TOD KP

CASE STUDIES

COMPILATION OF GOOD AND INNOVATIVE PRACTICES

TOD
Global Platform for Sustainable Cities
WORLD BANK GROUP
IBI

LEVEL 1 SCREENING

A comprehensive list of cities from low-middle income countries were shortlisted as potential candidates for case studies. This list of case studies was derived from:

- Case studies already included in World Bank publications/ workshops and presentations
- Part of GPSC/ World Bank-identified city TOD list
- Representative of the TOD framework as well as geographic distribution:
  - Scale- City/ Corridor/ Station
  - Context- Urban/ Suburban/ Greenfield
  - Mode of higher order transit- BRT/ MRT/ Heavy Rail
  - Size of city- Large and medium-sized cities (Tier 1 and Tier 2)

LIST OF BEST PRACTICE CITIES		
	1.	Mexico City, Mexico
	2.	Bogota, Colombia
	3.	Lima, Peru
	4.	Recife, Brazil
	5.	Curitiba, Brazil
	6.	Mumbai, India
	7.	Delhi, India
	8.	Hubli-Dharwad, India
	9.	Nanchang, China
	10.	Shenzhen, China
	11.	Guangzhou, China
	12.	Shijiazhuang, China
	13.	Tianjin, China
	14.	Hong Kong SAR, China
	15.	Ho Choi Minh City, Vietnam
	16.	Hue, Vietnam
	17.	Kuala Lumpur, Malaysia
	18.	Jakarta, Indonesia
	19.	Addis Ababa, Ethiopia
	20.	Dakar, Senegal
	21.	Abidjan, Africa
	22.	Johannesburg, South Africa
	23.	Cape Town, South Africa
	24.	Santiago, Chile
	25.	Dar es Salaam, Tanzania

LEVEL 2 SCREENING

The following table provides the updated list of relevant case studies based on World Bank's input, case studies recommended by experts and peer-reviewers, WRI/ITDP and IBI projects that explain good practices and innovative strategies from countries at low to medium income levels. The intent is also not to duplicate existing case studies already compiled by World Bank. E.g. Kings Cross TOD, London, UK.

Relevance of the Case Study to the Scale and Development context is also provided along with relevance to specific knowledge product(s). Key criteria for selection were based on the following factors:

- Is there policy-level support for promoting TOD at one or more governmental levels- central, state, local?
- Has TOD been applied at more than one scale- City/ Corridor/ Local (neighborhood)/ Station?
- Are there any TOD projects at the station scale implemented (operational/ under construction/ tendered/ development agreement in-place)?
- Does the city/ example represent a case where the conventional planning paradigm was challenged to implement TODs (e.g. land banking, land readjustment, PPPs).

COMPLETE LIST OF CITIES EVALUATED FOR LEVEL 2 SCREENING & RECOMMENDED CITIES FOR CASE STUDIES:	
South Asia	1. Delhi, India
	2. Hubli-Dharwad, India
Asia	4. Hong Kong SAR, China
	5. Shenzhen, China
	6. Guangzhou, China
	7. Seoul, Republic of Korea
America	7. Mexico City, Mexico
	8. Santiago, Chile
Africa	9. Cape Town, South Africa
	10. Johannesburg, South Africa

Disclaimer: *The Transit-Orientated Development Implementation Resources & Tools knowledge product is designed to provide a high-level framework for the implementation of TOD and offer direction to cities in addressing barriers at all stages. As the context in low and middle-income cities varies, the application of the knowledge product must be adapted to local needs and priorities, and customized on a case-by-case basis.*

SOUTH ASIA | CASE STUDY

DELHI. INDIA

Source: Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC) 2018 ©UTTIPEC. Reproduced with permission from UTTIPEC; further permission required for reuse.

DELHI, INDIA

QUICK FACTS

Geographic Context
South Asia (India) – National Capital Region, India

Scale
City, Corridor, Neighbourhood, Station

Context
Urban, Suburban, Greenfield

Mode of Higher Order Transit
Metro (Delhi Metro Rail Corporation)

Size of City (Population)
16.7 million (Tier-1)

Case Study Covered in WB Publication
No

URBAN CONTEXT

The National Capital Territory (NCT) of Delhi is the fastest growing city-region and the second most populous urban area in India. The metropolitan region spans a collection of cities and suburban settlements across the three states of Delhi, Uttar Pradesh, and Haryana. In 20 years between 1991 and 2011, the city region has grown in size from 685 to 1114 sq km, and grown in population from 8.7 to 16.3 million. The steep rise in population can be contributed primarily to migration from smaller towns and villages from across the country attracted by growing job opportunities in new developments in the outskirts of the city. This growth of working-class households was supported significantly by the first-of-its-kind metro system network developed by the Delhi Metro Rail Corporation (DMRC) in 2002. An average of 2.6 million commuters use the metro daily[1].

Much of Delhi's growth is observed along the outskirts of the city in areas like Gurgaon, Noida, Ghaziabad and East Delhi. The city at large exhibits large block sizes, low densities, segregated land uses etc. which reflects vehicle-centric planning. This has not only had catastrophic effects on the air quality of the city but has also resulted in congestion that can now essentially be described as a gridlock. In response, the DMRC began construction of the metro network in 2002. By 2018, until the writing of this study, DMRC has built over 8 lines spanning 332 km. The metro network has brought huge relief to the average commuting population. However, the sprawled nature of Delhi has made it difficult for the metro to expand its accessibility as effectively. In 2006, the National Urban Transport Policy was launched, which emphasized the importance of public transport and the need for Transit-oriented Development to leverage this investment. The Unified Traffic and Transportation Infrastructure Planning & Engineering Center (UTTIPEC), formulated to envision a unified and integrated mobility outlook for the entire region, identified a need for Transit-oriented Development (TOD) to accompany metro development in the city-region and began creating the TOD Draft guidelines in 2008.

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OVERALL TOD STRATEGY

The Delhi Metro Rail Corporation (DMRC) was jointly set up by the Government of India and Government of Delhi in 1995. The construction of the network was planned in 4 phases[5].

Phase I: A total of 65km of rail with 58 stations was planned for Phase I. Initial rail development was constrained within the Delhi limits and stations were built and opened between sDecember 2002 and November 2006.

Phase II: A total of 124.63 km long network with 85 stations and 10 new routes and extensions were built, out of which seven are an of the Phase I network. Color-coded lines and lines connecting to adjacent cities were created (Yellow Line to Gurgaon, Blue Line to Noida and Blue Line to Ghaziabad). These stretched from the national capital region, outside the physical limits of Delhi state, to the states of Haryana and Uttar Pradesh. At the end of Phases I and II, the cumulative total length of the network became 189.63km, including 143 stations over time. Operation of the network initiated between June 2008 to August 2011.

Phase-III: Consisted of 11 extensions to the existing lines and two additional ring lines (Pink and Magenta lines). This expansion included 28 underground stations and a total of 167.27km.

Phase IV: is expected to be complete in 2021 which totals to 100km.

The TOD Policy in Delhi was framed within the Influence Zone along MRTS corridor, designated as the **Transit-oriented Development (TOD) Zone** in the Master Plan for Delhi 2021, modified with the latest revisions in 2017. This zone comprises of all the areas lying within 500m of the metro transit corridor on either side. This area is expected to be delineated in the Zonal Development Plans to avoid ambiguity. The Master Plan incorporates TOD as a redevelopment strategy, encouraging private landowners to assemble and redevelop lands that have high TOD potential[2].

Figure 1: TOD Influence Zone Delineation | *Source*: Delhi TOD Policy Manual, 2007 ©Delhi Development Authority.

The Transit-oriented Development Principles adopted by the TOD Policy to guide the framing of regulations include:

1. Pedestrian and Non-Motorized Transport Friendly Environment
2. Connectivity and Network Density
3. Multi-modal Interchange
4. Inducing Modal Shift by easing access to public transport and dis-incentivizing private motor vehicle use.
5. Placemaking and Ensuring Safety
6. High-Density, mixed-use, mixed-income development near Stations

INFRASTRUCTURE PROVISION FOR DENSITY

The Master Plan of Delhi 2021 suggests requirements for decentralized infrastructure and resource conservation facilities, specifically including:

- Recycling of treated wastewater with a dual piping system
- Groundwater recharge through rainwater harvesting, conservation of water bodies and regulating groundwater extraction
- Treatment of sewage effluent for recycling for non-potable uses such as gardening.
- Passive cooling systems to ensure energy efficiency
- Solar heating systems are recommended on all plots for roofs of 300sqm or above.
- Incentive FAR and ground coverage is offered for implementation of the above.

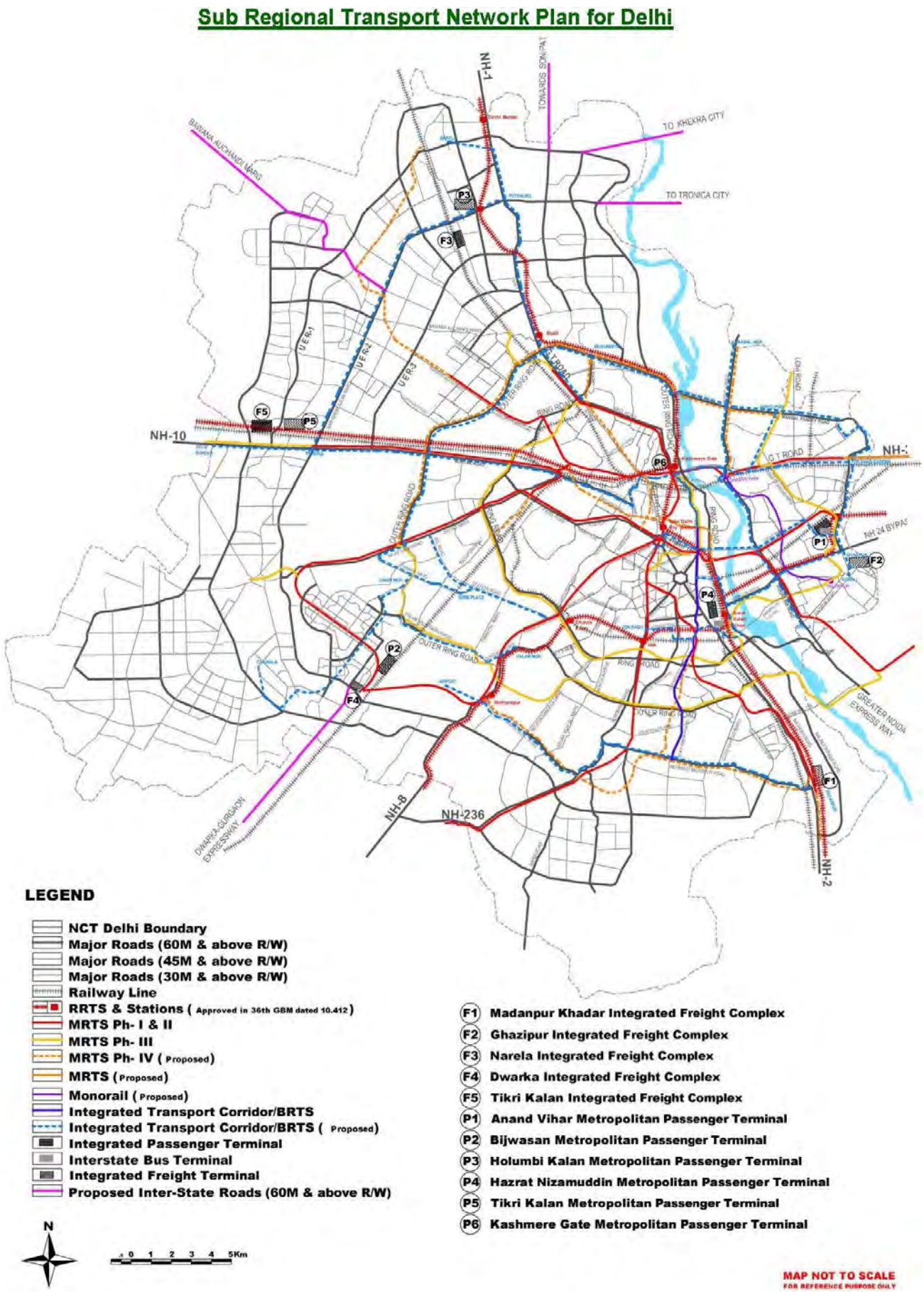

Figure 3: Delhi MRTS and Transport Corridors | *Source*: Master Plan of Delhi 2021, 2007 ©Delhi Development Authority.

KEY ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

The stakeholders involved in implementation of the Delhi TOD Policy include primarily the Delhi Development Authority (DDA), whose responsibility it is to evaluate TOD schemes and give development permissions; Competent Authority (CA) instituted under the respective State Acts, whose responsibility it is to acquire public amenity land and issue development permissions; and the Developer Entity (DE), who undertakes to participate in the TOD scheme. The roles and responsibilities of each entity during the development permitting process is shown below:

Figure 4: TOD Roles and Responsibilities Scheme | *Source*: Delhi TOD Policy Manual, 2007 ©Delhi Development Authority.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

The TOD Policy Manual suggests design strategies for TOD that govern the Development Control Regulations incorporated in the Master Plan of Delhi 2021. The Development Control Norms include the following strategies for land parcels measuring 1 HA or more[3]:

- **FAR and Density**: Higher densities are allowed for all developments that are planned on individual or amalgamated land parcels of size of 1HA or more. A minimum mandatory Floor Area Ratio (FAR) is imposed for housing for the economically weaker section. This norm is intended to encourage land pooling as a redevelopment strategy in the TOD influence zones. Larger land parcels allow DDA to extract land for public use including open spaces and transit plazas.
- **Mix of Uses**: Minimum 30% residential use, 10% commercial use, and 10% public amenities are compulsorily required on all land parcels irrespective of their dominant land use as per the Master Plan. Within the minimum residential area requirement, the Master Plan mandates housing units to be of smaller sizes. This is intended to encourage economic diversity within transit influence zones. Smaller unit sizes allow buyers the flexibility of purchasing small units in case of budget limitations and purchasing multiple units and combining them in case of larger family sizes. However, in practice, this requirement has been the most difficult to meet, because it increases the planned density of the development substantially. This, in turn, increases the infrastructural and parking requirement for the development.
- **Road Network**: A minimum 20% of the land is required to be reserved for roads, adhering to principles of 250m c/c road density of vehicular roads and 100m c/c density of the pedestrian network. These roads will be handed over to the Government as public roads, but will be maintained and kept encroachment free by the DE.
- **Open Spaces**: A minimum 20% of the land is required to be reserved for green open spaces for public use, adhering to principles of inclusion and another 10% green space for private use. In parcels smaller than 1 HA, private open space is allowable in the form of common terraces, rooftops or podiums.
- **Public Facilities**: Public facilities like schools and health facilities are required to be provided as part of the development.
- **Green Buildings**: The built form of the development is required to achieve a minimum of 3 stars or gold rating as per the Indian Green Building Standards
- **Traffic Impact**: Is expected to be assessed and mitigated through traffic management measures.

In addition to the above norms, the Master Plan also prescribed Street Design Regulations to be followed within the streets planned in a development under the TOD scheme. The street design elements are intended:

- Promote Preferable Public Transport Use
- For Safety of All Road Uses by Design
- For Pedestrian Safety, Comfort and Convenience on All Streets
- For climatic comfort for all Road Users
- To ensure universal accessibility and amenities for all street users
- To reduce Urban Heat Island Effect and Aid Natural Storm Water Management

FINANCIAL MODEL

There is no single financial model that can be identified in Delhi. Some of the expected sources of revenue are through the sale of FSI, external development charges (EDC) and betterment charges.

Extra FSI charges as per the Master Plan are as per standard rates, irrespective of land use/ use premises, to avoid any complications to change the use of FSI in future. This is both an advantage and a disadvantage as the uniform FSI rates for commercial and residential in Delhi, either adversely affect the affordability of residential or there are chances for the government to lose the opportunity to earn from the commercial FSI.

Though the resources of finance (direct collection and land value capture) have been identified, the use of revenue generated from TOD is not ensured through the regulations.

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IMPLEMENTATION STRATEGIES

TIMELINE:

- **1991-** Region was 685 sq km with a population of 8.7 million
- **1995-** DMRC was jointly set up by the Government of India and Government of Delhi
- **2002-** Began construction on first metro network by Delhi Metro Rail Corporation (DMRC)
- **December 2002-** Phase 1 starts
- **2006-** National Urban Transportation Policy was launched
- **November 2006-** Phase 1 competes
- **2008-** UTTIPEC began creating the TOD Draft Guidelines
- **June 2008-** Phase 2 begins
- **2011-** Region was 1,114 sq km with a population of 16.3 million
- **August 2011-** Phase 2 completes
- **2017-** Modified and revised Master plan for Delhi 2021
- **2018-** DMRC metro network has 8 lines spanning 332km
- **2021-** Phase 4 expected completion

ACTIONABLE STEPS

The TOD Policy Framework has been tested in different models of TOD pilots in Delhi, the most well-known being the Karkadooma station in East Delhi. The proposed site of the pilot TOD project of Karkadooma lies within Zone- E of the Zonal Development Plan, the land use of which is residential. More than 70% of the site falls within the 500m influence zone of two metro stations at Karkadooma, therefore the norms for 'Influence Zone' shall be applicable. The figure below illustrates three conceptual designs that follow the TOD norms[4].

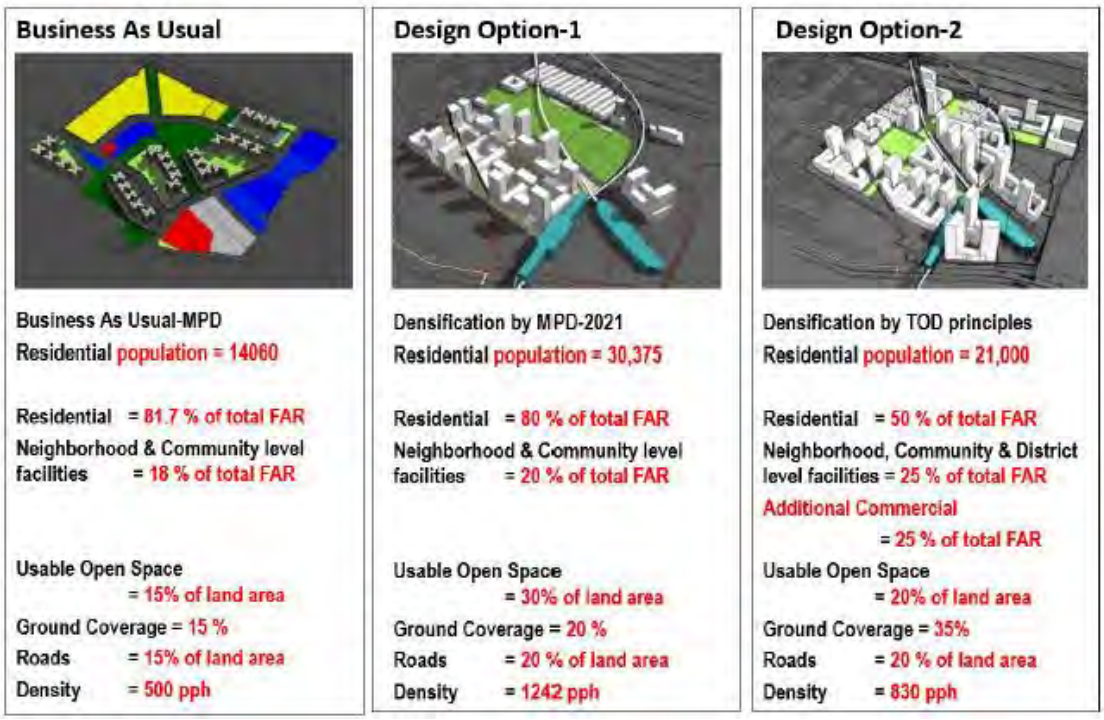


Figure 5: TOD Design Options | *Source:* Delhi TOD Policy Manual, 2007 ©Delhi Development Authority.

Design option two was favored during the stakeholder consultation process which was conducted to prioritize civic amenities.

The stakeholders consisted of resident welfare associations, trade associations, NGOs and civic society institutions, schools and local ward counselors.

KEY LESSONS

The following key takeaways should be derived from the Delhi example:

- The TOD policy in Delhi prescribes strict norms to follow and is, therefore, a comprehensive approach to planning TOD.
- Delhi is trying to provide affordable housing in TOD but with the strict percentage, it can restrict the market to participate.
- With regards to parking, Delhi is adopting a one-size fits-all approach even with various TOD typologies: city center TOD, suburban TOD, commercial TOD, Residential TOD.
- Even though Delhi has stringent TOD policies and urban design guidelines, there is still a lack of clarity in terms of the implementation process.

REFERENCE

1. Delhi Metro Rail Corporation Ltd. 2018. "Delhi Metro Interchange Stations Increase to 16, Ridership Registering Steady Growth." http://www.delhimetrorail.com/press_reldetails.aspx?id=bhc0DzbE6tklld
2. Mehta, Prerna V., Neha Mungekar, and Merlyn Matthew. 2016. "Transit Oriented Development Manual – Delhi TOD Policy and Regulations Interpretation." *World Resources Institute*. http://wricitieshub.org/publications/transit-oriented-development-manual-delhi-tod-policy-regulations-interpretation
3. Delhi Development Authority. 2007. "Master Plan for Delhi - 2021." *Ministry of Urban Development.* https://dda.org.in/ddanew/pdf/Planning/reprint%20mpd2021.pdf
4. Uttarwar, P.S., and Paromita Roy. 2015. "Transit Oriented Development (TOD) Policy - East Delhi Hub - Kadkadooma TOD project." UTTIPEC. http://urbanmobilityindia.in/Upload/Conference/ae9770cd-2c9c-4599-80b6-3f0cd3a83bfe.pdf
5. Transit Oriented Development for Indian Smart Cities. 2016. "Case Studies." *National Institute of Urban Affairs (NIUA) and Foreign & Commonwealth Office, Government of UK.* https://tod.niua.org/todfisc/book.php?book=1&section=4

SOUTH ASIA | CASE STUDY

HUBLI DHARWAD, INDIA

Source: Hubli-Dharwad BRTS Company Ltd 2016. ©HDBRTS. Reproduced with permission from HDBRTS; further permission required for reuse.

HUBLI DHARWAD, INDIA

QUICK FACTS

Geographic Context
South Asia (India) – Karnataka, India

Scale
Regional, Corridor

Context
Urban, Suburban, Greenfield

Mode of Higher Order Transit
Bus Rapid Transit System (Hubli Dharwad BRTS Company Ltd.)

Size of City (Population)
0.97 million (Tier-2)

Case Study Covered in WB Publication
No

CITY SUMMARY

Hubli and Dharwad are twin cities in the state of Karnataka and located at a distance of around 20km from each other. Hubli-Dharwad is the oldest city in Karnataka state with strong cultural and historical importance and is also the second-largest urban settlement in Karnataka after Bengaluru. While Dharwad is the district headquarters and Hubli is the business hub.

According to Census 2011, the city had a population of 9.43 lakhs. HDMC's population accounts for 4% of the urban population of the state and 90% of the urban population of the district. The population density in Hubli-Dharwad has been on an increase during the past three decades. The density increased from 1,837 persons per sq. km in 1971 to 4,292 persons per sq. km in 2011. However, the area of the corporation remained the same.

There is a steady and high volume of passenger traffic between the twin cities. Currently, this demand is catered by the NWKRTC through a bus-based system and private vehicles. Though buses account for only 7-11% of total traffic flow on the road between Hubli and Dharwad, they carry about 70-80% of people. A BRTS has been conceived along the P.B. road between Hubli and Dharwad, in order to meet the increased demand for ridership.

URBAN CONTEXT

The urban character of both Hubli and Dharwad cities is found to be complex, and the old city areas in both cities have been retained their original and traditional character. They are acting as religious nodes and are with narrow streets and inefficient infrastructure services. However, in other areas, due to the availability of services, cultural attractions, proximity to city core has always been under constant development pressure and resulted in over densification. While fringe areas are exhibiting a different development pattern which is comparatively organized growth pattern. Both cities exhibit medium density with medium-rise buildings with average 3-4 storeys.

As per the Karnataka Town and Country Planning Act, 1961, the Hubli-Dharwad Urban Development Authority (HDUDA) was constituted in the year 1987 for undertaking the responsibility of physical planning, and its jurisdiction includes the HDMC area and about 10 km area beyond HDMC, to include villages that could eventually become part of the urban area in future[1].

- Disjointed City Form: Hubli Dharwad grew organically as two different cities, which were amalgamated in 1964 into a single municipal corporation. Even though their economies are interdependent, structurally these cities have remained disjointed connected only by the present-day BRT corridor. Most development between the 2 cities is sprawling in

nature, which physically divides the 2 cities and forces intense urban development outwards and away from the primary corridor.

- Urban Sprawl: Availability of large tracts of land with urbanizing potential and very little demand has led to proliferating urban sprawl. Sprawl poses a threat to the forested and agricultural lands around the city cores.

Hubli-Dharwad today stands on the brink of a reformation in urban development. There the Spatial Development Framework created as a guide for the City Development Framework (2030), seeks to address five major issues in Hubli-Dharwad's spatial and social landscape[1]:

- Lack of spatial vision for the cohesive development of the city
- Urban sprawl and fragmentation
- Increasing pressure on the natural environment infrastructure
- Spatial inequalities and the jobs-housing mismatch
- Exclusion and disconnection emanating from
- High potential underused areas
- Disconnected street networks
- Inefficient residential densities and land use diversity

The strategies towards setting the TOD framework and the implementation strategies have been adopted from the Hubli Dharwad 2030 City Development Framework. They have been summarized below.

OVERALL TOD STRATEGY

Hubli-Dharwad area is currently undergoing rapid population growth. The proposed BRT will further fuel this growth. To cope with this, transit-oriented development is proposed along the corridor. This BRT system will minimize sprawl and will serve as a ready to use commuter system for the additional population. Also, the proposed revision of the comprehensive development plan (CDP) for Hubli Dharwad in 2015 is an opportunity to incorporate the TOD principles. Incorporating TOD into the development plan will help in delivering efficient, comfortable and affordable mobility options to its citizens. The urban cores of Hubli and Dharwad are 22km apart which is one of the primary factors defining the spatial growth pattern of the twin-city region.

Hubli-Dharwad has a road network which is dense but with constrained right-of-ways in the city cores. The two city cores are connected by PB Road, the only arterial road in the twin cities, which was also formerly a national highway. National Highway, radiating from Hubli center, including NH4, which is recently developed to bypass the traffic passing through these city cores. The constraints in road ROWs in the employment centers limits densification potential and results in congestion.

The spatial vision envisaged by the CDF 2030 is a compact polycentric city with dense urban cores linked by efficient public transport networks to mixed-use, complementary sub-centers, situated within a protected and integrated natural environment[1]. Development triggers in the area are ongoing projects like the widening of P.B. road, upcoming Hubli Dharwad BRT, Hubli airport modernization, proposed electrification and doubling of the railway line, inland container depots, goods yard along with improved Mumbai-Chennai road corridor etc. High land values in Hubli and Dharwad have led to haphazard development adjoining PB road and it needs to be streamlined to ensure optimal utilization of the road widening as well as the upcoming Hubli Dharwad BRT[1]. The City Plan (Vision 2030) promotes land use that supports transit. The Development Density Framework suggests a differential density paradigm for the city. It proposes higher densities and FAR allowances for areas with higher amenities and higher accessibility to jobs and city services. Primarily, the framework is defined with the metropolis boundary as the base.

- The Metropolis Boundary - Reimagining the Metropolis Boundary as a potential Urban Growth Boundary (UGB) allows for enforced limitations to new development outside of it. This area measures 220 sq km. However, developing the entire metropolitan area with the same density of development will lead to sprawled development. Accordingly, the next layer of density is defined, a high growth Zone measuring 83 sq km.
- High Growth Zone – Proposed Zone A – This zone includes all high demand and high opportunity areas as well as future strategic areas of growth. Within this zone, larger mix of uses and higher FAR should be proposed to enable compact and mixed-use development. The HDUDA Master Plan already recommends more intensive uses in "Zone A". It is proposed therefore that the High Growth Zone be considered for inclusion in the Master Plan as Zone A. However, unlike the Master Plan, this zone must be allowed higher FARs to accommodate the market demand.

- The final layer of the differential density is the TOD Zone, the areas within walking distance of the new BRT corridor connecting Hubli and Dharwad. TOD Zone - This zone has the advantage of access to a high capacity, high-frequency public transport system, which is expected to catalyze compact, mixed-use, and inclusive development.

The development structure of a city must be imagined in parallel with a transportation network that can support its growth and ensure equitable accessibility at all stages of growth. In addition to the BRT Corridor and the Proposed Bypass Road, a network of priority roads and corridors are identified, that contribute to the spatial strategy of growth.

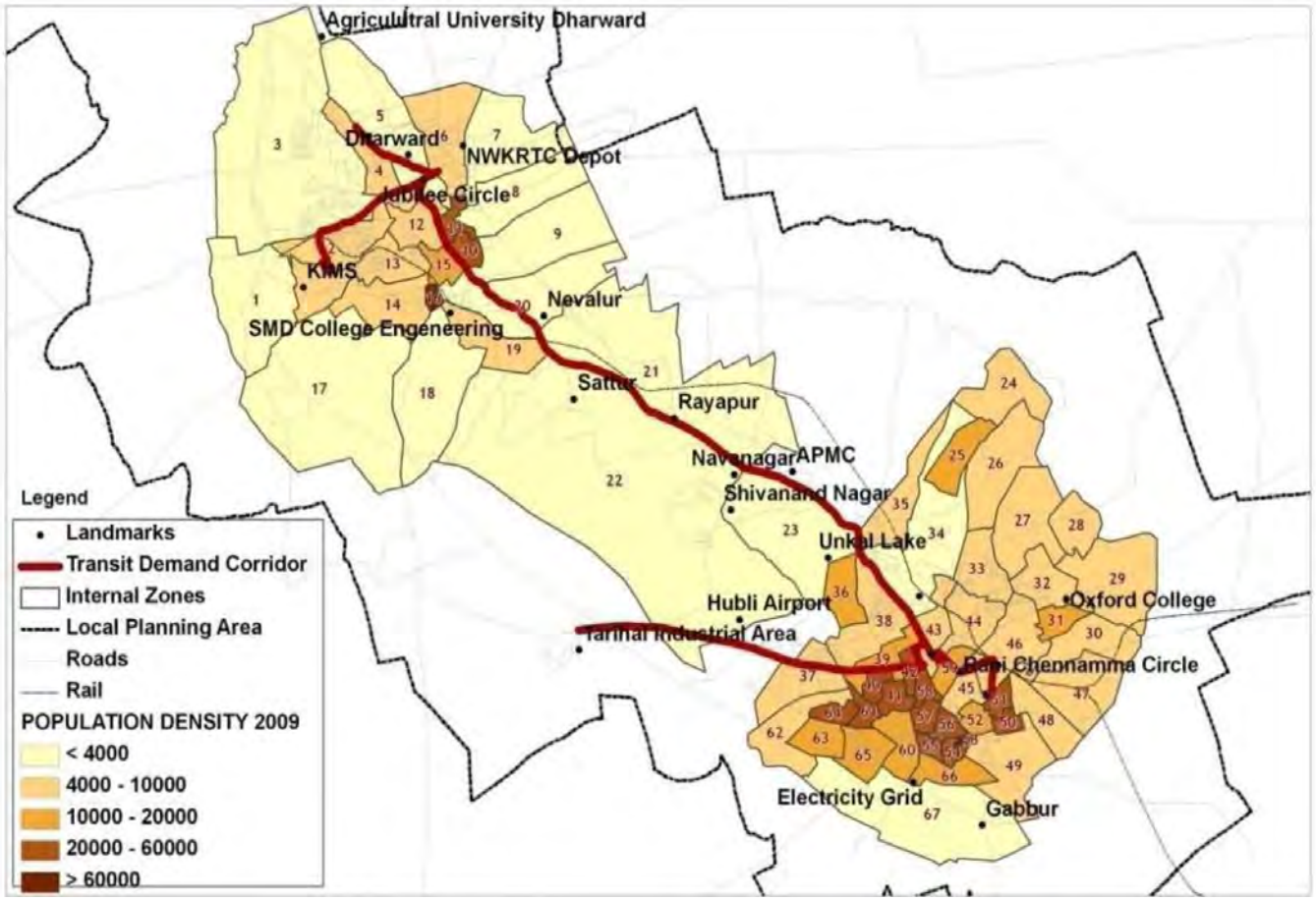


Figure 6: Density Framework for TOD | *Source:* Hubli Dharwad 2030 City Development Framework 2014 ©IBI Consultancy India Pvt Ltd.

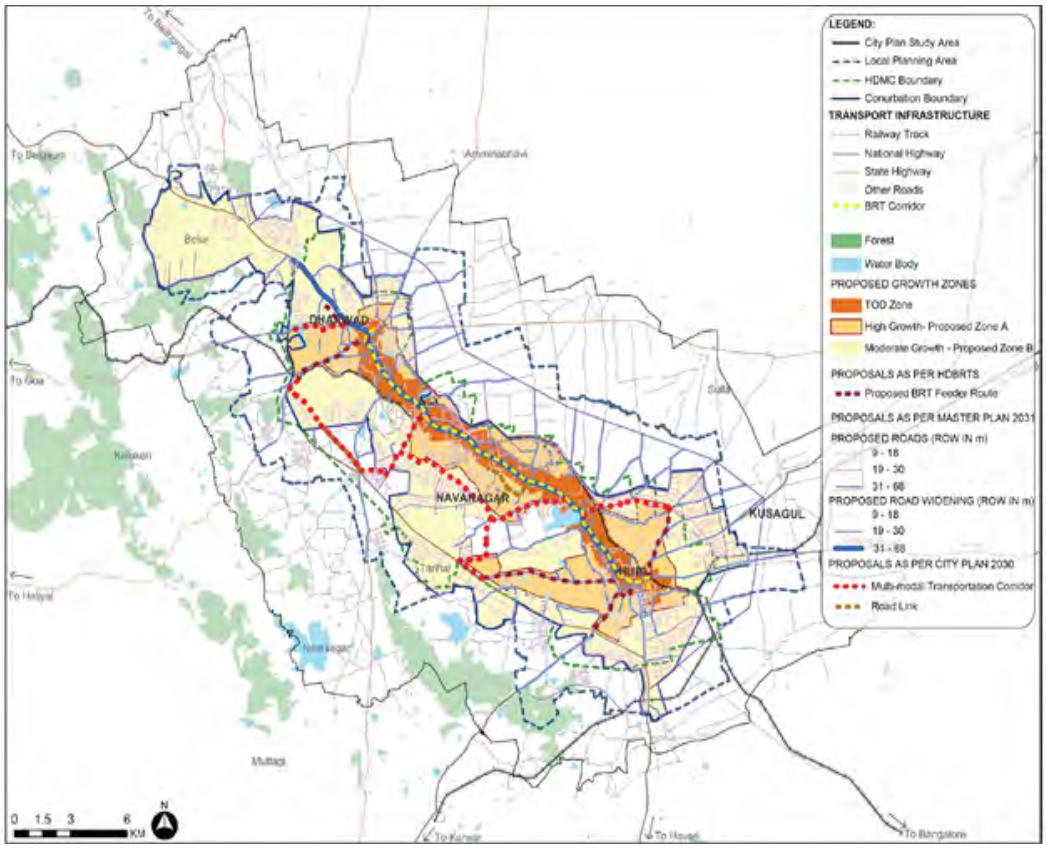


Figure 7: Proposed Transportation Framework as per Master Plan 2031 | Source: Hubli Dharwad 2030 City Development Framework by IBI Consultancy India Pvt Ltd.

KEY ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

The Hubli Dharwad 2030 City Development Framework (CDF), as the first of its kind in India, is set up to prepare Hubli Dharwad for the future by creating a vision and path for the future even before new programs at the State and Central level are introduced[1]. All potential opportunities for funding and financing can be streamlined to achieve the vision set forth in the Framework. Along with providing a larger Vision, the CDF also proposes immediate actions that the city agencies can adopt using existing sources of funds. A break-up of the CDF components and relevant implementation roles is illustrated in the figure below.

The Dharwad District Administration is envisioned as the Authority that will own the first three components of the Framework and be responsible for integration across sectors and jurisdictions. The implementation and monitoring of the Framework shall be within the scope and mandate of sector-specific and jurisdiction-specific agencies. The Primary Vision and Goals and Targets shall be monitored by a City Transformation Cell which in turn shall establish a continuous medium of interaction with the city and rural residents to enable resident inputs to inform the Framework.

While the DA shall be the Nodal Agency for the Spatial Growth Concept and Density Framework, as this will allow an integrated city-rural approach to guide economic growth in the study area, the HDUDA, HDMC, KIADB, and Gram Panchayats will be responsible to implement the proposals for setting up of growth nodes and growth corridors within their jurisdictions.

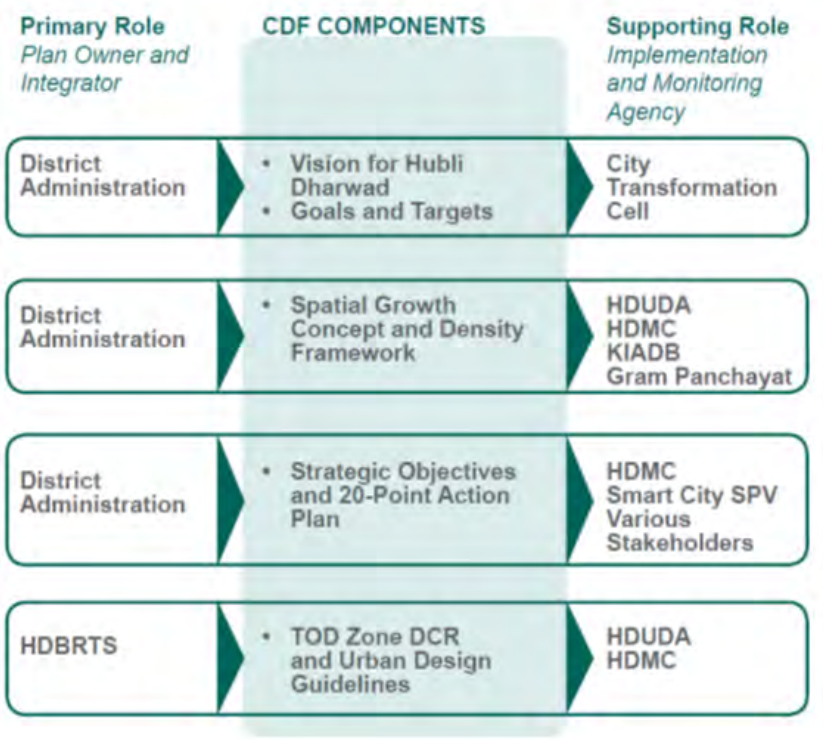


Figure 8: Proposed Transportation Policy Framework | Source: Hubli Dharwad 2030 City Development Framework 2014 ©IBI Consultancy India Pvt Ltd.

STRATEGIES TO ENCOURAGE TRANSIT USE

The HDBRTS, under the aegis of DULT shall be the Primary Nodal Agency for the TOD Zone DCR and Urban Design Guidelines. The HDUDA shall incorporate the TOD Zone DCRs into the Master Plan, while the implementation of the DCRs and Urban Design Guidelines shall be done by a TOD Implementation Committee set up within the HDMC.

OPPORTUNITIES

- Compact city cores connected by a high-capacity BRTS system offers the opportunity to create more well-connected compact cores.
- A large potential for intensification exists in many underutilized areas, without sprawling to natural areas.

FINANCING

TOD Incentives provide an opportunity to earn increased revenues through:

- Sale of Premium FAR
- Increased revenue through property taxes levied on higher built up areas

The revenues earned through the tools listed above shall be shared between the HDBRTS and HDMC as per mutual agreement. This source of revenue shall be used by HDBRTS for operations and maintenance of the BRTS system and shall be used by the HDMC to implement crucial public realm improvements.

IMPLEMENTATION STRATEGIES

The special regulations for Transit-oriented Development are intended to be provided to areas within walking distance of the corridor to incentivize high-density growth that can take advantage of transit and reduce reliance on private vehicles. The HDUDA Provisional Master Plan 2031 identifies a special BRT impact area which is 500m on either side of the BRT corridor and is earmarked as the TOD zone.

