development, or TOD, is a mixture of various uses like housing, office, retail and/or other commercial development and amenities integrated into a walk-able neighborhood and located typically within a half-mile of quality public transportation. (source:http://ctod.org/)

TOD Goals and Advantages

The goals of Transit Oriented Development are to:
- Reduce private vehicle dependency and promote public transport use through design, policy and enforcement
- Provide public transport access to the maximum number of people through densification and multimodal connectivity (Source: UTTIPEC, June & November, 2010)

The advantages of Transit Oriented Development are:
- Higher quality of life
- Better places to live, work, and play
- Greater mobility with ease of moving around
- Increased transit ridership
- Reduced traffic congestion and driving
- Reduced car accidents and injuries
- Reduced household spending on transportation, resulting in more affordable housing
- Healthier lifestyle with more walking, and less stress
- Higher, more stable property values
- Increased foot traffic and customers for area businesses
- Greatly reduced dependence on fossil fuels
- Greatly reduced pollution and environmental destruction
- Reduced incentive to sprawl, increased incentive for compact development
- Less expensive than building roads and sprawl
- Enhanced ability to maintain economic competitiveness

(Source: http://www.transitorienteddevelopment.org/)

2.2 TOD COMPONENTS AND PARAMETERS

The TOD components are the 3 Ds below (Source: Dr. Robert Cervero, U C Berkeley):

Density (For adequate population density for transit ridership)

Diversity (Mixed Use, Mixed Income that use transit)

Design (Safe, Comfortable, Active (24X7) Environment created by promoting walkability and access to transit.

The 3 Ds define the density, mix of uses and connectivity required within walking distance of transit stations to encourage transit use and a 24 hour environment around the transit stations.

Transit-Oriented Development (TOD) is compact, mixed use development near new or existing public transportation infrastructure that provides housing, employment, entertainment and civic functions within walking distance of transit. The pedestrian-oriented design features of TODs encourage residents and workers to drive their cars less and ride public transit more. A 500 m area around the transit station is considered a 5-minute walking distance in the vicinity of transit stations.

Some of the design principles that can be used to create transit oriented developments are:
- Pedestrian and non-motorized transport friendly environment
- Efficient Public and Para-transport System supporting the transit system
- Multimodal interchange and street connectivity
- Mixed land use and appropriate use intensities
- Placemaking
- Well managed parking

(Source: UTTIPEC, June & November, 2010)

2.3 TOD REVIEW OF TRANSIT STATIONS AROUND THE WORLD

Figure 2. Location of Metropolitan Cities Studied

The following methodology will be followed for this report:
- TOD Review and Analysis as follows:
  - Transit Routes and transit stations for the following metropolitan cities were chosen:
    - USA
      New York - Times Square and Woodhaven Boulevard Stations

Portland – Southwest 10th & Alder and Northeast Broadway & Ross Stops

- UK
  London – Piccadilly Circus and Hainault Stations
- Asia
  Hong Kong – Causeway Bay and Tai Po Stations
  Singapore – Raffles Place and Kallang Stations
- India
  New Delhi - Chawri Bazar and Race Course Stations
  Mumbai – Churchgate and Dadar Stations
- South America
  Sao Paulo – Se' and Paulista Stations

- The following information was studied for each transit route:
  - Year opened, number of stations & lines, ridership

- The following information was studied for each city:
  - Population, Area, Population Density
  - Photographs of areas around the stations were studied
  - Aerial maps of the stations/stops at 50 m scale and 100 m scale were studied
  - Aerial maps showing historical data (whenever available) to understand the land use changes around the transit stations
  - Google Map 3D models (whenever available)

The above information for each of the station areas reviewed and analyzed are included in the Appendix.

Example of Information in the Appendix

USA - New York City Subway New York City

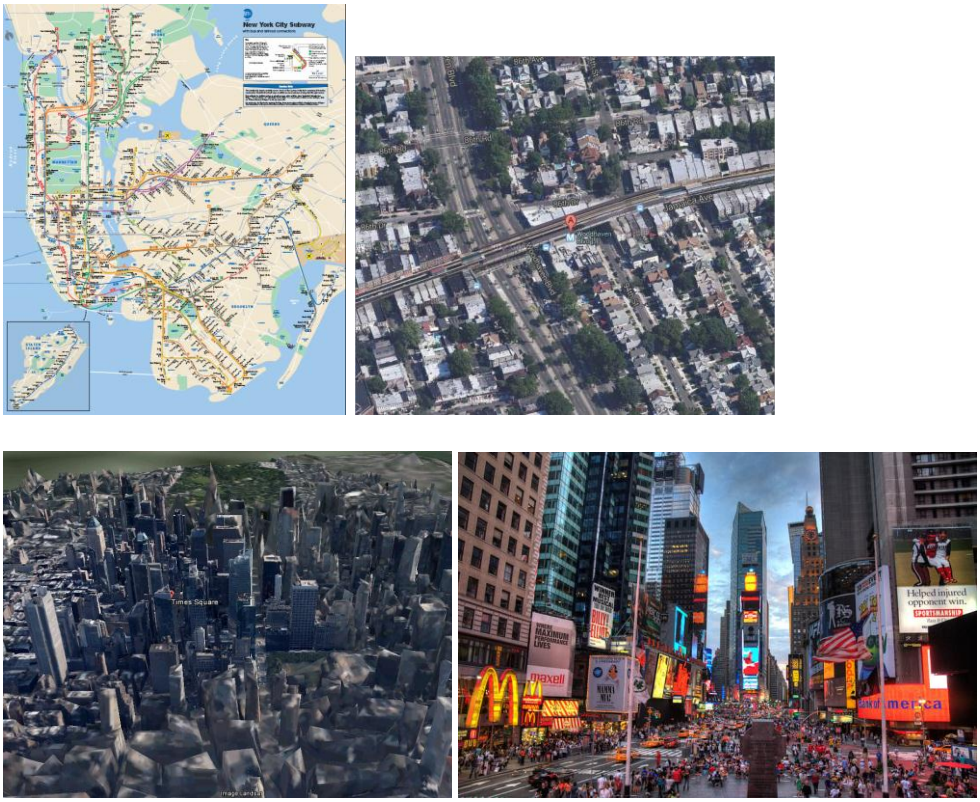

Figure 1. Route Map, Station Area Map, 3D View, Photos

City and Transit Route Information

- Number of lines: 34
- Number of stations: 421
- Daily ridership: 5.3 million
- Operator: New York City Transit Authority
- Began operation in: 1904
- Country: United States of America
- Area of the City: 1,213 km sq
- City's total population: 19.8 million