The lack of existing market demand in the TOD Zone will make it difficult to attract developments that are high density and mixed use. Hence the Hubli Dharwad city plan proposes the following key strategies[1]:

1. Create Statutory Regulations that encourage compact development – Decreased setback requirements and parking requirements will enable compact development in the TOD Zone. In addition FAR and other incentives should be offered for high density mixed-use developments in the TOD, the follow the urban design guidelines.
2. Institute a Land Taxation Scheme that incentivizes compact development

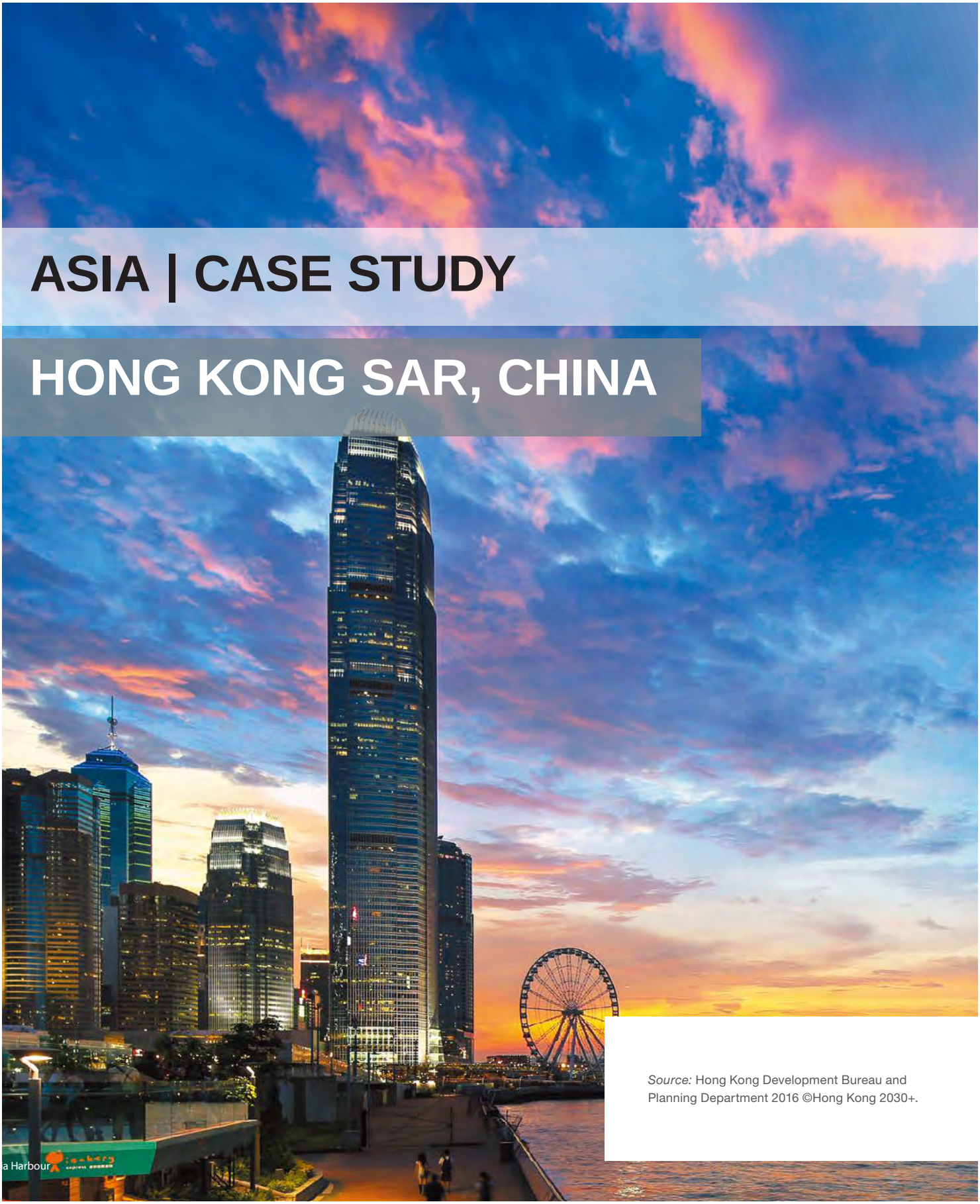
- Vacant Land Tax in High Growth Areas - Vacant land tax is proposed for all land parcels that are left undeveloped for a period of 5 years after implementation of the HDUDA Master Plan 2031 and the special TOD Zone regulations. Vacant Land Tax places a higher emphasis on taxing the land itself rather than on its improvements. This system will intend to incentivize compact development in areas identified for high-intensity growth and discourage land purchase and development in low growth areas.
- Higher Registration Fees in Moderate Growth Areas – high registration fees are proposed to discourage the sale of land in moderate growth areas to discourage speculative buying. Instead, Government authorities should be encouraged to purchase and bank lands near future growth nodes in moderate growth areas.

ENDNOTES

1. Ministry of Urban Development, Government of India and World Bank. 2014. “City Development Plan for Hubli Dharwad, 2041.” Accessed October 12, 2018. http://www.hdmc.mrc.gov.in/sites/hdmc.mrc.gov.in/files/HDCBUD.pdf
2. Chisholm, Gwen. 2001. “Design-Build Transit Infrastructure Projects in Asia and Australia.” *Transit Cooperative Research Program*. Accessed October 12, 2013. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_53.pdf

ASIA | CASE STUDY

HONG KONG SAR, CHINA



Source: Hong Kong Development Bureau and Planning Department 2016 ©Hong Kong 2030+.

HONG KONG SAR, CHINA

QUICK FACTS

Geographic Context
East Asia (China)

Scale
City, Corridor, Neighbourhood, Station

Context
Urban, Suburban, Greenfield

Mode of Higher Order Transit
Hong Kong MTR (Mass Transit Railway)

Size of City (Population)
7.4 million (Source: Census and Statistics Department, Hong Kong SAR, China (web)

Case Study Covered in WB Publication
Yes

CITY SUMMARY

Hong Kong SAR, China is one of the world's leading international financial centres with a long history of designing and implementing a robust and sophisticated multimodal public transportation network. The network is estimated to move over 12 million passengers a day which includes automated people mover systems (escalators and moving pavements), two high-capacity railways, trams, buses, mini and double-decker buses, taxis, and ferries. It is estimated that public transport trips make up 90% of the daily journeys in Hong Kong SAR, China, the highest rate in the world. The Hong Kong rapid transit railway system, known as the MTR, which alone caters to nearly 4.7 million daily trips.

URBAN CONTEXT

From the lens of urbanization and city form, Hong Kong SAR, China's compactness can be attributed largely to its constrained geography and topography consisting of several islands, hills, and the sea. While the city has some of the highest urban area densities in the world, only 30% of its total area is built-up resulting in relatively low gross densities compared to other Asian cities. Hong Kong SAR, China is estimated to have an urban area density of 26,100 people per square kilometer as compared to 31,700 persons per square kilometer in Mumbai, and 29,800 people per square kilometer in Surat (Gujarat). The city's resilience and its high quality of life index have helped in placing it as one of the top five liveable cities in Asia. On the other hand, the high cost of living expenses, housing affordability and deteriorating air quality are some of the challenges that the city continues to address through its integrated long-range planning process.

Governed under the structure of "one country, two systems", Hong Kong SAR, China has capitalized on its autonomous status and strategic location to emerge as one of Asia's leading metropolises with a strong sustainable development agenda. The integration of land use, transportation demand management and rail transit has been one of the hallmarks of Hong Kong SAR, China's evolution as a compact city with one of the most profitable mass transit systems in the world. In Hong Kong SAR, China, all lands are public-owned (except the land on which St John's Cathedral stands) and the government can lease or grant the land to public entities.

Hong Kong SAR, China's "Rail + Property" development model has enabled the city to maximize the limited area available for development in and innovative and aesthetic manner while at the same time enable its transit agency to generate revenues to finance investments in transit infrastructure and high-quality public realm design. In addition to this successful development

model, Hong Kong SAR, China's transportation demand management strategies such as car registration fees and transit-first policies have also played a substantial role in making Hong Kong one of the success stories of Transit-oriented Development in the world.

The MTR is financed, constructed and operated by the Mass Transit Railway Corporation (MTR)- currently serving as a private entity with Hong Kong SAR, China's administration serving as a large shareholder.[8] The following discussion highlights some of the key elements of Hong Kong's successful experience with creating transit-oriented development communities with a special emphasis on MTR's integrated property and rail development model within the organizing framework: enabling governmental policies, planning and design processes, use of innovative financial investment tools, and supporting implementation mechanisms.

Figure 9: Hong Kong's Railway Network in 2021 | *Source:* Hong Kong Railway Development Strategy 2014 TOD Design Options ©Hong Kong Transport and Housing Bureau.

Figure 10: MTR Stakeholder Roles | *Source:* MTR Corporation Limited 2014 ©MTR.

OVERALL TOD STRATEGY

The R+P development model is a cooperation between public and private interests using the TOD concept to concentrate development around a new MTR stop. The government hands out development rights around the station to the railway company, who in turn develops the land and can gain profit from the rising property values. By using this strategy the huge investments in new rail lines can be returned by profits from property development.

The initial investment in Hong Kong's mass transit system was limited to a 20 kilometer stretch, constructed in 1972. In the early years, two agencies were charged with operating the rail service- Mass Transit Railway Corporation (MTR) and Kowloon- Canton Railway Corporation (KCRC). In 2000, MTR was partially privatized with no subsidies received from the government in theory. Subsequently, in 2007, MTR merged with Kowloon-Canton Railway (KCR) Corporation. Through its development control legal framework, transit-first policies and a shareholding in the MTRC, the government of Hong Kong has successfully created an environment that provides financial flexibility and development control which ensures public interest related to transit-oriented developments in the city.

The following table outlines some of the key enabling policies and legal framework used in support of transit and property development[9]:

	Policy: Land Development[9]	Key Features
1	Grant of exclusive property development rights of the station areas to MTRC in exchange for its commitment to provide and improve mass transit railway as an essential mode of public transportation.	Incentive-based approach to encourage the corporation to plan and develop sites in a financially viable manner by "internalizing" benefits from rail and property development; Eliminates the costs associated with land banking and acquisition
2	Established MTRC as an independent corporation with government as a major shareholder to strengthen the role of transit agency as the single entity to serve as the master planner, property developer and property manager as well as generate revenues to sustain the transit service.	Government's commitment to remain as the majority shareholder of the MTRCL after the privatization for at least 20 years and own no less than 50% of shares and votes of the MTRCL; Lower transaction costs with single entity as opposed to multiple agencies
3	Permit joint ventures in real estate development with private sector investment in TODs	
4	Use of Transfer of Development Rights combined with commitment to encourage redevelopment of existing areas rather than allowing for suburban development	

Table 1: *Source:* IBI Group

The supporting public transportation system policies that have enabled TOD projects to flourish in Hong Kong's case include[6]:

Policy: Land Development[6]	Key Features
Limiting private car ownership and usage	Initial registration tax ranging from 35% to 100% of the vehicle cost.
	High fuel tax
Transit service coordination and protection (1980s)	White Papers on transportation policy
	Prohibited direct competition by other PT/feeder modes along the rail routes
Service proliferation and competition (1990s)	Railway Development Strategy, which set out development plans for four new rail lines or extensions.
	White Papers on transportation policy
Service rationalization and consolidation	Public transport interchanges are a required component of new railway stations to facilitate inter-modal feeder services
	Increase the proportion of rail-based public transport journeys from 33% in 1997 to 40–50

Table 2: *Source:* IBI Group

Hong Kong's planning system comprises development strategies at the territorial level and various types of statutory and departmental plans at the district/local level. In 1996, a consolidated plan known as the Territorial Development Strategy (TDS), the highest hierarchy of town plans, came to fruition. It provides a board, long-term framework on land use, transport and environmental matters for the planning and development of the territory.

In addition to acting as the transit operator and real estate developer, MTR has a significant role in the master planning and controlling the development processes in collaboration with the private sector. MTRC works in close collaboration with the city planners to define various parameters of station area planning from the time any plans to extend or construct new rail transit lines are proposed. These parameters include:

- Transit Alignment;
- Station Locations;
- Land values;
- Density potential;
- Financial returns;
- Long-term planning objectives; and
- Land use mix based on market demands and zoning constraints.

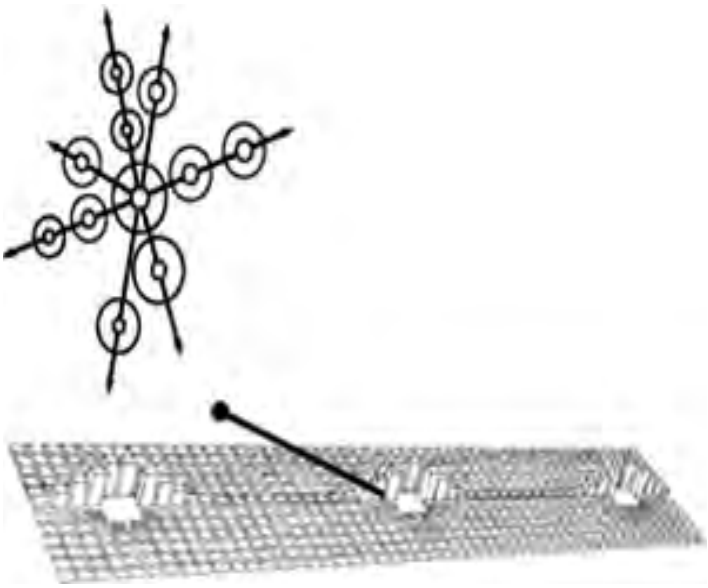


Figure 11: TODs as a "Necklace of Pearls" | *Source:* UC Berkeley 2010 ©UC Berkeley Center for Future Urban Transport. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

KEY ROLES AND RESPONSIBILITIES OF STAKEHOLDERS

Tang et al. (2004) identified the following four key elements behind the R+P approach in their study of the Integrated Rail-Property Development in Hong Kong[9]:

1. Policy. Favorable government support of transit and land-use integration, expressed by land grants and financial assistance to MTRC;
2. Process. Forward-looking planning, management, and control procedures that ensure an efficient approach from project inception to completion;
3. Project. High-quality real estate projects that appeal to tenants, shoppers, and transit users; and
4. Organization. An entrepreneurial entity that balances the financial interests of investors with larger societal goals.

The main agencies involved in shaping urban development policy and its integration with transit services in Hong Kong include:

- Land Development Corporation

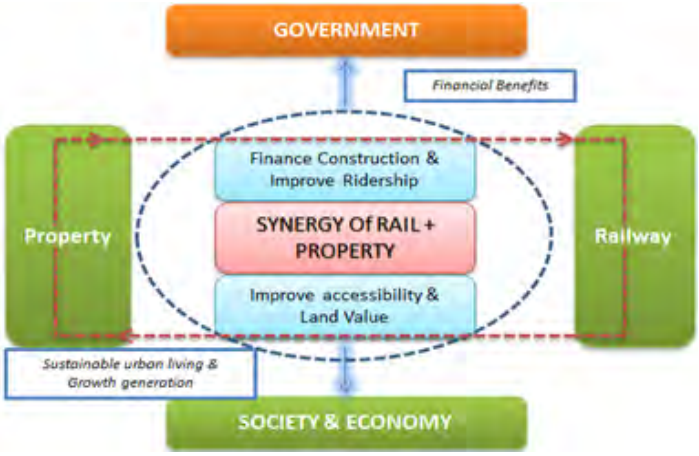


Figure 12: Institutional Mechanism of "R+P" Model | *Source:* MTR Corporation Limited 2011 ©MTR. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

The LDC, founded in 1988, negotiated in length with owners to acquire land and to demonstrate that it was aquired in a fair and reasonable manner before applying to the Secretary for Planning, Environment and Lands for compulsory land resumption. The LDC was replaced by the URA in 2001.

- Urban Renewal Authority (URA)- statutory government agency;

The URA was established in May 2001 under the Urban Renewal Authority Ordinance, to replace the Land Development Corporation, as the statutory body to undertake, encourage, promote and facilitate urban renewal of Hong Kong, with a view to addressing the problem of urban decay and improving the living conditions of residents in old districts.

- Mass Transit Railway Corporation (MTRC)- statutory corporation with government as a majority stakeholder listed on the Hong Kong stock exchange;

Originally established in 1975, to "construct and operate, under prudent commercial principles, an urban metro system to help meet Hong Kong's public transport requirements[8]"; MTR was re-established in 2000 as MTR Corporation Ltd. MTR Corporation is involved in businesses outside of transportation, including residential and commercial development, property leasing and management, advertising, telecommunication services and international consultancy services.

- Hong Kong Housing Society- Founded in 1948, the Hong Kong Housing Society is the second largest public housing provider in Hong Kong. It is a major urban renewal agent, which began its Urban Improvement Scheme (UIS) in 1974. Under the scheme, dilapidated buildings in the urban areas were acquired/resumed and redeveloped into modern housing blocks.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

MTR's transit-oriented development (TOD) model follows the 'network of pearls' urban development model, which designates widely spaced transport hubs connected through a fast transit network. Majority of the new R+P projects are defined by well-design station area plans that ensure "seamless integration" with its surrounding neighborhoods. Each station area is unique and varies by virtue of its contextual relationship with surrounding properties. Cervero and Murikami (2008) classify the R+ P projects into five broad typologies[8]. These include:

- High-Rise Office (HO): high-rise, predominantly office uses on small sites;
- High-Rise Residential (HR): high-rise, predominantly residential uses on small sites;
- High-Rise Residential (HR): high-rise, predominantly residential uses on small sites;
- Mid-Rise Residential (MR): medium-density, predominantly housing projects on medium-size plots;
- Large-Scale Residential (LR): predominantly residential uses on large sites with comparatively low plot ratios; and
- Large-Mixed Use (LM): mixture of housing, offices, retail, hotels, and others on large sites with medium plot rate.

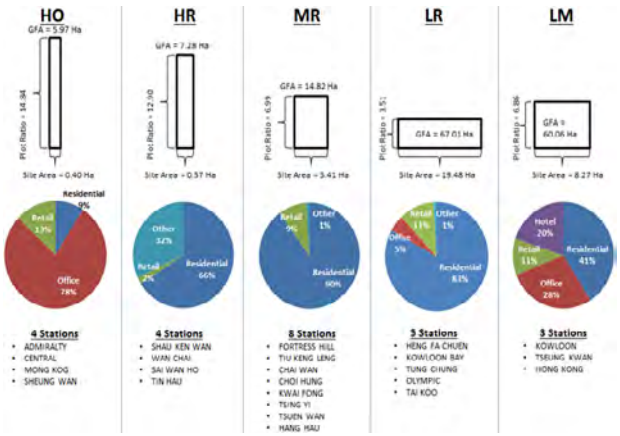


Figure 13: Classification of MTR Stations according to the Built-Environment Type and key clustering variables | *Source:* UC Berkeley 2010 ©UC Berkeley Center for Future Urban Transport. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

Station Area Planning and "Podium" Development

As discussed above, the 2nd and 3rd generations of MTR property developments have exerted a strong focus on pedestrian integration and connecting with the surrounding communities. The figures shown below illustrate the conceptual model followed by MTR in some of its recent property developments as some of its large-scale developments were raised public concerns related to alienating the surrounding neighborhoods, creating wall effects with towers that reduce air ventilation and increasing housing costs within these developments.

One of the typical station architecture styles representative of Hong Kong's development in the last two decades or so, is the "podium development" model[16]. The podium model involves building above the railway station, a "podium" retail level that can be accessed through the street level. Residential and commercial towers often sit on top of the podium level that are accessible from the station and the street level. The podium's roof is also seen in many instances serving the dual function of a landscaped park with community facilities for the residents.

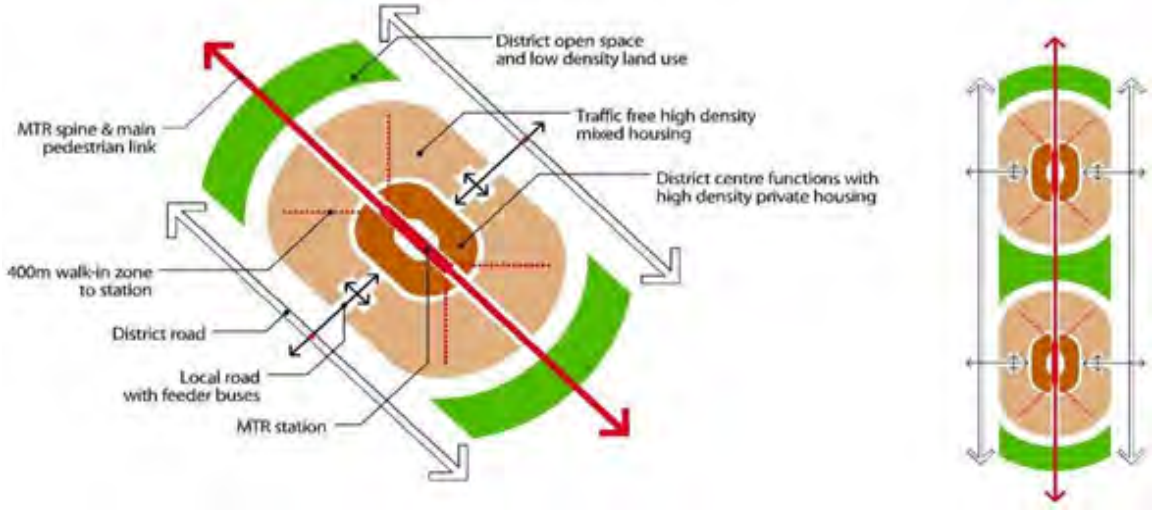


Figure 14: Overview of MTR's concept of R+P Development | *Source:* MTR Corporation Limited 2011 ©MTR. Reproduced with permission from MTR; further permission required for reuse.

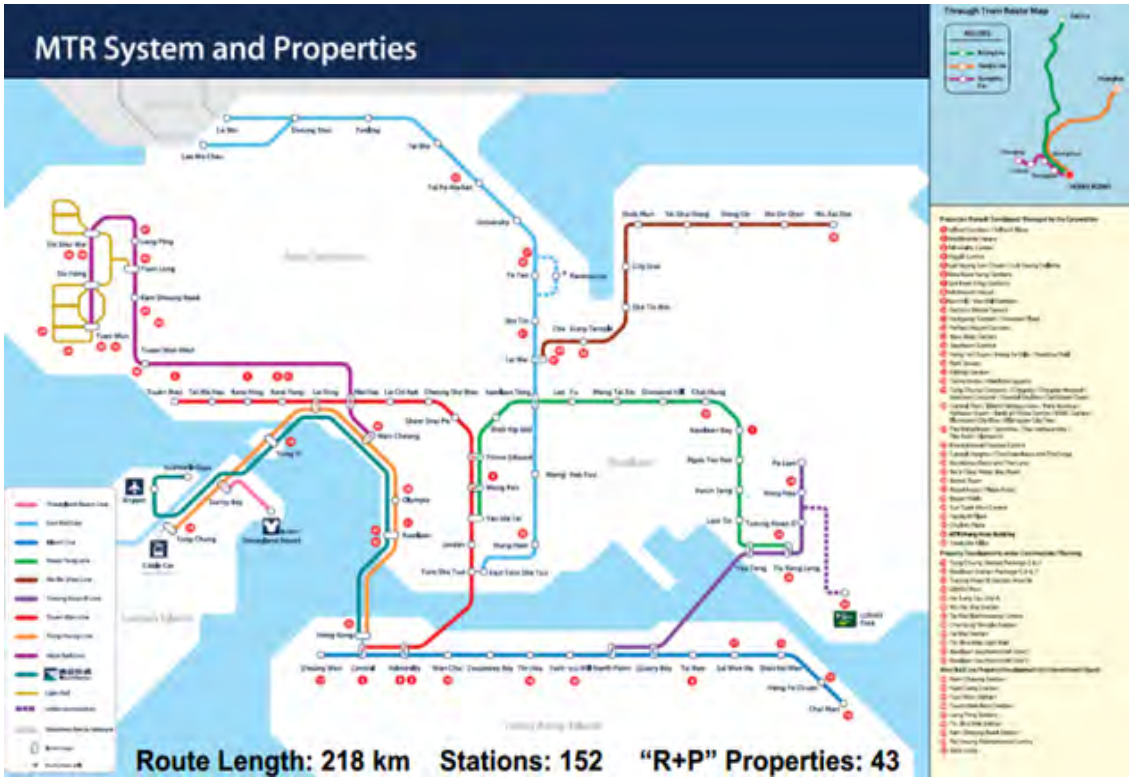
Figure 15: Podium Development Typologies in Hong Kong | Source: Dr. Sujata S. Govada ©UDP International. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

Invest: Rail + Property (R+P)-Hong Kong's Joint Development Financing Model

Since all lands are owned by the government in Hong Kong and leased to the private sector on a 50-year lease (renewable once for the same time period),

MTR receives assistance from the government in the form of land grants and development rights. This implies that MTR has to function as a self-sufficient entity able to generate its own revenue for operation maintenance and infrastructure improvements.

Since its inception in the late 1970s, MTR has focussed on leveraging its property assets as a source of revenue by undertaking diverse real estate development projects in the lands surrounding above the transit stations. MTR's strategy to pursue integrated property development has been the driving force for attracting the right mix of residential and employment densities that continues to improve the viability of its public transit system serving its dense urban cores. What helped Hong Kong apply the principles of value capture so effectively was the "combination of high population density, public land ownership,



	Office (sq.m.)	Retail (sq.m.)	Others (sq.m.)	Residential (units)	Total GFA (million sq.m.)	Residential/ Commercial ratio
Urban Line	234,898	299,363	-	31,366	2.6	78%
Airport Express Line	611,877	306,571	316,473	28,473	3.5	65%
Tseung Kwan O Line	5,000	105,814	63,030	30,414	2.3	93%
East Rail Line	67,541	113,238	113,491	4,771	0.7	60%
West Rail Line	95,800	145,130	50,346	19,206	1.8	84%
Ma On Shan Line	-	65,193	38,191	10,314	0.9	88%
Light Rail	-	53,117	-	9,108	0.6	91%
Kowloon Southern Link	-	-	-	1,500	0.1	100%
	1,015,116	1,088,426	581,531	135,152	12.5	

Figure 16: MTR System and Properties | *Source:* MTR Corporation Limited 2014 ©MTR. Reproduced with permission from MTR; further permission required for reuse.

and low automobile dependency". The R+P programme could be divided into three stages:

1st Generation: This initial stage of the R+P programme used solely a financing mechanism to recover the transit infrastructure investment costs and yield a net profit from nearby property developments as single-use properties above new stations along its Urban Line.

2nd Generation: The 2nd generation of the programme was influenced by Hong Kong's growth as a financial hub in the global market resulting in large-scale foreign-direct investments and international property developers.[10] During this phase, the development models transitioned from single-use properties to "mixed-use, pedestrian-oriented town developments examples of place-making" along the new Airport Express and Tseung Kwan O line extensions, also aimed to better connect jobs near the airport with residential areas concentrated in the traditional urban core.[10]

3rd Generation: The 3rd and the present generation of the R+P programme coincides with the opening of the fifth MTR subway line are more typical of "greenfield TODs" built on undeveloped or reclaimed lands from the sea, encompasses a diverse set of urban and suburban areas (in the New Territories). These sites encompass nearly 62 hectares and are planned based on unique station typologies that are context-sensitive and integrate innovative architectural and urban design concepts to create new destinations for the growing city. The most recent of such developments was the large Pop Corn shopping centre development which was built in conjunction with Tseung Kwan O station.

As mentioned earlier, the R+P model is one of the most successful joint development models in contemporary urban planning practice in terms of achieving the economic, social and growth management goals envisioned through implementation of TODs. In Hong Kong's case, this principle has also enabled the MTR to be classified as one of the most profitable transit systems in the world. The financial mechanism for the R+P development is relatively simple- MTR receives from the government the right to purchase 50-year leases on lands and in return pays a land premium to the government on a "Greenfield no railways basis" . Next, the MTR invests in the transit infrastructure and develops the property either on its own as a developer or in partnership with the property developer. With time, the property values increase because of its proximity to the rail transit network and its integration with the station. The increment in values is captured by MTR to invest in new infrastructure as well as offset the maintenance and operation costs.

In some cases, for example on lands with technical complexities such as development above stations, MTR generally sells the land only after having built the foundations and thus undertakes a part of the construction activities as an alternative profit source. In addition to selling development rights, MTR generally negotiates a share in the future property with the selected developer and profits and/or receives a co-ownership. MTR has also been successful in developing a strong portfolio of residential and commercial real estate projects that the agency has constructed, leased and rented. Finally, MTR often remains involved in the development as a property manager, generating additional incomes that way. At the end of 2011, MTR owned and rented over 85,000 residential units and 750,000 m² of commercial and office spaces in Honk Kong.

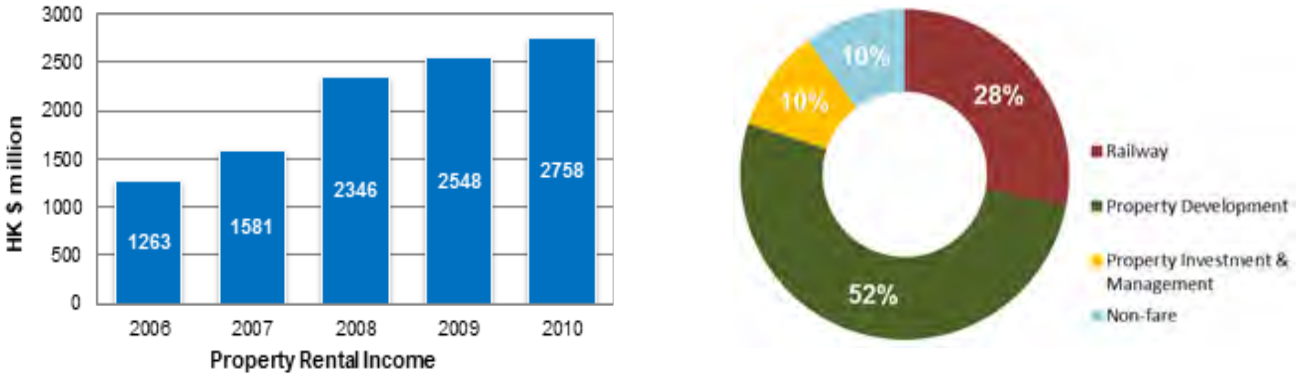


Figure 17: Property Rental Income, MTR (Left) and MTRC Revenue 2001-2005 Average (Right) | *Source:* MTR Corporation Limited 2014 ©MTR. Reproduced with permission from MTR; further permission required for reuse.

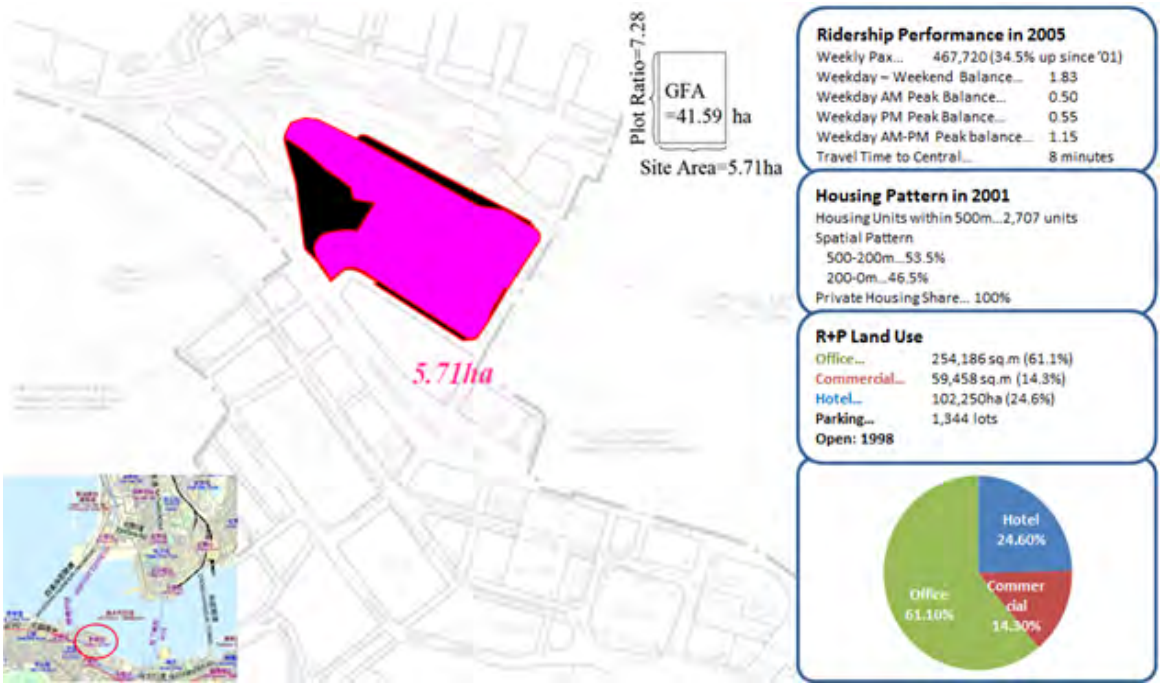


Figure 18: A case summary of Hong Kong's Rail + Property development | *Source:* UC Berkeley 2010 ©UC Berkeley Center for Future Urban Transport. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

INFRASTRUCTURE PROVISION FOR DENSITY

To help create capacity for sustainable growth, which is one of the building blocks proposed under Hong Kong 2030+, a smart, green and resilient city is proposed. It focuses on the scope that are relevant to land use planning, mobility and infrastructure in the built environment and is particularly applicable to new development areas and new neighbourhoods where comprehensive planning is more feasible.

Three building blocks of the territorial development strategy are proposed for achieving the vision and overarching planning goal. These building blocks are translated into spatial terms in a conceptual spatial framework.

Figure 19: Hong Kong's Railway Network in 2021 | *Source:* Hong Kong Development Bureau and Planning Department 2017 ©Hong Kong Development Bureau and Planning Department.

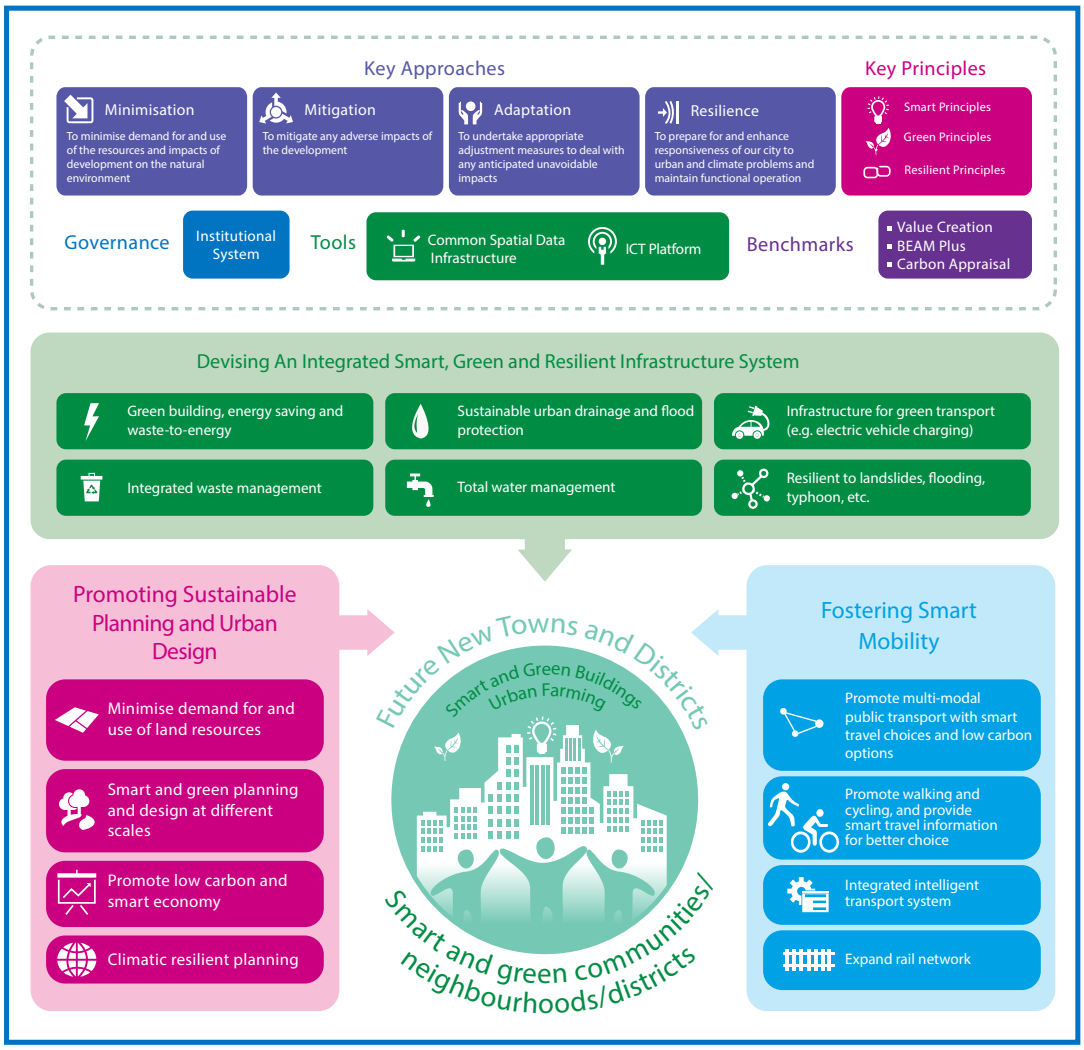


Figure 20: Smart, Green and Resilient City Framework for the Built Environment | *Source:* Hong Kong Development Bureau and Planning Department 2017 ©Hong Kong Development Bureau and Planning Department.

IMPLEMENTATION STRATEGIES

Tang et al. (2004) identified the following four key elements behind the R+P approach in their study of the Integrated Rail-Property Development in Hong Kong[9]:

1. Policy. Favorable government support of transit and land-use integration, expressed by land grants and financial assistance to MTRC;
2. Process. Forward-looking planning, management, and control procedures that ensure an efficient approach from project inception to completion;
3. Project. High-quality real estate projects that appeal to tenants, shoppers, and transit users; and
4. Organization. An entrepreneurial entity that balances the financial interests of investors with larger societal goals.
5. From a perspective of defining the roles and relationships of these agencies pertaining to the "R+P Development Model", the following illustrations provide a summary of the institutional arrangement and functions that have ensured successful implementation of TOD projects in Hong Kong[11].

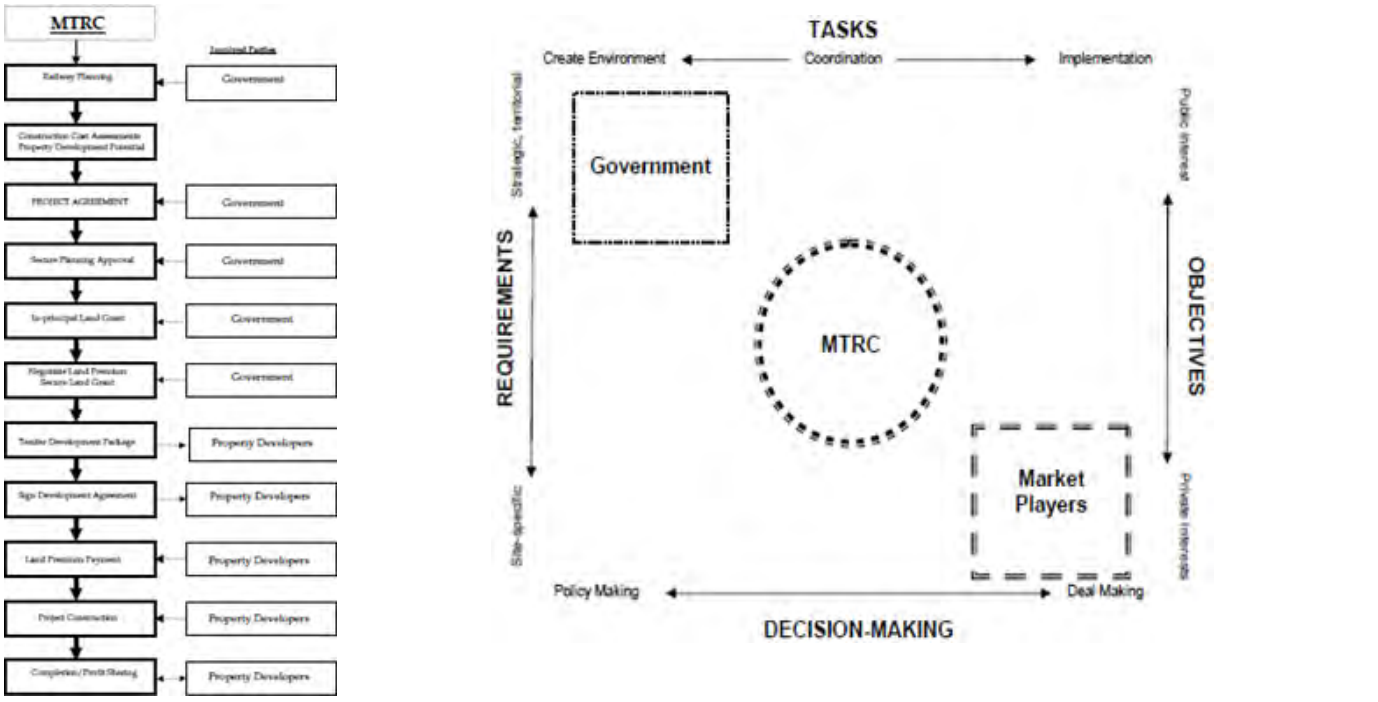


Figure 21: Institutional arrangement for R + P Development Model | *Source:* MTR Corporation Limited 2011 ©MTR. Reproduced with permission from Transport and Housing Bureau; further permission required for reuse.

KEY LESSONS LEARNED AND BEST PRACTICES

Lessons Learned from Hong Kong applicable to Global cities

An important lesson from the Hong Kong experience is that integrating transit with land-use can yield the finances needed to support TOD. The use of "Value Capture" as an infrastructure financing concept that seeks to capture land value created by new infrastructure, particularly transit. Value capture is effective in financing transit infrastructure, particularly in dense and congested settings. This is due to the high perceived importance for improved accessibility and an institutional capacity fit to support transit. Accessibility benefits present enormous opportunities for recapturing some of the value created by transit investment in land values and effectively supplement the traditional forms of revenue for transit systems, like fares.

The study by Tang et al. (2004) on Study of the Integrated Rail-Property Development Model in Hong Kong confirm the positive relationship between property development and MTR ridership as follows[9]:

a. High population concentrations and densities are associated with high MTR station ridership.

b. Private housing units clustered around MTR stations tend to exert a greater impact on the ridership than public housing.

c. Mixed land uses, compact environment and exciting street-level activities in the existing urban districts promote MTR ridership.

d. New development districts with attractive design, commercial facilities and efficient pedestrian connections along rail corridors enhance MTR ridership. Pedestrian connections must be convenient, direct, safe and pleasant for these developments to be successful and to increase property values.

The R+P program applied by the MTR Corporation in Hong Kong has been central to the success of Hong Kong in developing its rail system. The R+P program enabled MTR Corporation to capture real estate income to finance part of the capital and running costs of new railway lines, and to increase transit patronage by facilitating the creation of high-quality, dense and walkable catchment areas around stations.

The following three key concepts applied in the R+P program are essential to the program success and can be adopted by global

cities with railways as the trunk transit mode, by taking the transit-oriented development mechanisms to help finance new rail lines[14] :

Financial Sustainability Approach: The value for a rail company to only under-take those rail investments that can achieve a targeted rate of return (after factoring government support, in the form of land rights provided at before-rail price, used in a R+P program, or cash subsidies) to be financially sustainable.

Market-driven Approach: The need to plan development along each rail line comprehensively, with multiple stakeholders and partners, and to define the scale and timing of such developments based on market demand, location characteristics and institutional capacity.

Risk management approach: The value for a railway company to bring in relevant expertise and transfer a large part of commercial risks to private developers through PPPs and transactions with external partnerships.

ENDNOTES

1. Chisholm, Gwen. 2001. "Design-Build Transit Infrastructure Projects in Asia and Australia." *Transit Cooperative Research Program*. Accessed October 12, 2013. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rrd_53.pdf
2. Lam, William H.K. and Michael G.H Bell. 2002. *Advanced Modelling for Transit Operations and Service Planning*. Elsevier Publishing.
3. MTR Corporation Limited. 2014. "Investor's Information." Accessed October 6, 2018. https://www.mtr.com.hk/en/corporate/investor/patronage.php
4. "Demographia World Urban Areas, 9th Annual Edition." March 2003. Accessed November 12, 2013. http://www.demographia.com/db-worldua.pdf.
5. The University of Hong Kong. 2017. "Basic Knowledge of Land Ownership in Hong Kong." *Community Legal Information Centre*. Accessed October 15, 2017. http://www.hkclic.org/en/topics/saleAndPurchaseOfProperty/basic_knowledge_of_land_ownership_in_hong_kong/q1.shtml Tiry Corinne, 2011, Hong Kong, An Urban Future Shaped by Rail Transport, retrieved online on November 12, 2013 at http://chinaperspectives.revues.org/647#ftn1
6. Lo, Hong K., Siman Tang, David Z.W. Wang. 2008. "Managing the accessibility on mass public transit: The case of Hong Kong." *Journal of Transport and Land Use,* 1, 2 (Fall 2008): 23–49. http://jtlu.org
7. Tiry, Corinne. 2011. "Hong Kong, An Urban Future Shaped by Rail Transport." Accessed online on November 12, 2013. http://chinaperspectives.revues.org/647#ftn1
8. Cervero, Robert and Jim Murakami. 2010. "Rail Property Development: A Model of Sustainable Transit Finance and Urbanism." *UC Berkeley Center for Future Urban Transport.*
9. Tang, B.S, Y.H. Chiang, A.N. Baldwin, and CW Yeung. 2004. "Study of the Integrated Rail-Property Development Model in Hong Kong." *Research Centre for Construction & Real Estate Economics.* Hong Kong Polytechnic University.
10. Murukami, Jim. 2010. "The Transit-Oriented Global Centers for Competitiveness and Livability: State Strategies and Market Responses in Asia." *University of California Transportation Center.*
11. Hang-Kwong, Thomas HO. "Railway and Property Model- MTR Experience." Presentation at Building and Real Estate Advanced Lecture Series, 2011. Accessed November 12, 2013.http://www.bre.polyu.edu.hk/Happenings/2011Photo/20110412_

BREAdvancedLectureSeries-RailwayandPropertyModel-MTRExperience/RailwayandPropertyModel-MTRExperience.pdf

12. PWC. 2013. “Which Financial Mechanisms for Urban Railway Stations?” Accessed October 25, 2013. http://www.thecityfactory.com/fabrique-de-la-.cite/data.nsf/01771FA4413266A2C1257BF300556EC7/$file/financial_mechanisms_railway_stations.pdf

13. BS Tang, YH Chiang, AN Baldwin and CW Yeung, 2004, Study of the Integrated Rail-Property Development Model in Hong Kong, Research Centre for Construction & Real Estate Economics Department of Building & Real Estate Faculty of Construction & Land Use, The Hong Kong Polytechnic University

14. The World Bank. 2017. “Railway Reform: Toolkit for Improving Rail Sector Performance.” Accessed October 25, 2013. http://documents.worldbank.org/curated/en/529921469672181559/Railway-reform-Toolkit-for-improving-rail-sector-performance

15. Hong Kong Transport and Housing Bureau. 2014. “Railway Development Strategy 2014.” https://www.thb.gov.hk/eng/psp/publications/transport/publications/rds2014.pdf

16. Govada, Dr. Sujata S. n.d. “Large-scale Development - ULI and the Asia Society.” *UDP International.* https://asiasociety.org/files/uploads/331files/Sujata%20Govada.pdf

17. Hong Kong Development Bureau and Planning Department. 2017. “Hong Kong 2030+.” https://www.hk2030plus.hk/

ASIA | CASE STUDY

SHENZHEN, CHINA

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SHENZHEN, CHINA

QUICK FACTS

Geographic Context
East Asia (China)

Scale
City, Corridor, Neighbourhood, Station

Context
Urban, Suburban, Greenfield

Mode of Higher Order Transit
Metro (Transport Commission of Shenzhen Municipality & Shenzhen Metro Group)

Size of City (Population)
11 million (Tier-1)

Case Study Covered in WB Publication
No

URBAN CONTEXT

China's population is rapidly urbanizing, with 70% of its citizens expected to be living in urban areas by 2030[3]. Shenzhen is no exception, with a rising population of 11 million and the fastest urbanization rate in Eastern Asia.1 With such fast growth and a large urban realm, the provision of adequate and readily available public transportation is an essential part of combating and avoiding the congested road conditions that result in large populations. Metro integration within large cities is known as an effective, but expensive method of providing public transit.

Shenzhen is one of China's most rapidly growing cities in terms of economy and urbanization. With over 11 million people residing within the city in the Guangdong province, its large urban extent allows for a fairly low population density of over 2,000 people per square kilometer.1 This is substantially smaller when compared to its counterparts in Asia. Shenzhen has become one of the frontier cities that is leading the economic growth of China as the first of the nation's five Special Economic Zones (SEZ).2Special economic zones receive allowance from the government for more flexible, free market-oriented economic policies. Shenzhen is unsurprisingly designated as an SEZ, as after less than twenty years of development, it has transformed from a small fishing village to one of the largest metropolises in China.

In the 1990s, the economy in Shenzhen continued to grow exponentially, with a significant increase in secondary industries. The market-oriented policies allowed for foreign investment, which has led to continuous growth in the manufacturing industry.

With such immense growth, Shenzhen has started to design and develop a new development strategy for the city called the "Shenzhen 2030 Urban Development Strategy." Amongst this strategy is a focus on public transit, emphasized at the city's most major form of infrastructure development moving forward. In meeting this goal for improved public transit, the city began its strategic planning of a metro in 1998. The resulting metro and its funding methodology remain a model for transit implementation in Asia.

TOD K P

OVERALL TOD STRATEGY & CITY STRUCTURE

IMPACT ON URBAN FORM

The improved convenience, accessibility and quality of life allowed for by transit attracts development, intensification and investors to the rail corridor. The R+P funding mechanism is largely dependent on using the consequent increase in land value to incentivize the involvement of private stakeholders. The scarce availability of land in Shenzhen, due to its hilly topographic nature, allows for continued high housing prices. It is this scarcity which motivates the joint development undertaken by Shenzhen, SZMC and MTR.

The first phase of subway development was guided by government investment. Lacking experience with substantial transportation infrastructure projects like the metro, Shenzhen failed to capitalize on integrating property development with public transit development. In the Chinese context, the notion of transit-oriented development has yet to become supported by planning policy. The inflexible nature of Chinese planning policy does not allow the integration of transit and property development, and measures such as up-zoning for high-density development surrounding the rail corridor are not triggered by transit creation. The lack of integration of the interrelated systems led to the first phase of development largely ignoring land value, as the time-consuming nature of changing policy to support TOD would have led to too many delays.[4]

The second phase of the metro development was much more cognizant of subsequent increases in land values and used this to incentivize the SZMC to assist in funding the rail development. Special auctions of land were used to ensure that the metro company would receive land at a discounted price. Moreover, land concessions were refunded to the company as capital investments, which gave SZMC use of the land for no charge, while also allowing the value captured after the construction of the metro to be kept by the company.[3]

Finally, in the third phase of metro development, land-equity investments were engaged in place of capital investments. This agreement granted undeveloped land along the corridor to a third-party, thereby incentivizing involvement through the promise of land-value appreciation. In the case of the MTR, land premiums were shared 50/50 between the private entity and the government, in exchange for a build-operate-transfer agreement (BOT). [3]

Overall, the strategy for utilizing land values in funding the metro construction after establishing an R+P mechanism involved creating value, realizing that value and recycling it. Creating value involves the strategic siting of routes, stations and updating zoning parameters to allow for more profitable transit-oriented development along the rail corridor. This value must then be realizes by transferring land use rights to the involved stakeholders in exchange for joint development of the subway that captures land value premiums for the land developed after the metro construction. Finally, these land values can be recycled by using the land value appreciated to fund future transit and urban design projects that will further increase land values.

Figure 22: Land Value's integral role in the R+P funding Progress | *Source:* World Resources Institute 2017

FINANCIAL MODEL

In the context of Shenzhen, the rapid growth and economic affluence the city is experiencing lends to the application and viability of Metro-led transit-oriented development (TOD). As a central manufacturing city, connectivity to surrounding metropolitans in the Pearl Delta River Region could be improved with the introduction of a metro system. Specifically, the strategy looked to improve connection with Hong Kong SAR, China. To justify such a large undertaking, the innovative funding approach of Rail + Property (R+P) funding was experimented with, a trailblazer of its kind.

R+P funding not only encourages both state-owned and private metro companies to participate in R+P projects, but also uses innovative land-use rights transaction methods to overcome current barriers within the land-leasing system.[3] During the early stages of R+P implementation, it was realized the R+P was a new concept for local developers and led to increased costs and risks for private companies[3]. Particularly impacted was local metro company—Shenzhen Metro Group. To incentivize SMG, the local government reduced its cost and risk burdens through a complex financial arrangement[3]. The R+P financial scheme in the context of Shenzhen can be separated into three phases: government-led capital investment, auctions with special conditions and land-concession fee reimbursement, and land equity investment.[3]

The first, government direct investment, was scaled back to reduce public costs and to place a larger onus on private companies to invest. The Shenzhen city government, Reform and Development Commission, and Planning Commission proposed to decrease of government investment in capital costs from 70 to 50 percent, forcing the metro company to use bank loans and property development to make up the difference.[3]

Consequently, the government used special auctions to transfer land to Shenzhen Metro. Traditionally this land would have to be auctioned in an open, public auction.[3] However, the city ventured to pilot special auctions for R+P development projects. Special terms restricted the number of bidders, ensuring that Shenzhen Metro would obtain the land at a low price.[3]

Finally, land concession fees paid by the metro company were diverted to fund capital investments for the subway. This complex method allowed the city to grant land-use rights to the subway company free of charge, while also allowing Shenzhen Metro inherit the land premiums captured in the future.[3]

This three-phased financial scheme was not only an incentive for private entities to become involved, but also reduced the costs and risks undertaken by the government. Through a build-and-transfer (BT) arrangement for property development, construction risks were minimized and the private stakeholders were held accountable for their involvement in the project team. The implementation of R+P is vital to the success of the Shenzhen metro project and is a financial strategy that could improve the viability of metro projects going forward. [3]

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

Traditionally, the onus for large infrastructure projects, such as this, falls on the government and public to fund and implement. However, this case study exemplifies the beneficial shift from government-led to mixed-model funding of public transit projects. Shenzhen's exploration with R+P includes a partnership between the government and key stakeholders, the Shenzhen Metro Group and the MTR Shenzhen Corporation. Both private entities shared in the responsibility of financing the metro through an incentivized approach that captures the future land value and resources following the completion of the project.

The Shenzhen Metro Group Co. (SZMC) was enacted in 1998 as a large-scale proprietor under the control of the state-owned Assets Supervision and Administration Commission of the Shenzhen government. Creating the state-owned private entity allowed responsibility for metro expansion, construction and operation to be held in the private sector. Today, the private entity is responsible for the continued operation of the metro system it constructed and looks to continue to improve the safety and comfort of existing services.[5]

The MTR Shenzhen Corporation was the second stakeholder in the construction of the Shenzhen Metro. The corporation is Hong Kong SAR, China's major rail developer, as well as a significant land developer. Their role in the metro construction was incentivized by offering them pre-rail value for land abutting the rail corridor, lending to profitable and discounted development for the corporation.

The evolution of the Shenzhen Subway's financing mechanism has benefited from more than 10 years of efforts by the Shenzhen city government, dramatically altering the process of obtaining capital investment for large infrastructure projects. Instead, a flexible mechanism of cost recovery was created that made infrastructure costs a shared public-private investment and revenue generator.[3] This approach was effective in incentivizing the subway company to participate in R+P programs and ensuring the financial sustainability of subway projects. R+P development leverages the partnership between the public sector, transit companies, and developers for a collaborative financing and development scheme. By capturing the land value appreciation that follows transit projects, R+P can successfully finance large infrastructure investments without long-term debt for stakeholders.[3]

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

The success of Shenzhen's R+P planning can also be attributed to a streamlined and coordinated planning process that integrates multiple disciplines. Shenzhen borrowed from Hong Kong SAR, China's experience to streamline the details of the different phases of rail transit plans and to adjust its planning process.[3] This adjustment allowed for the creation of synergies between rail transit plans and the overall urban planning process, paving the way for successful TOD.

The coordination between land-use and transit plans in Shenzhen occurs at the route level by bundling zoning revision with transit planning.[3] Specifically, once the route plan of new metro lines is determined, an independent market analyses can be conducted and land-use surveys can pinpoint vacant lots with high development potential. The planning institute can then collaborate with the metro company and other governmental departments, to shortlist land lots for joint development. The zoning of these properties will be discussed by stakeholders to reach a consensus. Normally, the FAR of developable sites near metro stations is increased significantly, and more diverse land uses are permitted. This draft route plan with zoning proposals will be then submitted to the municipal planning committee (led by the mayor of the city) for further deliberation.[4]

Despite this innovative process, Shenzhen's integrated planning experience remains limited, when compared with Hong Kong SAR, China. As the "master planner and designer," the MTR Corporation is actively engaged in the entire urban planning process, whereas in Shenzhen they play a weaker role in the planning process and only route-level plans are determined.[3] This late-stage engagement may lead to missed opportunity for joint development, thereby restricting the extent to which transit plans could be optimized.[3] Thus, to fully achieve designs that reflect transit-oriented development, the policy framework that allows for integrated land use and transit planning must be advanced.

INCLUSIVITY & AFFORDABLE TOD SYSTEMS

The Songgang rolling stock depot is a typical example of the R+P development occurring in the suburbs of Shenzhen (Type 1). It is located near Bitou Station along Line 11 and borders Shenzhen and Dongguan. The depot covers an area of 42.09 hectares and is zoned as a "special control zone," based on future anticipation for subway construction[4]. In line with the aspirations of local communities, this land will not only be served by public transit services, but will be equipped with mixed uses and community facilities.[4]

These include[4]:

- Affordable housing on land above the rolling stock depot—FAR 2.0.
- Schools and residential housing east of the depot—FAR 3.0.
- Commercial and office developments near Bitou Station—FAR 6.0

Along with the renewed affordability of R+P housing along the rail corridor, using the metro costs only 2 yuan for the first 4 kilometers of travel. While this is accessible, riders from more affordable and periphery locations in Shenzhen may experience higher metro costs, as prices vary based on distance. This potential lack of affordability further justifies the integration of TOD design strategies like active transportation with the metro system. Adaptations and inclusions such as improved walkability could assist in keeping the metro system as affordable as possible.[4]

IMPLEMENTATION OF SOLUTION

APPROXIMATE TIMELINE

- **1998**- City began strategic planning of a metro. Shenzhen Metro Group was enacted
- **December 2004**- Metro service began
- **June 2011**- 5 more lines were opened
- **2016**- Line 7,9,11 Opened
- **2030**- Planed completion target

ACTIONABLE STEPS

- Identify needs/ Take Inventory
- Create Strategy Plan (Phases)
- Identify Key Stakeholders
- Find Funding
- Mitigate Competition
- Optimize/ Utilize Land Value
- Create Design Strategies to Encourage Transit Use

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

Shenzhen's metro system is a precedent for effective metro implementation, as its funding methodology improved the affordability of the mode for local governments and allowed for a public-private partnership in funding transit.

Although the Shenzhen metro construction may not be a perfect example of TOD, it shows definite strives towards becoming transit-oriented and its R+P funding strategy stands as an exemplary model for increasing the viability of metro systems within low-mid income cities.

ROADBLOCKS AND WAYS TO IMPROVE

In the Chinese context, the notion of transit-oriented development has yet to become supported by planning policy. The inflexible nature of Chinese planning policy does not allow the integration of transit and property development, and measures such as up-zoning for high-density development surrounding the rail corridor are not triggered by transit creation.

To improve from a situation like this they largely ignoring land value at the beginning phases, as the time-consuming nature of changing policy to support TOD would have led to too many delays. Then they established an R+P mechanism involved creating value, realizing that value and recycling it.

KEY LESSONS

The following key takeaways should be derived from the Shenzhen example:

- R+P funding uses innovative land-use rights transaction methods to overcome current barriers within the land-leasing system.
- The successful transition from a State-owned subway company to Private-owned subway companies.
- Streamlining and coordinating the planning process by integrating transit planning, land use planning and financial planning allowed for the creation of synergies between the series of rail transit plans and the overall urban planning process.

ENDNOTES

1. Atlas of Urban Expansion. 2016. “Shenzhen, Guangdong.” http://www.atlasofurbanexpansion.org/cities/view/Shenzhen_Guangdong
2. The Economist. 2010. “The spirit of enterprise fades.” *The Economist.* http://www.economist.com/node/15331470
3. Xue, Lulu and Wanli Fang. 2017. “Rail Plus Property Development in China: The pilot case of Shenzhen”. *World Resources Institute.* https://www.wri.org/sites/default/files/Rail_Plus_Property_Development_In_China_The_Pilot_Case_Of_Shenzhen.pdf
4. Shenzhen Urban Planning and Land Resource Research Center. 2013. “Overall Planning and Design of 7 Metro Superstructure in the Phase III Construction”.
5. Shenzhen Metro Group Co. Ltd. 2016. “Group Company Profile.” http://www.szmc.net/page/eng/about_szmc.html?code=9110

ASIA | CASE STUDY

GUANGZHOU, CHINA

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GUANGZHOU, CHINA

QUICK FACTS

Geographic Context
East Asia (China)

Scale
City and Corridor

Context
Urban

Mode of Higher Order Transit
BRT and Metro

Size of City (Population)
25 million (Tier-1)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

Guangzhou is the capital of Guangdong province and the third-largest city in China with over 14.5 million residing within in. Located North of Hong Kong SAR, China along the Pearl River, the city is rapidly growing in density, with nearly 1,800 people per square kilometer. The city is well-known as both a commercial center and a bustling port city with a sprawling population.[2]

As one of China's largest metropolitans, meeting the demands of a rapidly growing population places a burden on Guangzhou's public resources and services. The drive towards being a developed and world-class city required the strategic thinking that led to the initiation of the Bus Rapid Transit system. Particularly, Zhongshan Avenue is the corridor that links the most rapidly growing districts within Guangzhou. At its most western point, the Tianhe District on Zhongshan Avenue is home to intensive growth and densification, with large-scale high-rise development and a new rail station residing within it. At the end of the 22.5 km corridor, the Huangpu District is also dense and nature and urbanizing to include large high-rise communities and developments. With the urbanization and intensification occurring along Zhongshan Avenue, updating the transit networks to support this growth will be vital to the city's prosperity and overall efficiency.[2]

Prior to the introduction of the Guangzhou Bus Rapid Transit (BRT) system, congestion, gridlock and overcrowding, were words that characterized the former public bus system of China's Guangzhou. The city of over 14.5 million residents was tasked with the difficult challenge of reforming the flawed transit system to more effectively serve the users along Zhongshan Avenue, a central truck road, particularly.[4] Adopting a method of relieving the high demand placed on the bus and road systems along the corridor was a necessary adaptation to improve the efficiency and success of their transit systems. These challenges led way to the creation of Guangzhou's Bus Rapid Transit (BRT) system, which would soon become one of the most successful of its kind in Eastern Asia. The 2011 Sustainable Transport Award winner for innovative transport solutions, Guanzhou's BRT is a leader of its kind. Executive Director of the Institute for Transportation and Development Policy has stated "Guangzhou's transformations are nothing short of amazing… The new BRT system is changing perceptions about bus-based and high-quality mass transit. We hope all cities, not least those in the US, will be inspired by these examples".[5] A good example of successful transit-oriented development (TOD) and BRT implementation, the system is a prime illustration of the success transit can bring a city.

Although Guangzhou is void of specific policy promoting development along the BRT corridor, in practice, the city's planning authorities are more inclined to allow higher-density developments in recognition of the need for improved traffic conditions. The authorities are also open to relaxing minimum parking standards in light of the BRT's presence.

OVERALL TOD STRATEGY & CITY STRUCTURE

A BRT system was determined to be the most economical and timely method to overcome the shortcomings of the city's transportation networks. The alternative, building a metro system, posed the challenge of huge capital costs and delays in resolving congestion. Enacting this strategy was not without its challenges, as authorities had to overcome decades' worth of disjointed and piecemeal transportation planning within the city's street network. Years of slow service and delays on the bus system also left negative perceptions of bus transit with city residents.

Despite the circumstances, Guangzhou successfully opened its 22.5-kilometre BRT corridor in February of 2010.[2] It was structured with the goal of reducing congestion on one of the city's busiest roads, Zhongshan Avenue. With aims of improving the overall efficiency of the existing bus system, combatting congestion and its environmental impacts and changing public perception, the BRT represented a step towards transit-oriented development. Today, the Guangzhou BRT boasts of 850,000 average weekday riders, making it the busiest bus corridor in Asia (and the second-busiest bus corridor in the world, after Bogota).[2] The Guangzhou BRT's passenger flows are more than three times than those in other BRT systems within Asia.

To achieve such success in their BRT system, Guangzhou used careful planning and analysis to justify such a large-scale system. With twenty-six stations along a 22.5 kilometer stretch of the city's most congested roadway, the strategic approach includes express routes, designated bus lanes, direct metro connections and higher-capacity buses.1 Moreover, the system would support some of the world's highest flows and capacity, with buses arriving at stations every ten seconds during peak hours. Demand analyses played a large role in designing the system, with each BRT station designed to have separate east and westbound waiting platforms located on corresponding sides of the bus lanes. Their sizes have been calibrated to meet modeled demand and the needs of bus operations. Some stations are as short as 55 meters while Gangding, the busiest station in the world at 55,000 daily riders, is 250 meters long (the world's largest) and has multiple pedestrian bridges for access. [2]

The construction of the system was phased, with the first phase completed in February of 2010. Paired with the improvement of active transportation networks and supplementary transit systems along the BRT corridor, the approach proved to be the relief required for the congestion experienced along Zhongshan Avenue.

Figure 23: Gangding Station before (left) and after (right) the implementation of the BRT | *Source:* ITDP 2011 ©ITDP. Reproduced with permission from ITDP; further permission required for reuse.

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

In achieving such a successful implementation of the BRT system, stakeholder collaboration of both public and private entities was vital. Preliminary planning for a BRT system in Guangzhou began in 2003 by the Guangzhou city government. With no exemplary high-capacity BRT systems in China, the city was considering other corridors with significantly high congestion. To help with this the government enlisted the aid of The Institute of Transportation and Development Policy (ITDP) and Guangzhou Municipal Engineering Design and Research Institute (GMEDRI) for the planning and design. The two groups drafted the concept plan and carried out demand analyses and corridor comparison. They also drew up the operational and traffic plan, which included opening the BRT to more than one bus operator and allowing the buses to run both inside and outside the BRT corridors. The overall infrastructure funding for the project was provided by the Government of the People's Republic of China. Once the plans were constructed they were run by the operating agency GZ BRT Management Company and seven private bus companies.[7]

FINANCIAL MODEL

Capital costs for the Guangzhou BRT project reached 950 million Yuan (USD 103 million), which although high, is about one-twentieth of the per-kilometer costs of the alternative, a metro expansion.[2] The cost-effective investment was a more efficient way of increasing capacity and did not lead to increased consumer costs, due to significant government subsidy to reduce fare prices. The consequent benefits and cost-saving measures initiated through the BRT, including reduced operating costs, time savings, and reduced emissions and thereby emission credit and reduced consumer trip and health costs would pay for the project in just one year. The financial return on this initial government investment justifies the use of the BRT as a resolution for the congestion issues faced in Guangzhou.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

Public and green space improvements along the BRT corridor became a priority after its initiation. Guangzhou began implementing a greenway improvement project in 2010, creating hundreds of kilometers of green corridors across the city. This scheme saw the restoration of the Donghaochong Canal, an ancient canal that dates back to the Song Dynasty, which several BRT routes serve. The effort is part of a major project to clean up waterways around the city, including several canals connecting with the BRT corridor.

Additionally, cycling has received higher priority, with fully-separated and updated bicycle lanes built along both sides of the entire BRT corridor. Bicycle sharing programs have been enacted along the corridor, offering over 5,000 bicycles to citizens and thereby reducing motorized trips by over 7,500 daily, according to the ITDP.[1] The corridor also offers safe, free bike parking along the bus route. Pedestrian safety and comfort was also prioritized through the enactment of the BRT in Guangzhou, with the addition of new street crossings, pedestrian bridges connecting BRT stations to adjacent buildings and, whenever possible, seamless urban design and architecture that lend to a more comfortable walking experience. These investments have significantly improved perceptions of pedestrian safety and the quality of the walking environment.[2]

Aggregate yearly operating cost savings	93 million yuan (USD 14 million)
Value of aggregate time savings (2010)	158 million yuan (USD 24 million)
Average yearly value of certified emission credits	25 million yuan (USD 4 million)
Aggregate consumer savings on trip cost in 20 10	672 million yuan (USD 103 million)
Yearly reduction in health costs from respiratory illness	Unknown

Table 3: Annual value created by the BRT System | *Source:* ITDP 2011 ©ITDP. Reproduced with permission from ITDP; further permission required for reuse.

INFRASTRUCTURE PROVISION FOR DENSITY

Although the Donghaochong Canal restoration project was not directly coordinated with the BRT project, improvements in this area and in public spaces and pedestrian facilities along the BRT corridor will help retain high levels of transit passengers, by ensuring that corridors for accessing BRT by walking and cycling are attractive and vibrant. A similar transformation of a drab streetscape into a spectacular public space was achieved through the restoration of the Lizhiwan Canal, which also opened in 2010. These serve as examples of the shift towards transit-oriented development and corridor improvements in Guangzhou, as a shift towards improving the image and functionality of the BRT corridor has come to exist.

Until recently, the Donghaochong Canal was a polluted ditch running mostly under an elevated expressway. Uncontrolled urban development had encroached on the banks of the canal, and buildings were periodically flooded when waters overflowed the banks, sometimes spilling sewage into adjacent residential and commercial properties. Starting in 2009, a 3-kilometer stretch of land along the Donghaochong Canal was cleared and turned into a greenway, featuring world-class walking and cycling facilities and popular new green public spaces. In the surrounding area, more than 329,000 square meters of new commercial real estate is being developed.[3] The Donghaochong Canal Museum, housed in two historic villas, recently opened providing information on the canal and its history. The greenway project attracts people to live, work, and play and has become a popular free swimming area in the summer.

Figure 24: The Donghaochong Canal before and after restoration efforts to improve the vital public space along the BRT corridor. | *Source:* Far East BRT Planning Co., Limited ©Far East BRT Planning Co. Reproduced with permission from Far East BRT Planning Co.; further permission required for reuse.

INCLUSIVITY & AFFORDABLE TOD SYSTEMS

Along with improved modal options for BRT users, affordability has also significantly improved with the creation of the BRT system. Bus fares have undergone substantial simplification and restructuring as a part of a citywide low-fare program. Previously most bus fares were 2 Yuan (USD 0.30), though some longer routes had fares as high as 5 Yuan. As of 2010, all route fares cost 2 Yuan, a deliberate attempt by city government to subsidize and make the BRT system more accessible to all citizens. Also, within the BRT system, riders are allowed free bus transfers, whereas outside the BRT system they must pay a second fare to transfer. Smart Cards provide frequent BRT users a discount as well: after the first fifteen rides in a month subsequent fares are 1.2 Yuan. All of these changes have the effect of decreasing the average fare price for BRT riders.[2]

However, not only low-income households are enjoying the benefits of the project. Higher-income households along the BRT corridor, often car owners, initially opposed the BRT, fearing traffic conditions would worsen because of the reduced road space for cars. Contradictorily, the BRT has improved not only bus speed and travel time, but also private car speeds and travel time. With an encouraged and incentivized use of public transit, less private vehicles on the road has been beneficial for both the BRT system and those who decide to travel by private vehicle.

For those without cars, the BRT system has significantly enhanced regional accessibility by reducing the amount of time needed to travel around the city. It has also reduced travel costs, as users can transfer for free from BRT buses to other buses serving different routes. The system bodes well for lower-income households by allowing them simple access to the city center, while retaining their lower-value property on the periphery of the city. This increased affordability can be attributed to the success of the overall system.

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE

- **2003-** Preliminary planning for a BRT system began
- **2005-** Conceptual plan, demand analysis & corridor comparison[6]
- **2006-** Phase 2 planning; traffic, operational and design planning; & demand analysis for Phase 1[6]
- **2007-2008-** Implementation planning & design[6]
- **2009-** 3km stretch along Donghaochong Canal was cleared and turned into a greenway
- **2010-** First phase of construction completed February

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Conduct Analysis of Area
3. Create Strategy Plan (Phases)
4. Identify Key Stakeholders
5. Find Funding
6. Optimize/ Utilize Land Value
7. Create Design Strategies to Encourage Transit Use
8. Market to Encourage Active Transport

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

A good example of successful TOD and BRT implementation, the system is a prime illustration of the success transit can bring to a city. The success of the project will undoubtedly bring transit-oriented development that intensifies and urbanizes the city along the Zhongshan corridor, lending to a more environmental and social-inducing urban form. Evidence from around the world shows that when high-quality transit service is in place, it encourages denser, more mixed-use land uses, setting a land use pattern more conducive to walking, biking, and transit in place of automobile trips. If this investment in multi-modal transportation encourages even a very small fraction of the several million people who live along the Zhongshan corridor to forgo a car purchase the impacts on GHGs is very large.[4] Further, if local developers capitalize on these alternative transport assets and build dense, walkable, mixed-use housing developments with low parking ratios, the impact will grow larger than estimated here and be better sustained over time.

ROADBLOCKS AND WAYS TO IMPROVE

Enacting this strategy was not without challenges, as authorities had to overcome decades' worth of disjointed and piecemeal transportation planning within the city's street network. Years of slow service and delays on the bus system also left negative perceptions of bus transit with city residents. The methods used to improve were careful planning and analysis to justify such a large-scale system. Demand analysis played a large role in designing the system. The project also supports a comprehensive approach to transportation planning in rapid-growth scenarios, as congestion cannot be resolved without a balanced modal share and shift in user attitude.

KEY LESSONS

The following key takeaways should be derived from the Guangzhou example:

- Adopting a method of relieving the high demand placed on the bus and road systems existing along the corridor were a necessary adaption to improve the efficiency and success of their transit system
- The Guangzhou BRT boasts 850,000 average weekday riders.
- Public/ Private Partnership.
- Exemplifies modal connectivity and encourages active transportation as a supplementary mode, with updated cycling and pedestrian infrastructure that is both safe and of world-class design.

ENDNOTES

1. Center for Clean Air Policy. 2013. “Developing Sustainable Transportation with the Guangzhou Bus Rapid Transit System and Multi-Modal Transport Network.” CCAP Booklet, China Transport. http://ccap.org/assets/CCAP-Booklet_ChinaTransport.pdf
2. Huges, Colin, Xianyuan Xhu. 2011. “Guangzhou, China: Bus Rapid Transit Emissions Impact Analysis.” *ITDP.* https://www.itdp.org/wp-content/uploads/2014/07/GZ_BRT_Impacts_20110810_ITDP.pdf
3. Far East Mobility. 2018. “Donghaochong canal and greenway.” *Urban Development Best Practice Case Studies: BRT & Urban Transport Planning*. http://www.fareast.mobi/en/bestpractices/donghaochong
4. Suzuki, Hiroaki, Robert Cervero, and Kanako Luchi. 2013. “Transforming Cities with Transit: Transit and Land Use Integration for Sustainable Urban Development.” *The World Bank,* Urban Development Series.
5. Morris, Jessica, and Stephanie Lotshaw. 2011. “Guangzhou wins 2011 Sustainable Transport Award for innovative transport solutions.” *Institute for Transportation & Development Policy.* https://www.itdp.org/guangzhou-wins-2011-sustainable-transport-award-for-innovative-transport-solutions/
6. Fjellstrom, Karl. 2010. High capacity BRT planning, implementation & operation: Case study of the Guangzhou BRT. *ITDP*. Accessed July 24, 2018. http://www.uncrd.or.jp/content/documents/5EST-B2B3.pdf
7. Institute for Transportation and Development Policy. 2018. “How to Move Nearly 30,000 People per Hour Across a City.” *Development Asia.* Accessed July 25, 2018. https://development.asia/case-study/how-move-nearly-30000-people-hour-across-city

ASIA | CASE STUDY

SEOUL, REPUBLIC OF KOREA

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SEOUL, REPUBLIC OF KOREA

QUICK FACTS

Geographic Context
East Asia (Republic of Korea)

Scale
City, Neighbourhood, Station and Corridor

Context
Urban and Suburban

Mode of Higher Order Transit
BRT and Metro

Size of City (Population)
25 million (Tier-1)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

With over 22 million residents and a population density of 10.4 million inhabitants over a land area of 605 square kilometers, Seoul is one of the largest and fastest growing mega-cities in the world. Amongst this population, only a small percentage of Koreans have access to a car (2 per 1,000 persons) as of 1970. Although ownership has increased vastly over the last 30 years, with 215 of every 1,000 currently owning a vehicle, this increase can be attributed to the inadequate transit provision within Seoul.[1] The result of such demand is a burdened bus system, characterized by both high passenger volumes, lengthy ride durations and distances and reduced bus speeds. Demand greatly outweighing the public provision of transit, a drive towards transit-oriented development (TOD) became a necessity to solve the overwhelming congestion and declining bus quality experienced in the city.

Until 1974, Seoul was almost entirely dependent on bus services with intensive congestion, passenger volumes and trip distances. This encouraged the creation of an urban rail system. Seoul's first metro line was enacted in 1974 and has since grown to a total of 487 km in 2004 with close to 400 stations.

The rail network in Seoul is now one of the largest in the world and carries 8.4 million passengers per day—more than twice the daily passenger volumes on the New York subways and the London underground. [6]

The main problem, however, was poor bus service, which, in turn, encouraged increasing car use. Although it did not deal with the core problem of unregulated private bus firms, the Seoul Metropolitan Government made several attempts to improve bus service and ridership. The first curbside bus lanes were installed in 1984 and expanded to 89 km by 1993, 174 km by 1994, and 219 km by 2003.[4] The network of reserved bus lanes helped speed up bus travel somewhat, but it did not succeed in raising bus use. Clearly, more drastic changes were necessary. Hence, Myung-Bak Lee, the former mayor of Seoul, implemented more pressing reforms that involved generating car-dominated areas, reclaiming space for pedestrians, and fully integrating a BRT system supported by policy interventions and technical advocates. Due to such high densities, the Seoul metropolitan government over the years has also aggressively sought to decentralize growth, mainly in the form of building master-planned new towns sited on the region's periphery.

TOD KP

OVERALL TOD STRATEGY & CITY STRUCTURE

Over the past several decades Seoul has followed a pattern of American-style sprawl with a rise in private automobile ownership. However, population densities in Seoul have historically been and remain high by global standards.[5] The city of Seoul itself, along with the port city of Incheon and surrounding Kyunggi Province, constitute the Seoul Metropolitan Area (also called the Seoul National Capital Area), with more than 23 million inhabitants—the world's second-largest urban agglomeration.[5] In 2006, Seoul and Incheon combined had the sixth-highest population density in the world (16,700 people per square kilometers).[5]

The deep reform of public transport in Seoul has been a major step towards retaining its competitive edge. The former Mayor of Seoul, Myung-Bak Lee, led the charge of reinvesting in Seoul. In 2001, Lee ran for mayor of Seoul, largely on a platform of reinvigorating the central city as means of creating a more sustainable yet productive city.[3] His platform called not only for expanding public transit services, but also for reducing the ecological footprint of private cars by reclaiming urban space consumed by roads and highways. "Why scar the interior of the city," he reasoned, "to funnel suburbanites to office jobs in the core?"[3]

INFRASTRUCTURE PROVISION FOR DENSITY

A major culprit was the network of elevated freeways into central Seoul—facilities that severed longstanding neighborhoods, formed barriers and created visual blight[5]. Although freeways provided important mobility benefits, Lee recognized that those benefits had to be weighed against their nuisance effect.

Public transit had to be substantially expanded and upgraded to absorb traffic. The city did so by extending subway lines and creating seven new lines of exclusive median-lane buses (stretching 84 kilometers, later expanded to 162 kilometers) and 294 kilometers of dedicated curbside bus lanes.[3]

LAND TENURE & LAND VALUE CAPTURE

The freeways to greenways conversion created higher market demands. The greenways along the TOD corridors further boosted land value and development activity along these busy corridors. When the elevated freeway existed housing prices within three kilometers fell.[2] This shows the previous blight that Mayor Lee spoke about. When the freeway was convert to a greenway the housing prices within 2km of it rose as much as 8%. [2] More high-value industries and commercial parcels also came to the corridors near the greenway. This spoke volumes for the community's values. Quality of place won over a car dominance.

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

The former Mayor Lee, and the Seoul Development Institute (SDI) were crucial in enacting far-reaching reforms for Seoul's public transit system. When elected in June 2002, Lee promised to improve the public transport system in Seoul and commissioned a series of comprehensive studies performed by the research division of SDI.[4] The studies resulted in recommendations for the modernization of the metro and bus fare structures and payment systems, better integration of bus and metro services, an expanded network of reserved bus lanes, and a complete overhaul of the organization and operation of bus services.[4] The transport specialists at SDI, led by Dr. Gyengchul Kim and Dr. Keeyeon Hwang, were the main technical advocates for these changes, while Mayor Lee and his staff provided the necessary political support.[4]

Elevated Freeway

Urban Greenway

Figure 25: Freeway to Greenway Conversion[2] | *Source:* The World Bank 2013 ©Seoul Metropolitan Government 2003. Reproduced with permission from WB; further permission required for reuse.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

One of the first major changes was an entire redesign of the bus network to integrate more than 400 different bus routes. All bus services are now grouped into four types, color-coded for passenger ease.

To coordinate bus services, the Seoul Metropolitan Government set up a new Bus Management System (BMS) using advanced intelligent transport system (ITS) technology. Global positioning system (GPS) terminals located in every bus now permit a central bus control center to monitor all bus locations and speeds, adjust the number of buses per route, communicate with bus drivers, and provide real-time information to passengers.[4] The new BMS facilitates more dependable bus service and optimizes service distribution by adjusting bus assignments and schedules to conform to travel demands.[1]

In addition to the complete redesign of the route network, the system of dedicated bus lanes was expanded from 219 km to 294 km, with more expansions planned.[4] Most significant, however, is the development of a true BRT network with dedicated center bus lanes, high-quality median bus stops, real-time information integration and state-of-the-art buses.[3]

The Seoul Metropolitan Government now views BRT as a much more economical and efficient way to provide public transport services than metro expansion, which can take many years to construct and requires large capital investments.

Nevertheless, the extensive rail system in Seoul remains the backbone of public transportation. Better integrating bus services with the metro is, therefore, essential. Bus routes and stops have already been relocated to facilitate simple transfers between modes. The city is currently in the process of building 22 additional transfer centers as well.

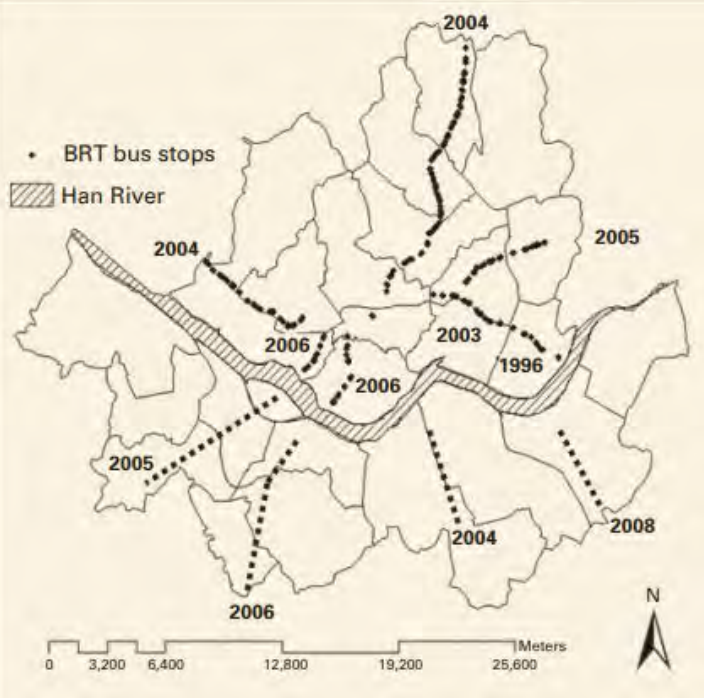


Figure 26: Bus Rapid Transit Corridor in Central Seoul[2] | *Source:* The World Bank 2013 ©World Bank. Reproduced with permission from WB; further permission required for reuse.

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE[6]

- **1953-** First public bus began services
- **1970-** Only 2 in every 1000 people had access to a car
- **1974-** Seoul Conducted its first metro line, 8km long
- **1984-** First curbside bus lanes were installed
- **1993-** Bus lanes expanded to 89km
- **1994-** Bus lanes expanded to 174km
- **2001-** Myung-Bak Lee ran for mayor on the platform of reinvigorating the central city as means of creating a more sustainable yet productive city
- **June 2002-** Lee was elected and promised to improve the public transport system
- **2003-** Bus lanes expanded to 219km
- **December 2003**- Results from studies performed by SDI were published recommending coordination and modernization of the metro and bus systems.
- **January 2004-** Mayor Lee conducted public relations campaign to explain the benefits of reform
- **July 2004-** Start date for implementation of reform
- **2004-** Metro line expanded to 487km and bus lanes expanded to 294km
- **July 2009-** Metro line 9 opened for operation

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Create Strategy Plan (Phases)
3. Establish Policies
4. Identify Key Stakeholders
5. Optimize/ Utilize Land Value
6. Create Design Strategies to Encourage Transit Use
7. Market Plan

KEY LESSONS LEARNED AND BEST PRACTICES

The dramatically altering reforms of July 2004 completely restructured bus services in Seoul and increased demand-based control over routes, schedules, and other aspects of service. An integrated metro and bus system allow for seamless transition between modes and a far superior overall public transport system. Central to the reforms was the introduction of an entirely new system of fully-separated BRT routes.