India- New Delhi

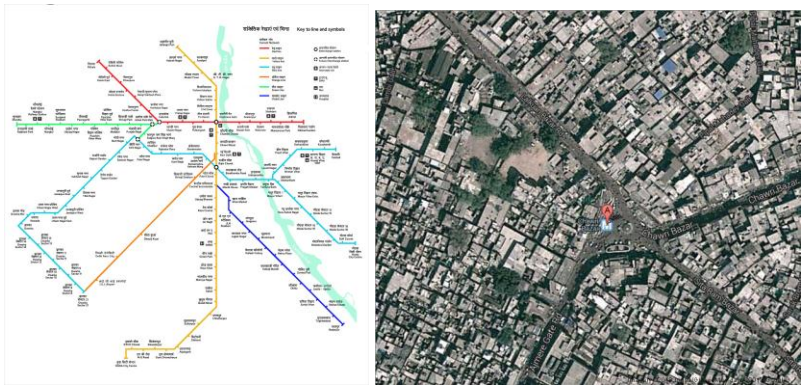

Figure 2. Route Map, Station Area Map Photos

City and Transit Route Information

- Number of lines: 7
- Number of stations: 142
- Daily ridership: 2 million (2,000,000)
- Operator: Delhi Metro Rail Corporation
- Began operation in: 2002
- Country: India
- Area of the City: 1,590 km sq
- City's total population: 21.7 million

Transit Routes Summary

Country	City	Population in Millions (Metro area)	Transit Authority	Transit Type	Year Started	No. of Lines	No. of Stations
USA	New York	19.8	New York City Transit Authority	Rapid Transit	1904	43	421
USA	Portland	0.6	Portland Streetcar & TRIMET	Streetcar	2001	2	76
UK	London	15	London Underground Limited	Rapid Transit	1863	11	270
China	Hong Kong	7.1	Mass Transit Railway Corporation Limited	Rapid Transit	1979	22	152
Singapore	Singapore	5.3	Land Transport Authority, SMRT, SBS Transit	Rapid Transit	1987	5	104
India	New Delhi	21.7	Delhi Metro Rail Corporation	Rapid Transit	2002	7	142
India	Mumbai	20.7	Central and Western Railway	Suburban Rail	1853	6	90
Brazil	Sao Paulo	19.8	Companhia do Metropolitano de Sao Paulo, Via Quatro	Rapid Transit	1974	5	64

Figure 3. Summary of Transit Systems in Various Metropolitan Cities

Transit Station Area Summary

City	Station Name	Street Pattern	Block Size	Road Widths	Density	Number of Floors	Land Use
New York	Times Square	Grid	74mX260m; 70mX260m grids. Block size varying when diagonal road cuts	8m-13m	High	15+	Commercial Office
	Woodhaven Boulevard	Grid	50mX100m; 50mX150m grid	10m-25m	Low to Medium	2 to 4	Residential
Portland	Northeast Broadway & Ross	Grid	Varying between 45mX65m to 140mX200m	15m to 35m	Low to Medium	3 to 5	Mixed Use
	Southwest 10th & Alder	Grid	75mX75m; 75mX100m grid	6m-10m	Medium	5 to 10	Mixed Use
London	Picadilly Circus	Grid	50mX75m;50mX100m grid	6m-10m	Medium	5 to 7	Commercial Office
	Hainault	Grid	Varying between 70mX75m to 75mX200m	8m-20m	Low to Medium	2 to 4	Residential
Hong Kong	Causeway Bay	Grid with irregular parcels	45mX135m girds with varied sizes of parcels	7m - 30m	High	15+	Mixed Use
	Tai Po	Grid with irregular parcels	50mX200m	7m - 30m	High	15+	Mixed Use
Singapore	Raffles Place	Grid with varied parcels	Varying between 30mX60m to 125mX270m	8m-45m	High	15+	Mixed Use
	Kallang Station	Grid with varied parcels	varying 75mX150m to 75mX200m	8m-25m	High	15+	Mixed Use
Delhi	Chawri Bazar	Irregular	30mX60m blocks with narrower roads within	≤10m	High	2 to 5	Mixed Use
	Race Course	plots with cul-de-sac	60mX100m plots with cul-de-sac	25m-30m with 9m inner roads	Low to Medium	2 to 5	Mixed Use
Mumbai	Dadar	Grid with irregular parcels	50mX75m to 75X200m	6m - 20m	Medium to High	5 to 15+	Mixed Use
	Churchgate	Grid	50mX75m to 50mX100m	6m-10m	Medium to High	5 to 15+	Mixed Use
Sau Paulo	Se'	Varying Grid	20mX60m to 100mX150m	7m - 40m	Medium	5 to 10	Mixed Use
	Paulista	Grid	100mX100m to 100mX200m	8m-20m	Medium to High	5 to 15+	Mixed Use

Figure 4. Summary of Station Area, Street Design, Block Size, Density & Land Use

Ridership, Population, Area, Density

Country	Metropolitan Area	Population in Millions (Metro area)	City Area Km2	Population Density	Daily Ridership in Millions	Population % using Transit (ridership /total)
USA	New York	19.8	34,490	574/km2	5.3	26.77%
USA	Portland	2.2	17,310	127/km2	0.011	0.005%
UK	London	15	8,382	1789/km2	2.7	18.00%
China	Hong Kong	7.1	1,104	6,431/km2	4.6	64.79%
Singapore	Singapore	5.3	716	7,402/km2	2.6	49.06%
India	New Delhi	21.7	43,016	504/km2	2	9.22%
India	Mumbai	20.7	4,355	4,753/km2	7.6	36.71%
Brazil	Sao Paulo	19.8	7,943	2,492/km2	2.9	14.65%

Figure 5. Summary of Population, City Area, Density, Ridership & percentage of ridership

Data Sources (US Census 2010, National Census UK 2012, Hong Kong Statistical and Census Data 2012, Singapore Statistics 2012, India Census 2011, Brazil Census 2013 and Transit Route Information for the above cities)