Studies have proven that BRT systems around the world can provide excellent express service at a fraction of the cost of new rail systems. The experience with BRT in Seoul has been a resounding success.

ROADBLOCKS AND WAYS TO IMPROVE

One roadblock appeared right after the major reform in which there was tremendous service disruption, public discontent, and political uproar. A smooth transition to the completely new bus routes, fare structure, and fare payment system required more time. In particular, there should have been a trial period to test the reforms on a selective basis instead of immediately adopting them system-wide. Mayor Lee created campaigns to inform the citizens about this major reform however he only ran the campaign for six months prior to the start date. To improve this in the future, more time and effort to distribute the appropriate information to the public before implementing the reforms should be planned.

KEY LESSONS

The following key takeaways should be derived from the Seoul example:

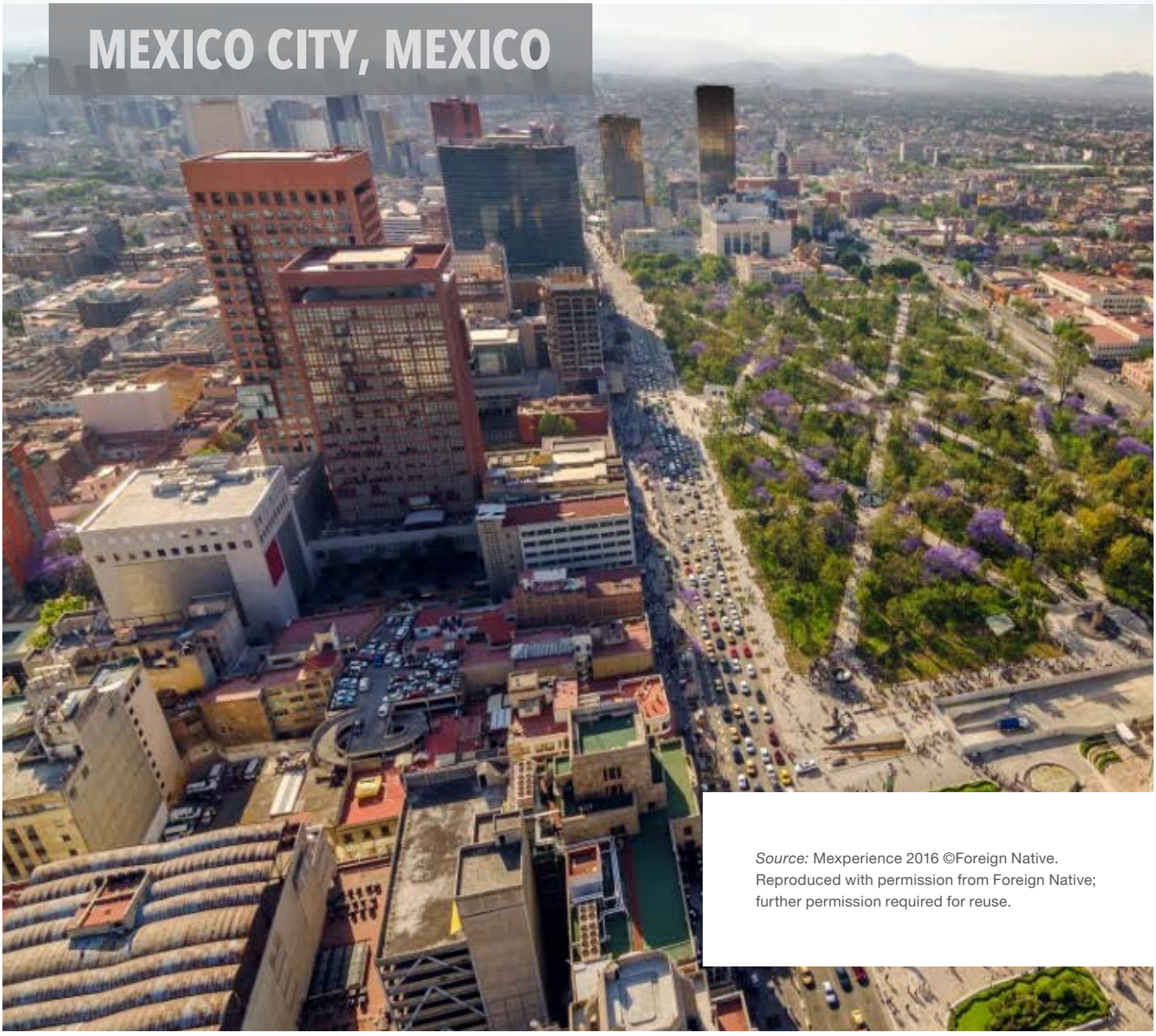
- Mayoral-led efforts
- Minimized network of elevated freeways
- Both BRT and metro lines were exponentially increased in length
- Integrated Intelligent Transportation Systems (ITS)
- Created 400 bus routes and constructed 22 major transfer centers.

ENDNOTES

1. Development Institute. 2004. “Monitoring bus service systems: For Seoul bus system reform programs, Seoul, South Korea.” *Seoul Development Institute.*
2. Suzuki, Hiroaki, Robert Cervero, and Kanako Luchi. 2013. “Transforming Cities with Transit: Transit and Land Use Integration for Sustainable Urban Development.” *The World Bank,* Urban Development Series*.*
3. Seoul Development Institute. 2003. “Guidelines for implementation of the transportation system reform in Seoul: Bus operation system.” *Seoul Development Institute.*
4. Seoul Development Institute. 2003. “Guidelines for implementation of the transportation system reform in Seoul: Policy for public transportation fare.” *Seoul Development Institute*.
5. Atlas of Urban Expansion. 2014. “Seoul”. http://www.atlasofurbanexpansion.org/cities/view/Seoul
6. Seoul Metropolitan Rapid Transit Corporation. 2005. “Origin and development of the Seoul metropolitan subway system.” *Seoul Metropolitan Rapid Transit Corporation.* http://www.smrt.co.kr/english/ smrt/state_smsc.jsp?m1=1&m2=4.

AMERICAS | CASE STUDY

MEXICO CITY, MEXICO



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MEXICO CITY, MEXICO

QUICK FACTS

Geographic Context
South America (Mexico)

Scale
City, Corridor, and Station

Context
Urban

Mode of Higher Order Transit
BRT Metrobus and Metro

Size of City (Population)
21.4 million (Tier-1)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

Mexico City, the capital of Mexico, is home to over 17 million people and a population greater than any other city in North America. The city has a population density of approximately 8,400 people per sq. kilometer and is growing by 2.5% annually.[1] With such an immense population and an urban area that is gradually becoming denser, various issues have come to arise as a result. Congested travel modes, significant pollution and smog, and unsafe transit systems are each a result of the growth Mexico City has been experiencing. In order to combat these adverse effects, in 2005, Mexico City created a Bus Rapid Transit (BRT) system called Metrobus.

Metrobus is the world's sixth busiest BRT system and is a continually-expanding system which now carries more than 300 million passengers a year across 125 kilometers and six lines of exclusive bus lanes.[8] Compared to the jitney bus services that BRT replaced, travel times in BRT corridors have fallen by 40 percent and there are 30 percent fewer accidents. In addition, 15 percent of drivers in corridors served by BRT reportedly have switched to public transit.[4]

The improvements have also produced modest reductions in emissions of greenhouse gases and smog.

The Metrobus greatly enhanced the public sector's direct involvement in the planning of key transportation services and administrative faculties, which had suffered throughout previous decades. This outcome is arguably just as—if not more—important than BRT's impacts on mobility, safety, and pollution. Mexico City's surface transit industry has transitioned from a system dominated by an unruly and unmanageable set of independent, small-scale operators concerned only for personal gain. Instead, a professional, modernized, faster, safer, environmentally-conscious system replaced jitney service improving the experiences of millions that rely on public transportation in their day-to-day lives.

TOD KP

OVERALL TOD STRATEGY & CITY STRUCTURE

Mexico City generated a quick-to-implement, modest, and yet highly visible programmatic success on key corridors in the city. In 2005, Metrobus opened and replaced 350 standard buses with 97 BRT vehicles, owned by both private and public companies.[6] The project consists of two components, the first being the construction of a mass transit corridor along Insurgentes Avenue, integrated with traffic management for private vehicle travel. The system would include various elements for more efficient and comfortable travel including: exclusive bus lanes, upgraded pedestrian facilities leading to stations and low-polluting buses to replace the former polluting and low-capacity vehicles. The second component of the project would be the monitoring of the system and the creation of cycling linkages and new corridors to create a more integrated system. [6]

The approach towards implementing the BRT system was particularly complicated for Mexican officials, as existing, independent bus and jitney providers were highly resistant to the movement, as it would essentially put them out of business. The independent operations being undertaken prior to the BRT can be characterized as unruly and unmanageable, with operation sacrificing service standards for revenue.[5] The shift towards greater public control over transit allows for a focus on achieving transportation best practices that are beneficial socially, economically and environmentally. Reaching this point of public-sector control required strategic compensation, negotiation and persuasion at times. Initially, the government granted private operators compensation, which financially onerous, was replaced with guaranteed income in the new BRT system. Moreover, when financial methods were unsuccessful in inducing collaboration with jitney operators, city officials used rivalry groups to outflank operators that were not cooperating and threaten to move forward with new partner's instead.[5] This strategic approach to combating BRT opposition proved successful.

The siting of Mexico City's first BRT system was also strategic in its creation. Although ridership was projected to be lower, BRT implementation began Insurgentes Avenue, on the basis that it was located in a very prominent area and that political negotiations with the independent bus operators were likely be simpler. This allowed for a less-costly and quick example of visible BRT success in the city, paving the way for subsequent corridors to be expanded to match the successes of Insurgents.

INFRASTRUCTURE FUNDING

In addition to the submission of opposition, the strategy towards BRT financing would prove both beneficial and forward-thinking for Mexico City. Projected to cost over USD49.4 million, a combination of public, private and carbon financing methods were used.[8] Specifically, with regard to carbon financing, Mexico City government intended to use the purchase of greenhouse gas emission reduction to finance the project, as well as Clean Development Mechanism (CDM) revenues. With the objective of reducing carbon emissions through the introduction of the BRT, this financing method proved to be viable and resulted in more funding than anticipated for the Metrobus. Over 35,000 tons of carbon dioxide are reported to have been reduced annually due to the new BRT system.[6]

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

Essential to the success of Mexico City's BRT system was the mayor-led drive for control over the existing transportation system in Mexico City. Gaining control over the formerly unmanaged private sector service providers, through compensation, negotiation and when unsuccessful, credible threats, allowed for public transit to be expanded to actually include the public sector. The project overall can be characterized as government-led, with the strategic integration of private entities to assist in financing and operating the system.

The planning, management and construction financing were largely provided by the Mexico City government. Internalizing infrastructure costs allowed for large-scale capital financing to be taken care of, while vehicle provision and fare administration were contracted to reputable private entities, RTP and CISA.

The newly elected Mayor, Lopez Obrador, strategically timed changes to Mexico City's bus service to solidify public support, by pushing the agenda for both BRT and highway expansion, exemplifying an agenda of balanced transportation.[5] This assisted in quieting the car-supportive voters that would normally have opposed the project. Policy objectives of safety, enhanced air quality, environmental sustainability and urban redevelopment of distressed areas of the city led the drive and appeal for the project.

This government intervention was paired with the creation of a new public entity, Metrobus, and partnering with private entities RTP and CISA, which would operate and maintain operations of the BRT. This allowed for safer and more professional operation of the public transit system that provided fair and objective fare systems to residents. As well, the city expanded the financial benefits of public-private partnership arrangements beyond original bus and jitney owners to generate more widespread industry support for the changes.[5] Providing the public bus operator with the opportunity to act as a participant in the creation of the first BRT line, city officials gained the support of public sector workers, accessed their experiential wisdom, and reduced the number of new buses requiring financing.

Public and private entities involved also strived to be transparent with and cognizant of the citizens that would be utilizing the system. To understand whether a mandate for change existed within Mexico City's residents, public consultation booths across the city were used to gain an impression of locals' thoughts and opinions on a potential BRT system. By using a comprehensive approach, inclusive of the various stakeholders, Mexico City was able to introduce a system that was widely supported and successful as a result.

TOD KP

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

Mexico City implemented tried and true policy templates from other cities, as well as, leveraging external resources to help catapult new ideas for transport onto the public agenda. Environment Minister Claudia Sheinbaum developed the BRT proposal with the support and advice of a global network of sustainable transport researchers, funders and development agencies. In designing their BRT system, Mexico City was driven by the mayoral political agenda of supporting a balanced transportation system.[5] With this said, future developments intend to address cycling networks and the extension of the BRT corridor to better integrate these modes. With over 855,000 passengers daily, Metrobus has been successful in ensuring a shift from a car-dominated modal preference.[4] Ridership has instead switched to transit, as well as cycling which has been seamlessly integrated into the BRT system with the 2010 creation of EcoBici. EcoBici is a bike sharing program created to increase the popularity of bike commuting in Mexico City, with over 6,000 bikes and 250 stations dispersed amongst the city as of 2015.[3] The widespread system is efficient and simple to use and was strategically launched near transit stations to encourage multi-modal travel. With the intention to expand the system even further in 2018 and to improve bike infrastructure to support EcoBici, cycling is likely to be a large influence in discouraging car travel in Mexico City.

To encourage this increased transit use, which has resulted in a reduction of car use by 15%, focusing on the environmental aspect of transportation was an important driver.[4] Formerly plagued by smog and pollution, the BRT system aimed to mitigate these adverse effects and reduced the amount of harmful air pollutants riders were exposed to be 2-3 times. Accident rates were also significantly reduced by up to 30%. Providing a safer and healthier system to its citizens was one important factor to improving their use of transit.[4]

Additionally, upgrades to the stations and fleet of buses being used allowed for greater capacity and comfort for riders. Overcrowding and congestion discourage ridership, thereby combating these issues is vital to encouraging transit use. The use of vehicles with a 160 passenger capacity versus the smaller standard buses in the past system was beneficial to tackling the issue of crowding.[6] Moreover, the improved efficiency that arose from the BRT system was a vital determinant in encouraging a shift for private car use to public transit. Commute time have been reported to have seen reduction of up to half an hour and buses are strategically timed to arrive at high frequencies of up to 56 per hour during peak times of the day.[6] In scenarios where public transit becomes the more efficient option, it is unsurprising that the modal shift moves in its favor.

Tepalcates Central Station (Before)

Tepalcates Central Station (After)

Figure 27: MetroBus Station Design | *Source:* New York City Global Partners Innovation Exchange 2012 ©Metrobus.

INCLUSIVE & AFFORDABLE TOD SYSTEMS

Inclusivity and affordability are also essential parts of improving the appeal of public transit. In the case of Mexico City's Metrobus, all paper tickets and cash payments have been removed from the system and payment occurs solely with the use of rechargeable fare cards.[2] This method of payment, although efficient, has its shortcomings, in that only some of the stations have card recharge stations. It also costs citizens 10 pesos to initially purchase the card, which has impacts on the system's affordability. Each ride costs 6 pesos, which includes as many transfers as need be and use of all five BRT lines.[2] The ability to travel at such lengths and with unlimited transfers has the effect of improving the affordability of the transit line for riders that travel from periphery neighborhoods to the inner city. While the system may not be as largely subsidized comparably with examples in Asia, for instance, the price is by no means a complete barrier to public transit use.

In the spirit of transit-oriented development, including affordable housing in the developments that result along the BRT corridor is being emphasized to cater to the diverse population using the system. One example is the IntegrARA Iztacalco development which is less than a quarter mile from a BRT line and is reusing a greyfield industrial site to create 720 affordable housing units.[7] The development includes courtyards, recreational spaces, cycling facilities and mixed-use, high density buildings to create a neighborhood closely resembling best practices of transit-oriented development. By catering to a broad range of income levels and providing a mix of private and public spaces with close access to both the BRT and metro corridors, the development makes living near transit an affordable option.

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE [9]

- **June 2005-** Metrobus Bus Rapid Transit (BRT) began operations- Line 1 Phase 1
- **March 2008-** Opening of Line 1 Phase 2
- **December 2008-** Opening of MetroBus Line 2
- **2010-** EcoBici, bike sharing program, was created
- **May 2010-** Start of construction of Line 3
- **February 2011-** Opening of Line 3
- **April 2012-** Opening of Line 4
- **November 2013-** Opening of Line 5
- **2015-** EcoBici had 6,000 bikes and 250 stations in Mexico City
- **January 2016-** Opening of Line 6
- **February 2018-** Opening of Line 7
- **2018-** Expand EcoBici system further and improve bike infrastructure.

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Create Strategy Plan (Phases)
3. Identify Key Stakeholders
4. Find Funding
5. Mitigate Competition
6. Optimize/ Utilize Land Value
7. Create Design Strategies to Encourage Transit Use

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

Mexico City's implementation of a BRT system is well-known as best practice in the TOD development realm. With clear improvements to efficiency, environmental impact, rider satisfaction and capacity, the system has been a success. Mexico City was successful in their use of public-private partnerships and environmental reduction as methods of financing the large capital cost infrastructure project. Mexico City involved not only private corporations, but the bus operators and drivers as well, which allowed for a diverse investment group to buy-in to the project. Moreover, by focusing on the environmental aspects of transit provision, the city was able to capitalize on carbon emission reduction costs to finance the project, whilst also improving their ecological footprint.

ROADBLOCKS AND WAYS TO IMPROVE

A major roadblock while implementing the BRT system was the independent bus and jitney providers were highly resistant to the movement, as it would essentially put them out of business. The independent operations being undertaken prior to the BRT can be characterized as unruly and unmanageable, with operation sacrificing service standards for revenue. The way that they improved this situation was first by compensation, negotiation and persuasion. When financial measures were unsuccessful city officials used rivalry groups to outflank operators that were not cooperating and threatened to move forward with new partners instead.

KEY LESSONS

The following key takeaways should be derived from the Mexico City example:

- Project consisted of two components- Construction of a mass transit corridor and then monitoring the system and creating cycle linkages and new corridors.
- Metrobus greatly enhanced the public sector's direct involvement in the planning and territorial management of key transportation services.
- Over 35,000 tons of carbon dioxide are reduced annually due to the new BRT system.
- Increased transit use resulted in a 15% reduction in car use.
- Accident rates have been reduced by to 30%.
- Less than a quarter mile from a BRT line 720 affordable housing units were created.

ENDNOTES

1. Atlas of Urban Expansion. 2018. "Mexico City." http://www.atlasofurbanexpansion.org/cities/view/Mexico_City
2. Ciudad de Mexico. 2018. "Metrobus." *Metrobus.* http://www.metrobus.cdmx.gob.mx/
3. Petalta, Martha Delgado. 2017. "Lessons from Ecobici for the Implementation of Public Bicycle Systems in Mexico." *Global Cities Covenant on Climate Secretariat.* Friedrich-Ebert-Stiftung.
4. Aguilera, Guillero Calderon. 2012. "Best Practice: Metrobus Bus Rapid Transit System." *New York City Global Partners.* http://www.nyc.gov/html/ia/gprb/downloads/pdf/Mexico%20City_Metrobus.pdf
5. Transforming Urban Transport: The Role of Political Leadership (TUT-POL). 2016. "Mexico City's Bus Rapid Transit: Incrementally Laying the Groundwork for Large-scale Transformation." *Harvard University, Graduate School of Design.* http://research.gsd.harvard.edu/tut/files/2016/10/MexicoCityBrief1003.pdf
6. United Nations. 2018. "Mexico City Bus Rapid Transit." *Sustainable Development Knowledge Platform*. https://sustainabledevelopment.un.org/index.php?page=view&type=99&nr=49&menu=1449
7. urbanNext. 2014. "IntegrARA: Urban Affordable Housing in Mexico City." *a | 911.* https://urbannext.net/integrara/
8. The World Bank. 2018. "Mexico City Insurgentes Bus Rapid Transit System Carbon Finance Project." *Projects and Operations.* http://projects.worldbank.org/P082656/mexico-city-insurgentes-bus-rapid-transit-system-carbon-finance-project?lang=en

AMERICAS | CASE STUDY

SANTIAGO, CHILE

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SANTIAGO, CHILE

QUICK FACTS

Geographic Context
South America (Chile)

Scale
City and Corridor

Context
Urban

Mode of Higher Order Transit
BRT and Metro

Size of City (Population)
6.3 million (Tier 2)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

Santiago, Chile, the capital city of Chile, is one of the most densely populated cities in the Americas. With a population of over 7 million people, it is the most populous city in Chile, with a density of almost 9,000 people per square kilometer.[1] The population is dispersed across a large urban area, which continues to increase in its extents and population annually. Transportation in Chile has be known to be lengthy and inefficient, with safety and passenger treatment receiving very low priority. Between the absence of fare integration with other transport services or with the subway, higher demand than provision, the poor treatment of passengers and a high accident rate, the transit system does not provide an environment that encourages its use.[3] Commuter resentment against the system was rising and according to a survey conducted in 2003, the bus system was voted the city's worst public service.[3]

Persistent and severe complaints prompted intervention from the government of Chile to overhaul the city's public transport system with a metro and bus-based integrated system, focused on including a high-tech centralized control system. An entirely new transport industry structure was conceptualized and financed through an international bid for tenders.

The resulting system of a seamlessly integrated BRT and metro lends to the ideals of transit-oriented development (TOD) that are being emphasized in planning and development practices currently. A system of efficiency, passenger comfort and safety for both riders and the environment has resulted from necessary interventions.

OVERALL TOD STRATEGY & CITY STRUCTURE

Transantiago, the public transport system in Santiago, Chile is comprised of a bus rapid transit (BRT), feeder bus lines and a metro system. It completed its fourth year of operation in February 2011. Prior to Transantiago's implementation, the city's public transport system proved to be problematic. The system was fully privatized and run by 3,000 independent operators, using a fleet of converted trucks, unfit for public transport.[3] Since 2001, the buses enabled 43 percent of the motorized trips in the city.[3]

Santiago's overall strategy to improving the shortcomings of these systems was an integrated multi-modal system inclusive of a BRT and an expanded Metro network. BRT development involved the creation of 18.8 km of segregated corridors, 4.6 km of new road connections, 62.7 km of road and pavement improvements, and construction of about 70 bus stops.[3] The bus fleet was made up of 1,200 new low-floor articulated trunk buses, 1,500 conventional trunk buses and 2,300 feeder buses.[3] The expansion of the metro network expansion included construction of 66 km of tracks and 68 stations at a total cost of USD $2.4 billion. About 45 km of tracks were built between 2000 and 2006, enhancing the ability of the system to deliver 830,000 trips per day. Another 21 km were built after 2006 which enabled 254,000 additional daily trips.[3] The integration of cycling facilities and bike sharing within public transit is also planned for enhancement, to allow for active transportation options with the modal split.

Integration of transit services involved the installation of a unified financial system, contactless fare cards, and the construction of two inter-modal stations. The system allowed for the integration of information systems for operational control and data collection, investment estimated at USD $30 million.[3]

Overall, the implementation of Transantiago was based on two objectives: complementation and integration. Complementation related to the enhancement of both the BRT and Metro systems to better complement each other and create a multi-modal system. Integration references the development of a single-fare system of both bus and Metro. Through these underlying objectives, a system that serves over.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

Santiago has utilized a variety of design strategies to ensure the increased and continued use of their transit services upon their expansion. A main driver in ridership is the seamless integration of the BRT and Metro systems. With a unified fare system which uses contactless fare cards, transferring between modes is efficient and affordable.[3] In the case of Santiago's two inter-modal transit stations, riders do not even have to leave the confines of the station to transfer between modes. This increased accessibility and convenience for riders is a vital influence in their use of the full transit system, all modes included.

Essential to furthering Metro and BRT integration was the introduction of connected cycling infrastructure within transit systems. Formerly, Santiago had very few cycling networks separated or on their roadways, which was mitigated in 2007 with a plan to introduce 690 kilometers of bike lanes throughout both rural and urban areas.[2] Still in its implementation phases city-wide, examples of inclusion in districts of the city have come to exist. For example, the district of Providencia engaged in a public bike system as of 2009, which has grown from an initial 1,000 bikes to over 4,000. Costing only USD2.00 monthly for unlimited trips of up to an hour, the system caters to a broad range of citizens from 14 to 80 years of age.[2] Compared to other South American cities, Santiago is reported to have the best cycling integration as shown in the table below. With heightened and simplified access to and from transit stations via bicycle, citizens' willingness to use transit rather than private vehicles has improved.

	Santiago	Montevideo	Quito	Florianopolis	Score per item
Bicycles allowed on board only off peak (3) any time (4) special facilities (5)	0	1	1	0	2
Bicycle ease access to public station/stops	2	0	1	0.1	3.1
Public Bicitaxis and/or bicycles access to stops and stations	1	0	0	0	1
Cycling facilities at stations/stops, lifts, ramps, etc.	2	0	0	0.6	2.6
Educational facilities that encourage use of bicycles	2	1	2	0.3	5.3
Other policies that promote cycle friendly culture. Ex. Coordinating agency for public transport and cycling.	2	1	0	0.3	3.3
General quality	**10**	**5**	**4**	**2.3**	

Score explanation: 0: there is nothing, 1: minimum facilities, 3: reasonable quality facilities 5: broad existence of high quality facilities and high level of integration

Table 4: Santiago's cycling integration statistics when compared to similar Latin American cities.[2] | *Source:* Paolo Jiron ©UN Habitat. Reproduced with permission from UN Habitat; further permission required for reuse.

Moreover, a continued focus on ensuring Transantiago is expanding to meet demand ensures efficiency and capacity, which are both drivers for heightened ridership. Santiago, Chile is reported to have the highest rail extension growth of all Latin American countries, with over 60km of rail expansion anticipated as shown in Figure.[2] In addition, simple design measures such as; colored bus lanes to avoid private vehicle incursion and delays in travel, lighting inclusion within bus stops for safety purposes and environmental policies that reduced emissions up to 20%.[3] These strategies, although seemingly minuscule, have large impacts on the efficiency and comfort of public transport systems in Santiago and can be attributed to greater rider satisfaction.

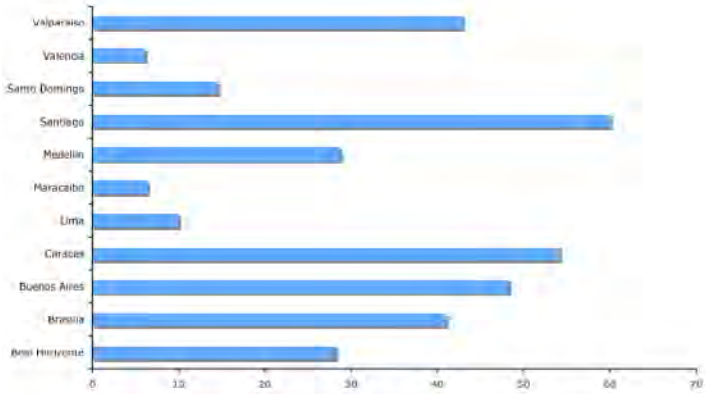


Figure 28: The rail expansion (in km) expected for various Latin American countries, Santiago leading the expansion trends.[2] | *Source:* Paolo Jiron ©UN Habitat. Reproduced with permission from UN Habitat; further permission required for reuse.

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

Essential to the implementation of Transantiago were the various stakeholders that played a role in its road to fruition. Developed under the mandate of the Urban Transportation Plan for Santiago (PTUS), a Presidential Advisory Commission was enacted to create an institutional framework for implementing the project. The commission consisted of the Ministers of Public Works and Housing, the Santiago Metropolitan Region, Transport Under-secretary, Environmental Commission Director and the Metro leaders.[2] Each with different priorities and focuses with regards to transportation, different perspectives were brought to the planning process and an integrated framework of a variety of urban priorities was developed.

The overall infrastructure funding was raised multiple ways. Forty-five percent of it was raised through public-private partnerships. Whereas, the remaining infrastructure was founded by the Ministry of Housing and Urbanism.[4]

The PTUS was eventually restructured and replaced with Transantiago, still led by the presidential advisors. The lack of lower-level stakeholder integration, in this case, can be described as one of the biggest downfalls to the project. With only high-level organization leaders engaged, local authorities, citizens and operating staff were not advised. Instead, the Presidential Advisory Commission had sole control, which led to a lack of accountability, coordination and efficiency.[2] Decentralizing the responsibilities with regards to public transit and including lower-level actors represents a much more effective institutional framework. Best practices from other contexts should be considered in this case for future success with public transit.

TOD KP

INCLUSIVITY & AFFORDABILITY IN TOD SYSTEMS

Offering more adequate public transportation is a step in the right direction in terms of offering equitable and accessible transport for all. Based on factors such as cost and safety of transit options, Santiago is working towards improved inclusivity in Transantiago. With regards to fare affordability, Transantiago costs USD$0.74 per ride paid via contactless fare cards. Statistically, lower income groups are more likely to walk, but compared with higher-income groups, use the bus more often and are not likely to drive private vehicles as shown in figure.[2]

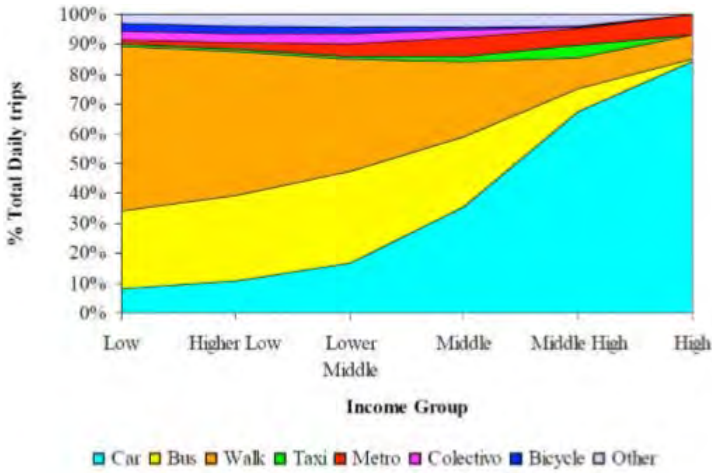


Figure 29: Modal share by income level in Santiago, Chile.[2] | *Source:* Paolo Jiron ©UN Habitat. Reproduced with permission from UN Habitat; further permission required for reuse.

To be derived from the above figure is the lower use of metro when compared to the BRT, as well as the tendency for lower-income households to walk instead. These statistics can lend to a question of affordability in the system. Although the fare seems insignificant when compared to North American comparable cities, in the context of Santiago, the underlying avoidance of public transit should be studied to consider possibilities for public subsidy.

Additionally, with regards to TOD, affordable housing has become a larger priority for the city since the 1990s, as shantytowns and slum housing were a prevalent option for lower-income households. To mitigate the effects of this unhealthy and inadequate housing type, conditioned planning has emerged in Santiago. This form of land use planning allows urban development to expand beyond city limits on a case-to-case basis, allowing residential development to spill out into the peripheries of the city.[2]

The issue with this form of housing development is its lack of connectivity and self-sufficiency, often creating instances of urban islands on the city periphery. Although this allows for larger areas for social housing and more affordable land, transportation in the future must better link these areas to allow for true TOD. As well, the creation of separated low-income districts is a concept that has been largely refuted in present times, as these locations amplify crime and safety concerns and are likely to be disproportionality exposed to health hazards when compared to middle and high-income groups. Strategic mixing of different income groups and better transportation integration with these periphery locations should be considered for development in the future.

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE

- **2000-** Metro network expansion started
- **2001**- Buses enabled 43% of the motorized trips in the city
- **2003-** Bus System was voted worst public survey
- **2006-** Added 21km to existing 45km of metro network
- **2007-** Plan was mitigated to add 690lm of bike lanes through rural and urban areas.
- **2009-** Providencia engaged in a public bike system
- **2011-** Transantiago completed fourth year of operation

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Create Strategy Plan (Phases)
3. Identify Key Stakeholders
4. Conduct Inter-Agency Collaboration
5. Find Funding
6. Optimize/ Utilize Land Value
7. Create Design Strategies to Encourage Transit Use

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

Santiago is the resulting system of a seamlessly integrated BRT and metro lends to the ideals of transit-oriented development(TOD) that are being emphasized in planning and development practices currently. A system of efficiency, passenger comfort and safety for both riders and the environment has resulted from necessary interventions.

A positive lesson to be taken from the case study is the concept of modal integration. Route re-organization was a complex technical problem (requiring a supply-demand balance for a social optimum), but allowed for Metro and BRT interaction. Strives towards also including cycling networks within this system will further the integrated nature of Transantiago. Ensuring a range of modal options not only allows for variety, but affordability and convenience in transit systems, and thus moving this agenda forward in other contexts will be essential.

ROADBLOCKS AND WAYS TO IMPROVE

Although Santiago created a widely used and integrated BRT and Metro system with Transantiago, the project had various roadblocks that should be learned for in applying BRT and Metro systems to other contexts. The first of these roadblocks was the lack of inter-agency collaboration in the planning of the system. In theory, this advisory commission provided an organized method of involving various government agencies, however, the tactic failed to include lower-level agencies and public input. A way to improve from this aspect of the project is the need for institutional coordination, which the project was successful in achieving, but also the inclusion of those that will use, operate and interact with the transit system on a daily basis. Another roadblock of the project is its potential concerns with regards to affordability, both with regards to fare and housing around the corridor. A way to improve this would be to develop transit with social issues and inclusivity in mind. This should be a priority in all context.

KEY LESSONS

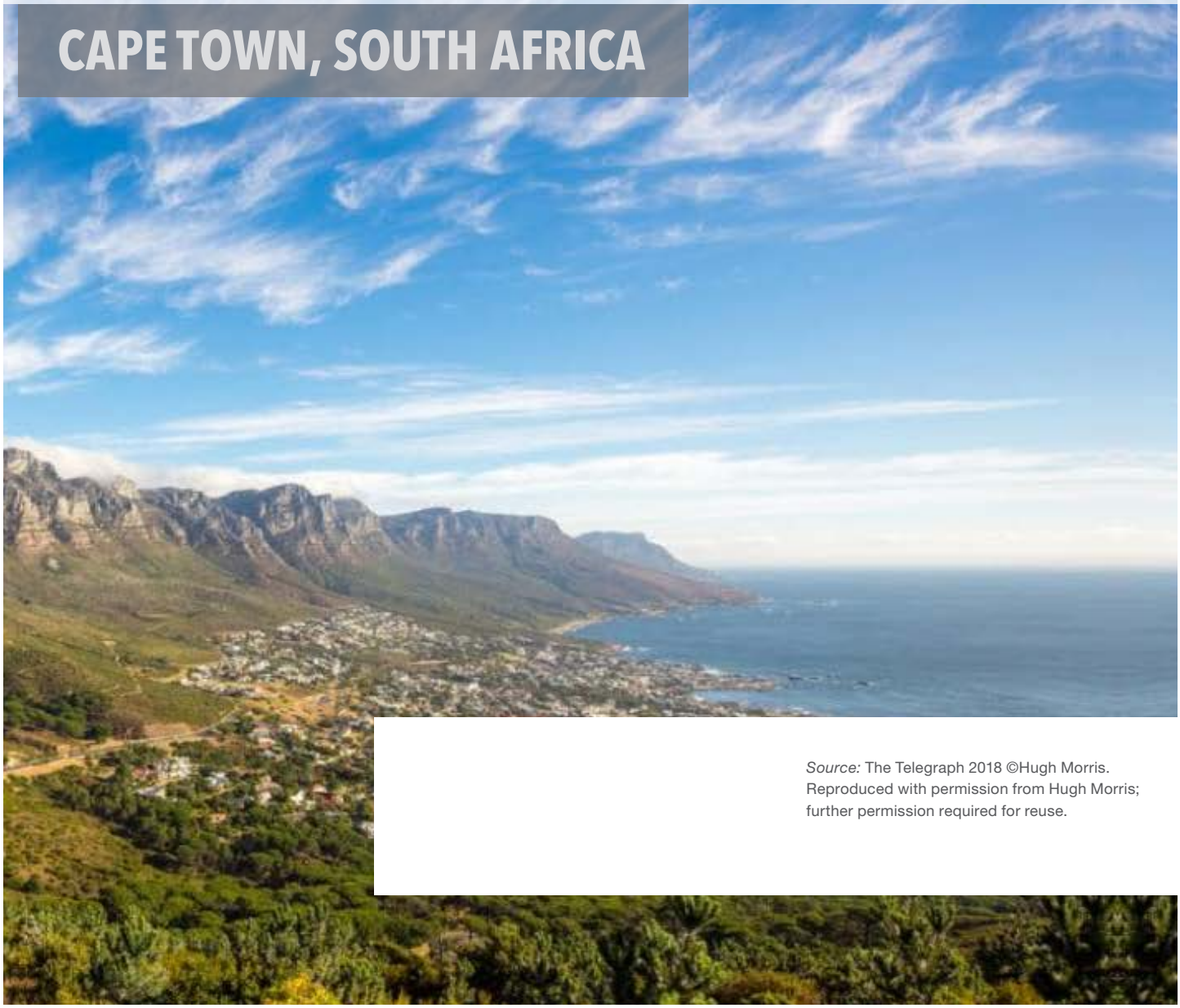
1. The following key takeaways should be derived from the Santiago example:
2. Santiago's overall strategy for improving the shortcomings of these systems was an integrated multi-modal system inclusive of a BRT and an expanded Metro network.
3. Transantiago was based on two objectives: complementation and integration
4. Affordable housing includes strategic mixing of different income groups and better transportation integration.

ENDNOTES

1. Atlas of Urban Expansion. 2016. "Santiago." http://www.atlasofurbanexpansion.org/cities/view/Santiago
2. Jiron, Paola. 2013. "Sustainable Urban Mobility in Latin America and the Caribbean." *United Nations Habitat Global Report on Human Settlements*. https://unhabitat.org/wp-content/uploads/2013/06/GRHS.2013.Regional.Latin_.America.and_.Caribbean.pdf
3. The World Bank. 2013. "Urban Transport Reform: The Santiago Experience." *Projects & Operations.* http://www.worldbank.org/en/results/2013/04/11/Urban-Transport-in-Santiago
4. Hidalgo, Dario, and Pierre Graftieaux. 2007. "Case Study Transantiago, Santiago Chile." *A Critical Look at Major Bus Improvements in Latin America and Asia.* The World Bank.

AFRICA | CASE STUDY

CAPE TOWN, SOUTH AFRICA



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CAPE TOWN, SOUTH AFRICA

QUICK FACTS

Geographic Context
Africa (South Africa)

Scale
City, Neighbourhood, and Corridor

Context
Urban and Suburban

Mode of Higher Order Transit
BRT

Size of City (Population)
3.7 million (Tier 2)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

Cape Town, South Africa is the second largest city in South Africa, after Johannesburg, with a population of over 3.7 million people. [1] The population is dispersed across close to 2500 square km of land, providing for a population density of 1,480 per square km, which is also lower than that of Johannesburg. [2] By 2030 the population is projected to only increase slightly to about 4.3 Million.[5] Unique to the South African context, when comparing it to other low-mid income cities, is its quite high proportion of citizens living under the poverty line. Over 36% of Cape Town's citizens are below the poverty line, with 4 % having no access to electricity and almost 10% without access to sanitation. [2] With such a high proportion of its citizens in need of social assistance, the 2010 World Cup in South Africa provided a valuable opportunity to the city to improve its social services, specifically adequate public transportation for low-income households.

At the national level, 12 cities were chosen to receive extra support to upgrade and integrate all modes of public transport to better host the event. Nine of the 12 cities were host cities to World Cup events, including Cape Town and Johannesburg among other cities. The BRT in Cape Town is still functioning and can be considered to be Africa's second system after Johannesburg's Rea Vaya.

TOD KP

OVERALL TOD STRATEGY & CITY STRUCTURE

The MyCiTi service forms part of an economic development strategy reliant on integrated transportation in the City of Cape Town (CoCT) in South Africa. In 2010, MyCiTi opened two pilot routes for the 2010 World Cup. The following year, the City of Cape Town began full services on MyCiTi's 16km corridor, rated bronze-standard. [4] The system continues to expand and servces the city center and airport.

MyCiTi began operations in May 2010, shortly before the FIFA World Cup, providing a shuttle service from the Civic Centre to Cape Town International Airport. It also included a temporary route around the City Bowl for the World Cup specifically. The first proper Bus Rapid Transit (BRT) phase (Phase 1A) opened in May 2011.[4] Characterized by features beyond those of traditional bus services, such as exclusive bus lanes, frequent timetables and an automated fare system, MyCiti is Cape Town's version of Bus Rapid Transport (BRT). It is an unprecedented public transport venture for the city, implemented in the hope of providing greater mobility to the majority of the population. [4]

By 2015, MyCiTi provided a BRT service and feeder services in most areas of the city, including low-income areas disadvantaged by their distances from the amenities and employment opportunities concentrated in the center. [4]

In addition to the BRT, concurrent ITDP work has included bringing the Access Africa program to Cape Town. This program intends to allow health care workers to visit more patients daily by providing bicycles to low-income health care workers who traditionally would work long hours and only access patients by foot. [4]

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

The Institute of Transportation and Development (ITDP) began working in the City of Cape Town in 2002, initially focused on building support for the concept of BRT. They would become one of the largest and most vital stakeholders in driving the improvement of public transportation in Cape Town. Through workshops and the exchange of international best practices – particularly bringing in experts involved in the implementation of Bogota's gold-standard TransMilenio – support for the BRT grew. [4] In 2007, ITDP joined the team creating the business plan and financial model for the MyCiTi BRT, and helped guide the project to success.[4]

As part of the process, ITDP assisted with the formalization of Cape Town's existing informal public transport industry, empowering small business owners to enter the formal market and transform into competitive companies. [4] Like in Johannesburg, the BRT system is now operated by companies comprised of former taxi operators. [4]

That said, MyCiTi service was largely a public funded initiative. One can argue that the success of the BRT necessitates greater integration of private sector participation at the outset, rather than the private sector waiting to see the success of the system.[4] The time horizon for such a scheme – which aims to have connected the entire city by 2030 – must take into account the long and difficult processes of navigating land changes, poor spatial legacies, uncertainty surrounding the minibus taxi industry, and major shifts in societal attitudes towards public transport.