Summary

London (1863) and New York (1904) have the oldest transit systems. Mumbai suburban train was started around the same time as the London transit system (1850-1860). Portland has a street car system for a population of 0.6 million. Hong Kong (64.79%) and Singapore (49.06%) have the highest percentage of the total population using transit. Hong Kong metro started in 1979 and Singapore metro started in 1987. New Delhi metro which started in 2002 has 9.22% of the total population using the metro. Population Density is the highest for Hong Kong and Singapore, followed by Mumbai and Sao Paulo and the lowest for Portland. Percentage of population using transit is higher for the cities with higher population densities (Hong Kong, Singapore, Mumbai) and also higher for cities with a long history of transit usage (New York and London),

The street pattern for most of the stations follow a grid pattern ranging from a traditional grid with rectangular blocks, blocks of varying sizes and with irregular parcels and varying grid patterns. Chawri Bazaar station (Delhi) has an irregular street pattern and the Race Course Road station (Delhi) has plots and cul-de-sac pattern. Street widths range from 6 meters to 45 meters with an average street width of 8 meters to 15 meters. Chawri Bazaar station (Delhi) has narrow streets (less than 5 meters) within the irregular blocks. The block sizes range from 30 meters in width to 200 meters in length with an average block size of 50 meters in width and 100 meters in length. Woodhaven Boulevard station (New York) and Hainault station (London) have predominantly low to medium density residential uses and Piccadilly Circus (London) and Times Square (New York) and Piccadilly Circus have predominantly medium to high density commercial/office uses. Most of the stations reviewed have mixed use developments around the stations. The station areas in Hong Kong, Singapore and the Times Square station (New York) have the highest densities with a majority of the high rise buildings with 15+ floors.

2.4 TRANSIT ORIENTED STRATEGIES FOR USA, UK, ASIA & SOUTH AMERICA

The following transit-oriented strategies were reviewed:

New York City

Due to increase in population, the importance of rapid transit and provision of cheap, safe, speedy and comfortable transportation was emphasized (Haupt, 1891). The Department of City Planning, City of New York, promotes strategic growth, transit-oriented development, and sustainable communities in the City, in part by initiating comprehensive, consensus-based planning and zoning changes for individual neighborhoods and business districts, as well as establishing policies and zoning regulations applicable citywide. The New York City Strategic Plan states that the City is channeling new development to transit-rich areas. The City's goal by 2030 is to locate 95% of new development within a 10 minute walk of a metro stop (Source: http://www.nyc.gov).

Portland

The Portland Strategic Plan is designed to guide future investments by the Metro TOD Program, in order to ensure the program maximizes the opportunities for catalyzing transit-oriented development throughout the region and advance TOD in all station areas and bus corridors. The plan includes an evaluation of existing conditions, a typology framework for an area's TOD readiness and guidelines for phasing TOD activities (CTOD, 2011). The idea of reintroducing a modern streetcar service in Portland was in response to the recommendations of the 1988 Central City Plan. The initial streetcar alignment connected major ridership generators and employment centers. As a development stimulus, the streetcar has been a major success. The Portland Streetcar System Concept Plan (SSCP) identifies potential corridors that will build on the success of the existing streetcar system and expand service to best serve Portland's neighborhoods and business districts. Corridors were evaluated based on development potential, operational feasibility, transit connectivity and public involvement.
Efforts are being made to make the SSCP an integral part of the city's update to the Comprehensive Land Use Plan (City of Portland, 2009).

London

The idea of an underground railway linking the City of London with some of the railway termini in its urban center was proposed in the 1830s and it opened in 1863 (Day & Reed, 2010).

The City of London's Infrastructure Delivery Plan includes the following:

City Together Strategy Vision for Transport - To encourage sustainable forms of transport and to reduce our impact on climate change and improve the way we adapt to it.

The Core Strategy Vision is to promote more sustainable travel patterns and modes of transport and increase public transport capacity.

Definition of Transport Infrastructure - Transport infrastructure in the City's context incorporates the streets, walkways and public realm which enable pedestrian movement; the shared spaces, highways and cycle parking facilities which enable safe and secure cycling; the highways, roads lanes and vehicle parking facilities which accommodate motor vehicles, essential for servicing, delivery and operation of buses, taxis and private vehicles; the underground tube systems and over-ground rail networks and stations which provide public transport connections within and beyond the City nationally and internationally; and the river transport system for both freight and passenger transport to and from the City's wharf and piers increased.

The overall transport standard that the City is aiming for is that people should have a range of sustainable choices of transport modes which operate in a safe, secure, sustainable and efficient manner for business and leisure related trips. (City of London, 2011)

Hong Kong

Construction of the MTR was prompted by a study, released in 1967, commissioned by the Hong Kong Government in order to find solutions to the growing road congestion problem (Freeman, Fox, 1967).

The Hong Kong 2030 Planning Vision and Strategy, an integrated approach to land-use, transport and environmental protection, was adopted, leading to a "Preferred Development Option" which highlighted the planning concepts of setting development axes along railways and allowing more intensive development around railway stations. Urban development in Hong Kong generally follows a "Public Transport-oriented Development" approach. Based on the estimation by the Planning Department, approximately 42% of the housing and employment population and 75% of the commercial and office floor areas are located within a radius of 500 meters of railway stations. This demonstrates the integration of land use and transport planning and a compact and efficient urban development approach (Government of Hong Kong, 2007).

Singapore

The origins of the Mass Rapid Transit (MRT) are derived from a forecast by city planners in 1967 which stated the need for a rail-based urban transport system by 1992 (Sharp, 2005 & Fang, 2004).

"A sustainable population for a dynamic Singapore" (National Population and Talent Division, Singapore, 2013) recommends the following:

- Planning and investing in infrastructure ahead of demand, to create high quality urban spaces and ensure that our infrastructure can support a range of population trajectories, with a total population of about 5.8 to 6.0 million in 2020, and 6.5 to 6.9 million in 2030.
- Transportation planning will include 800 new buses to the public bus fleet over 5 years, increasing capacity by 20%, extending the rail network by about 100 km to 280 km by 2021 so that 8 in 10 homes will be within a 10-minute walk from a rail station in 2030.
- From now till 2016, 90,000 private housing units and 110,000 public housing units will be completed to help meet the demand for housing.
- More land will be set aside for parks and green spaces, in tandem with population growth and the park connector network will be increased to 360 kilometers by 2020 so that at least 85% of our households will live within 400 m of parks by 2030.
- Exploring new technology and innovative solutions, to expand and optimize our land use, create new land capacity, and make use of space more efficiently and effectively to enhance liveability and support longer-term needs.