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

The MyCiTi Integrated Rapid Transport system was very unique compared to other BRT systems in the sense that it incorporated all the other motorized and non-motorized transport methods that had already existed in the area into one cohesive new system instead of replacing them. By doing so MyCiTi was able to design a system that encompassed a passenger's entire journey, including arriving to the bus system from over 50m away, to easily being able to board the vehicles, and to be able to report any problems that may have occurred along the way. The system paid specific attention to accessibility to all. The stations provide level, seamless boarding onto vehicles through the use of dedicated boarding points, wheelchair accessible toilets, and wide entrance gates. The new fleets include low floor kneeling vehicles with level entry and wheelchair seating. They also have created "Kassel Kerbs" which allows drivers to position their vehicle close to the bus stops without tire damage.[5]

Along with accessibility, MyCiTi has also planned the wayfinding of the area to help encourage usage. In each station is equipped with audio LED screens and service information in a wide variety of formats. Outside the station is door to station infrastructure to lead the way from anywhere in town. They did this by providing tactile signage, tactile paving, and dedicated customer support staff to help lead the way.[5]

Due to the incredible design of the stations, the influence is spreading the rest of the city. The growth in commuter numbers, private developers and local businesses is bringing value to the area and encouraging public growth, public investment, and new development to occur.

INCLUSIVE & AFFORDABLE TOD SYSTEMS

Many sources point to the BRT system's potential as representative of a healthy democracy. Such a characteristic, similar to environmental benefits, the mixing of different backgrounds, or more equitable access to amenities, all of which are important barriers to Cape Town's prosperity, hasn't been evaluated through a cost-benefit analysis or other quantifiable measures. To paraphrase a comparison by Enrique Peñalosa, who championed the BRT system when he was the mayor of Bogotá in Colombia, a city now renowned for its thriving public transport system: "that thirty people on a bus can zoom past a Maserati with one person in, because thirty people should get thirty times the space as one person, no matter how much money they make. That's true democracy." [3]

With such vast poverty experienced in Cape Town, achieving a truly democratic system of transport is an essential priority going forward. With simple necessities such as sanitation and electricity unachievable for many South African households, public subsidy and increased affordability of transit should be explored to encourage heightened use. Without this affordability, modal preferences will remain dominated by cars (for higher-income households) and walking or cycling (for lower income households).

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE

- **2002-** The Institute of Transportation and Development (ITDP) began work in Cape Town
- **2007-** IDTP created business plan and financial model for MyCiTi BRT
- **2010-** Opened two pilot routes to operate during 2010 World Cup
- **May 2010-** MyCiTi began operations
- **May 2011-** Bus Rapid Transit (BRT) Phase 1A opened
- **2015-** MyCiTi provided a BRT service between 8 cities with additional feeder services
- **2030-** Goal year for entire city to be connect with MyCiTi

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Establish Transportation Department
3. Create Strategy Plan (Phases)
4. Identify Key Stakeholders
5. Find Funding
6. Integrate Existing Operators with New Operators
7. Optimize/ Utilize Land Value
8. Create Design Strategies to Encourage Transit Use

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

The 2010 World Cup in South Africa provided a valuable opportunity to the city to improve its social services, specifically adequate public transportation for low-income households. Building a BRT system through MyCiTi was not enough on its own. It was essential that it was affordable for all. Without this affordability, modal preferences would remain dominated by cars for the higher income households and walking and cycling for the lower income households.

ROADBLOCKS AND WAYS TO IMPROVE

Underlying the issue of low ridership levels was the greater challenge of how effectively BRT can operate within Cape Town's urban form. The roadblock of implementing BRT in a city characterized by long travelling distances for residents, meaning less revenue than in other denser cities, as well as peak periods when buses are virtually empty on their return trips.

Ways to improve to a successful BRT system is the concerted effort to develop urban areas around transit-oriented principles. Measures such as zoning land for dense, high-rise development around BRT corridors and constraining development further away from them would increase the ridership needed for BRT in Cape Town to be as impactful as possible.

KEY LESSONS

The following key takeaways should be derived from the Cape Town example:

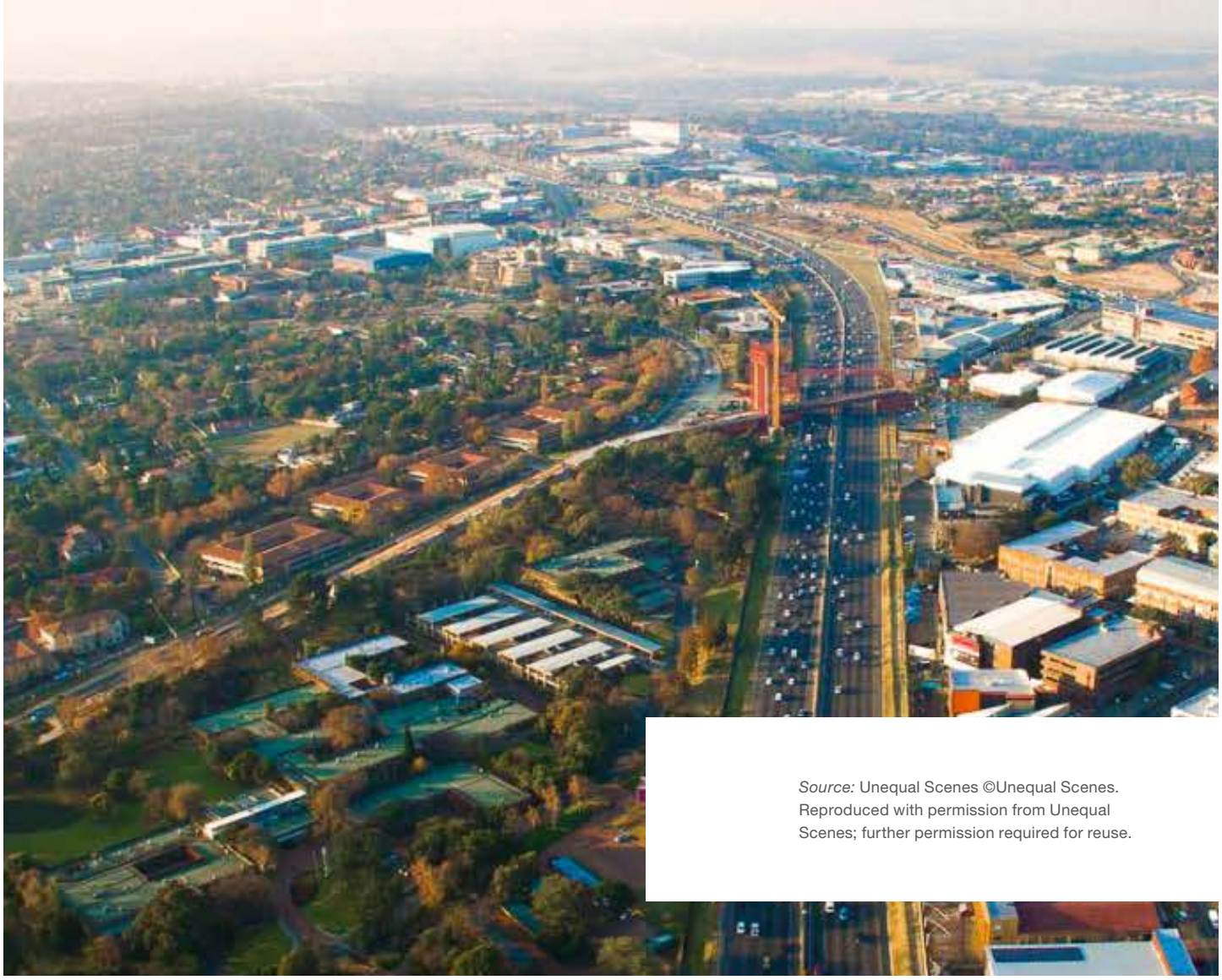
- Over 36% of Cape Town's citizens are below the poverty line
- The BRT system is now operated companies comprised of former minibus taxi operators.
- MyCiTi service was largely a public funded initiative
- Access Africa program was also incorporated, providing bikes to low-income health care workers

ENDNOTES

1. Atlas of Urban Expansion. 2016. "Cape Town." http://www.atlasofurbanexpansion.org/cities/view/CapeTown
2. Statistics South Africa. 2017. "Poverty on the Rise in South Africa." *Statistics South Africa.* http://www.statssa.gov.za/?p=10334
3. Smit, Rouen. 2014. Future Cape Town. "Cape Town's MyCiTi system: 5 important changes." *Our Future Cities.* http://futurecapetown.com/2014/10/cape-towns-myciti-system-5-important-changes/#.WtmzFy5uaM8
4. Tennant, Megan. 2015. "Cape Town's MyCiTi BRT - Four Years into its 'Democracy'." *UrbanAfrica.* https://www.urbanafrica.net/urban-voices/cape-towns-myciti-brt-four-years-into-its-democracy/
5. Davies, Guy. 2014. "South Africa: Inclusive design of Cape Town's Bus System." *Zero Project.* Accessed July 25, 2018. https://zeroproject.org/policy/cape-town/

AFRICA | CASE STUDY

JOHANNESBURG, SOUTH AFRICA



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JOHANNESBURG, SOUTH AFRICA

QUICK FACTS

Geographic Context
Africa (South Africa)

Scale
City, Neighbourhood, and Corridor

Context
Urban and Suburban

Mode of Higher Order Transit
BRT and Metro

Size of City (Population)
10 million (Tier 1)

Case Study Covered in WB Publication
Yes

URBAN CONTEXT

The political capital of the Republic of South Africa, Johannesburg is situated in Gauteng province, the most densely urbanized area of the Republic. It is home to an estimated 10 million people and has a population density of 2,900 people per square kilometer.[5] By 2030 Johannesburg is projected to grow to about 11.5 Million.[5] Despite a growing population and economy, there is extreme income disparity and around 63 percent of households do not own a car. [2]

In 2006, following municipal elections, the new Mayor created a transportation department with the aim of better organizing urban mobility. This entity became responsible for transport planning and regulation within the city boundary. [3]

Upon awarding of the 2010 (19th) FIFA World Cup event, Johannesburg took a keen interest in improving the transport system in order to live up to the projected image of being a 'World Class City'. In particular, Johannesburg would need to accommodate the fans and tourists that would visit during the events and Rea Vaya was planned and implemented as a result. [1]

Rea Vaya was the first full bus rapid transit (BRT) system to be implemented on the African continent and provides many learning experiences that can be replicated in other cities.

Its key objectives are:

- Economic growth
- Poverty alleviation
- Restructuring the apartheid city
- Sustainable development
- Good governance

TOD KP

OVERALL TOD STRATEGY & CITY STRUCTURE

The lack of investment in public transport, as well as the long distances (beyond a reasonable walk or bike trip) which separated home and the workplace in Johannesburg led directly to the growth of the informal 'taxi minibus' industry. Initially, this development was viewed as a positive 'entrepreneurial' trend as it required little to no state control.

The ability of the private sector to make money with low levels of investment quickly led to an oversupply and intense competition between service providers. By the 1990s, as in many cities across the developing world, the situation had degenerated into a system that served the operators, while simultaneously marginalizing the user with poor travel times, high fares and unsafe vehicles driven by drivers with poor skills.[3]

Johannesburg's bus rapid transit system Rea Vaya has saved South Africa as much as $890 million so far in reduced travel time, improved road safety and reduced carbon emissions, according to a recent report by the New Climate Economy, a project affiliated with the World Resources Institute.[4]

LAND TENURE & LAND VALUE CAPTURE

The Rea Vaya provided enhancements to the surrounding areas creating an increase in land values for neighboring property owners. Some of these enhancements include:

- Increases in regional productivity
- Enhanced employment accessibility;
- Environmental Benefits

KEY STAKEHOLDERS & GOVERNMENT RELATIONSHIPS

One of the most challenging aspects of implementing any transport reform is the resistance to change by those benefiting most from the present system. In much of the developing world this usually means the informal minibus owners and drivers.[1]

In Johannesburg, much of the resistance to changes in transport organization came from the powerful taxi unions. These strong groups made a solid defense of their right to operate unhindered and un-regulated. This was identified early on as a major challenge to successful public transportation implementation.

Today, there are four levels of institutions responsible in some way for transport in South Africa. There are national, regional (provincial), city or metropolitan area and local or district bodies.[1] The national Ministry of Transport is responsible for policy and legislation for transport. It is also responsible for:

- Implementing national policy and legislation;
- Coordinating the functions of the Department of Transport
- Preparing and initiating legislation
- Performing any other executive function provided for in the Constitution or in national legislation.

The Gauteng Provincial Government's role is to ensure the implementation of national policy across the province by providing oversight.[3] A creation of a new body called the Gauteng Transport Management Authority became responsible for improving transport at the regional-level and in setting quality standards and norms. The Gauteng Intermodal Strategic Public Transport Network (GISPTN) forms the basis for reform and requires linkage between the road and rail networks. It also prioritized public transport services and investments in developing infrastructure.[3]

In 2003, the City of Johannesburg formulated an Integrated Transport Plan (ITP) signed by the political head of province, as well as the Minister of Transport. It consisted of the priority for public transport, improvements to curbside lanes, infrastructure for commuters, better signage and improved passenger information.[3] These improvements really gave minibuses a better traffic environment to function.

Typically in transport, there is a split in responsibility between national and city governments that can be challenging to resolve. There was also the additional challenge of engaging existing operators and establishing a forum under which they can productively participate in the eventual delivery of mass transit. The technical skills required for planning are complex and often do not exist at the local-level. Thus, it was not until city officials and the Mayor became aware of the system in Bogotá, Columbia that the idea of BRT for Johannesburg was born.

The new city administration decided to more aggressively explore BRT systems in other cities, specifically Bogotá, Columbia and Guayaquil, Ecuador. Through a step-by-step approach, Johannesburg established a planning and development department for the delivery of the BRT.[3] The BRT system had to be planned within a fairly constrained urban environment, both financially and in land provision. It would be planned as the backbone of a future transport system interconnected with rail to provide high levels of accessibility and capacity.[3]

DESIGN STRATEGIES TO ENCOURAGE TRANSIT USE

Attention was given to making the system and stations functional and attractive.[3] This included pre-paid boarding; level boarding for full accessibility; multiple stopping bays; and secure, weather-protected stations. Stations have been designed with the local urban environment in mind and aesthetics were prioritized, commissioning local artists to add character and culture to bus stops.[3]

BUS MANAGEMENT SYSTEM USING INTELLIGENT TRANSPORT SYSTEMS (ITS)

A robust but affordable bus management system was required in the context of Johannesburg. The Automatic Public Transport Management System (APTMS) was developed by a private consortium to deliver an ambitious range of information and services, including dynamic passenger information.[4]

Passenger information provision was a new concept to both those providing public transport and those using it.[4] Traditionally, minibuses were merely numbered or known by the drivers' names and routes varied and stop locations were unpredictable. The concept of having a set timetable and frequency was, therefore, a learning curve for drivers and passengers.[4]

INCLUSIVE & AFFORDABLE TOD SYSTEMS

It was also agreed that the development of Rea Vaya would be employment neutral, providing an equal number of jobs to citizens as those that were lost. It was also decided that it should have a strong identity and brand image – and the concept Rea Vaya 'we are going' was adopted.[3]

Since its inception, 700 permanent jobs have been created in Phase 1A and some 3300 temporary jobs during the construction period.[4] Efforts have been made to design a system that is accessible to those with mobility impairments, such as level boarding at the BRT stations. This system has been a considerable benefit to all levels of society, but especially to women as minibuses were often unsafe, especially at night.[4] The stations are manned, the surroundings are monitored and initial overcrowding of the service has now been overcome, solving many of the grievances with former minibus service.

Executive Mayor Parks Tau stated "Left to the forces of the market alone, the poor would be cast to the edges of the city, huddled together in crowded shacks, trapped there by the cost of mobility," Mayor Tau said in his address. "This is exactly what we seek to disrupt and transform when we speak of confronting apartheid spatial patterns."[7] Rea Vaya created the ability to have mixed-use, mixed-class development, and focuses on location and affordability of housing.

IMPLEMENTATION OF TRANSIT ORIENTED DEVELOPMENTS

APPROXIMATE TIMELINE [6]

- **2003-** The City of Johannesburg formulated an Integrated Transport Plan (ITP)
- **November 2006-** A transportation department was created within the city of Johannesburg's government
- **October 2007-** Rea Vaya BRT construction begins
- **April 2009-** Beginning of Phase 1A
- **August 2009-** First bus began operating
- **June 2010-** FIFA World Cup 2010 awarded 12 cities infrastructure funding.
- **February 2011-** Taxi industry shareholders hand over their operating licensed and equity in return for share in Rea Vaya.
- **October 2013-** Phase 1 completed

ACTIONABLE STEPS

1. Identify needs/ Take Inventory
2. Create Strategy Plan (Phases)
3. Establish Transportation Department
4. Identify Key Stakeholders
5. Find Funding
6. Mitigate Competition
7. Create Brand
8. Market Plan
9. Optimize/ Utilize Land Value
10. Create Design Strategies to Encourage Transit Use

KEY LESSONS LEARNED AND BEST PRACTICES

SUMMARY

The successful implementation of Rea Vaya is a real milestone in Africa, a place which has suffered, particularly low-income populations, lacking formal public transport for the past 25 years. An affordable but high-quality bus system has been put in place, while also overcoming significant political challenges that have hampered initiators before them. In addition, it has saved South Africa $890 Million so far by reducing travel time improving road safety, and cutting down on carbon emissions.[4]

ROADBLOCKS AND WAYS TO IMPROVE

One of the most challenging aspects of implementing any transport reform is the resistance to change by those benefiting most from the present system. In much of the developing world this usually means the informal minibus owners and drivers, which fought to remain unregulated in the case of Johannesburg.[1]

To improve this relationship, Johannesburg created a plan that integrated all forms of transportation with political support. The plan consisted of modest priority for public transport, both minibus taxis and buses, improvements to curbside lanes, modest infrastructure for commuters, better signage and improved passenger information. 3These improvements really gave minibuses a better traffic environment to function rather than creating a proper public transport network across the city.

KEY LESSONS

The following key takeaways should be derived from the Johannesburg example:

- Rea Vaya was designed to address historical inequalities, increase civic pride and to provide safe, affordable transport
- Inclusion of a strong and powerful informal sector into formal and professional transport planning
- Marketing plan was highly inspired by the Transmilenio in Bogota
- Project was employment neutral- creating at least as many jobs as it removed.

ENDNOTES

1. Eickmans, Luuk, and Emelda Nasei. 2011. “Sustainable Mobility for African Cities - Promoting non-motorised transport options and compact cities as complements to public transport.” *United Nations Human Settlements Programme*. Nairobi, Kenya.
2. Weinstock, Annie. 2009. “Rea Vaya: We are going!” *Sustainable Transport,* No. 21 (Winter 2009), 16-18. Institute for Transportation and Development Policy.
3. Kouakou, Eric, and Djan Fanny. 2008. “Overview of public tranpsort in Sub-Saharan Africa.” *Trans-Africa Consortium*. https://www.uitp.org/sites/default/files/cck-focus-papers-files/Transafrica_UITP_UATP_PublicTransport_in_SubSaharan_Africa_2008.pdf
4. Allen, Heather. 2013. “Africa’s First Full Rapid Bus System: the Rea Vaya Bus System in Johannesburg, Republic of South Africa.” *Global Report on Human Settlements 2013.* https://unhabitat.org/wp-content/uploads/2013/06/GRHS.2013.Case_.Study_.Johannesburg.South_.Africa.pdf
5. World Population Review. 2017. “Johannesburg Population.” http://worldpopulationreview.com
6. REA VAYA. 2018. “Rea Vaya Timeline.” Accesssed July 24, 2018. https://www.reavaya.org.za/welcome/timeline
7. REA VAYA. 2015. “Corridors of Freedom to boost Rea Vaya passenger numbers.” Accessed July 24, 2018. https://www.reavaya.org.za/news-archive/october-2015/1229-corridors-of-freedom-to-boost-rea-vaya-passenger-numbers

TOD KP

GLOSSARY OF TERMS

TOD

Global Platform for Sustainable Cities

WORLD BANK GROUP

IBI

GLOSSARY OF TERMS

ACTIVE USES

Land uses, such as retail, coffee shops, storefronts, cafes, restaurants and hawkers zones, which keep the area active with pedestrian activity at street level and maintain visual interest, are termed as active uses.

AFFORDABLE HOUSING

Affordable housing provides housing mainly for those whose income is below the median household income. Both the private sector and government in India are exploring options for creating housing for low-income groups. The Government of India, both at central and state level has initiated various schemes to assist in the delivery of affordable housing. It includes public sector working as a facilitator and engaging the private sector to build housing, with rental units that are subsidized by the government through rental subsidy programs.

ANNUAL DEPRECIATION ALLOWANCE

Annual depreciation allowance is the amount of tax deduction allowed by the tax code that investment property owners may take each year until the entire depreciable asset is written off.

To calculate, you must first determine the depreciable basis by computing the portion of the asset allotted to improvements (land is not depreciable) and then amortizing that amount over the asset's useful life, as specified in the tax code: Currently 27.5 years for residential property and 39 years for non-residential.

Property Value x Percent Allotted to Improvements

= Depreciable Basis

Then,

Depreciable Basis ÷ Useful Life

= Annual Depreciation Allowance

ASSET

In financial accounting, an asset is an economic resource. Anything tangible or intangible that can be owned or controlled to produce value and that is held by a company to produce positive economic value is an asset.

BUSINESS IMPROVEMENT DISTRICT (BID)

A business improvement district (BID) is a defined area within which businesses are required to pay an additional tax (or levy) in order to fund projects within the district's boundaries. The BID is often funded primarily through the levy but can also draw on other public and private funding streams. These districts typically fund services, which are perceived by some businesses as being inadequately performed by the government with its existing tax revenues, such as cleaning streets, providing security, making capital improvements, construction of pedestrian and streetscape enhancements and marketing the area. The services provided by BIDs are supplemental to those already provided by the municipality[1]. The revenue is derived from a tax assessment on commercial property owners and in some cases, residential property owners.

BREAK-EVEN RATIO (BER)

BER is a ratio some lenders calculate to gauge the proportion between the money going out to the money coming, so they can estimate how vulnerable a property is to default on its debt if rental income declines. BER reveals the percent of income consumed by the estimated expenses.

(Operating Expense + Debt Service) ÷ Gross Operating Income

= Break-Even Ratio

BER results:

Less than 100% - expenses consuming less than available income

Greater than 100% - expenses consuming more than available income

BROWNFIELD REDEVELOPMENT

Development on a brownfield site is commonly referred to as Brownfield redevelopment. Brownfield sites are abandoned or underused industrial and commercial facilities available for reuse. Expansion or redevelopment of such a facility is often complicated by real or perceived environmental contaminations. The land may be contaminated by low concentrations of hazardous waste or pollution and has the potential to be reused once it is cleaned up. Land that is more severely contaminated and has high concentrations of hazardous waste or pollution, such as a superfund site, does not fall under the brownfield classification.

BUS RAPID TRANSIT (BRT)

BRT systems use buses or specialized vehicles on roadways or dedicated lanes to transport passengers without interference from other traffic. Such systems usually include dedicated bus lanes, signal priority at intersections, off-bus fare collection to speed up boarding, level boarding (low-floor buses or high-level platforms) to speed up boarding and enhance accessibility and enclosed stations.

CAP RATE

This popular return expresses the ratio between a rental property's value and its net operating income. The cap rate formula commonly serves two useful real estate investing purposes: To calculate a property's cap rate, or by transposing the formula, to calculate a property's reasonable estimate of value.

Net Operating Income ÷ Market Value

= Cap Rate

Or,

Net Operating Income ÷ Cap rate

= Market Value

CAPACITY

The maximum number of people that can be carried past a given location during a given time period under specified operating conditions, without unacceptable delay, hazard, or restriction, and with reasonable certainty

CAPACITY BUILDING

Capacity building (or capacity development) is the process by which individuals and organizations obtain, improve and retain the skills, knowledge, tools, equipment and other resources needed to do their jobs competently or to a greater capacity (larger scale, larger audience, larger impact, etc).

CAPITAL INVESTMENT

Capital investment refers to funds invested in a firm or enterprise for the purpose of furthering its business objectives. Capital investment may also refer to a firm's acquisition of capital assets or fixed assets, such as manufacturing plants and machinery that is expected to be productive over many years.

CASH FLOW AFTER TAX (CFAT)

CFAT is the amount of spendable cash that the real estate investor makes from the investment, after satisfying all required tax obligations.

Cash Flow Before Tax - Tax Liability

= Cash Flow After Tax

CASH FLOW BEFORE TAX (CFBT)

CFBT is the number of dollars a property generates in a given year after all expenses, but in turn still subject to the real estate investor's income tax liability.

Net Operating Income - Debt Service - Capital Expenditures

= Cash Flow Before Tax

CASH ON CASH RETURN (COC)

CoC is the ratio between a property's cash flow in a given year and the amount of initial capital investment required to make the acquisition (e.g., mortgage down payment and closing costs). Most investors usually look at cash-on-cash, as it relates to cash flow before taxes during the first year of ownership.

Cash Flow Before Taxes ÷ Initial Capital Investment

= Cash on Cash Return

CATALYST PROJECTS

Catalyst projects are public or private projects that are planned and designed to cause a corresponding and complementary development reaction to surrounding properties. They are projects of sufficient magnitude to stimulate redevelopment of underdeveloped properties or major rehabilitation of underutilized buildings. The identification and implementation of catalyst projects provide an opportunity for public and private investments to receive a reasonable return. The measure of return on investment can include jobs creation, increase in land value, improved transportation and access and new housing units.

CENTRAL BUSINESS DISTRICT (CBD)

The heart of an urban area, usually located at the meeting point of the city's transport systems, containing a high percentage of shops and offices. High accessibility leads to high land values, and therefore intensive land use. Consequently, development is often upwards. Within the CBD, specialist areas, such as a jewelery quarter, benefit from external economies. Vertical land-use zoning is also common, so that retail outlets may be on the ground floor, with commercial users above them and residential users higher up.

CENTRALITY

In graph theory and network analysis, indicators of centrality identify the most important nodes. Centrality can be used to identify the most influential people in a social network, key infrastructure nodes in the Internet or urban networks, and superspreaders of disease. Betweenness, closeness, and degree centrality are the three most important indicators for transit networks.

CLOSENESS CENTRALITY

A measure of accessibility to a node within a network that measures the inverse of the sum of the distances of a node from all other nodes.

COMPLETE STREET

Road design philosophy where road space is allocated to safely balance the needs of all road users, including pedestrians, cyclists, transit and motorists. Transportation choice is increased when safe and appealing options for getting from place to place are provided- options to walk and bike provide opportunities for increased community health and reductions in air and noise pollution.

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN (CPTED)

Crime Prevention Through Environmental Design (CPTED) is a multi-disciplinary approach to deterring criminal behavior through environmental design. CPTED strategies rely upon the ability to influence offender decisions that precede criminal acts. As of 2004, most implementations of CPTED occur solely within the built environment.

DEBT COVERAGE RATIO (DCR)

DCR is a ratio that expresses the number of times annual net operating income exceeds debt service (e.g. total loan payment, including both principal and interest).

Net Operating Income ÷ Debt Service

= Debt Coverage Ratio

DCR results:

Less than 1.0 - not enough NOI to cover the debt

Exactly 1.0 - just enough NOI to cover the debt

Greater than 1.0 - more than enough NOI to cover the debt

DEGREE CENTRALITY

Number of times a node has with other nodes in a network. In transit networks, interchange stations between many lines or modes (hubs) have a high degree centrality.

DEVELOPMENT CONTROL REGULATIONS (DCRS)

DCRs are the primary regulatory tool used to guide development that ultimately shapes a city's urban form and functions. It includes guiding the development and use of land, built environment FAR's, density, heights, setbacks and the public realm. Critical to the success of an efficient and effective transit system is the combination of basic employment opportunities and a mix of housing typologies supported with major retail, civic, cultural, entertainment and community facilities. The DCRs, which are currently proposed as blanket for the entire city, need to be revisited and should be modified into more context-specific Development Code Regulation.

DEVELOPMENT PLAN

It is an aspect of town and country planning comprised of a set of documents that set out the local authority's policies and proposals for the development and use of land in their area. The development plan guides and shapes day-to-day decisions as to whether or not planning permission should be granted, under the system known as development control or development management. In order to ensure that these decisions are rational and consistent, they must be considered against the development plan adopted by the authority, after public consultation and having proper regard to other material factors.

EMPLOYMENT DENSITY

Number of jobs in an area.

ENCLOSURE

Degree to which buildings, walls, trees, and other vertical elements define streets and other public spaces.

FLOOR AREA RATIO (FAR)/FLOOR SPACE INDEX (FSI)

The FAR or FSI is the ratio of the total floor area of buildings at a certain location, to the size of the land at that location, or the limit imposed on such a ratio.

As a formula: Floor Area Ratio= (Total covered area on all floors of all buildings on a certain plot)/(Area of the plot).

Thus, an FSI of 2.0 would indicate that the total floor area of a building is two times the gross area of the plot on which it is constructed, as would be found in a multiple-storey building.

FEEDER BUS ROUTES

A feeder bus route is a bus service that picks up and delivers passengers to a higher order transit station, such as a rapid rail transit station, express-bus stop or terminal.

FORM-BASED CODE

Form-based codes foster predictable built results and a high-quality public realm by using physical form (rather than separation of uses) as the organizing principle for the code. These codes are adopted into city or county law as regulations, not mere guidelines. Form-based codes are an alternative to conventional zoning.

Form-based codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another and the scale and types of streets and blocks. The regulations and standards in form-based codes, presented in both diagrams and words, are keyed to a regulating plan that designates the appropriate form and scale (and therefore, character) of development, rather than only distinctions in land-use types. This is in contrast to conventional zoning's focus on the micro-management and segregation of land uses and the control of development intensity through abstract and uncoordinated parameters (e.g., FAR, dwellings per acre, setbacks, parking ratios, traffic LOS) to the neglect of an integrated built form. Not to be confused with design guidelines or general statements of policy, form-based codes are regulatory, not advisory.

FUTURE VALUE (FV)

FV shows what a cash flow or series of cash flows will be worth at a specified time in the future. FV is calculated by "compounding" the original principal sum forward in time at a given "compound rate".

GROSS VEHICLE MASS (GVM)

Gross vehicle mass is the maximum operating weight/mass of a vehicle as specified by the manufacturer [1], including the vehicle's chassis, body, engine, engine fluids, fuel, accessories, driver, passengers and cargo, but excluding that of any trailers. [2]. The term is used for motor vehicles and trains.

The weight of a vehicle is influenced by passengers, cargo, even fuel level, so a number of terms are used to express the weight of a vehicle in a designated state. Gross combined weight rating (GCWR) refers to the total mass of a vehicle, including all trailers. GVWR and GCWR both describe a vehicle that is in operation and are used to specify weight limitations and restrictions.

GREENFIELD DEVELOPMENT

Greenfield development is the creation of planned communities on previously undeveloped land. This land may be rural, agricultural or unused areas on the outskirts of urban areas. Unlike urban sprawls, where there is little or no proper suburban planning, greenfield development is about efficient urban planning that aims to provide practical, affordable and sustainable living spaces for growing urban populations. The planning takes future growth and development into account, as well as avoiding the various infrastructure issues that plague existing urban areas.

GROSS OPERATING INCOME (GOI)

GOI is gross scheduled income after vacancy and credit loss, plus the income derived from other sources such as coin-operated laundry facilities. Consider GOI as the amount of rental income the real estate investor actually collects to service the rental property.

Gross Scheduled Income - Vacancy and Credit Loss + Other Income

= Gross Operating Income

GROSS RENT MULTIPLIER (GRM)

GRM is a simple method used by analysts to determine a rental income property's market value, based upon its gross scheduled income. You would first calculate the GRM using the market value at which other properties are sold and then apply that GRM to determine the market value for your own property.

Market Value ÷ Gross Scheduled Income

= Gross Rent Multiplier

Then,

Gross Scheduled Income x Gross Rent Multiplier

= Market Value

GROSS SCHEDULED INCOME (GSI)

GSI is the annual rental income a property would generate if 100% of all space was rented and all rent was collected. If

vacant units do exist at the time of your real estate analysis, then include them at their reasonable market rent.

Rental Income (actual) + Vacant Units (at market rent)

= Gross Scheduled Income

HIGHER ORDER TRANSIT

Higher order transit refers to a transit service that operates on a dedicated right-of-way or in a priority situation, and therefore moves more efficiently than the regular flow of traffic and can carry large numbers of people quickly and comfortably. Examples of higher order transit include buses that have dedicated lanes, metro and commuter rail, which operate on their own separate tracks.

HISTORICAL DAILY PEAK HOUR FACTOR

The ratio of Peak Hour Peak Direction Passenger Demand for a typical route (i.e. representative of the system as a whole) to its total daily boardings in both directions. His factor helps to convert daily passenger flows into peak hour passenger flows. It should be ideally be determined by looking at historical data. Please note that this factor is usually higher for public transport as compared to total traffic.

INFILL DEVELOPMENT

Infill development is the term used for new development within existing communities on previously underutilized sites, typically at a higher density. Good infill developments fit in seamlessly within the existing urban fabric and the contributing elements include: setback- the distance from the front facade of the house to the street and should be the same distance as other houses on the street, height- which should be compatible with the height of buildings surrounding the lot and mass- the bulk of the house.

INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

It refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the internet, wireless networks, cell phones and other communication mediums.

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

ITS refers to the application of information and communication technologies to transportation infrastructure and vehicles.

INTENSIFICATION

Urban intensification is the construction and reconstruction of compact communities in the existing built-up area of the city. Intensification includes new development, which raises the density on sites and within communities. These compact communities are supportive of transit, cycling and are pedestrian-friendly and promote local jobs and services.

INTERMODAL TRANSIT HUB

Intermodal Transit Hubs are stations or centres where a range of different transportation modes (i.e. cycling, walking, metro, private vehicle, bus, autos and taxis) come together and allow for easy transfers from one mode to another. They can also facilitate transfers at different scales: local, regional and intercity.

INTERNAL RATE OF RETURN (IRR)

This popular model creates a single discount rate, whereby all future cash flows can be discounted until they equal the investor's initial cash investment. In other words, when a series of all future cash flows is discounted at IRR, that present value amount will equal the actual cash investment amount.

LAND AMALGAMATION

Amalgamation can relate to the combining of one or more allotments to create one single parcel of land. It is required for the purpose of assembling land for urban expansion, infill development, or redevelopment. In this process, the original landowners or occupants voluntarily contribute a certain percentage of their land to the government or other project initiators, and in return receive compensation in the form of money, or serviced land, or any other form.

LAND VALUE CAPTURE (LVC)

Land value capture is a policy approach that enables communities to recover and reinvest land value increases that result from public investment and other government actions.

Common land value capture tools include: transferable development rights, betterment contributions, public land leasing, inclusionary housing and zoning, linkage or impact fees, business improvement districts and certain applications of the property tax. These tools can help finance transit and infrastructure improvements, affordable housing, parks and open spaces, utility upgrades and other critical services. With

this additional funding, local and regional governments can more sustainably advance municipal fiscal health, enable infrastructure investment and address the challenges of sustainable urbanization.

LEGIBILITY

Ease with which people can create a mental map so that the spatial structure of a place can be understood and navigated as a whole.

LIGHT RAIL TRANSIT (LRT)

It is a form of urban rail transport using rolling stock similar to a tramway, but operating at a higher capacity, and often on an exclusive right-of-way. It operates primarily along exclusive rights-of-way and uses either individual tramcars or multiple units coupled to form a train that is lower capacity and lower speed than a long, heavy-rail passenger train or metro system.

A few light rail networks tend to have characteristics closer to rapid transit. Other light rail networks are tram-like in nature and partially operate on streets. Light rail systems are found throughout the world, on all inhabited continents. They have been especially popular in recent years, due to their lower capital costs and increased reliability compared with heavy rail systems.

LOAN TO VALUE (LTV)

LTV measures what percentage of a property's appraised value or selling price (whichever is less) is attributable to financing. A higher LTV benefits real estate investors with greater leverage, whereas lenders regard a higher LTV as a greater financial risk.

Loan Amount ÷ Lesser of Appraised Value or Selling Price

= Loan to Value

LOCAL TRANSIT

Public transport operating on fixed routes with frequent stops (100-400 m apart), generally in mixed traffic on surface roadways, relying heavily on walk access and egress.

LOCAL TRANSIT SERVICE AREA

The reasonably contiguous area served by the local transit network, not including regional services. Indicative extent would be the area within 1 km of regularly served local stops. This area does not include portions of the metropolis connected to the local service area solely by regional services.

LOCAL TRANSIT BOARDINGS

The annual number of passengers boarding local transit vehicles, counting separately each boarding made in the course of single journey or trip between origin and destination. Also known as unlinked passenger trips (UPT). Boardings on regional services should not be included in city totals when using this tool.

MASS RAPID TRANSIT

It is a type of high-capacity public transport, generally found in urban areas. Unlike buses or trams, mass rapid transit systems are electric railways that operate on an exclusive right-of-way, which cannot be accessed by pedestrians or other vehicles of any sort and which is often grade separated in tunnels or on elevated railways.

Modern services on rapid transit systems are provided on designated lines between stations, typically using multiple electric units on rail tracks, although some systems use guided rubber tires, magnetic levitation or monorail. The stations typically have high platforms, without steps inside the trains, requiring custom-made trains in order to minimize gaps between train and platform. They are typically integrated with other public transport and often operated by the same public transport authorities. However, some rapid transit systems have at-grade intersections between a rapid transit line and a road or between two rapid transit lines. It is unchallenged in its ability to transport large numbers of people quickly over short distances, with little to no use of land.

MARKET POTENTIAL VALUE

Unrealized market value of a station area, sometimes measured through a composite index considering major drivers of demand, including current and future human densities, current and future number of jobs accessible within 30 minutes by transit, and major drivers of supply (including the amount of developable land, potential changes in zoning, and market vibrancy).

MEAN LOCAL TRANSIT TRIP LENGTH

The average distance traveled by one public transit boarding passenger, calculated by dividing total local transit person-km by total local transit boardings

MIDBLOCK CROSSING

Midblock crosswalks facilitate crossings to places that people want to go, but that are not well served by the existing traffic network. These pedestrian crossings, which commonly occur at schools, parks, museums, waterfronts and other destinations, have historically been overlooked or difficult to access, creating unsafe or unpredictable situations for both pedestrians and vehicles.

MIXED-USE

Mixed uses are defined by a diverse mix of land uses, including housing, employment, regional attractions and public spaces, allowing people to walk to work or to shop rather than driving for all daily needs. It also includes vertical types of mixed-use development, like residential land use over the commercial uses, so that the distance between the activities is decreased and accessibility between different activities is increased.

MODE SHARE

Trips taken by a particular mobility choice, such as car, transit, cycling or walking, as a proportion of the total number of trips.

MULTI-MODAL TRANSPORT SYSTEM (MMTS)

Multi-Modal Transportation System (MMTS) explores the coordinated use of two or more modes of transport for efficient, safe, pleasant and comfortable movement of passengers in urban areas. It provides the convenient and economical connection of various modes to make complete journeys from origin to destination. Generally, MMTS has been characterized by increased capacity, efficient access and better location of both integration and nodes. Public transport is an important constituent of the multi–modal transportation system and hence, the local and regional public transportation system must be an integral part of the same.

MULTI-LEVEL CAR PARKING

Structured parking refers to an above- or below-grade structure designed to accommodate vehicle parking. This type of parking is more expensive than surface parking, but is a much more efficient use of land (a 3-storey parking structure requires a third as much land as a surface lot) and has long-term value for integrated mixed-use development.

MULTI-USE DEVELOPMENT

Multi-use development is a type of urban development that blends residential, commercial, cultural, institutional or entertainment uses, where those functions are physically and functionally integrated and provide pedestrian connections [1][2]. Mixed-use development can take the form of a single building, a city block or entire neighborhoods. The term may also be used more specifically to refer to a mixed-use real estate development project—a building, complex of buildings or district of a town or city that is developed for mixed-use by a private developer, (quasi-) governmental agency, or a combination thereof.

NET OPERATING INCOME (NOI)

NOI is a property's income after being reduced by vacancy, credit loss and all operating expenses. NOI is one of the most important calculations to any real estate investment because it represents the income stream that subsequently determines the property's market value– that is, the price a real estate investor is willing to pay for that income stream.

Gross Operating Income - Operating Expenses

= Net Operating Income

NET PRESENT VALUE (NPV)

NPV shows the dollar amount difference between the present value of all future cash flows using a particular discount rate– your required rate of return– and the initial cash invested to purchase those cash flows.

Present Value of all Future Cash Flows - Initial Cash Investment

= Net Present Value

NPV results:

Negative - the required return is not met

Zero - the required return is perfectly met

Positive - the required return is met with room to spare

NETWORK EXTENT

The number of kilometers of route in a public transport network, without double-counting kilometers where routes share the same path.

NODE VALUE

Measure of importance of a public transit station based on passenger traffic volume, intermodality, and centrality within the network; measured through a composite index.

NON-MOTORIZED TRANSPORTATION (NMT)

Non-motorised Transportation (also known as active transportation and human-powered transportation) includes walking and cycling and variants such as small-wheeled transport. It can be a very attractive mode of transport for relatively short distances, which make up the largest share of trips in cities. The key to reversing the trend toward more private vehicle use is making walking and cycling attractive, together with improving public transport. This can be done through a range of activities, including construction of sidewalks and bike lanes, bike sharing programmes, urban planning and pedestrian-oriented development. NMT is a highly cost-effective transportation strategy and brings about large health, economic and social co-benefits, particularly for the urban poor.