Sao Paulo

The Sao Paulo Metro was voted Best Metro Americas at the MetroRail 2010 industry conference. The metro does not cover all areas of the city but it is complemented by a 260 kilometer suburban network. The metro runs underground through the city center but on elevated structures or at grade in outer areas. To reduce the cost of new construction some suburban lines were to be converted to metro and provide more frequent service. (Source: http://www.urbanrail.net/am/spau/sao-paulo.htm)

Sao Paolo has entrenched urban planning and a "Compact City" model in an effort to reduce greenhouse gas (GHG) emissions. Its land use policy ensures sustainable development, densification, development along transport corridors, and an integrated, coherent, environmental and urban landscape. Transportation planning considers social equity and access to urban goods and services. Sao Paolo aims to create a mixed use, dense and compact urban environment, where citizens live in close proximity to all required urban needs. (source: http://planning.cityenergy.org.za/

The São Paulo 2040 plan prepared by the Municipality of Sao Paulo has begun with a preliminary strategic vision based on Sao Paulo Priorities and drawing upon other city experiences, and has pursued vigorous consultation with more than 25,000 citizens and commentators, while developing five strategic propositions, social cohesion, urban development, environmental improvement, mobility and business opportunity. The master plan is also called "Sao Paulo 2040: The City We All Want". Some of the long-range goals include greenways along both major rivers, a 15-minute walk to park facilities for everyone, a 30-minute or less commute for everyone, and regional commercial centers to ease some of the traffic and infrastructure loads on the city center. (source: http://blog.mipimworld.com/2012/05/sao-paulo-2040/#.UsKaMrSo3mi)

Summary of Transit Oriented Strategies for the Above Cities

All of the above transit systems were developed in response to population growth, demand for rapid transportation and reduction of traffic congestion. All of the above strategies recommend policies for promoting development along transit routes on an ongoing basis.

The above Transit Oriented Strategies include all or some of the following key components:

- Maximizing opportunities for channeling new development to transit rich areas

- Locating new development and housing within a 10-minute walk from transit stations or stops
- Comprehensive, consensus-based land use changes for neighborhood and commercial districts for strategic growth, sustainable development and transit oriented development
- Creating transit corridors bases on development potential, operational feasibility, transit connectivity and public involvement
- Making the Transit Oriented Plan a part of the Comprehensive Land Use Plan
- The definition of Transportation Infrastructure to include roads, bicycle paths, public transport, rail transport, air transport and waterways transport
- Creating a range of sustainable transportation modes which are safe, secure, sustainable and efficient for business and leisure trips
- Public Transport oriented approach by integrating land use and transport planning for compact and efficient urban development
- Planning and investing in infrastructure ahead of time to create high quality urban spaces and accommodate future population growth
- Planning for a 30-minute or less commute time with mixed use, dense and compact urban environment

In summary, all the above policies recommend the following strategies:

- Maximizing development around transit
- New development and housing within a maximum walking distance from transit stations and stops
- Creating transit corridors for connectivity
- Integrating land use and transportation for compact and efficient urban development
- Providing adequate and appropriate transportation infrastructure for maximum accessibility to all sustainable transportation modes

2.5 TRANSIT ORIENTED STRATEGIES IN INDIA

The following transit-oriented strategies were reviewed:

Mumbai

Mumbai has the advantage of a high modal share of the public transportation (88%). The existing Mumbai Suburban Railway carries over 7 million passengers per day, and is supplemented by the Brihanmumbai Electric Supply and Transport (BEST) bus system, which provides feeder services to station-going passengers to allow them to complete their journeys (Municipal Corporation of Greater Mumbai, 2008)

The rail system and bus system are insufficient to solve the problems of traffic congestion in the city. Solutions such as road widening and increased capacity of railway system were implemented but still many areas are still not reached by the efficient transportation.

In 2003, MMRDA (Mumbai Metropolitan Region Development Authority) aimed to find long-term solution to traffic for easy transportation in the MMR. So MMDR with the help of M/s. Delhi Metro Rail Corporation (DMRC), TATA Consultancy Services and Indian Institute of Technology formulated the Master Plan, along with Detailed Project Report, for the Mumbai Metro. The Master Plan was approved by the Authority in 2004.

The proposal covers 146.5 kilometers in which 32.5 kilometers will be underground while the rest is erected from the ground. Metro Rail Project was established to connect the parts of the city that are not connected to the rail system and covers the distance of areas which are 0.5 and 1 kilometer apart. It covers Navi Mumbai, Thane, Virar and Vasai. (Source: http://mmrdamumbai.org).

In May 2003, the original Mumbai rapid-transit plan was updated to include an elevated 10-kilometre, 13-station elevated light rail line linking Versova, Andheri and Ghatkopar. The system will be built in three phases over a 15-year period, with overall completion expected in 2021 (Source: http://www.mumbaimetroone.com)

The Master Plan prepared by the DMRC for the Mumbai Monorail, has been divided into the following phases for the implementation of the project:

- First phase from Wadala to Chembur is 8.80 km long.
- Second phase from Wadala to Sant Gadge Maharaj Chowk is 11.20 KM long.

The monorail inauguration for the first phase is in February 2014. (Source: http://mmrda.maharashtra.gov.in/mumbai-monorail-project).

The strategy for transportation (Municipal Corporation of Greater Mumbai, 2008) includes the following:

- Ensuring adequate accessibility for transportation
- Providing safe and sustainable transportation systems
- Augmenting/strengthening of public transport systems
- Investing in critical transportation infrastructure projects
- Traffic and pedestrian safety management and improvements
- Parking policy

The Transit Oriented Development strategies (Municipal Corporation of Greater Mumbai, 2008) include the following:

- Intensification of development along the transit corridors at railway stations to reduce the road traffic considerably.
- Allowing higher FSI (Floor Space Index) for commercial developments on selective basis keeping in view the congestion levels and overcrowding at suburban stations.
- In case of new transit systems urban renewal schemes, a 500 m x 500 m area of each station shall be considered for higher FSI incentives.
- The BEST which is the public transport bus operator has several depots where vertical development is possible for multistoried parking and commercial development so that the revenues generated can be utilized for significant improvements in bus operations which are otherwise incurring huge losses.