OPERATING EXPENSES

Operating expenses include those costs associated with keeping a property operational and in service. These include property taxes, insurance, utilities and routine maintenance. They do not include payments made for mortgages, capital expenditures or income taxes.

OPERATING EXPENSE RATIO (OER)

OER expresses the ratio (as a percentage) between a real estate investment's total operating expenses dollar amount to its gross operating income dollar amount.

Operating Expenses ÷ Gross Operating Income

= Operating Expense Ratio

OVERLAY ZONE

Overlay zone means a set of land use and development requirements designed to be applied over, or in addition to, the requirements of the underlying zone for a specific purpose, without removing or modifying the underlying zone.

PERT CHART (PROGRAM EVALUATION REVIEW TECHNIQUE)

A PERT chart is a project management tool used to schedule, organize and coordinate tasks within a project. A PERT chart presents a graphic illustration of a project, as a network diagram consisting of numbered nodes (either circles or rectangles), representing events or milestones in the project linked by labelled vectors (directional lines), representing tasks in the project. The direction of the arrows on the lines indicates the sequence of tasks.

PASSENGER-KILOMETERS TRAVELED

The total distance traveled by passengers on transit vehicles (for a single route or a system), which may be determined by multiplying the number of unlinked passenger trips by the average length of such trips.

PASSENGER TRAFFIC DENSITY

The total number annual transit passengers passing the average point along a system or route in both directions combined, formed by dividing system PKT by network extent (for a system) or route PKT by route length (for a single route).

PARK AND RIDE

Park and rides are car parking lots that offer transit users a place to park their car, then transfer to a public transit service to complete their journey. They are typically used in suburban locations where distances from destinations to transit service are further. Park and ride facilities should be visible from, and located along, heavily used commuter routes. They should be landscaped, weather resistant, well-lit and should contain a range of amenities.

PEDESTRIAN PLAZA

A public space that can act as an important organizing element within a station area, helping to facilitate transfers between modes, acting as receiving points for pedestrians and containing a range of services and amenities for transit users.

PEDESTRIAN-FRIENDLY DESIGN.

Design intended to enhance the pedestrian experience, typically through improved amenities (for example, attractive landscaping, lighting, and seating areas) and by improving the efficiency of walking (for example, small city blocks, grid street patterns, and high road connectivity that provide direct, less circuitous pathways).

PER CAPITA

For each person; in relation to people taken individually.

The term is used in a wide variety of social sciences and statistical research contexts, including government statistics, economic indicators and built environment studies.

PERMEABILITY

Extent to which urban forms permit the movement of people or vehicles in different directions.

PEAK HOUR PEAK DIRECTION PASSENGER DEMAND

The number of transit passengers carried in the peak hour in the peak direction. This occurs almost universally on weekdays and is measured for a single route at its maximum load point.

PUBLIC INFORMATION CENTER (PIC)

Public Information Centers aim to establish a more effective, centralized distribution mechanism to safeguard the integrity and accurate distribution of government information. Moreover, it serves as a vital framework for collecting public opinions and feedback through building a communication path between the public and the government. It shall be the information source where the government can pertain constant betterment in government administration.

The PIC tends to public inquiries, complaints, suggestions and provides a centralized communication channel with the government. It offers a one-stop service in the provision of government information.

PUBLIC-PRIVATE PARTNERSHIP (PPP)

A formal partnership between a public sector entity and a private corporation often used to construct and operate infrastructure facilities or develop certain urban areas.

PLACEMAKING

Placemaking is a term that began to be used in the 1970s by architects and planners to describe the process of creating squares, plazas, parks, streets and waterfronts that will attract people because they are pleasurable or interesting.

PLACE VALUE

Determinants of the attractiveness of a place, including amenities; schools; health care facilities; type of urban development; local accessibility to daily needs by walking and cycling; quality of the urban fabric around the station, in particular its pedestrian accessibility; small size of urban blocks and fine mesh of connected streets, which create vibrant neighborhoods; and mixed pattern of land use. It is measured through a composite index

POPULATION DENSITY

Population density is a measurement of population per unit area or unit volume; usually quoted per square kilometer or square mile (which may include or exclude, for example, areas of water or glaciers).

Commonly this may be calculated for a county, city, country, territory or the entire world.

PRESENT VALUE (PV)

PV shows what a cash flow or series of cash flows available in the future is worth in today's dollars. PV is calculated by "discounting" future cash flows back in time, using a given "discount rate".

PUBLIC-PRIVATE PARTNERSHIPS (PPP)

Public-private partnership (PPP) describes a government service or private business venture, which is funded and operated through a partnership of government and one or more private sector companies. These schemes are sometimes referred to as PPP or P3.

PPP involves a contract between a public-sector authority and a private party, in which the private party provides a public service or project and assumes substantial financial, technical and operational risk in the project. In some types of PPP, the cost of using the service is borne exclusively by the users of the service and not by the taxpayer. In other types (notably the private finance initiative), capital investment is made by the private sector on the strength of a contract with the government to provide agreed services and the cost of providing the service is borne wholly or in part by the government. Government contributions to a PPP may also be in kind (notably the transfer of existing assets). In projects that are aimed at creating public goods like in the infrastructure sector, the government may provide a capital subsidy in the form of a one-time grant, so as to make it more attractive to private investors. In some other cases, the government may support the project by providing revenue subsidies, including tax breaks or by providing guaranteed annual revenues for a fixed period.

PPP involves many models, including Design-Build-Finance (DBF) and Design-Build-Finance-Maintain (DBFM).

PUBLIC REALM

The public realm consists of public spaces such as streets, parks and sidewalks. The public realm is also a place where the community can come together through collaborative activities, such as street festivals and other programmable activity.

RAPID TRANSIT

Public transport operating on fixed routes at a significantly higher average speed than local service, usually in exclusive rights-of-way and/or completely separated from surface traffic. Access depends on both walking and local public transport service. Stations are typically 800m-2km apart.

REAL ESTATE ASSESSMENT

The primary goal of the Real Estate Assessment Department is to ensure the fair and equitable assessment of all real property in the County of Gloucester, based on fair market value, with the end result being the fair and even distribution of the tax burden among all property owners.

REGIONAL TRANSIT

Public transport operating on fixed routes within and outside the local service area, offering higher average speeds than even rapid transit, with average station spacing usually longer than 2km. A large share of access may be by motorized transport.

REFUGE ISLAND

A refuge island, also known as a pedestrian refuge, pedestrian island and colloquially as a “pork chop” island, is a small section of pavement or sidewalk, completely surrounded by asphalt or other road materials, where pedestrians can stop before finishing crossing a road. It is typically used when a street is very wide, as the pedestrian crossing can be too long for some individuals to cross in one traffic light cycle. They can often been seen on roads with higher speed limits also.

RIGHT-OF-WAY (ROW)

A right-of-way is land that is used for transportation purposes, such as for a trail, driveway, rail line, street or highway. A right-of-way is often reserved for the purposes of maintenance or expansion of existing services.

ROAD DIETS

A road diet, also called a lane reduction or road rechannelization, is a technique in transportation planning whereby the number of travel lanes, and/or effective width of the road, is reduced in order to achieve systemic improvements.

SENSE OF PLACE

Though sense of place has been defined differently and used in different ways, it is often used in relation to characteristics that make a place special or unique, as well as to those that foster a sense of authentic human attachment and belonging.

SPECIAL ECONOMIC ZONE (SEZ)

A special economic zone (SEZ) is an area in which business and trade laws are different from the rest of the country. SEZs are located within a country’s national borders and their aims include: increased trade, increased investment, job creation and effective administration. To encourage businesses to establish in the zone, financial policies are introduced. These policies typically regard investing, taxation, trading, quotas, customs and labour regulations. Additionally, companies may be offered tax holidays, whereupon establishing in a zone they are granted a period of lower taxation.

SHARED PARKING

Shared parking is a land use/development strategy that optimizes parking capacity by allowing complementary land uses to share spaces, rather than producing separate spaces for separate uses. In effect, shared parking makes spaces publically accessible, rather than reserved for a particular tenant or property owner. It may be privately constructed and operated, depending on a contractual agreement, but should remain within the government’s jurisdiction for long-term transport planning purposes.

SIDE LANES

Side lanes are a type of bike lane in-between a main travel lane and a dedicated turn lane. They can help prevent conflicts between cyclists and motorists who wish to make a turn (this assumes there is a bike lane along the street on the preceding block or blocks).

SIGNAGE

Signage is wayfinding and instructional signs erected at the side of or above roads, to provide information to road users.

SIMULATION

Simulation is the imitation of the operation of a real-world process or system. The act of simulating something first requires that a model be developed; this model represents the key

characteristics, behaviors and functions of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.

Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training, education and video games. Often, computer experiments are used to study simulation models. Simulation can be used to show the eventual real effects of alternative conditions and courses of action.

SOLID WASTE

Solid waste means any garbage, refuse or sludge from a wastewater treatment plant, water supply treatment plant or air pollution control facility. It also includes discarded materials, like solid, liquid, semi-solid or contained gaseous material, resulting from industrial, commercial, mining and agricultural operations and from community activities. It does not include solid or dissolved materials in domestic sewage or solid or dissolved materials in irrigation return flows or industrial discharges.

SPRAWL

A pattern of development characterized by uniform low density, lack of a distinctive core, poor accessibility, dependence on automobiles, and uncontrolled and noncontiguous land expansion.

SMART GROWTH

Smart growth refers to a collection of land use and development principles that aim to enhance our quality of life, preserve the natural environment and save money over time. Smart growth principles ensure that growth is fiscally, environmentally and socially responsible and recognizes the connections between development and quality of life. Smart growth enhances and completes communities by placing a priority on infill, redevelopment and densification strategies.

STATUTORY PLAN

A statutory plan is a legal document that must go through three readings and a public hearing before it is adopted. Once adopted, there is a legal obligation on the part of both the municipality and the residents to adhere to the plan.

STORMWATER

Stormwater is water that originates during precipitation events and snow/ice melt. Stormwater can soak into the soil (infiltrate), be held on the surface and evaporate or runoff and end up in nearby streams, rivers, or other water bodies (surface water).

STREET GRID NETWORK

The grid plan, street grid plan or gridiron plan is a type of city plan in which streets run at right angles to each other, forming a grid. These patterns display a higher degree of connectivity than other road hierarchical patterns, which feature dead-end streets and fewer through connections.

STREETSCAPE

It is a term used to describe the natural and built fabric of the street and defined as the design quality of the street and its visual effect. The concept recognizes that a street is a public place where people are able to engage in various activities. A streetscape needs to have boundaries to ensure safe travel for all roadway users. Signs, curbs, fences and landscaping can effectively create an inclusive, yet safe environment that provides a sense of physical comfort for diverse users and activities. The aesthetic appeal elements of beautification initiatives, attractive lighting, street furniture, clean streets and outdoor dining contribute to sense of place. Amenities should be designed to get people out of their cars to socialize, interact with their environment and discover other mobility options.

SWOT ANALYSIS

SWOT analysis (or SWOT matrix) is a strategic planning technique used to help a person or organization identify the Strengths, Weaknesses, Opportunities, and Threats related to business competition or project planning [1]. It is intended to specify the objectives of the business venture or project and identify the internal and external factors that are favorable and unfavorable to achieving those objectives

TAX INCREMENT FINANCING (TIF)

TIF is a method to use future gains in taxes to finance current improvements (which theoretically will create the conditions for those future gains). When a development or public project is carried out, there is often an increase in the value of surrounding real estate, and perhaps new investment. This increased site value and investment sometimes generates increased tax revenues. The increased tax revenues are the “tax

increment." Tax Increment Financing dedicates tax increments within a certain defined district to finance debt issued to pay for the project. TIF is designed to channel funding toward improvements in distressed or underdeveloped areas where development might not otherwise occur. TIF creates funding for "public" projects that may otherwise be unaffordable to localities, by borrowing against future property tax revenues.

TAXABLE INCOME

Taxable income is the amount of revenue produced by a rental on which the owner must pay federal income tax. Once calculated, that amount is multiplied by the investor's marginal tax rate (i.e., state and federal combined) to arrive at the owner's tax liability.

Net Operating Income - Mortgage Interest - Depreciation, Real Property - Depreciation, Capital Additions - Amortization, Points and Closing Costs + Interest Earned (e.g., property bank or mortgage escrow accounts)

= Taxable Income

Then,

Taxable Income x Marginal Tax Rate

= Tax Liability

TRANSFERABLE DEVELOPMENT RIGHTS (TDR)

Transferable development rights are the transfer of rights to develop land, to government, local authorities or corporations. When an owner of land transfers his rights to develop their land to a government, local authority, corporation or government use, the same land is used for infrastructure projects such as road widening, metro rail projects, parks, gardens and schools or may be for making new roads or for any other projects of public utility. DRC (Development rights certificate) will then be issued to the owner of the land, the main purpose of the whole process being to aquire the required amount of land in a hassle-free manner. The DRC will allow the landowner an additional built-up area in return for the area for which their rights have been relinquished and enables them to develop the given area or transfer rights for consideration.

TIME VALUE OF MONEY

Time value of money is the underlying assumption that money, over time, will change value. It's an important element in real estate investing because it could suggest that the timing of receipts from the investment might be more important than the amount received.

TRANSFER OF DEVELOPMENT RIGHTS (HEIGHT AND DENSITY EXCHANGE)

Also called density bonusing, this tool offers developments a level of density that surpasses the allowable Floor Area Ratio (FAR). In exchange for increased height/density that surpasses the zoning by-law, developers are required to provide a service or benefit to the community as negotiated by the municipality, such as amenities or housing needed by the community. Density bonusing policies must be written into a municipality's Official Plan in order for it to be used as a development tool.

TRAFFIC CALMING

Traffic calming is intended to slow or reduce motor-vehicle traffic in order to improve safety for pedestrians and cyclists and improve the environment for residents. These may include narrower traffic lanes, speed bumps, raised pedestrian crossings and pedestrian refuge islands in medians, amongst others.

TRANSFORMER STATION

A station of an electricity generation, transmission and distribution system where voltage is transformed from high to low, or the reverse, using transformers

TRANSIT-ADJACENT DEVELOPMENT (TAD)

Development that is in close proximity to transit stops or facilities. However, this type of development is not designed to promote transit ridership. A TAD lacks functional connectivity to transit, whether in terms of land-use composition, station access or site design.

TRANSIT-ORIENTED DEVELOPMENT (TOD)

Transit-oriented developments (TOD) are 'urban villages' where all residents are within a 5-10 minute walk of efficient public transit and can 'live, work, play, shop and learn' in a pedestrian-friendly environment- without the need of a car. TOD is a planning approach that calls for high-density, mixed-use business/residential neighborhood centers to be clustered around transit stations and corridors. TOD is considered a "smart growth" strategy because it addresses the issue of where growth should occur from a sustainability perspective and it coordinates land use and transportation such that both land and infrastructure are used efficiently. As its name implies, TOD is designed to be served by transit, rather than or in addition to the automobile. Networks of streets and multi-use paths are

also created to provide a walkable and bikeable environment that is conducive to living, working and shopping in the same area. TOD is focused within an 800m radius of transit stops, with the highest intensity and mix of land uses concentrated within one-quarter mile or adjacent to the station. Land use intensities and densities decrease away from the core area, with transitions included in development plans to ensure compatibility with existing neighborhoods.

Peter Calthorpe summarizes the main characteristics and goals of TOD as follows:

- Organize growth on a regional-level to be compact and transit-supportive.
- Place commercial, housing, jobs, parks and civic uses within walking distance of transit stops.
- Create pedestrian-friendly street networks, which directly connect local destinations.
- Provide a mix of housing types, densities and costs.
- Preserve sensitive habitat, riparian zones and high-quality open spaces.
- Make public spaces the focus of building orientation and neighbourhood activity.
- Encourage infill and redevelopment along transit corridors within existing neighborhoods.

TRANSIT PRIORITY SIGNALS

Traffic signal priority allows transit vehicles to travel through signalized intersections with little or no delay. Since transit vehicles hold many people, giving priority to transit can potentially increase the person throughput of an intersection. There are different types of signal priority: passive, active and real-time. A passive priority strategy uses timed coordinated signals in the area-wide traffic signal timing scheme. An active priority strategy involves detecting the presence of a transit vehicle and gives the transit vehicle special treatment. The system can give an early green signal or hold a green signal that is already displaying. Real-time control strategies can consider not only the presence of a transit vehicle, but the adherence to schedule and the volume of other traffic. One common strategy is to give priority only to late buses, but not to early buses. This strategy optimizes schedule adherence (and therefore waiting time) rather than running time.

TRANSIT-SUPPORTIVE DEVELOPMENT (TSD)

TSD consists of a mix of housing, shops, restaurants, offices, civic buildings and open space in close proximity to a transit station. Transit-supportive planning and development rethink land use and development patterns to achieve a balanced transportation system where walking, cycling and riding transit are used more than the private automobile. This is primarily accomplished by designing communities so that walking, cycling and riding transit are more convenient and attractive options.

TRANSPORTATION DEMAND MANAGEMENT (TDM)

By influencing travel behavior through the implementation of strategies such as carpooling, parking management, cycling programs, flexible working hours, high occupancy vehicle lands and incentives for transit, walking and cycling, the resulting transportation system is more efficient.

URBAN REDEVELOPMENT

It is conceptually similar to land readjustment, with the exception that it happens in existing urban areas and often involves a rezoning by the government of a given area from a low-density (single-family housing) to higher-density (mixed-use or commercial) development. It is also accompanied by a provision of infrastructure improvements (mass transit, such as metro lines) that can support such up-zoning.

URBAN HEAT ISLAND

An urban heat island (UHI) is an urban area or metropolitan area that is significantly warmer than its surrounding rural areas, due to human activities. The temperature difference usually is larger at night than during the day and is most apparent when winds are weak. UHI is most noticeable during the summer and winter. The main cause of the urban heat island effect is from the modification of land surfaces. Waste heat, generated by energy usage, is a secondary contributor. As a population center grows, it tends to expand its area and increase its average temperature. The less-used term, heat island, refers to any area, populated or not, which is consistently hotter than the surrounding area.

Monthly rainfall is greater downwind of cities, partially due to the UHI. Increases in heat within urban centers increases the length of growing seasons and decreases the occurrence of weak tornadoes. The UHI decreases air quality by increasing the production of pollutants such as ozone and decreases water quality, as warmer waters flow into area streams and put stress on their ecosystems.

VALUE CAPTURE

An opportunity to generate revenues by capitalizing on the value created by infrastructure investments (often transit and other government-backed projects) by developing or selling property or collect¬ing fees or taxes. Value capture can be facilitated through direct measures, such as the sale of properties or the granting of a development franchise, or through indirect methods, such as extracting surplus from other property owners (through a betterment tax, for example) or reaping higher proceeds from regular property taxes.

VEHICLE CAPACITY

The average number of people that a vehicle can be scheduled to carry at capacity (as defined herein)

WASTEWATER DISPOSAL

It is a process used to convert wastewater into an effluent (outflowing of water to a receiving body of water) that can be returned to the water cycle with minimal impact on the environment or directly reused.

WAYFINDING

The means in which people orient themselves in physical space and navigate from place to place. Can include the physical design of spaces and assistive features, such as signage.

WORLD BANK (WB)

The World Bank is an international financial institution that provides loans to countries of the world for capital projects. The World Bank's stated goal is the reduction of poverty, which its Articles of Agreement define as commitments to the promotion of foreign investment, international trade and to the facilitation of capital investment.

ZONING REGULATIONS

Zoning regulations specify whether zones can be used for residential, commercial, industrial, institutional or open space purposes, that may also regulate lot size, placement, bulk (or density) and the height of structures.

Zoning consists of dividing a particular region of land into districts or zones and specifying the types of land uses that are allowed and prohibited for each zone. This is performed by the county and is typically specific to certain, unincorporated areas. Zoning, in its basic form, attempts to separate residential property use from other property uses.

TOD KP

TOD KP

SAMPLE DOCUMENTS AND REPORTS

TOD

Global Platform for Sustainable Cities

WORLD BANK GROUP

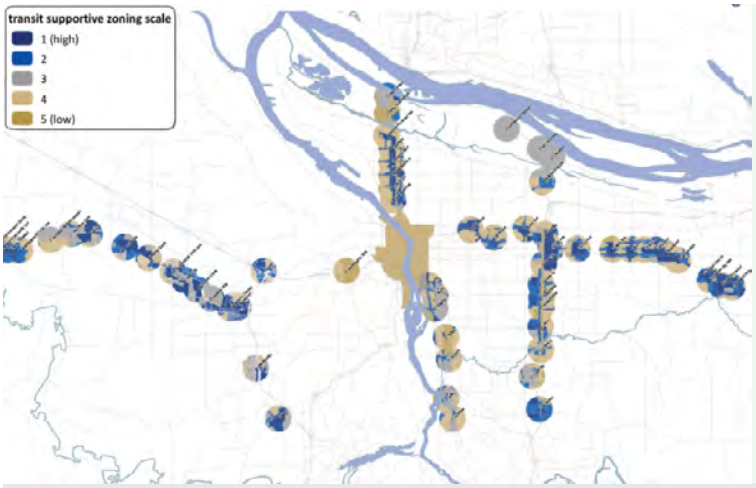
IBI

TOD KP

INTRODUCTION

This supplement to the TOD Knowledge Products provides examples of documents, reports, and terms of references from cities throughout the world where TOD is under implementation. The most relevant case examples are provided for specific groups of knowledge products. The intent of providing these examples is not to limit the scope or understanding of a subject matter. Rather, the user may choose to refer to them to understand the type of output that can be expected by using the various tools and resources provided under the TOD Knowledge Products, knowing and acknowledging that outputs will differ depending on the context of the assignment.

CONTENTS



ASSESS

AS-A01 TOD READINESS ASSESSMENT

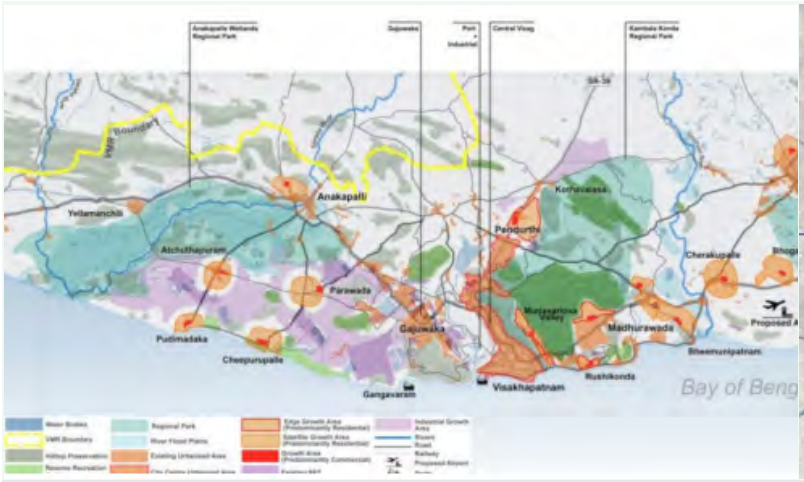
AS-A02 TOD SCALE AND CONTEXT ASSESSMENT

PRODUCT SUMMARY

The TOD Readiness Assessment and Scale and Context Assessment tool are developed to help cities in understanding the contextual readiness of the city, corridor, or site and identify the appropriate scale and context at which to plan for TOD.

CASE EXAMPLES

Example	Type	Example Source	URL
Transit Oriented Development Strategic Plan - Denver, US	Report	City of Denver. 2014. *Transit Oriented Development Strategic Plan*. Consultant Report, MIG, EPS, OV Consulting, Denver, CO: Federal Transit Administration.	Link
TOD City Specific Plan - Bhopal, India	Report	MOUD (Ministry of Urban Development), India. 2016. *TOD City Specific Plan - Bhopal*. Consultant Report, IBI Group, Bhopal: Sustainable Urban Transport Project (SUTP).	Link
Transit Oriented Development Strategic Plan - Portland US	Report	CTOD (Center for Transit-Oriented Development), Nelson Nygaard. 2011. *Transit-Oriented Development Strategic Plan*. Consultant Report, Portland: Portland Metro.	Link



ASSESS

AS-A03: THRESHOLDS FOR REAL ESTATE DEMAND

AS-H01: HOW TO UNDERTAKE REAL ESTATE MARKET ANALYSIS (STEP-BY-STEP GUIDE)

AS-R01: REAL ESTATE ANALYSIS BEST PRACTICES (REF DOC.)

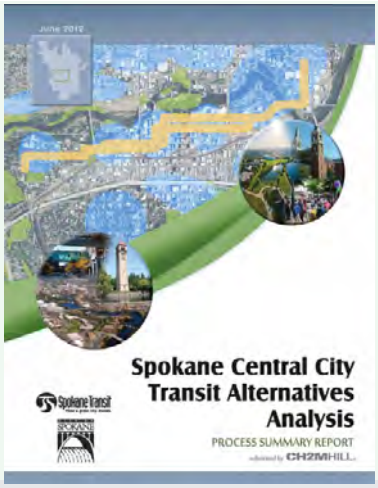
AS-P01: REAL ESTATE ANALYSIS TERMS OF REFERENCE (TOR TEMPLATE)

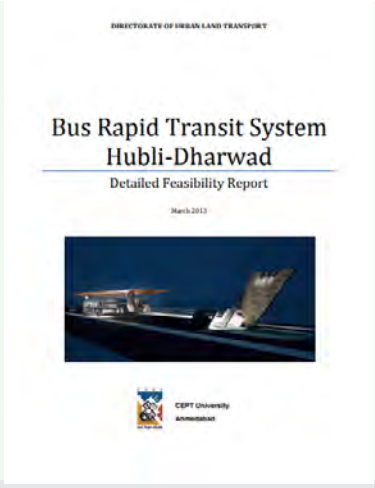
PRODUCT SUMMARY

The real estate tools aid in establishing the real estate knowledge required to undertake a successful TOD development. Through the use of the tools, the market area with the appropriate demand can be determined. It can also be better understood what development is most in demand, based on demographic, geographic and economic trends.

CASE EXAMPLES

Example	Type	Example Source	URL
Transit-Oriented Redevelopment of the Dwarka Bus Station	Report	GVMC (Greater Visakhapatnam Municipal Coorporation), USTDA (US Trade and Development Agency). 2017. "*Transit-Oriented Redevelopment of the Dwaraka Bus Station- Feasibility Study Final Report*." Consultant Report, AECOM, IBM, KPMG, Visakhapatnam: AECOM.	Link
Revenue maximizing study in particular for non-fare box revenues with affordability studies	Report	MRVC (Mumbai Railway Vikas Corporation Ltd). 2014. "*Revenue maximising study in particular for non-fare box revenues with affordability studies*." Consultant Report, PriceWaterhouseCooper, Mumbai.	Link
Real Estate Information System	Weblink	Urban Redevelopment Authority. n.d. *Realis Tool*. Accessed 08 18, 2018.	Link





ASSESS

AS-A04: THRESHOLDS FOR RAPID TRANSIT MODE SELECTION

AS-H02: HOW TO UNDERTAKE RAPID TRANSIT ALTERNATIVES ASSESSMENT (STEP-BY-STEP GUIDE)

AS-P02: TRANSIT ALTERNATIVES ANALYSIS TERMS OF REFERENCE (TOR TEMPLATE)

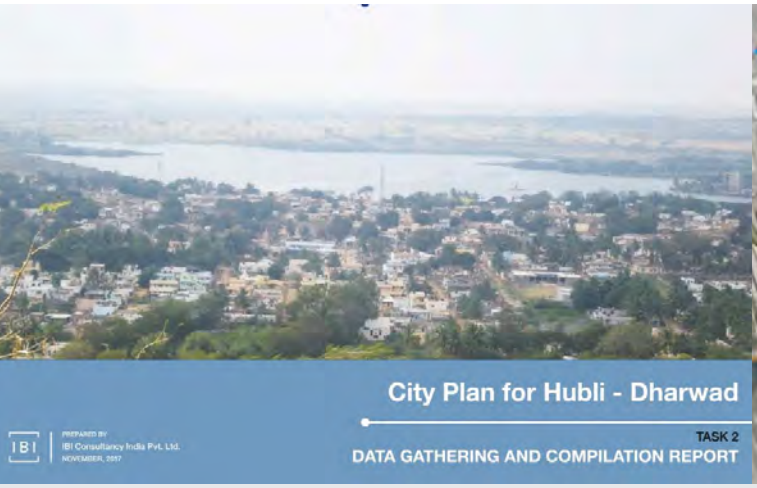
PRODUCT SUMMARY

The rapid transit assessment tools are intended to help cities who are planning the first rapid transit corridors or those that are planning an extension of existing transit networks.

The tools will aid in identifying, evaluating and selecting the appropriate rapid transit alternative including route alignment, mode and technology relative to existing city conditions and financial viability.

CASE EXAMPLES

Example	Type	Example Source	URL
Bus Rapid Transit System Hubli-Dharwad	Report	DULT (Directorate of Urban Land Transport) (2013). *Bus Rapid Transit System Detailed Feasibility Report.* Consultant Report (CEPT), Hubli-Dharwad	Link
Spokane Central City Transit Alternatives Analysis	Report	Sound Transit (2012). *Spokane Central City Transit Alternatives Analysis Process Summary Report*. Consultant Report (CH2M Hill), Spokane	Link
Rapid Transit Initiative - London, ON	Report	City of London, ON; LT (London Transit). 2016. "*SHIFT -London's Rapid Transit Initiative*." Consultant Report, IBI Group, WSP, London ON, Canada	Link
Corridor Assessment and Ranking for Selecting one Pilot Smart Corridor	Report	EDF (European Development Fund) (2016). *Report on the Corridor Assessment and Ranking for Selecting at Least One Pilot Smart Corridor.* Consultant Report (NTU/LB). Addis Ababa: The European Union.	Link



ASSESS

AS-H03: HOW TO UNDERTAKE INFRASTRUCTURE CARRYING CAPACITY ASSESSMENT (STEP-BY-STEP GUIDE)

AS-P03: INFRASTRUCTURE ANALYSIS TERMS OF REFERENCE (TOR TEMPLATE)

FINANCE

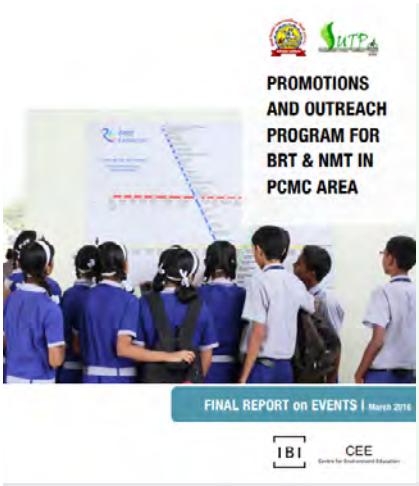
FI-A01: INFRASTRUCTURE CAPITAL & OPERATING COST ESTIMATES/RANGES (SPREADSHEET)

PRODUCT SUMMARY

These tools help in evaluating the infrastructure carrying capacity of a site for transit-supportive densities, based on the development context. Further, they help in estimating the cost requirements for infrastructure capital and operating costs.

CASE EXAMPLES

Example	Type	Example Source	URL
Hubli-Dharwad City Plan - Data Gathering and Compilation Report	Report	HDBRTS Ltd. (2017). *City Plan for Hubli-Dharwad Data Gathering and Compilation Report*. Consultant Report (IBI Consultancy India Pvt Ltd), Hubli-Dharwad.	Link
TOD Regulations for Delhi - Annexure-1 - (vii) Infrastructure Provision	Statutory Document	DDA (Delhi Development Authority). (2016). *Proposed Transit Oriented Development (TOD) Regulations - Page 19*. New Delhi, Delhi, India.	
Capital Improvement Program, California	Report	California National City 1887 Incorporated. (2017). *Fiscal Year 2017 - 2021 5-Year Capital Improvement Program (CIP)*. Budget Report, National City.	Link
Capital Operating and Maintenance costs estimates, Nashville	Report	Nashville Area Metropolitan Planning Organization. 2007. "*Nashville Southeast Corridor High-Performance Transit Alternatives Study - Chapter 9*." Final Report, Nashville TN.	



ENABLE

EN-C01: STAKEHOLDER ENGAGEMENT - GAME (REF. DOC.)

EN-C02: MAKING A CASE FOR TOD TO THE PUBLIC - COMMUNICATION STRATEGY (REF.DOC.)

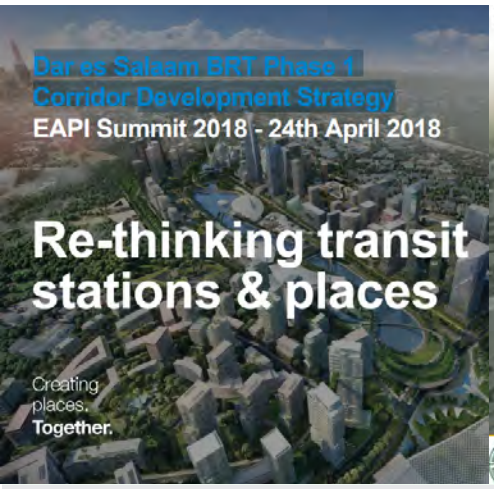
EN-P01: COMMUNICATION STRATEGY TERMS OF REFERENCE (TOR TEMPLATE)

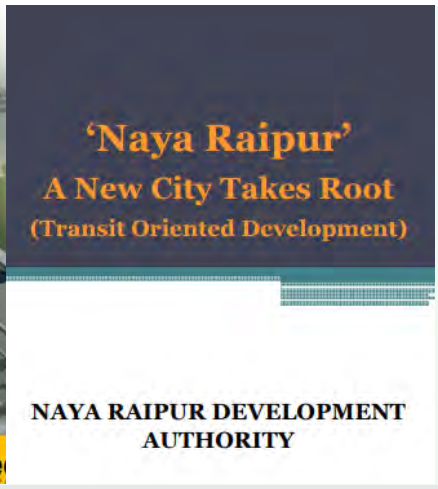
PRODUCT SUMMARY

The Communications tools help to build ownership among all the TOD stakeholders. The myriad tools that can be employed include online and print strategies, physical games and other media that can communicate the benefits of the TOD plans.

CASE EXAMPLES

Example	Type	Example Source	URL
Community Engagement, Roosevelt Station TOD	Report	Sound Transit. (2017). *Summary of Community Engagement*. Seattle: City of Seattle, Roosevelt Neighborhood Association	Link
Strategic Communications Plan, Manassas Park	Report	Arup USA, Inc. 2009. "*Marketing TOD Strategic Communications/ Marketing Plan*." Manassas Park.	Link
Promotion and Outreach Program, Pimpri Chinchwad	RFP	PCMC (Pimpri Chinchwad Municipal Corporation). n.d. "Selection of Consultants for Promotion and Outreach Program (POP) for BRT & Non-Motorized Transport (NMT) Systems in Pimpri-Chinchwad." Pimpri Chinchwad, India.	Link
Promotion and Outreach program for BRT & NMT in PCMC area	Report	PCMC (Pimpri Chinchwad Municipal Corporation). 2016. *Promotions and Outreach Program for BRT & NMT in PCMC Area.* Consultant Report (IBI Group, Centre for Environment Education), Pimpri Chinchwad: SUTP (Sustainable Urban Transport Project).	Link





PLAN+ DESIGN

PD-H01: HOW TO PREPARE A CITY-WIDE TOD PLAN (STEP-BY-STEP GUIDE)

PD-H02: HOW TO PREPARE A CORRIDOR TOD PLAN (STEP-BY-STEP GUIDE)

PD-H03: HOW TO PREPARE A STATION AREA PLAN (STEP-BY-STEP GUIDE)

PD-H04: HOW TO PREPARE A SITE LEVEL TOD PLAN (STEP-BY-STEP GUIDE)

PD-R01: TOD PLANNING PRINCIPLES & DESIGN GUIDELINES (REF. DOC.)

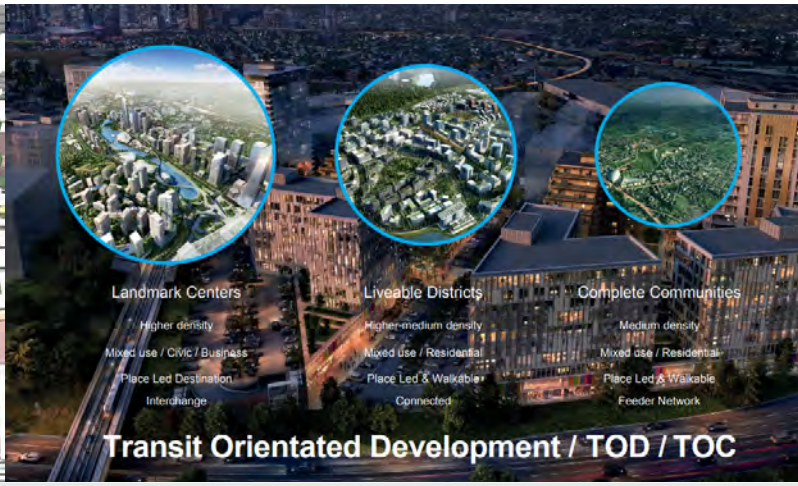
PD-P01: TOD PLANS TERMS OF REFERENCE (TOR TEMPLATE)

PRODUCT SUMMARY

The How-to Guides for Plan+Design along with the Planning Principles demonstrate the processes to be followed in undertaking TOD planning at different scales under different contextual conditions. The outputs below are an illustration of how these tools will help you define the final products.

CASE EXAMPLES

Example	Type	Example Source	URL
Dar es Salaam BRT Phase 1 Corridor Development Strategy	Presentation	Broadway Malyan. 2018. "Dar es Salaam BRT Phase 1 Corridor Development Strategy." Client PO-RALG Tanzania. Dar es Salaam: The World Bank; Nordic Development Fund	Link
Kakardooma TOD Proposal, Delhi	Presentation	UTTIPEC (Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre). n.d. East Delhi Hub – Kadkardooma TOD Proposal. New Delhi: Delhi Development Authority	
Naya Raipur TOD Study	Presentation	NRDA (Naya Raipur Development Authority). 2013. 'Naya Raipur' A New City Takes Root (Transit Oriented Development). Naya Raipur.	
City of Cape Town TOD Strategic Framework	Report	Transport for Cape Town. 2015. "City of Cape Town TOD Strategic Framework." Strategic Plan, City of Cape Town.	Link



PLAN+ DESIGN

PD-H05: HOW TO DEVELOP TOD SUPPORTIVE ZONING FRAMEWORK (STEP-BY-STEP GUIDE)

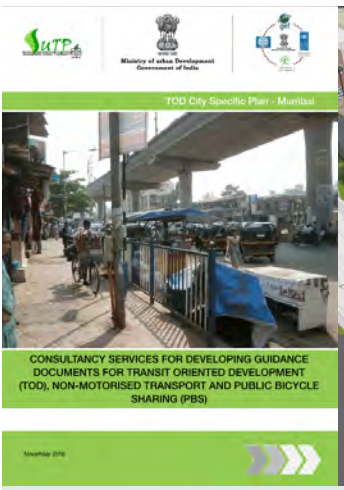
PD-R02: TOD ZONING CODE TEMPLATE (REF. DOC.)

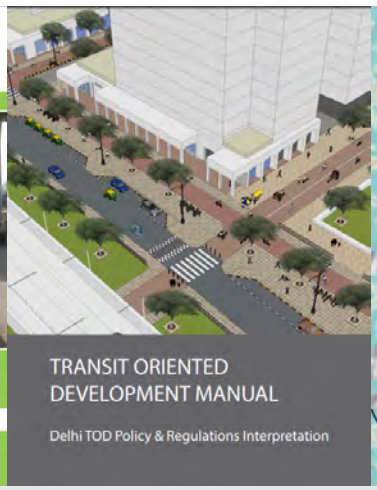
PRODUCT SUMMARY

The TOD Zoning Framework tools provide guidance on how TOD concepts and ideas can be converted into a statutory zoning regulation within the city.

CASE EXAMPLES

Example	Type	Example Source	URL
TOD Regulations for Delhi	RFP	Delhi Development Authority. 2017. “Master Plan for Delhi-2021”. New Delhi	Link
Sample TOD Overlay Zoning Ordinance - Reconnecting America	Report	Valley Connections. 2001. Model Transit-Oriented District Overlay Zoning Ordinance. http://www.reconnectingamerica.org/assets/Uploads/bestpractice230.pdf, California: Community Design + Architecture, Inc.	Link
Comprehensive Development Control Regulations, Ahmedabad	Weblink	UD&UHD (Urban Development and Urban Housing Department). 2017. “Comprehensive General Development Control Regulation - 2017.” Gandhinagar.	Link
Spatial Development Framework, Johannesburg	Report	City of Johannesburg. 2016. "Spatial Development Framework 2040 City of Johannesburg Metropolitan Municipality." Prepared in collaboration with Urban Planning and Design Lab, Iyer Urban Design Studio and Urban the Morphology & Complex Systems Institute, Johannesburg.	Link





PD-H06: LAND AMALGAMATION FRAMEWORK (STEP-BY-STEP GUIDE)

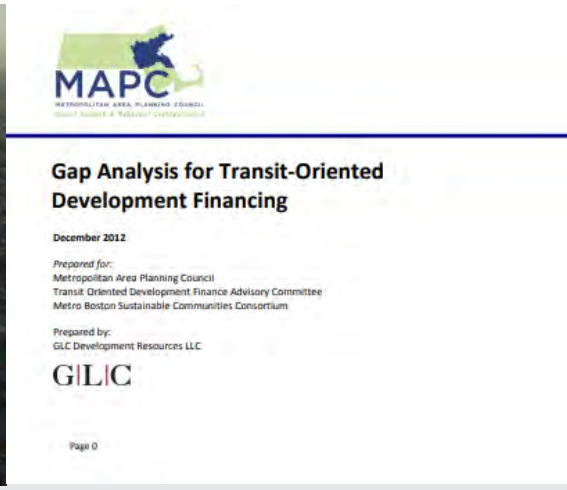
PLAN+
DESIGN

PRODUCT SUMMARY

The Land Amalgamation Framework tools guides cities on how to develop and define the area to be amalgamated and different ways to undertake the amalgamation process.