Delhi

Delhi Development Authority (DDA) prepared a perspective plan for Delhi (MPD-2001) in 1984 and recommended a multi modal transport system. The Urban Arts Commission suggested some modifications to the proposal of DDA and recommended the development of the existing Ring Railway with three radial underground MRT corridors. Feasibility Report on Integrated Multi Modal Mass Rapid Transport System of Delhi (IMMRTS) prepared by RITES

recommended a three-component system comprising of Rail corridors, Metro corridors and dedicated bus way.

To rectify the traffic congestion issues due to phenomenal growth of population In New Delhi over the past decades, the Government of India and the Government of National Capital Territory of Delhi, in equal partnership have set up a company named Delhi Metro Rail Corporation Ltd. In 1995 and commissioned the development of Delhi Metro (Source: http://www.delhimetrorail.com/)

The Delhi Metro Rail Corporation has been certified by the United Nations as the first metro rail and rail-based system in the world to get "carbon credits for reducing greenhouse gas emissions" and can claim 400,000 carbon credits for a ten year period beginning in 2007 (The Hindu, 2009).

Transit Oriented Development, Policy, Norms and Guidelines prepared by UTTIPEC for New Delhi have proposed a Transit Oriented Development Annexure to the Delhi Master Plan 2021.

The Annexure includes the following:

The concept of the Master Plan for Delhi in the past was based on a poly-nodal, polycentric, distribution of work centers, largely based on road transport nodes. The disadvantage of this has been a distortion between infrastructure, transport and land use. Congestion is a major issue with increase in use of private vehicles. Therefore, it is imperative to move people away from private vehicles towards the use of public transportation. This can be done by offering more attractive alternatives to the use of personal modes – low cost, comfortable, non-motorized transport, pleasurable walking experiences and easily accessible and comfortable mass transportation with easy, convenient and comfortable intermodal transfers for last mile connectivity. This is possible through Transit Oriented Development. The development should take place according to new corridors of mass movement to achieve spatial balance and synergy between land use and transportation.

TOD shall have the following benefits:

Mobility options, better quality of life, housing for all, private sector participation, self-sufficiency, cheaper public transport, reduced environmental degradation public money savings, multidisciplinary multidepartment approach.

Components of the UTTIPEC Transit Oriented Development, Policy, Norms and Guidelines:

An overall TOD Influence Zone of a radius of 2,000 meters around the Transit station was introduced. This overall TOD Influence Zone is divided into the following three subzones:

- Intense TOD Zone – areas within 300 meter radius of the transit station
- Standard TOD Zone – areas within 800 meter radius of the transit station considered a 10-minute walking radius.
- TOD Transition Zone – areas within 2000 meter radius of the transit station considered a 10-minute cycling distance

A detailed Influence Zone Plan for a single Transit station or a group of transit stations with the following components:

- Urban Design Framework
- Transport Impact Assessment and mitigation strategies
- Decentralized Infrastructure and sustainability plan
- Economic viability and implementation model

TOD Policy and Development Control Norms that include the following components:

- Pedestrian and Cycle/Cycle-Rickshaw friendly environment
- Connectivity – street network for all modes
- Multi-modal interchange: mass transportation modes integrated with modal transfers
- Modal shift measures – shift to sustainable modes with road use regulation, mixed-use, parking policy
- Placemaking and Safety – urban places for enjoyment, relaxation and equity
- High Density, Mixed-Income Development – compact neighborhoods for shorter commutes and equity

Specific policies for the following Development Standards:

- achieving desired block sizes for retrofitted, redevelopment/infill and greenfield developments
- accessibility criteria for social infrastructure
- minimum mixed-use development
- FAR and Density Thresholds (Source: UTTIPEC, 2013)

Summary of Transit Oriented Strategies for Indian Cities

There has been a substantial investment in mass transit systems in recent years to augment existing transportation systems, increase accessibility to sustainable transportation modes and to reduce traffic congestion. There has also been a shift from a poly-nodal, polycentric, distributed urban development approach to compact, dense, urban development along transportation and transit corridors. Transit oriented development is recommended as a technique to move people away from private vehicles towards the use of public transportation by offering more attractive alternatives to the use of personal modes like:

- low cost, comfortable, non-motorized transport
- pleasurable walking experiences
- easily accessible and comfortable mass transportation with easy, convenient and comfortable intermodal transfers for last mile connectivity

The above Transit Oriented Strategies include and recommend the following key components:

- Intensification of development along transit corridors
- Adequate accessibility for safe and sustainable transportation systems
- Traffic and pedestrian safety management
- Parking policy
- Policies for retrofitted, redevelopment/infill and greenfield developments
- TOD influence zones for areas within a certain radius of transit stations or stops
- Detailed influence zone plans for creating pedestrian friendly environments, multimodal connectivity, modal shifts, placemaking and high density development

CHAPTER 3 – TRANSIT ORIENTED DEVELOPMENT (TOD) ANALYSIS FOR THE INDIAN CONTEXT

3.1 TOD ANALYSIS FOR TOD COMPONENTS

An analysis was done to determine whether the transit oriented development components, Design, Density and Diversity are being used or are applicable to the following transit stations and stops.

		TOD COMPONENTS						Other
City	**Station Name**	**Design**		**Density**		**Diversity**		**Type of Use, Unique features**
		Walkability & Access to transit	**Active, 24x7**	**Land Use Density**	**Transit ridership**	**Mixed Use**	**Mixed Income**	
New York	Times Square	Yes	Yes	Yes	Yes	Yes	No	Commercial, Employment area with businesses
	Woodhaven Boulevard	Yes	Yes	No	Yes	No	Yes	Predominately residential area
Portland	Northeast Broadway & Ross	Yes	Yes	No	Yes	No	Yes	Predominately residential and suburban area
	Southwest 10th & Alder	Yes	Yes	Yes	Yes	Yes	No	Commercial, Employment area
London	Picadilly Circus	Yes	Yes	Yes	Yes	Yes	No	Commercial, Employment area
	Hainault	Yes	Yes	No	Yes	No	Yes	Predominately residential area
Hong Kong	Causeway Bay	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area
	Tai Po	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area
Singapore	Raffles Place	Yes	Yes	No	Yes	Yes	Yes	Commercial, Employment, Residential area
	Kallang Station	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area
Sau Paulo	Se'	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area
	Paulista	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area
Delhi	Chawri Bazar	No	Yes	Yes	Yes	Yes	Yes	Older Commercial, Employment, Residential area
	Race Course	No	No	No	Yes	Yes	No	Mixed use suburban area
Mumbai	Dadar	No	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area; interchange station for local rail
	Churchgate	Yes	Yes	Yes	Yes	Yes	Yes	Commercial, Employment, Residential area

Figure 6. TOD Analysis

Summary of TOD Analysis for TOD Components

All of the transit stations except Hainault Station in London and Woodhaven Boulevard Station in New York meet the components for Design, Density and Diversity. The Hainault Station in London and Woodhaven Boulevard Station in New York have low to medium density with predominately residential uses. These transit stations provide connectivity to the commercial and employment areas of the city. Even though the land use density in the vicinity of these transit stations is low, the residential uses generate adequate ridership for transit. Times Square station in New York, Southwest 10th and Alder transit stop in Portland and Piccadilly Circus in London are the main commercial and employment areas in the City. The limited residential use in these areas will not provide the mixed income land uses. However, since these areas are the main commercial and employment areas, they are accessible and used by a mixed income population. The stations in Singapore, Hong Kong and Sau Paulo have some residential uses that could serve a mixed income group.

The Chawri Bazaar station in Delhi is an older area with narrow roads and densely developed buildings. Even though there is a street grid for walkability, the streets are extremely congested with pedestrian movement and vehicular traffic and are not adequately designed for walkability with safe pedestrian crossings, vehicular separation etc. Accessibility to transit and multimodal connectivity is not easy, convenient or comfortable.

The Dadar station in Mumbai and the Race Course Road station in Delhi provide some walkability and safe pedestrian crossings, vehicular separation etc. Accessibility to transit and multimodal connectivity is easy and convenient at the Dadar station because the Dadar station is an interchange station for local rail. However, the accessibility can be made more comfortable.

Accessibility to transit at the Race Course Road station can be improved and made more pedestrian friendly.

Both the Chawri Bazaar station in Delhi and Dadar station in Mumbai lack pedestrian spaces, do not have placemaking opportunities, lack open spaces, parks etc. and do not provide pleasurable walking opportunities.

The Chawri Bazaar station in Delhi and the Dadar station in Mumbai have a 24X7 environment due to the mixed use nature of the existing uses.

The Race Course Road station has adequate open spaces, parks etc. to create placemaking opportunites and pleasurable walking opportunities. However, the density of land uses is not sufficient to create a 24X7 environment.

The Churchgate station has adequate walkability and safe pedestrian crossings, vehicular separation etc. but it can be improved to create a safe pedestrian environment. Accessibility to transit and multimodal connectivity is easy and convenient but it can be made more comfortable. There are some open spaces, parks etc. that can be utilized to create placemaking opportunities and pleasurable walking opportunities. There is a 24X7 environment due to the mixed use nature of the existing uses.

The main differences between the areas around transit stations and stops in USA, UK, Asia and the transit stations in India are:

Transit Stations & Stops in USA, UK, Asia	Transit Stations in India
Walkability and access to transit is safe, convenient and comfortable due to a walkable street network in the vicinity of the stations and multimodal connectivity	Although there are existing street networks, walkability and access to transit is not safe, convenient and comfortable and multimodal connectivity is lacking or needs improvement
24X7 environment created by placemaking components like parks, seating areas and a pleasurable walking experience	24X7 environment created by existing diverse uses but placemaking components like parks, seating areas and a pleasurable walking experience is lacking
Land use density varies but is adequate to generate transit ridership	Land use density varies and may be adequate to generate transit ridership
Transit ridership is adequate and continues to be enhanced with greater connectivity	Lack of accessibility to transit and multimodal connectivity may be detrimental to the potential of generating ridership
Even though some of the stations have predominantly residential uses, the transit network provides connectivity to commercial and employment areas and ensures ridership	Most of the stations have mixed uses and the transit network provides connectivity to commercial and employment areas
Although all the transit station areas do not have mixed income uses, they are accessible to mixed income groups	Most of the stations have mixed income groups and are accessible to mixed income groups

Figure 7. Summary of TOD Analysis for TOD Components

3.2 TOD ANALYSIS FOR TRANSIT ORIENTED STRATEGIES

The main differences between the transit oriented strategies in USA, UK, Asia and India are:

Transit Stations & Stops in USA, UK, Asia	Transit Stations in India
Most of the transit systems were introduced as a solution to the road congestion problem caused by growth of population and automobiles and limited land availability	Most of the transit systems were introduced as a solution to the road congestion problem caused by growth of population and automobiles in the recent years and limited road capacity
Transit Oriented policies have been developed and enhanced for a number of years to constantly improve transit ridership	Transit oriented policies are fairly new and were developed after the introduction of the metro or transit oriented strategies and/or are just being introduced
Maximizing opportunities for channeling new development to transit rich areas has been a major strategy	Intensification of development along transit corridors and the introduction of an overall TOD Influence Zone for dense development along transit corridors are just being introduced
Public Transport oriented approach by integrating land use and transport planning for compact and efficient urban development has been a major strategy	Adequate accessibility and connectivity for safe and sustainable transportation systems and strategies for appropriate land uses and land use densification are just being introduced
Planning and investing in infrastructure ahead of time for future population growth has been a major strategy	Investment in critical transportation infrastructure projects and high density, mixed-use and compact development concepts are just being introduced
Planning for a maximum commute time is a major strategy	Policies for compact development and multimodal connectivity to reduce commute times are just being introduced
Policies for enhancing the existing safe, convenient and comfortable accessibility to transit stations has been a major strategy	Traffic and pedestrian safety management and parking management strategies are just being introduced

Figure 8. TOD Analysis for Transit Oriented Strategies

Summary of TOD Analysis for Transit Oriented Strategies

The transit oriented strategies in USA, UK and Asia have focused on catalyzing development along transit oriented corridors. The strategies have been implemented on an ongoing basis and specific targets have been introduced for enhancing development along transit corridors and enhancing transit accessibility and ridership. Since rapid transit is a new phenomenon in Indian cities, strategies for densification of development along transit corridors, encouraging compact development and enhancing transit accessibility and ridership are just being introduced.