CASE EXAMPLES

Example	Type	Example Source	URL
Dar es Salaam BRT Phase 1 Corridor Development Strategy	Presentation	Broadway Malyan. 2018. "Dar es Salaam BRT Phase 1 Corridor Development Strategy." Client PO-RALG Tanzania. Dar es Salaam: The World Bank; Nordic Development Fund	Link
TOD Manual, Delhi	Manual	UTTIPEC (Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre), WRI India. 2014. Transit Oriented development Manual- Delhi TOD Policy & Regulations Interpretation. Delhi: World Resource Institute.	Link
TOD City Specific Plan, Mumbai	Report	MOUD (Ministry of Urban Development), India. 2016. *TOD City Specific Plan - Mumbai*. Consultant Report, IBI Group, Mumbai: Sustainable Urban Transport Project (SUTP).	Link



FI-A02: REAL-ESTATE DEVELOPMENT PRO-FORMA (SPREADSHEET)

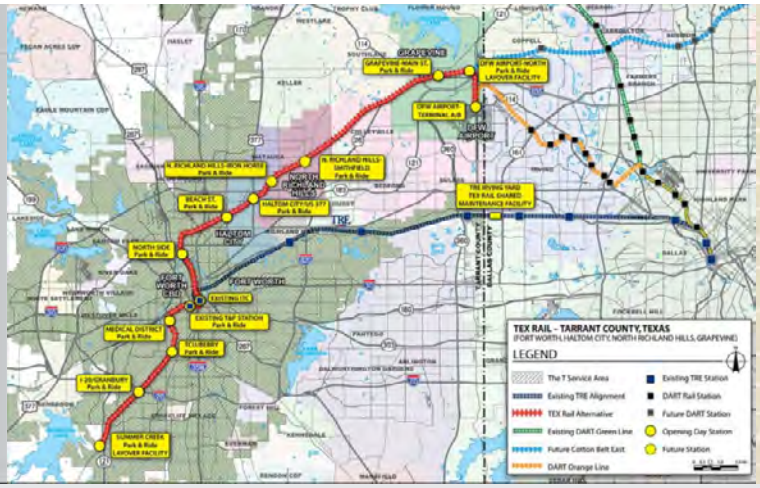
FINANCE

PRODUCT SUMMARY

The Real Estate Development Pro-Forma tool provides primary understanding about the assessment of return on investment (ROI), based on certain basic project development parameters.

CASE EXAMPLES

Example	Type	Example Source	URL
Market and Pro-Forma Analysis	Report	City of Sacramento. 2007. “Market and Pro-Forma Analysis.” Sacramento : Bay Area Economics .	Link
Transit-Oriented Development in Mexico City	Presentation	DUSP (Department of Urban and Spatial Analytics), MIT. 2016. “Transit-Oriented Development in Mexico City.” Mexico City.	Link
Gap Analysis for Transit-Oriented Development Financing	Report	MAPC (Metropolitan Area Planning Council). 2012. “Gap Analysis for Transit-Oriented.” Consultant Report (GLC Development Resources LLC), Boston.	Link



FINANCE

FI-H01: LAND VALUE CAPTURE FRAMEWORK (STEP-BY-STEP GUIDE)

FI-R01: DEVELOPMENT INCENTIVES (REF. DOC.)

FI-R02: LAND VALUE CAPTURE MECHANISMS AND BEST PRACTICES (REF. DOC.)

FI-R03: MUNICIPAL FINANCE TOOLS (REF. DOC.)

PRODUCT SUMMARY

The development incentives, municipal finance, LVC and PPP tools will guide cities or developers in structuring projects so as to maximize value and revenue and share the risks during the life cycle of the project.

CASE EXAMPLES

Example	Type	Example Source	URL
Land value capture as a funding source, Warsaw Metro	Report	Polska, Sprawne Panstwo Program- Ernst & Young. 2011. "*Land value capture as a funding source for urban investment- The Warsaw metro system*." Warsaw.	Link
Transit Value Capture Analysis, Chicago Region	Report	CMAP (Chicago Metropolitan Agency for Planning). 2010. "*Transit Value Capture Analysis for the Chicago Region*." Consultant Report (S. B. Friedman & Company).	Link
Feasibility Study, Dwarka	Report	Corporation, Greater Visakhapatnam Municipal. 2017. "*Transit-Oriented Redevelopment Of the Dwaraka Bus*." Consultant Report (AECOM, IBM, KPMG), Visakhapatnam.	Link
Tax Increment Financing	Presentation	Chapa, Jay. 2013. "*Tax Increment Financing: TEX Rail/Transit-Oriented Development*." Fort Worth.	Link
Innovative Municipal Financing, Tamil Nadu	Report	Venkatachalam, Pritha. 2005. "*Innovative Approaches to Municipal Infrastructure Financing: A Case Study on Tamil Nadu, India*." Tamil Nadu, India: Development Destin Studies Institute.	Link

FI-H02: PRIVATE SECTOR PARTICIPATION FRAMEWORK (REF. DOC.)

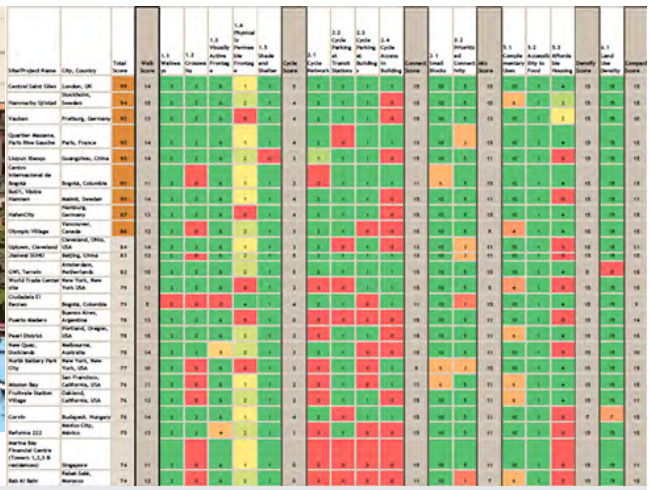
FINANCE

PRODUCT SUMMARY

This resource provides a compilation of municipal financing tools that are applied globally and a guide for the cities on how to deploy these tools.

CASE EXAMPLES

Example	Type	Example Source	URL
Indian Stations Redevelopment PPP Framework	Report	Indian Railways; FICCI. 2017. "Indian Railways Station Redevelopment- Transforming Railways and Creating Win-Win Opportunities." Consultant Report (The Boston Consulting Group).	Link
TOD Development – Capitol Hill Properties Redevelopment	RFP	Sound Transit. 2014. "*Request for Proposals TOD Development – Capitol Hill Properties Redevelopment*."	Link



IMPLEMENT

IM-A01: MONITORING AND EVALUATION (CHECKLIST)

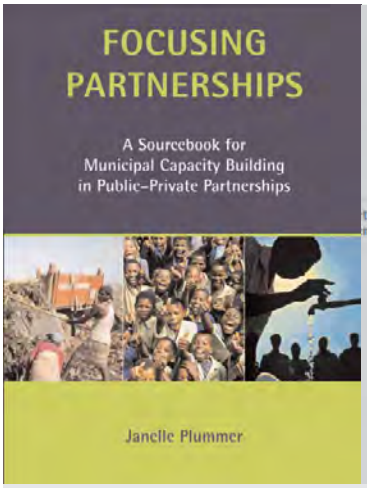
IM-A02: TOD KPI (Spreadsheet)

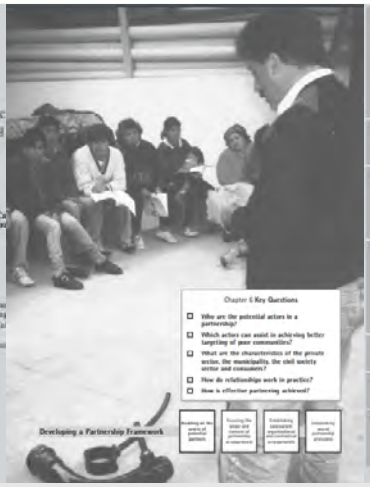
PRODUCT SUMMARY

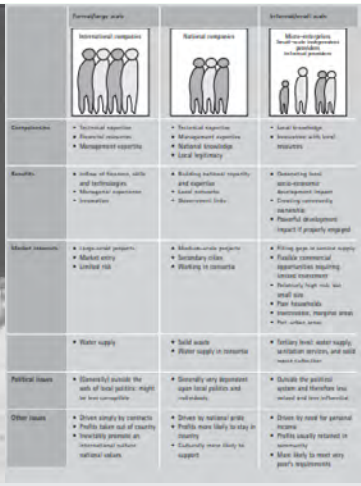
The Monitoring and Evaluation tools provide cities with guidance on how to monitor and evaluate the performance of ongoing and completed projects with respect to TOD goals.

CASE EXAMPLES

Example	Type	Example Source	URL
Evaluating Transit-Oriented Development Using a Sustainability Framework	Report	Renne, John L. n.d. "6 *Evaluating Transit-Oriented Development Using a Sustainability Framework: Lessons from Perth's Network City*." Perth	Link
Project Evaluation Report, Philadelphia	Report	Commission, Delaware Valley Regional Planning. 2003 . "*Project Evaluation Report Implementing Transit-Oriented Development in the Philadelphia Metropolitan Area*." Philadelphia	Link
TOD Indicators	Report	NIUA (National Institute of Urban Affairs). n.d. *Assessing TOD- A List of Indicators*. India: NIUA and Foreign and Commonwealth Office (UK).	
TOD Scores	Weblink	The Institute for Transportation and Development (ITDP). 2014. TOD Scores.	Link







IMPLEMENT

IM-H01: HOW TO UNDERTAKE CAPACITY BUILDING (STEP-BY-STEP GUIDE)

IM-P01: CAPACITY BUILDING TERMS OF REFERENCE (TOR TEMPLATE)

PRODUCT SUMMARY

These tools will help cities assess their own capacities and formulate a response to be able to build capacities as needed for planning and implementing TOD.

CASE EXAMPLES

Example	Type	Example Source	URL
Capcity Building Reforms, Kolkata	Presentation	KMC (Kolkata Municipal Corporation). 2009. “KMC: Capacity Building Program – A Reforms Initiative.” Kolkata.	Link
Assessment of Capacity Building Needs	Presentation	NIUA (National Institute Of Urban Affairs). 2015. *A Study to Qualitatively Assess the Capacity Building Needs of Urban Local Bodies (ULBs)*. Research Division, NITI Aayog,.	Link
Capacity Building in PPPs	Report	Plummer, Janelle. 2002. *FOCUSING PARTNERSHIPS- A Sourcebook for Municipal Capacity Building in Public–Private Partnerships*. UNDP, Earthscan Publications Ltd, London,Sterling, VA.	Link

TOD K P

GOOD PRACTICE NOTE

Integration of Road Safety Considerations in Transit-Oriented Development projects

WORLD BANK GROUP TOD Global Platform for Sustainable Cities gef UKaid from the British people GRSF Global Road Safety Facility IBI WRI INDIA

This note was prepared with funding from UK AID, through the Global Road Safety Facility (GRSF), for the World Bank as part of the assignment: ***"Integration of Road Safety Considerations in Transit-Oriented Development Projects"***.

It has been prepared by World Resources Institute India (WRI India) team led by Prerna V. Mehta and included Abhishek Behera, Binoy Mascarehnas and Jaya Dhindaw, and supported by Madhav Pai, Chetan Sodaye, Dhawal Ashar, Himanshi Kapoor and Rajeev Malagi; under the leadership of Gerald Ollivier and Alina Burlacu, with peer review by Blanca Domine, Said Dahdah, Wanli Fang, and Juan Miguel Velasquez Torres. Dipan Bose offered helpful comments during the finalization of the document.

September 2020

ABBREVIATIONS

AE	Automated Enforcement
BRT	Bus Rapid Transit
FOB	Foot over bridge
GDP	Gross Domestic Product
IPT	Intermediate Public Transport
NMT	Non-motorized Transport
PIARC	World Road Association
RSIA	Road Safety Impact Assessment
ROW	Right of Way
RSA	Road Safety Audit
RSI	Road Safety Inspection
SAM	Safe Access Mass-transit
TOD	Transit Oriented-Development
VKT	Vehicle Kilometers Traveled
WRI	World Resources Institute

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INTRODUCTION

1. Based on 2018 findings of the World Health Organization (WHO), the number of deaths due to road crashes is 1.35 million deaths per year. While this number is quite high and increasing every year, the rate of road crash deaths per 100,000 of population has remained constant, at around 18 deaths, over the years. This rate of deaths is however not distributed proportionately amongst the different regions and countries. The high-income countries have recorded lowest average rate at 8.3 per 100,000. In contrast to this number, low-income countries have the highest annual road traffic fatality rates averaging at 27.5 deaths per 100,000– more than three times the average for high-income countries.

ROAD CRASH AND IMPACT

2. Most of the deaths and injuries from road crashes are of the working age population, which negatively impacts both the economy and the demography of the region. Road traffic injuries are currently the 8th leading cause for death for all age groups, and further compounding the demographic impact is the fact that road crashes are the leading cause of death for children and young adults, between the ages of 5 and 29 years.

3. Road traffic crashes have a high economic impact, costing 3 percent of a country's GDP on average. They also cause a significant impact on the individuals as well as their families. Injuries arising due to road crashes can lead to trauma for the individual and loss in productivity. Along with costs of treatment, economic challenges may further be increased due to temporary or permanent loss of income as well. Along with the victim, road crashes take an emotional toll on the immediate family members and caregivers during treatment process or any deaths and add to the economic burden as they may need to take time off work or school to care for the injured.

4. The distribution of road users varies within different regions and income groups of countries. This impacts the variations in death rates amongst the users. The low- and middle-income countries have a significantly high proportion of pedestrians, cyclists and two- or three-wheeler motorized vehicles. Overall, the global road traffic deaths for pedestrians and cyclists is at 26% and another 28% for two- and three-wheeler motorcyclists, totaling nearly 54% of vulnerable road users. This proportion varies in comparison between the economic group of countries, with a high percentage of road crash victims being car occupants.

	Americas	Europe	Africa	Eastern Mediterranean	South-east Asia	Western Pacific	World
Drivers/ passengers of 4 wheeler vehicles	34%	48%	40%	39%	16%	22%	29%
Motorized 2-3 wheeled vehicles	23%	11%	9%	15%	43%	36%	28%
Cyclists	3%	5%	4%	2%	2%	6%	3%
Pedestrians	22%	27%	40%	34%	14%	22%	23%
Others/ unspecified	18%	9%	7%	10%	25%	14%	17%

Table 1. Distribution of deaths by road user type by WHO Region (Source: WHO 2018)

5. Globally, a significant percentage of road crash victims being car occupants is also an indicator of insufficient infrastructure for controlling traffic speeds and volumes. Furthermore, when people use private cars more for their daily activities, it results in a higher level of total vehicle-kilometers traveled (VKT). Choice of using personal vehicle over using non-motorized transport or public mass transport may be attributed to the car-centric planning and design of road infrastructure. Many countries lack adequate protected infrastructure for pedestrians and cyclists. This discourages users to walk or bicycle to their destinations.

6. Mode-choice plays a critical role in road safety. Public mass transit systems not only provide faster and safer transportation mode choices, they also help reduce dependency on privately owned vehicles on the road. Public mass transit services typically follow designated routes as well, thereby minimizing interferences between different types of road users. While many countries still have to develop mass transit infrastructure such as metro rails, public bus system is quite prevalent, with bus rapid transit (BRT) and bus only lane infrastructures being developed. Absence of proper first and last mile connectivity to the transit stations poses security threats for road users and discourages them from using public transport.

7. Additionally, a city's urban form conditions, such as built density, land-use mix and street layout, are also critical aspects for road safety, and can impact a variety of influencing factors, ranging from traffic speed to modal choice. Larger block sizes and suburban layouts mean longer walking and biking distances for users and hence a preference for private vehicles. Barcelona, Spain and Atlanta, USA both have comparative population sizes (2.8 million and 2.5 million respectively). However, they vastly differ in built-up area, with just 162 sq.km for Barcelona, compared to 4280 sq.km for Atlanta. This has a significant impact on mode choice, where only 20% of trips in Barcelona are car dependent, compared to 77% in Atlanta. The road safety impact is clearly evidenced by the traffic fatality rate of just 1.9 deaths per 100,000 population in Barcelona compared to 9.7 deaths in Atlanta.

SAFE SYSTEM APPROACH

8. The Safe System approach derives from the Swedish ***Vision Zero*** and Dutch ***Sustainable Safety*** strategies that have a long-term goal for a road traffic system to be eventually free from fatalities and serious injuries. It represents a shift away from traditional approach of preventing collisions to a more forgiving approach of preventing fatalities and mitigating serious injuries in road crashes. The traditional approach emphasizes the responsibility of road users to avoid crashes rather than the responsibility of system designers to provide a safe mobility system.

9. The Safe System approach takes into account that humans are vulnerable and fallible, and errors are to be expected. It aims at ensuring these mistakes do not lead to a crash, and if a crash does occur, it is sufficiently controlled to not cause a death or a life-changing injury. Thereby with a "zero-harm goal", it places a strong emphasis on road builder/operator and vehicle manufacturer accountability for road safety performance.

10. The Safe System approach emphasizes shared responsibility. Government agencies at different levels and a range of multi-sectoral agencies and stakeholders – including policy makers, road engineers, planners, vehicle manufacturers, enforcement officers, emergency medical agencies, road safety educators etc. – are accountable for the system's safety and all road users – drivers, cyclists, and pedestrians are responsible for complying with the system rules.

11. This approach further caters to the larger socio-economic and environmental challenges faced in urban areas. While making the road an equitable space for all users, ensuring accessibility and usability for all, it helps address issues associated with road traffic such as congestion, public health, and pollution.

12. The Safe System approach is anchored around the following four principles:

    - **People make mistakes** that can lead to road crashes.
    - **People are vulnerable** – The human body has a limited physical ability to tolerate crash forces before harm occurs i.e. being seriously injured or killed.
    - **A shared responsibility** – Those who plan, design, build, and manage roads and vehicles and provide post-crash care share the responsibility to prevent crashes resulting in fatal and serious injuries. In a true Safe System, road users also have the responsibility such as vehicle safety feature maintenance, complying with the policies etc.
    - **Strengthen all parts of the system** – There is a need to improve the safety of all parts of the system - roads and roadsides, speeds, vehicles, and road use - and if one part fails, road users are still protected.

13. Along with these principles, it must also be noted that road crash deaths and serious traffic crashes and injuries are preventable and should not be accepted as part of the mobility system. Lack of safety should not be a trade-off for faster mobility. Rather, the mobility system should be both safe and efficient.

14. Safe system comprises of four components below (Figure 1):

    - **Safer Roads:** Safety features are to be included into the design of roads in order to reduce the risk of crashes and the severity of injuries if a crash occurs. Typical measures include segregation of different types of road users and traffic moving at different directions and speeds, traffic calming measures, targeted improvements of crash hot-spot etc.
    - **Safer Speeds:** Speed limits help in avoiding crashes and the severity of the same. The human body being vulnerable has a limit for experiencing and enduring physical trauma. Based on road types and the contexts, appropriate speed limits need to be established and enforced.
    - **Safer Vehicles:** Vehicles are to be designed and maintained to minimize the occurrence and consequences of crashes focusing on the survivability post a collision. While the vehicle design technology (braking systems, sensors, passive safety components etc) is critical, the onus is also on the users to buy safer vehicles and maintain them to the highest standards.
    - **Safer Road Users:** As part of the shared responsibility, it is necessary for road users to comply with the road rules and for system designers to actively work towards reduction of traffic volumes, educating users of the risks, adhering to proper usage of roads, ensuring proper post crash health facility etc.

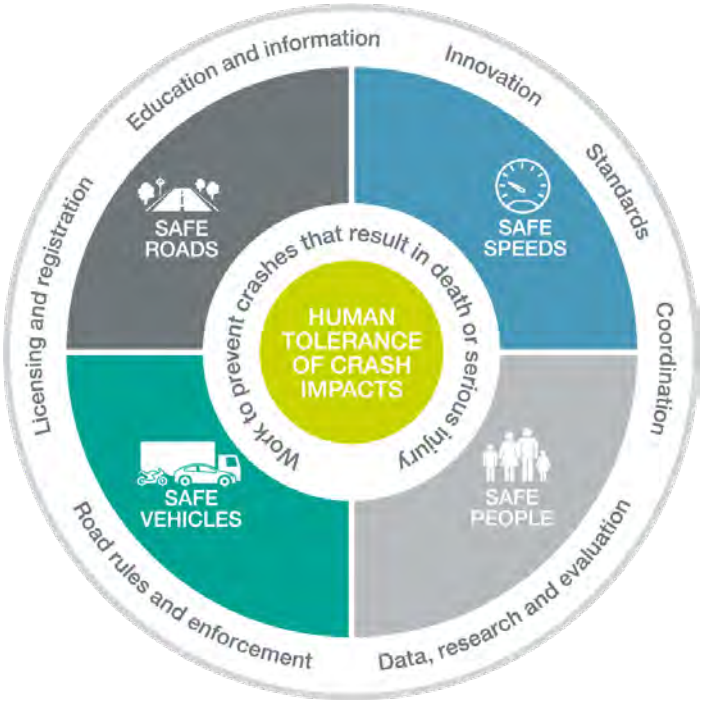


Figure 1. Safe system diagram

Adapted from Safer Roads, Safer Queensland: Queensland's Road Safety Strategy 2015–21 (www.roadsafety.gov.au/nrss/safe-system)

CASE FOR TRANSIT-ORIENTED DEVELOPMENT (TOD)

15. In order to achieve sustainable growth, globally cities are looking at integrating land use and transportation planning. An outcome of this endeavor is the application of transit-oriented development, better known by its acronym TOD. It is a "multidisciplinary planning and design strategy to ensure compact, mixed-use, mixed-income, pedestrian and two-wheeler friendly cities, and suitably dense urban development organized around transit stations". By virtue of its character, a TOD scheme advocates for environmental sustainability by promoting public transit and non-motorized transport, and socially-inclusive economic development that is equitably distributed creating safe urban spaces for all users.

16. The World Bank's TOD Community of Practice summarizes eight key principles for implementing TOD:

    - Align human densities, economic densities, mass transit capacity, and transit network characteristics for greater accessibility.
    - Create compact regions with short commutes.
    - Ensure the resilience of areas connected by mass transit.
    - Plan and zone for mixed-use and mixed-income neighborhoods at a corridor level.
    - Create vibrant, people-centric public spaces around mass transit stations.
    - Develop neighborhoods that promote walking and cycling.
    - Develop good-quality, accessible, and integrated public transit.
    - Manage demand for private vehicles.

17. TOD involves creating concentrated nodes of moderate-to-high density developments supporting a balanced mix of diverse land uses which are located within 5-10 minutes of walking distance, I,e, 800m-1km from mass rapid transit stations. This integration of transportation and land use planning, with other elements such as market demands, environmental systems, community input and technical efficiencies, allows for placement of employment, entertainment, leisure and residential uses near each other around the rapid transit stations. This allows for reduced trip lengths and number of trips and prioritizes public transit use and reduces dependency on private motor vehicles.

18. There is a strong interrelationship between TOD and road safety. A well-executed TOD scheme has the potential to make far-reaching impacts on the road safety scenario in the city. At the citywide level, TOD influences urban form and mode-choice; two very critical factors for road safety. The mixed-use land use developments with active frontage and accessible services centered within safe walking and cycling distances around transit stations, encourages users to choose for transit combined with non-motorized commute over use of cars. This pattern of considerable mode shift minimizes the number of cars on the street thereby reducing the chances of conflicts. At the neighborhood level, TOD promotes more pedestrian-friendly streets with lower traffic speeds, which significantly improves the safety of the most vulnerable road-user group.

19. This note forms a part of the engagement between the World Bank and World Resources Institute India (WRI India) to leverage existing work on "TOD Implementation and Resource Tools" being developed as part of the Global Platform for Sustainable Cities (GPSC), by identifying and addressing road safety gaps to develop improved guidelines to apply the safe system approach to existing TOD projects around the world.

SCOPING

20. As part of the engagement between the World Bank and WRI India, a review of existing literature and references on TOD projects developed by the World Bank and other leading organizations and practitioners across the world was undertaken to analyze best practices of urban road safety. A road safety diagnostic on the existing TOD Toolkit Knowledge Products was also carried to identify gaps and how to address the same.

21. It was observed that the existing literature and the toolkits discussed the importance of TOD and how to execute a TOD project from an institutional setup, planning along transit routes, and financing of the same. They however did not explicitly discuss the need for enabling or ensuring road safety within a TOD area.

22. These gaps have then been subsequently addressed by World Resources Institute to support systematic inclusion of roads safety and universal accessibility in TOD projects through five stages of TOD implementation - ***Assess, Enable, Plan & Design, Finance*** and ***Implement***.

23. This Good Practice Note summarizes the various road safety considerations and measures that may be undertaken.

ASSESS

24. 'Assess' is the first stage of the TOD Resources and Implementation toolkit. This initial stage helps in determining how "ready" a city is for TOD, based on "analysis of a complementary set of economic, geographic, demographic, economic, urban form, and institutional factors." TOD readiness assessment also involves road safety assessment. This further contributes to the case for implementing a TOD design.

25. The road safety assessment must be further aligned to a TOD network design, i.e. it should be able to highlight issues and direct towards appropriate design interventions catered for a TOD area. Through the knowledge products and the literature reviewed it is evident that road safety assessment for TOD readiness involves three distinct measures:

    - Road safety capacity reviews: policy, regulatory and institutional framework assessment,
    - Road inventory, road crash data collection and analysis,
    - Road safety assessment and engineering tools.

ROAD SAFETY CAPACITY REVIEWS: POLICY, REGULATORY AND INSTITUTIONAL FRAMEWORK

26. The first measure looks at assessing 'efficiency and effectiveness' of the various existing policies and regulatory frameworks and institutional setups available at the local, regional, and national levels. These are analyzed based on their capacities to execute planning, design and implementation of a TOD project, including road safety.

27. The World Bank's Road Safety Capacity Review Guidelines present a two-stage, iterative process that culminates in the preparation and implementation of projects designed to launch the identified long-term country investment strategy. These two stages are based on the six recommendations provided for road traffic injury prevention:

    1. Identify a lead agency in government to guide the national road safety effort.
    2. Assess the problem, policies and institutional settings relating to road traffic injury and the capacity for road traffic injury prevention in each country.
    3. Prepare a national road safety strategy and plan of action.
    4. Allocate financial and human resources to address the problem.
    5. Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences and evaluate the impact of these actions.
    6. Support the development of national capacity and international cooperation.

28. The first stage of the process concerns the conduct of a country capacity review (recommendation 2). The capacity review assesses the lead agency role (recommendation 1) and specifies a long-term investment strategy and identifies Safe System projects to be launched (recommendations 3 & 4). And the second stage of the process concerns the detailed preparation and implementation of the Safe System projects (recommendations 5 & 6).

29. While these Guidelines offer a comprehensive approach for any kind of road safety capacity review, as part of the “Assess” step of determining TOD readiness, we would focus on the first two recommendations.

30. Based on the reviews of existing literature, it was observed that more than often, road safety and TOD policies were independent of each other. However, road safety is an intrinsic component of TOD implementation, it therefore needs to be part of TOD readiness assessment. Any existing road safety mandate of the government such as Vision Zero – aiming at zero road crash – must be included as part of the TOD policy. Additionally, policies to prioritize implementation of public transport systems and encouraging citizens to use the same may be included in the TOD implementation policy as a champion cause.

31. Institutional capacities are also assessed to determine the right mix of professionals within the implementation agency. In order to make informed decisions to reduce road crashes and make safe spaces for all road users, it is essential to include road safety experts who are adept with safe system practices. Additionally, the team of experts should also ideally include urban designers and planners who have experience in complete street design.

32. This capacity assessment will help identify shortcomings in readiness for TOD implementation that may further be addressed through the remaining steps.

ROAD INVENTORY, ROAD CRASH DATA COLLECTION AND ANALYSIS

33. Evidence based advocacy helps in decision making and prioritizing funding and project implementation. Data collection and proper data analysis helps in sending the right message to communities and gaining their support and also support of various stakeholders, and provides the basis for making relevant improvements.

34. In order to undertake TOD readiness assessment of a city, it is essential to assess the existing physical infrastructure. Assessment of the existing physical urban fabric of the city and around the station areas – existing urban density and character, road network land use etc – help determine future planning and design, and strategies for implementation. These also have a direct correlation with ensuring road safety for all, especially the vulnerable users.

35. Socio-economic and demographic data, high-definition aerials and satellite imagery, site surveys, local employment data, travel pattern information, contextual information such as immediate land use, level of urbanization, future development and growth patterns, transport network information such as mode share, transit ridership, vehicle counts etc clearly play an essential role in TOD readiness. However, very often road crash data are not included during the data collection process for determining TOD readiness of a city. Analysis of crash data can help identify relevant patterns and assist in developing policies and institutional framework to reduce crash related deaths and injuries by using TOD development as a planning tool.

36. In order to make comprehensive road crash analysis, the crash data need to be supported by inventory of the roads and road network within the station area. Below there are typical components that should ideally be part of a road inventory. While this is not an exhaustive list of components in a road inventory, it may be modified based on the local context and data collection mechanisms available with the city

37. Typical inventory includes:

- Type of road – arterial or connector
- Width of Right of Way (ROW), length, number of lanes and width, directionality
- Presence of lanes for transit, shared vehicles, shared use etc
- Presence of median
- Presence of sidewalk and width
- Intersections – signalized or not
- Presence of cycle lane, type, width, buffer and type, shared
- Use of transit along the ROW and nature of transit.

- Transit amenities like bus stops, BRT stops, train stations
- On street parking and alignment
- Drainage
- Mid-block crossings and any other type of pedestrian crossing such as foot over bridge (FOB) and underpasses
- Safety measures such as hawk-eye, speed cameras, etc
- Street amenities such as street lights trees, furniture, utility etc
- On-street vending, and any other relevant information

38. At a city level, a high road fatality rate can be used to advocate for a TOD plan and the urgency for implementation. At the corridor level, the mapping of road safety data will identify the vulnerable road users and indicate the most critical zones that can be improved through the implementation of TOD. If road crash data are analyzed in conjunction with traffic data, such as VKT and mode-share, they can make a stronger case for assessing TOD readiness. At the station- area level, safe access to the transit station can be assessed through road crash data.

39. Below there is a list of variables that needs to be collected as part of road crash data. Depending on the contexts, resources, and budget, these may be adapted and modified at local, regional and national levels. Based on the information collected different types of analysis may be carried as discussed later.

40. These variables collected as part of crash data should be comprehensively analyzed in a holistic manner. If it is observed that certain data variables aren't robust, then necessary remedial measures must be undertaken by the concerned agencies.

DATE & TIME	Recording of date and time variable allows for seasonal and hourly comparisons of the incidents. Frequent occurrences of road crashes during a time of the day can be compared with the local traffic data to establish if any correlation exists between the occurrences and traffic volumes.
CHARACTERISTICS OF PERSONS INVOLVED	Crash data must include the number of persons involved in the incident and other basic information. Variables that need to be recorded about the persons involved in the crash include road user type (pedestrian, cyclist, vehicle driver, passenger etc), age and gender, persons with special needs including disabled and pregnant women, physical condition of the users including level of alcohol in the body, details about use of any safety equipment such as protective gears, seat belts etc and type of injury sustained.
CHARACTERISTICS OF VEHICLE	Data about the vehicles involved in the crash including type, age, country, safety equipment if any, date of last periodical technical check according to applicable legislation.
CRASH SEVERITY	Crashes are also defined by their severity – which is based on the impact on the persons involved - fatal injury, serious injury, minor injury, property damage/non-injury.
CRASH TYPE	Information on the type of crash including modes involved, for example vehicle-vehicle or vehicle-pedestrian or vehicle-bicycle, etc. during the crash needs to be recorded. Other information that is required includes maneuvering of vehicles during the crash: type of impact or collision, speed of vehicles etc. Understanding the events of the crash can help in determining the interventions necessary.
CRASH LOCATION (GEO-CODED)	Maintaining records of crash location over a period will help identify blackspot and critical areas within the city. A higher number of occurrences in an area would mean a higher priority and a greater scope of implementing improvements.

41. Based on the information available, following types of analysis techniques may be adopted:

    - **Basic Trend Analysis:** This requires data to be recorded at the crash-level (date & time of crash, vehicles & modes involved, location of crash and number of serious injuries and fatalities) and each record in the dataset must correspond to one unique crash.
    - **Crash Factor Analysis:** It is observed that the cause of road crash is often identified as an error on the part of the driver. Non-behavioral factors, such as road design or vehicle failure, are almost never considered. For a crash factor analysis, it is important to analyze the detailed crash report recorded by the police, and not just rely on the aggregated dataset.
    - **Blackspot Identification:** Blackspots are locations with high crash risk, as determined by high crash occurrences. The analysis requires the geographic location of each crash, recorded as accurately as possible. Location information is particularly important in identifying priority areas for intervention and course correction.

42. Road crash data can be sourced from multiple agencies. However, each have their own challenges and limitations. A single crash-injury database does not always provide adequate information to give a holistic picture of road traffic injuries. Many countries have therefore started using both crash data collected by the police along with the health sector data.

    - **Police records** are the primary source for crash data. Most road crash reports will typically contain date & time of crash, location, vehicles involved and number of injuries & fatalities. In addition, the crash description may contain information about how the crash occurred, Precinct-level data are then rolled-up and aggregated by the central police department, which is usually what is made available publicly. This information isn't always the most accurate information – primarily due to human errors in the process of collecting and recording the data. Additionally, only major crashes that cause serious injuries or fatalities or involve more vehicles often get reported to the police. Minor crashes or near misses are often under-reported and thus do not always get included in this primary crash data source. It is therefore recommended to complement police data with other secondary data sources.
    - **Hospital Records** are maintained by the government bodies like a City Municipal Health Department. These data are useful in cases where there isn't adequate follow-up by the Police for example when a road crash victim is initially reported as injured but may have subsequently died after the police report was filed. Also, in some cases, a police report does not get filed due to various reasons.
    - **Vehicle Insurance Records** supplement police records, especially in cases where a police report was not filed. Insurance records tend to provide a more comprehensive description of vehicle damage information, which is useful in understanding the causes of the crash.

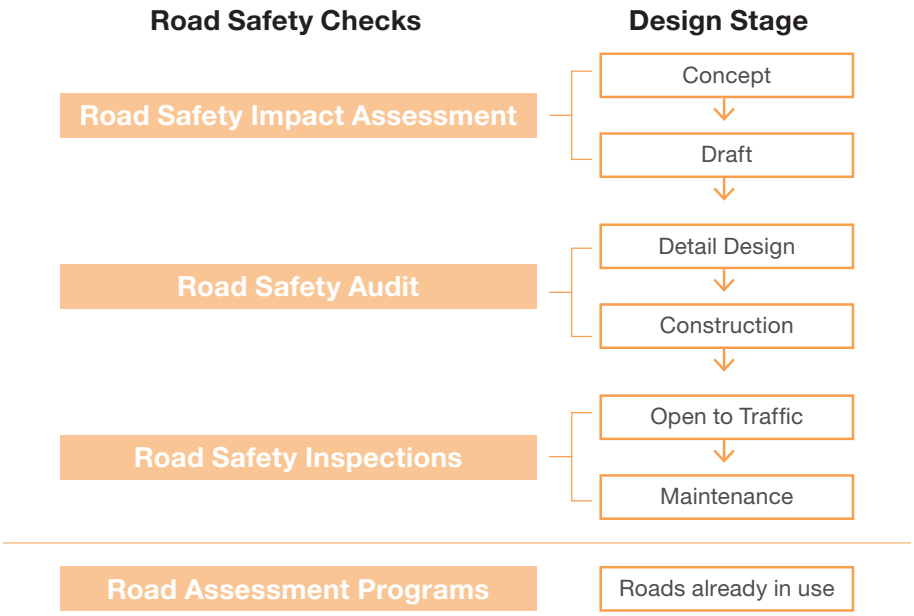
ROAD SAFETY ASSESSMENT AND ENGINEERING TOOLS

43. Use of crash data for risk assessment mentioned above has traditionally been considered a reactive approach. In recent years, more proactive tools for risk identification have been developed. These aren't merely a check on design compliance, but a holistic assessment of the road by considering the various elements present.

44. These risk identification tools are adopted at different stages of implementation of a road design and may be undertaken for both new roads or road feature or modification to an existing road. These tools also help in the identification of solutions to the risks identified and prioritizing suggested interventions.

45. The road safety check types are:
    - **Road Safety Impact Assessments or RSIA** is a strategic comparative analysis of impact between different possible schemes of a new road design or any modifications to an existing network, to ensure that the scheme selected is the one that has the best outcome for road safety. This is carried out before detailed planning begins and helps in the decision-making process.

- **Road Safety Audit or RSA** is a formal detailed systematic and technical safety check performed to check that the selected scheme is designed and constructed in such a way as to yield the greatest road safety benefits, and to detect any potential hazards throughout all stages from planning to early operation. The auditors carrying out the checks should be trained and must be independent from the designer and from the contractor. Usually a list of potential safety deficiencies and recommendations for improvement are included in the audit report.
- **Road Safety Inspection or RSI** is a periodical on-site verification of road characteristics and defects, undertaken as part of a dedicated inspection of an existing road or through maintenance procedures to enable the detection of potential crash risks. These are largely a preventive safety procedure carried out by independently trained experts.
- **Road assessment programs** – typically undertaken on existing roads, these quantify the expected safety outcomes for a network, route or location.



46. While these tools are applicable for all types of contexts and road types, for the purpose of TOD readiness, these need to be applied within a framework created specifically for a TOD station area environment, reflecting their key characteristics:

    - **Functionality of roads in TOD station area:** what is the function of the road around the station, as part of the overall road network: arterial road? Connector that caters to local traffic? Road including a mix of transit with the typical vehicular and pedestrian movements? Within a TOD area, roads are designed to include the mass transit within the ROW or are catered towards the mass transit station to accommodate the inflow and outflow of the users – feeder routes.
    - **Homogeneity of road design in TOD station area:** what is the character of the road within a TOD context: orientation of streets towards the transit station; unidirectional or bi-directional; different types of speed limits that are enforced; level of segregation across the different road users using protective measures or adequate buffers with different speeds or having a common shared speed based on the most vulnerable user.
    - **Predictability of road network in TOD station area:** what is the predictable use of the road space: are the road users familiar with the behavior demanded by different road types, and what they may expect from them and others? Do the roads have legible markings and signage for efficient use; what kind of priority is given to which road user and where, are these measures being enforced etc.

47. While these tools will help in determining the quality of the existing physical road infrastructure by identifying potential threats that may cause severe or fatal crashes in the future, they however need to be analyzed specific to the principles of TOD and the local socio-cultural contexts. Based on these assessments, any future planning and design interventions may be determined along with implementation strategies that may be temporary or tactical in nature leading to more permanent solutions.

ENABLE

48. The second step in the TOD Implementation and resources tool is 'Enable'. It lays down "proactive tasks that cities and states will need to take towards creating successful TOD planning processes". This stage focuses on strategies to institutionalize the process and objectives of TOD; build local capacity, both institutional and in civil society; and pursue policy and financial reforms conducive for successful TOD implementation.

49. As highlighted in the toolkit, successful TOD implementation requires advocacy to align stakeholder interests, and garnering political support for identification and elimination of policy barriers. This would eventually help in creating a mandate for TOD and establish the goals and objectives that align with the local needs and caters to its immediate context.

50. Road safety can be used as one of the metrics for making a successful case for TOD to the leadership, highlighting its social and economic benefits. As highlighted earlier, road crashes have a negative social and economic impact – leaving aside the individual emotional impacts it may have for the victims and their families. Formulating mitigation strategies around road safety primarily includes modal shift to Non-Motorized Transport (NMT) modes and public transport which further has far reaching economic and environmental benefits. TOD influences road safety in several ways:

    - It moves more people onto public transit, thereby reducing the frequency of private motorized trips, which reduces the frequency of crashes.
    - It promotes an urban form that is high density with mixed land-use; which facilitates more trips to be within walking or biking distance; thereby further reducing dependence on automobiles which further reduces crash frequency.
    - It is designed to be pedestrian and bike friendly, providing safer infrastructure for the most vulnerable road user groups.

51. These safety benefits of TOD and their inter-relationships are not always easily apparent to stakeholders. It is crucial to demonstrate this linkage to stakeholders, both within government and in the community. The communication strategies and outreach mechanisms within the institutions, political leaderships, stakeholders and public needs to be strengthened to highlight that road safety is a shared responsibility and requires a buy-in from all those involved in decision making.

52. Safe system approach requires a shift in responsibility from road users to system designers, builders and managers. Therefore the existing regulations and institutional setups require changes that include mandates and provisions to enable road safety. In order to achieve this, education and capacity building needs to be extended to these system designers - planners, engineers, architects, health professionals, law enforcement officers and others.

53. This can be achieved through joint collaborative sessions or multi-agency workshop sessions with implementation agencies local civic bodies, professionals and different stakeholders with a wide representation that is inclusive of all age, gender, user groups and physically challenged and disabled persons. Results from crash data and physical infrastructure assessments discussed earlier may also be used to educate the participants about the road safety challenges and help in enabling them to advocate for better systems and strategies to mitigate these issues. This will help institutionalize road safety within the respective areas or jurisdictions. Such collaborations will help align interests of the different parties and identify a common road safety goals and objectives, addressing individual interests, motives and possible trade-offs.