3.3 CASE STUDY – BANGALORE METRO TOD ANALYSIS

Bangalore is located in South India in the state of Karnataka. Bangalore is the administrative, industrial and cultural capital of the state of Karnataka. It has been recently renamed "Bengaluru".

A mass rail transit system (MRTS) was conceived for the City of Bangalore in 2003 and the first stretch of the transit system started operating in 2011. Bangalore Metro Rail Corporation Ltd (BMRCL), a joint venture of Government of India and Government of Karnataka is a Special Purpose Vehicle entrusted with the responsibility of implementation of Bangalore Metro Rail Project. The Bangalore Metro was christened as "Namma Metro".

With the introduction of Metro, the modal split in favor of public transport is assumed to 70% by 2021 assuming a growth rate for the city traffic as 3% for the horizon years. The projections for the number of passengers expected to travel by metro for the year 2021 is 16.1 lakhs per day. Estimation of traffic demand on the two corridors was done based on primary surveys (DMRCL, 2003 & http://www.bmrc.co.in).

The Zoning Regulations for Bangalore state that the areas which fall within 150 m radius from the metro terminals shall be eligible for a maximum FAR of 4 for all permissible uses, irrespective of the FAR applicable for the respective uses in the respective tables. However, this will be applied only after the completion of the metro stations and also the same to be confirmed by the BMRCL. Till such time the existing regulations shall apply. TDR (Transfer of Development Rights) may be permitted till the completion of the Metro stations and not after that. However, FAR shall not exceed 4 in any case (Bangalore Master Plan 2015, Land Use Zonal Regulations, BDA).

An analysis of the population density data and an analysis of the areas around the Bangalore Metro were done to determine the strategies needed to promote ridership and additional density around the newly introduced metro in Bangalore.

Year	Population	Percentage%
1951	780000	91
1961	1207000	55
1971	1654000	37
1981	2930000	77
1991	4130000	41
2001	5101000	24
2011	8426000	65
2025	9845000	17
2030	10880000	11
2050	15000000	38

Figure 9. Population Growth Table (Source: Census of India, 2011 & Demographia, 2010)

Land Use	1983	1990	2003	2011	2013
Total excluding agricultural, open space, green belt and vacant land	202 sq.kms	284 sq.kms	421.41 sq.kms	564.63 sq.kms	Not determined
Total Population	2.93 million	4.13 million	6 million	8.42 million	9.58 million
Total Metropolitan Area	NA	NA	NA	NA	1,307 sq.kms
Overall Density	NA		NA	NA	7,329/sq.km

(Bangalore Master Plan 2015- Vision Document & Census India 2011)
Figure 10. Density, Population

	2003	2011	2013
Residential Land Use	159.76 sq.kms (37.91% of total)	243.69 sq.kms (43.16% of total)	Not determined
Residential Use Density	37,556/sq.km or 150/acre	34,552/sq.km or 138/acre	Not determined

(Bangalore Master Plan 2015- Vision Document & Census India 2011)
Figure 11. Residential Density

The city's population stands at 9.58 million as of now (Source: Provisional Census 2011 Data released in 2013). Bangalore Metropolitan Area is 1307 sq.km consisting of the areas covered by the Bruhat Bangalore Mahanagar Palike, surrounding villages and the Bangalore-Mysore Infrastructure Corridor Project Area (Bangalore Master Plan- 2015, Vision Document). According to Census India 2011 data, the projected population for 2025 is 9.8 million. **The current population has already reached the 2025 projected population levels (almost)**. The 500 m influence area around the Bangalore Metro, Phase I covers approximately 13% of the area of Bangalore and most of the important commercial areas including the city center are within this zone (Sekar and Karuppannan, 2012).

The current overall population density of Bangalore is similar to the population density of Singapore and Hong Kong. The projected ridership for 2021 is 16.1 lakhs per day which is approximately 17% of the projected population. The projected ridership percentage is similar to the ridership percentage of the London Metropolitan area.

Findings of an Existing Conditions Survey of the 150 m influence zone around the Srirampura Metro station in Bangalore are as follows:

- Approximately 5-6 acres
- Residential uses comprise 60% of the land uses around the station
- FAR for residential uses is 1.75 and FAR for commercial is 2.5
- A total of 122 households with a population of 1,550 (approximate) and a residential density of 250/acre

The Srirampura Metro Station Existing Conditions survey also indicates limited opportunities for additional development and density.
(Survey by CiSTUP, Bangalore)

A recent study on transit oriented performance for the Bangalore Metro (Nagaraj, 2013) includes the following findings:

- Although the Bangalore Master Plan 2015 recommends higher FARs, the higher FARs cannot be achieved due to requirements for lot sizes and abutting road widths. It will be very difficult to achieve the maximum development potential around the metro stations. Therefore, only the lower FARs may be achieved for a major portion of the area around the metro stations.
- A major portion of the existing uses may already use up the lower FARs.
- Densification around the metro stations may occur incrementally and over a number of years or may not occur at all.
- The opportunities for road widening are limited

- As indicated in the Bangalore Master Plan 2015, the city of Bangalore has diverse neighborhoods with various types of densities and land uses. Therefore, a uniform FAR or connectivity design may not work for all the station areas.

The study recommends the following:

- The design principles for creating and encouraging transit oriented development around metro stations in Bangalore will have to be customized for the existing areas that the metro will serve.
- Since the areas around the metro stations are diverse in nature, detailed station area plans that incorporates the intent of the above TOD design elements must be developed for each station.
- The plans must include recommendations for land use and transportation connectivity and must serve as an integrated land use and transport station area plan (Nagaraj, 2013)

Since the 500 m influence zone of the Phase I Metro only occupies only 13% of the total area of Bangalore, TOD strategies must be developed to channel new development along the metro and incentives must be provided for additional densification and development along the Metro corridor to promote ridership.

Conclusions of the TOD analysis for the Indian context have been developed based on this case study and the above analysis for Delhi and Mumbai.

3.4 CONCLUSIONS OF TOD ANALYSIS FOR THE INDIAN CONTEXT

The TOD analysis concluded that at least some or all of the TOD components, Design, Density and Diversity exists in the areas around the transit stations. A mix of uses, mix of income and a 24-hour environment are created by the mix of uses, a network of streets and population density in the areas around some or all of the transit stations.
Therefore, the density and diversity components of TOD are already existing because the transit systems are being introduced in cities with a fairly high population (2 million +) with fairly high population densities.

Each area of the city has diverse land uses and a diverse population mix. The type and size of building blocks and the type and width of streets vary in different parts of the cities. The limited road capacity and the increase in automobiles and population have resulted in congestion, delays and pollution.

Although the population densities around the newly introduced transit systems may be adequate for transit ridership, accessibility to transit and multimodal connectivity is lacking. The proposed strategies recommend densification of development along transit corridors and accessibility to transit but do not recommend strategies to promote ridership for the existing population.

The proposed development standards for densification of development along transit corridors require large block sizes compared to the existing densely developed small blocks. There are existing mature and diverse land uses and densities along the transit stations. The opportunities for road widening are also limited. Therefore, the opportunities for additional densification may vary and in some areas the opportunities will be very limited. Assembly of parcels for adequate block sizes for high density development will take several years. There are no strategies for

providing incentives for parcel assembly. There are no strategies for retaining the existing high densities or for phasing out existing development or for phasing in the high density development.

The strategies do address the issues of investing in critical transportation infrastructure and better traffic and transportation management and parking management. Pedestrian safety and convenience are also addressed.

The strategies do not address immediate and short term solutions for generating transit ridership and moving people away from private vehicles towards the use of public transportation.

Therefore, the proposed strategies may not reduce congestion on an immediate and short term basis. Therefore, the congestion problem will grow as the population grows. The issue of increasing transit ridership on an ongoing basis is also not addressed.

CHAPTER 4 – TRANSIT ORIENTED DEVELOPMENT (TOD) RECOMMENDATIONS FOR THE INDIAN CONTEXT

4.1 OVERALL RECOMMENDATIONS

Some transit stations may be located in dense city centers with vibrant local and regional economies. Others may be in predominately residential areas for providing a convenient means for commuters to travel to and from work and other destinations. Some stations may be located in areas that are experiencing rapid growth and change, while others may be in more established, mature areas where any change will be incremental. Every station area, whether existing or proposed, will face unique challenges and will require strategies specific to the area to create high-performing transit-oriented development (TOD) projects with their own unique character, role and function (http://ctod.org/).

In order to promote transit ridership, the transit oriented strategies must address land use and transportation and short term and long term solutions. The existence of mature and diverse land uses and densities along the transit stations must be recognized and using the existing population around the transit stations to generate ridership must be explored. Enhancing multimodal connectivity to areas not connected by the transit systems should be considered for generating and increasing transit ridership. The design principles for creating and encouraging TOD development around transit stations will have to be customized for the existing areas that the transit will serve. Strategies for providing incentives for parcel assembly must be explored. Strategies for retaining the existing high density development or phasing out existing development and for phasing in the high density development must be explored.

4.2 SPECIFIC RECOMMENDATIONS

The areas around the transit stations must be developed as transportation hubs for the catchment areas around the transit station to provide connectivity within the catchment area and connect other areas in the vicinity that are not connected by the proposed transit systems.

The proposed transit oriented policies must encourage the activities of the surrounding areas that could range from being an economic hub, residential neighborhood, industrial area, information technology area, business district, institutional area or parks and recreation.

The main aim of the transit oriented policies must be to minimize private vehicle dependency and promote public transit ridership in the areas around the metro stations.

The goals of the transit oriented policies must be to:

- develop the desired land use density and mix for that specific transit station that promote transit ridership and enhances the activities of the surrounding area
- provide the appropriate transportation connectivity to the catchment areas
- achieve the daily boarding targets for that specific transit
- achieve the overall projected ridership and modal shift for the transit system
- address commuter preferences to make public transit comfortable, time saving, economic, accessible, reliable and safe
- provide appropriate traffic management practices like congestion pricing and parking management practices like parking fees, no parking zones etc.

- encourage nonmotorized transportation (bicycle) use and walking
- encourage the use of nonmotorized para transit

The TOD design principles must be incorporated as appropriate to the transit station area to provide some or all of the following for achieving the above goals:

- Pedestrian and non-motorized transport (bicycle) friendly environment for multimodal interchange and street connectivity
- Efficient Public and Para-transport System (motorized and non-motorized) supporting the transit system
- Placemaking and Parking Management
- Traffic Management
- Land use and appropriate land use intensities
- Block size, street grid, density etc. suitable to the transit station area and surrounding areas
- Walkability and paratransit influence zones suitable to the transit station area and surrounding areas
- Phasing plan for new development
- Incentives for parcel assembly
- Retaining existing uses
- Enhancing the use of the limited roads for walkability
- Promoting public transit ridership for the existing uses

The following general strategies for encouraging public transit ridership must be used on an ongoing basis to achieve the above goals are:

- Encouraging businesses to provide shuttle buses to the transit stations from the catchment and develop teleworking, flex time schedules and subsidizing transit fares for employees within the station area
- Educating the community regarding the benefits of public transit
- Improving transit facilities according to commuter preferences
- Incorporating seamless travel and multimodal integration with Intellegent Transport Systems (ITS), smart cards etc.
- Integrating paratransit travel into the seamless travel and multimodal integration and/or providing prepaid facilities for paratransit
- Encouraging nonmotorized paratransit (cycle rickshaws etc. for shorter distance travel)
- Using smaller buses with less seating capacity for providing the last mile connectivity in residential areas and in the central core of the city
- Including sustainability strategies like rain water conservation, waste management, energy conservation, waste water reuse etc. for the existing and proposed land uses
- Including strategies for emergency management and disaster management
- Developing efficient feeder routes for serving the catchment areas and areas not served by transit

The proposed policies must include appropriate implementation and enforcement strategies and specific short term and long term targets to be met.

Once the transit oriented policies are developed, implemented and enforced, the involved agencies must continue to promote public transit ridership and minimize private vehicle dependency on an ongoing basis. New strategies must be developed on an ongoing basis to ensure commuter satisfaction.

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APPENDIX