54. These communication strategies will help champion the cause for road safety within the institutions and decision making agencies and will help include road safety as an integral component while drafting area TOD specific policies and regulations at local or regional scales. It will also advocate for a shift to more efficient and sustainable transport mode choices and create supporting infrastructure

Safe Access to Mass transit: Role-playing activity

The Safe Access to Mass-transit (SAM) workshop toolkit is developed in the form of an interactive activity to address the need for safe access around mass transit stations. It includes the SAM capacity building workshop, which is based on the WRI India publication ***Safe Access to Mass Transit Manual:*** *Safe Access to Mass Transit Stations in Indian Cities.*

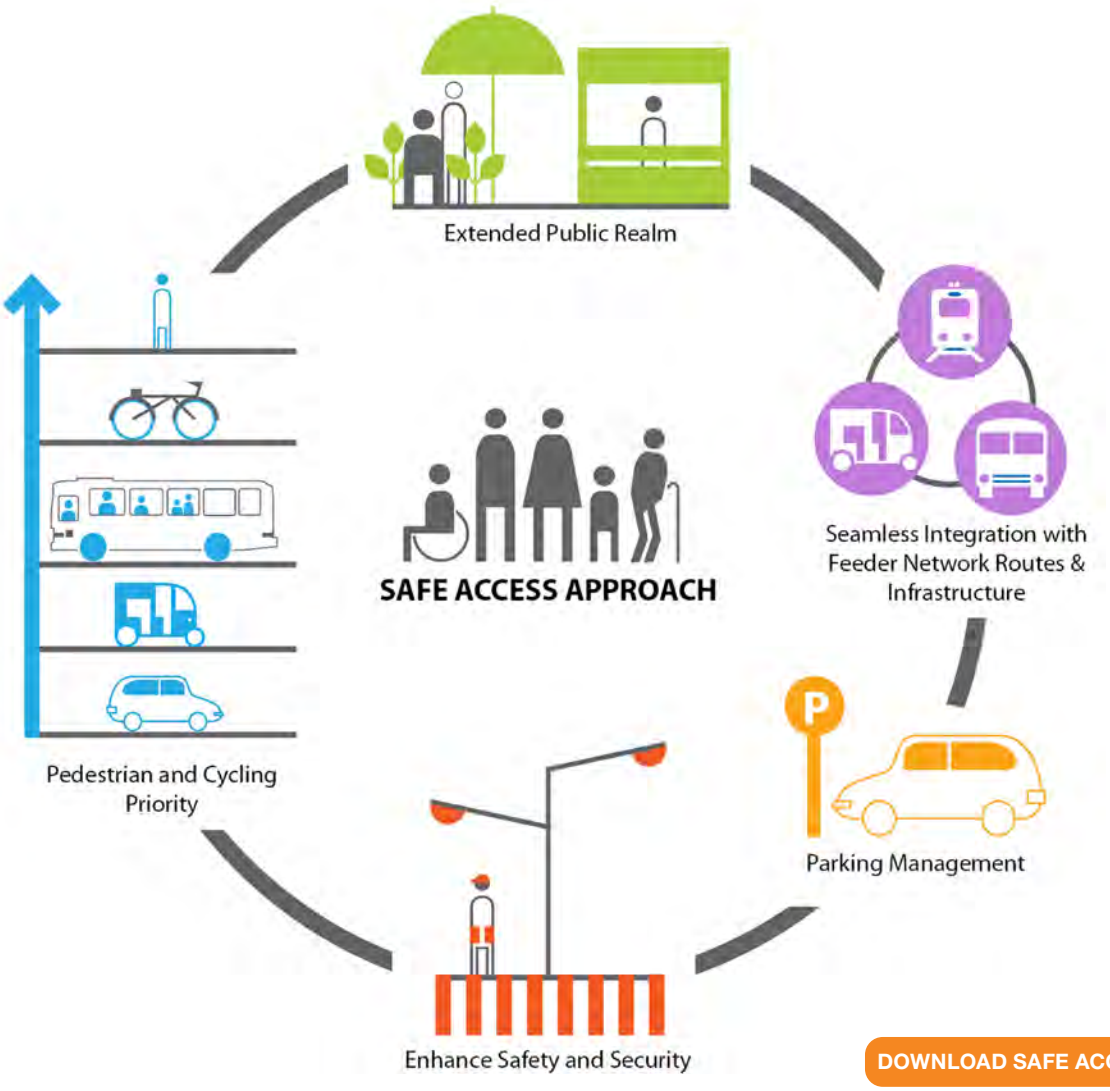


Figure 2. Five principles of Safe Access

DOWNLOAD SAFE ACCESS MANUAL HERE

Or Visit the link below to download the manual.
www.wrirosscities.org/research/publication/safe-access-mass-transit-manual

Using a workshop format, participants divided into groups will explore the processes involved with developing last-mile connectivity, and co-create proposals with community and city representatives for such strategies. It aims at inculcating awareness about the importance of safe and equitable access (through its principles) for all street/ public space users and help derive solutions through a collaborative decision-making process.

The outcome of the exercise is to derive implementable solutions that are based on safe access principles, while negotiating the complexities involved in their adoption. These solutions are then prioritized based on an interactive bottom up role-play interactive activity. This activity solely focuses on last mile connectivity solutions to provide safe and livable station areas, applying the 5 principles of last mile connectivity, i.e. walking, cycling, public spaces, etc.

PLAN+DESIGN

55. The Plan & Design stage of TOD Implementation and Resources tools has a significant role to play in ensuring road safety in comparison to the other four stages. It "focuses on providing guidance on the planning and design process that remain flexible and relevant to adapt over time specific challenges, and contexts change. It also presents action strategies and tools to create a more compact land development pattern hinged upon pedestrians and cyclists."

56. TOD planning and design typically takes place at three levels - the city, the corridor and the station area. However, it is at the station area level that issues around the provision of safe access infrastructure are the most relevant. The station is the anchor point for the station area; and all development should be oriented towards it with a high level of safety for first and last mile connectivity. An efficient TOD neighborhood is one that facilitates the safe and convenient access to transit for all modes.

57. TOD projects highlight the co-relation between land use planning, transport planning and design. These developments advocate for a modal shift from private motorized vehicles to more safer and sustainable modes of transport. This leads to increased number of users within a station area and with availability of different mode choices, increase in number of conflicts between different modes and their respective speeds. These changes make road safety a crucial component in the context of a TOD

58. An essential aspect of a TOD project is the identification of the conflict points and provision of safe and efficient connectivity between the transit station and the neighborhood around the station. It must be therefore be noted that this stage includes many specific features of street design for TOD, such as the creation of pedestrian networks with trunk routes oriented towards the transit station; the delineation of speed zones; and transfer and feeder service integration. Therefore in order to enhance the road safety considerations one has to consider two interconnected themes:

    - Planning of networks in the TOD zone
    - Design of the infrastructure within these networks.

PLANNING OF TOD NETWORKS

59. Typically, TOD is understood as densification around a transit station by increasing the built-up density and diversifying the permissible land uses with the station area. With such dense urban environments, the number of users in the public realm also increases significantly, posing safety concerns for all users. This requires provision of efficient networks connecting these developments to the transit station. If these networks are not adequately provided, then it discourages the use of transit and NMT infrastructure to access these developments, resulting in a much lower transit use than planned for.

60. To achieve safe networks within a TOD area, the "Sustainable Safety" principles of functionality, homogeneity and predictability will need to be looked more comprehensively for planning and designing of roads, so that they align with the TOD principles and can be integrated with the local context. These principles tailored for TOD requirements have been briefly explained below:

    - **Functionality of roads in TOD area:** While assessing road safety it is critical to understand the mixed function of the road network – whether it is an arterial road that includes a mix of transit or a connector that caters to traffic accessing the developments in the TOD or feeders that focus on accessing the transit stations as well as distributing traffic within the station area. The planning and design considerations are therefore made keeping in mind the mixed function in the street. The functions of the road in a TOD are also related to the mix of land use along it and may vary through the time of the day impacting the volume of users on it.

- **Homogeneity of road design in TOD area:** Homogeneity of road design refers to the prevention of large differences in speed, mass and direction. The road network in a TOD area caters to all kinds of speeds and volume of vehicles within its ROW – slow moving pedestrians and persons with needs, cyclists, faster moving cars and other motor vehicles, feeder services such as intermediate public transport (IPT) and public buses, and high speed mass transit vehicles such as BRT or metro rails. It is crucial to ascertain the capacity of these network based on the function they serve and segregate the users and different modes by using protective measures or adequate buffers between the modes to ensure maximum safety. It is supported by orienting streets towards the station, determining directionality of these streets to enable ease of traffic flow within the station areas, and maintaining speeds based on the immediate context – nature of land use and function of the streets. These principles are detailed out on PD-H07 subsection Capacity, Orientation and Safety; as well as in safety design guidelines provided in PD-R02.

- **Predictability of road network in TOD area:** This refers to the usability of the road space – "are the road users familiar with the behavior demanded by different road types, and what they may expect from them and others". The design of road infrastructure and amenities are such that the users can recognize the type of road and are aware of its function. Within a TOD, higher mix of users, reinforces the need for predictability to achieve safety. Prioritization of road users, distribution of lanes within a ROW, stops and utilities, markings on the roads, signage, visibility, movement lines at intersections (especially for pedestrians, cyclists and other vulnerable users) gets highlighted.

61. The most critical aspect for the creation of a strong inter-linkage between the transit station and the developments within station area is network planning. There are five key principles of network planning for TOD zones. This note briefly discusses each of the principles, which have been detailed out in the updated toolkit.

- **COVERAGE:** The network should have an extensive reach so as to connect every property within TOD zone.
- **CONTINUITY:** There should not be missing links (gaps) in the network.
- **ORIENTATION:** The network should be oriented towards the transit station, providing as direct connectivity as possible.
- **CAPACITY:** The capacity of the network should be adequate to meet the high volumes of transit commuters, particularly along the trunk routes leading to the station.
- **SAFETY:** Achieve a high standard of safety should be the guiding principal behind each and every decision on network planning; especially for the safety of vulnerable road users.

62. "Coverage" helps define the extent of street network and accessibility for different road users and hence provide for suitable solutions to ensure safe access. "Continuity" refers to the connectivity within the network and its density, ensures equitable access to the transit without congesting any area, and channelize traffic flow within the TOD zone. "Orientation" is facilitating the directed movement to and from transit stations and hence help in placing required infrastructure for safe movement. "Capacity" refers to the spatial quality of the network for all road users to ensure adequate space within the ROW based on the volumes of each type of user the network is catering to. Lastly "Safety" refers to creation of safer and segregated infrastructure within the network to avoid any type of crash. These as principles of network planning, help in creating framework for implementing physical safety measures.

63. For example, sidewalks are designed to function separate from vehicular travel lanes and cycle infrastructure. They are designed as per best practices and recommended design guidelines to accommodate the anticipated number of pedestrians using the segment of the network depending on how it connects to the transit station and any other node within the station area. However, these attributes will become redundant if the sidewalks are not part of a network that is not continuous and connect different nodes within the TOD area including the transit station.

Appendix A summarizes these five principles and includes guidelines and strategies on how to implement them.

DESIGN OF ELEMENTS WITHIN TOD NETWORK

64. The design of TOD network infrastructure looks at specific components of access infrastructure from a micro, site level scale. The objective is to ensure that the infrastructure meets the highest standards for safety for all road users, especially for commuters accessing the transit station.

65. Out of the various street design elements, the following are essential from a road safety perspective in TOD areas as they cater to the movement patterns of the users within the station area:

- **Walking infrastructure:** Walking is the direct mode to access transit stations and also are the most likely means for first and last mile connectivity to other modes
- **Cycling infrastructure:** Cycling has a higher reach than walking, and as a healthy and sustainable mode of transport, greatly increases the commutable distance to the transit station.
- **Feeder transit and para-transit infrastructure:** feeder and para-transit services considerably enhance the service area for a station and function to support the main transit service.
- **Design of shared streets:** Shared streets are designed to cater to the needs of the most vulnerable user and deploy various measures to reduce traffic volumes and decrease speeds.
- **Design of the station area:** the area around the transit station is meeting points for trunk routes and transfer of commuters from feeder services to main transit route takes place.

Appendix B provides design guidelines and consideration regarding these five elements with respect to a TOD area.

66. The guidelines in Appendix B are not intended to encompass design standard and guidelines for streets in the general context. For such guidance, one may refer the national codes of the relevant country, or one of the many published street design guidelines that are intended for this purpose. The intention of the Appendix is to cover only design guidelines that are specific to the provision of safe access to the transit station, within the context of the TOD zone. These guidelines must be seen as additional (and not a replacement) to general street design codes or guidelines, as the case may be.

FINANCE

67. The Finance stage of TOD Implementation and Resources Tool creates a framework for estimating capital costs for transit infrastructure and urban development, determining possible funding sources for execution of plans, establishing mechanisms for investments in real estate and user safety, enabling methods for forging public private partnerships, and identifying revenue generators. These financial tools are supported by various local and regional laws and other enabling regulatory tools, guidelines and different development incentives for developing successful TOD projects.

68. TOD implementation in high income countries is sometimes characterized by the intent to increase population densities and transit ridership supported by economic development. On the other hand, middle- and low-income countries are either characterized by high urban densities or else very low in areas that are at early stages of development.

69. TOD projects are developed with an intent to increase urban density (or support the existing high urban density in many medium- to low-income countries) and are supported by increased transit ridership and economic development that is derived from well-defined regulatory and policy frameworks and strong institutional capacities. This may increase traffic exposures resulting in increased road crash risks. Therefore, high quality transit investments supported with comparable investments in safe public infrastructure, timely revisions in development regulations, and active participation of the private sector are a must.

70. The resources available mostly cover financing mechanisms to support investments in developing transit and supporting infrastructure and real estate development, but they do not discuss tools for supporting road safety issues such as infrastructure provision or transport management. It should also be noted that financing of TOD projects doesn't end with execution of the project on ground. Funding mechanisms and a sustainable business model needs to be developed that would also take care of financial aspects of maintenance of this newly developed infrastructure.

71. As discussed earlier, road crash related deaths and injuries have a significant economic impact. Additionally, different transit alternatives will also have a different impact on road safety. Therefore, it is prudent to include cost comparisons of alternatives and road safety net benefits when conducting cost-estimation studies for TOD.

72. Developing infrastructure for safety is an expensive task, and on many occasions, the local city governments may not have enough capacity and resources or finances to implement such interventions. As an alternative, development incentives are provided to the developers to implement pedestrian and cyclist safe infrastructure through their property in lieu of additional FAR or any other incentive. Large property owners would either subdivide their plots to create a NMT network through their property or else will grant easement access. These owners benefit by increasing footfall within their commercial establishments.

73. These property owners may also 'adopt' sidewalks adjacent to their property and help maintain them. This may require the city government to also layout guidelines for designing and maintaining sidewalks by property owners. Many city bye-laws have a provision for setbacks. Adjacent large developments may amalgamate their side setbacks along the common edge to create pedestrian and cyclist friendly space. Front setbacks may also be combined with the sidewalk to increase its width.

74. Furthermore, there may be local or national laws that may be specifically targeted towards generating funds for implementing NMT needs within their jurisdiction. These may be directed towards improving safety within the TOD projects.

75. Cordon area congestion road pricing is a system of charging users for entering and using roads in a demarcated or restricted area that is subject to congestion due to excess demand. This kind of a pricing strategy helps regulate demand and helps in managing congestion without increasing the supply. In some other countries, like Argentina, a percentage of money collected as insurance fees is directed to Agencia Nacional de Seguridad Vial (ANSV) – the nodal agency in charge of road safety.

IMPLEMENT

76. The “Implementation” stage is the final stage of the TOD Implementation and Resources Toolkit. It concerns with “mobilizing a multitude of resources, partnerships and innovative implementation mechanisms that help leverage public sector investment in transit and infrastructure with private sector development”. The execution of a TOD project doesn’t follow a linear process and requires addressing institutional and regulatory shortcomings, guidelines for planning and execution – including prioritizing of projects, distribution of finances, as well as monitoring and evaluation followed by regular updates based on the feedbacks.

77. Like in any urban development project, TOD implementation takes shape after analysis of existing plans, institutional setup and infrastructure, completion of detailed planning and designing process, establishing a finance model with adequate investments etc. The issue of road safety doesn’t have much overlaps with this stage, however, based on the outcomes of these earlier stages, this stage may be strengthened with safety considerations at different steps of implementation:

INSTITUTIONAL SET-UP AND CAPACITY BUILDING

78. As part of the Assess stage, TOD readiness assessment captures the existing institutional capacity of the implementation agencies. Based on their existing team structure, necessary modifications may be made. In order to mitigate any road safety related shortcomings in the assessment, it is essential to include it as part of capacity building – given its importance as a co-benefit of TOD implementation.

79. As is the case of any large-scale public project, a multi-disciplinary team is required that is spread over different sectors. This would include local government officials, professionals with technical knowledge, and a range of specialists and advisors. New experts may need to be hired as staff or included as consultants. As mentioned earlier in the Assess section, qualified road safety experts with knowledge of safe systems are essential to be part of the project team to help it taking informed decisions to help reduce road crashes and improve safety. It would be more effective if the other members of the team, i.e. planners and urban designers, have prior experience and knowledge of transportation planning and complete street design. While this forms the core team, additional advisors and experts may also be engaged to make holistic decisions regarding the implementation and impact of TOD projects. Representatives from various government departments and private sector that are related to different aspects of TOD such as housing and real estate, environment, public works, economic development, and marketing and communication are desirable.

80. Representatives from the civil society such as neighborhood associations, business improvement districts, resident welfare associations, advocacy groups etc as part of the project team is also ideal as they have first-hand knowledge regarding challenges they face in their vicinity especially regarding road safety and security. This can be used to garner the required political support as well.

EXECUTION OF DESIGN

81. After developing the necessary plans and design of safety elements within a TOD project, and securing financing for the projects, the actual execution of the project may be carried out in phases after setting up the priorities. This priority-based phasing of projects may be prepared as part of an Implementation Plan by the nodal agency and infrastructure providers after discussions with stakeholders and public.

82. Stakeholder engagement is a continuous process since the project inception. This participatory design process not just helps in identifying the challenges and opportunity areas of a project and integrate with any other plan or development happening in the project area, but also contributes to placemaking and helps in contextualizing the project. It allows the implementation agency with prioritizing of the projects and mitigate road safety issues in the afore said implementation plan.

83. As these projects are expensive to implement, and full-fledged and permanent implementation of design should be executed after a temporary or interim re-design process that may be done as a pilot project in a small selected area within the TOD station area to monitor the impact and then implement at a larger scale across other station areas. Additionally, it may also be carried out using temporary tactical installations or cheap constructions to test the impact on the site. If needed, minor design changes or additions can be made for the entire design before making it permanent.

Intersection redesign at HP Intersection in Mumbai (WRI India)

MONITORING AND EVALUATION

84. Implementation of a TOD project doesn't complete with its execution. As mentioned earlier in Finance, maintenance and management of the built infrastructure is equally important in a TOD project cycle. A Maintenance Plan may be developed that would focus on maintenance of the road safety infrastructure to increase its usable lifespan and safety measures of the development. This avoids frequent repair work and the attached additional costs.

85. As also mentioned above, impact of any intervention has to be measured to understand its effectiveness. While earlier it was looking at feasibility and testing of an intervention, here one is measuring the long term impact of a more permanent implementation. For this comparison a before and after implementation stage data needs may be collected.

86. This measured project impact and user feedback further needs to be communicated to decision makers and community members. This will help formulate new regulatory policies and guidelines and inform design approach for future projects and assist in advocating for the same to community members, political leaderships and other stakeholders.

TOD KP

APPENDIX A

1. Typically, TOD is understood as densification around a transit station by increasing the built-up density and diversifying the permissible land uses with the station area. Along with this, another equally important aspect of TOD planning includes the provision of efficient networks connecting these developments to the transit station. If these networks are not adequately provided, then it discourages the use of transit and NMT infrastructure to access these developments, resulting in a much lower transit use than planned for. The most critical aspect for the creation of a strong inter-linkage between the transit station and the developments within station area is network planning. There are five key principles of network planning for TOD zones:

COVERAGE
The network should have an extensive reach, such that every property within the TOD zone is connected to the network.

CONTINUITY
There should not be missing links (gaps) in the network.

ORIENTATION
The network should be oriented towards the transit station, providing as direct connectivity as possible.

CAPACITY
The capacity of the network should be adequate to meet the high volumes of transit commuters, particularly along the trunk routes leading to the station.

SAFETY
Achieving a high standard of safety should be the guiding principle behind each and every decision on network planning; especially for the safety of vulnerable road users.

TOD Knowledge Product PD-H07 provides more details and covers these five principles in more detail.

Principle 1: Coverage

2. The principle of Coverage means that every property within the defined influence area, must connect to a network leading to the station. It is neither practical nor desirable, for the coverage of every network to be as extensive as another. The importance of direct access of a network will depend upon the property's location with relation to the station.

3. As shown in Figure 3 below, a station area in the denser parts of the city, where transit network coverage is high, will normally only have two realms for the planning of access, the walking realm and the area outside the walking realm. This walking realm is normally considered as what an average commuter can walk in 5-10 minutes, which is about 400 to 800m. This distance increases in a low-density suburban area to a walking reach of 10 - 15 minutes (800m - 1.2km).

4. The realm for cycling is much higher, typically 3 - 5 times the size of the walking realm; based on an average cycling speed of 18 to 25km/h, and an average willingness to cycle time of 10 - 15 minutes. Likewise, the feeder service or para-transit realms are likely to reach up to 3 - 5km from the transit station, which typically extend up to and beyond the TOD zone boundary.

5. A key component for the planning of these realms is the delineation of trunk routes leading to the station. It is not possible for every property to have direct connectivity to the station across all realms. The more practical solution is to connect properties to a few trunk routes leading to the station. This creates a strong an extensive network that offers multiple choices to the users. Additionally, it is not practical to provide distinct networks for each feeder mode, and therefore prioritizing of network planning is required based on mobility needs of each mode as shown in Figure 4.

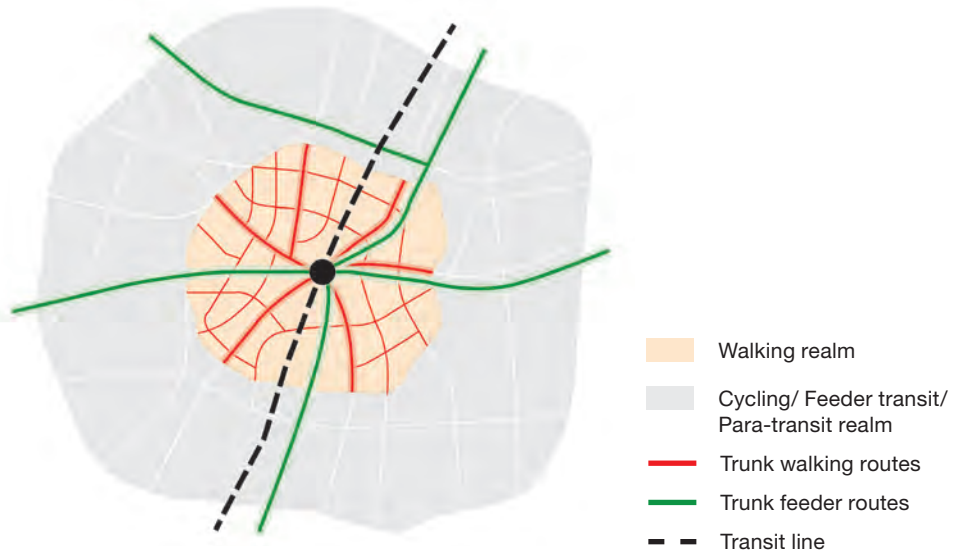


Figure 3. The different realms for planning of station area

PRIORITY 1: Walking

PRIORITY 2: Cycling and Feeder transit services

PRIORITY 3: Para-transit and Shared vehicles

PRIORITY 4: Personal motor vehicles

Figure 4. Hierarchy of priority for mobility planning

Adaptation of hierarchy of priority for mobility planning, prominent in many global cities at the forefront of sustainability. This hierarchy of priorities is all the more relevant for station areas, given the focus of moving people away from personal vehicles and onto transit.

Principle 2: Continuity

6. Maintaining the network continuity within the context of the station area, means that every property should be seamlessly connected to every other property, and to the transit station without any gaps or missing links in the network. If access networks to the station are not continuous, then it forces the commuter to use other elements of the road infrastructure that do not meet its safety requirements.

7. The critical importance of network continuity is often neglected in cities in developing countries, where infrastructure provision is scattered and disjointed, making it near impossible to complete a trip entirely along the network.

8. In built-up, dense urban areas, it is generally difficult to build new infrastructure to complete the network. Therefore, one must rely on other more practical strategies to achieve a satisfactory result. Measures to bridge network gaps include:

    - Developing off-road connectors
    - Using development incentives to augment the network
    - Developing grade-separated infrastructure
    - Designing for shared infrastructure

Principle 3: Orientation

9. In the third principle of Orientation the station is placed as the anchor point of the network and connects properties to the transit station as directly as possible. The key component to ensure a network is well-oriented towards the station is to identify and develop trunk routes. As these trunk routes are expected to carry the majority of commuter volume to the station, these routes are therefore to be planned to be as straight as possible in the direction of the station.

10. In a greenfield TOD zone, orienting the network is a lot easier, as there aren't too many hindrances that would interfere in this process. In this scenario, the network is likely to reflect with the station at the center and trunk routes emanating outward in every direction. Branch connectors can then be provided connecting to the main trunk routes, thus ensuring that every property is well connected to the station.

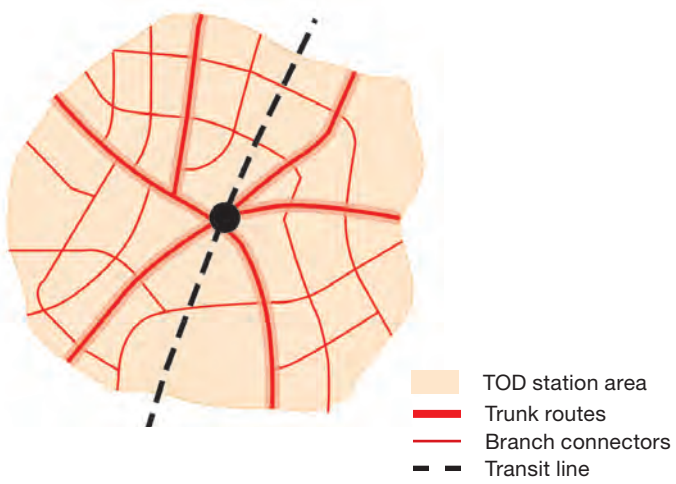


Figure 5. Oriented the feeder network in a greenfield station area

11. However it is a challenge in an already built-up urban environment. Here, one has to work within the limitations of the existing built-environment as well as the available right-of-way.

12. There are, broadly, three aspects to determining the alignment of the trunk routes that offer the best possible orientation towards the station. It is to be noted that these aspects aren't necessarily to be assessed chronologically, because it is likely that one will have to iteratively assess different options, before arriving at the best possible solution. The three aspects are:

    - Determining the main nodes or activity generators
    - Assessing strategies to minimize deviations
    - Assessing favorable local conditions

Principle 4: Capacity

13. Capacity deliberations are most pertinent in the planning of the trunk routes along the network. The following sub-sections discuss various measures to augment capacity along the network. The following measures to augment network capacity have been briefly discussed:

- **Reallocate road space**
  The most important tool to ensure adequate capacity is to reorganize the use of road space in the TOD zone. Road space is a critical and finite commodity, especially in built-up urban areas. The judicious allocation of this space plays an important role in determining the quality and safety of mobility in the TOD zone. In order to determine what's appropriate, it is important to carry out pedestrian and cyclist volume by capacity studies similar to determining vehicular traffic. This helps in understanding the requirements for reallocating road space to accommodate wider sidewalks that can meet the desired Level of Service for pedestrians.

- **Incorporate building setbacks**
  A TOD policy can be introduced to allow for the transformation of the street level floor of a residential property for commercial uses along major trunk routes. The city can link the permissions to develop ground-floor retail activities where the setback is maintained as an extension of the public sidewalk. The ownership of this space can remain with the property owner, but its built conditions and usage will be guided by the city TOD policy.

- **Eliminate on-street parking & streamline other road uses**
  An effective way to free-up road space is to reduce the provision of on-street parking, especially along the trunk feeder routes leading to the station. This additional space can then be allocated to sidewalks, cycle lanes or feeder-bus lanes.

- **Create one-way street networks**
  If there is a good network of parallel streets, and relatively small block sizes, one can consider creating a network of one-way streets, alternatively running in opposite directions. One-way street networks have the advantage of being easier to manage at intersections, as they require fewer signal phases than a regular two-way intersection. A one-way C-shaped loop is also a great way to connect to the transit station. By making loop one-way for vehicular traffic, more road space can be allocated to other feeder network infrastructure, such as sidewalks, cycle lanes and station transfer points.

- **Reduce interruptions in flow**
  The capacity of a trunk route on a feeder network is not only determined by the road space allocated to it, but also by the frequency of interruptions to its flow. The more frequent the interruptions to free-flow conditions, the greater will be the reduction in capacity. A crucial aspect of trunk route planning along the network is the adoption of various strategies to minimize interruptions, mainly through the diversion of conflicting traffic movements. Some measures for reducing interruptions in flow:
  - Eliminate traffic intersections along major trunk routes leading to the station. This can be achieved by converting intersecting streets into cul-de-sacs or by modifying the intersection to only allow vehicles to enter and exit the minor street, but not cut across the trunk route.
  - Limit the number of driveways on the main trunk routes. This reduces the number of breaks along the sidewalk, again improving free-flow conditions.
  - Another important measure especially pertinent to feeder transit service, is signal priority. Signal phasing can be designed to give more green time for traffic and pedestrians along the main trunk routes.

- **Provide more entry & exits at the station**
  The capacity of any network is determined by its most constrained point. In the context of feeder networks, this point is often the immediate station area, which has the highest volume of commuters utilizing the smallest amount of space. Station infrastructure can be designed with multiple entries and exits, directly taking people further along on the feeder network.

  One can even consider different points of access for commuters on different modes, to reduce the load at one location.

Principle 5: Safety

14. Planning for the safe provision of access networks in a TOD zone, requires one to make certain hard decisions that may somewhat lessen the mobility of other traffic, in favor of the safety and mobility of the feeder network traffic. Traffic in a TOD zone (both vehicular and pedestrian) can broadly be divided into two buckets: traffic destined to or originating from the station; and traffic not concerned with the station in any way. In most instances, the priorities of these two groups will clash with each other. However, the principle of safety must have the highest priority.

15. The process of balancing these conflicting priorities can be made easier by defining the boundaries within a TOD zone, where the priorities of transit commuters are to be placed higher than those of other traffic. Typically, in the area closest to the station, traffic bound to the station must be given the highest priority. Similarly, traffic directed to and from the station should be of high priority along all the major trunk feeder routes leading to the station. Once the feeder priority areas of the TOD zone are defined, the next step is to determine measures to ensure a high level of safety for the feeder modes in question.

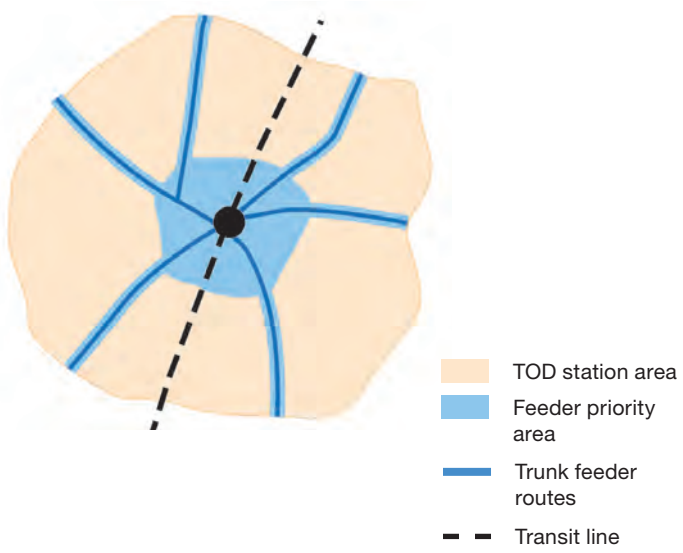


Figure 6. Determining the feeder priority area in the station area.

16. Measures to improve safety

- **Provide dedicated infrastructure**
  Dedicated infrastructure is a good measure on wide trunk routes, especially where there is a high volume of vehicular traffic, moving at a very high speed. It is considered as the safest measure, though not always the most practical. Excluding infrastructure for walking, it is not necessary, or even desirable, for the entire feeder network to be made up of dedicated infrastructure. This can take two forms; namely physically segregated infrastructure, and lane-marked infrastructure.

- **Implement speed zoning & traffic-calming measures**
  The severity of road crashes and injuries sustained, including fatality, is also related to the vehicle speeds. Vehicle speeds more than 50km/h have high fatality risks and have risk more than five times than that for vehicles driving below 30km/h. Furthermore, higher speeds reduce the driver's capacity to stop the vehicle on time or having greater stopping distances and reduce the maneuvering ability to avoid a crash.

  Speed zoning is the single most effective measure for the provision of safe mobility in the TOD zone. It is recommended to adopt a uniform speed limit for the walking realm across all TOD zones in the city. Within the walking realm, a speed limit of 15-30km/h is strongly recommended. In certain short sections, where the high pedestrian volumes, coupled with local traffic accessibility demands, a significantly lower speed limit (of 5km/h) may be desirable.

  Recommended speeds for TOD zone planning

  – 5km/h: Narrow streets where traffic & pedestrians share the road
  – 15 - 30km/h: All streets within the station walking realm & neighborhood streets outside the walking realm
  – 30km/h: Trunk feeder bus / cyclist routes to the station
  – 50km/h: Maximum prescribed design speed for all other roads in the TOD zone

It is also important to note that the desired speeds and speed zoning measures do not only entail enforcing speed limits through regulation, but also requires the implementation of appropriate traffic-calming infrastructure (discussed later) to ensure that the design speed is in sync with the speed regulation. Enforcing speed limits may also be supported by the use of Automated Enforcement (AE) technologies that detect and record violation of road rules without direct human involvement. Speed cameras enforcing speed limits are a common application of AE.

- **Reduce vehicular traffic volume**
  There are different measures that can be considered to reduce traffic volume in the TOD zone, particularly in the walking realm. The measures are discussed here.
  - **Restrictive measures:** Traffic volume in the walking realm can be significantly reduced, by adopting strategies to discourage personal motor-vehicle usage. For instance, reducing parking availability, or increasing the cost of parking, in the walking ream encourages more commuters to avoid personal motor-vehicle usage.
  - **Regulatory measures:** Another strategy is to adopt regulatory measures, such as restricting certain vehicle classes during peak commuter time periods. For instance, freight vehicles may not be allowed in the walking realm from 8:00 AM to 9:00 PM.
  - **Alternate bypass routes:** Traffic volume in the walking realm can also be reduced through the creation of alternate routes that bypass this area. For instance, a new road may be developed to carry through traffic that does not originate, or is not destined to, a location within the walking realm.
  - **Eliminating through traffic:** Another measure to limit traffic volume within the walking realm is to convert certain streets into dead-ends (cul-de-sacs) or loops back to the same road outside the walking realm. This discourages the use of these streets by any traffic that is not locally bound. Loops are preferable to cul-de-sacs because often the streets in the near vicinity of the station are not wide enough to accommodate a functional cul-de-sac.
  - **Full Pedestrianization of Streets:** Pedestrian-only paved streets could be created for routes in the TOD station area that connect to the transit station with developments having high footfall, or generate heavy pedestrian traffic due to commercial and recreational activities along those routes. Barring access for emergency vehicles and delivery vehicles during early morning or late night hours, no motor-vehicle is allowed in these streets. Cyclists may also be required to dismount and walk their cycle (see Figure 7 below). Along with promoting economic activities and keeping the streets active, these pedestrian-only streets provide uninterrupted movement to and from the stations for pedestrians without any kinds of obstructions and safety concerns from other vehicles.

Figure 7. Pedestrian only street in Sao Paulo, Brazil *(Source: © WRI)*

All diagrams present are to intended to be illustrative of the concepts and should be adjusted to the urban and traffic flow context.

APPENDIX B

1. The design of TOD network infrastructure looks at specific components of access infrastructure from a micro, site level scale. The objective is to ensure that the infrastructure meets the highest standards for safety for all road users, especially for commuters accessing the transit station. This covers five subsections :

   - Walking infrastructure
   - Cycling infrastructure
   - Feeder transit and para-transit infrastructure
   - Design of shared streets
   - Design of the station area

Walking infrastructure

2. Walking is the most important mode choice within any station area, not just for direct access to the transit station, but also, as the most likely means of first and last mile connectivity to other commute modes.

Sidewalk Design

3. The most crucial component of the walking network is the sidewalk which is assigned for the specific use of the pedestrians. A cohesive and dense network of sidewalks, (of adequate capacity), ensures a high level of safety for walking in the station areas. A well-functioning sidewalk will have spaces assigned for other important elements and uses. A sidewalk comprises of three components, namely the frontage zone, walking zone and the multi-utility zone as shown in Figure 8. The following Table 2 includes important considerations and challenges for designing sidewalks. Additional design guidelines for these and other concerns have been provided in the PD-R02 Knowledge Product.

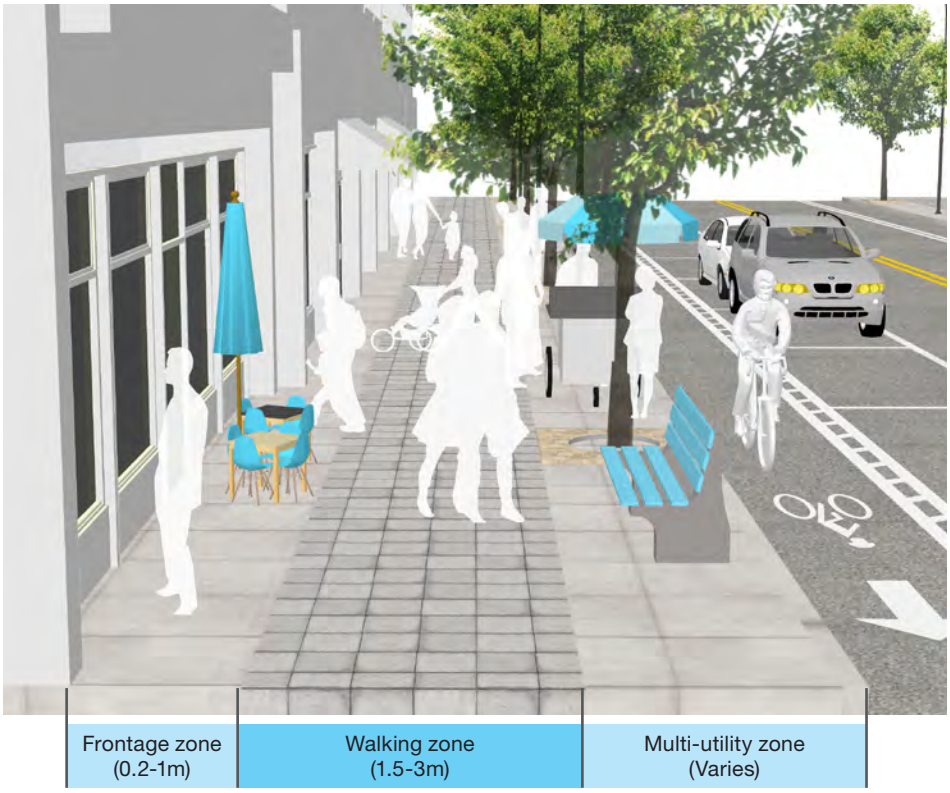


Figure 8. Three components of a sidewalk

	Frontage Zone	Walking Zone	Multi-utility Zone
Purpose	This is the area touching the boundary of the right-of-away, that is, abutting the property edge line or compound wall. It is meant to accommodate spill-over uses from the adjacent property. Active frontage and multi-utility zones provide 'eyes-on-the streets' and creates a sense of security for pedestrians.	It is the area immediately adjacent to the frontage zone which is actually used by pedestrians to walk. This space should be kept free of encumbrances that impede walking.	It is the area, normally located between the walking zone and the traffic or parking lane. Its use will vary depending on the context, to accommodate street vending, street furniture, trees, utility boxes, light poles, signal posts, signage posts, crossing waiting areas, etc.
Typical Widths	The width of the frontage zone can be between 0.2 to 1m. In the case of large developments, it is a good practice to ensure that building setbacks are designed to serve as additional frontage zones	For feeder lines to the main walking routes, a walking path width of 1.5m minimum may be acceptable. Typically, 3m should be the minimum width for the walking zone on a trunk route.	There is no standard width for this zone, as it will depend on context and the available right-of-way.

Table 2. Three components of a sidewalk

Distinguishing the walking path

4. It is important to note that the boundary lines of the three stated components of the sidewalk are notional. Their actual space requirements are likely to vary along the corridor, depending upon the context at that particular point along the right-of-way, as well as the adjacent land-use. However, it is a good idea to offer some visual cues to distinguish the walking zone, especially along the trunk walking routes to the transit station. This can be achieved by the use of softer design elements, such as a different pavement style or surface treatment (paved versus landscaped) or creating a marginal height difference. These cues aid in guiding road user behavior, informing people about the appropriate use of the space.

Deviations in the walking path

5. In some situations, deviations in the walking path are unavoidable - on account of the presence of a tree or a difficult-to-relocate utility box. In such cases, the walking path should be designed to curve around the encumbrance, preferably with a gradual transition.

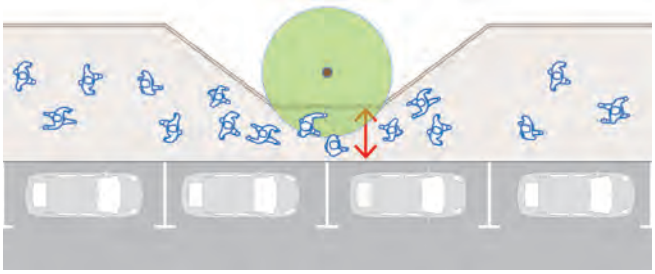


Figure 9. Immovable obstructions on the sidewalk restricting pedestrian movement

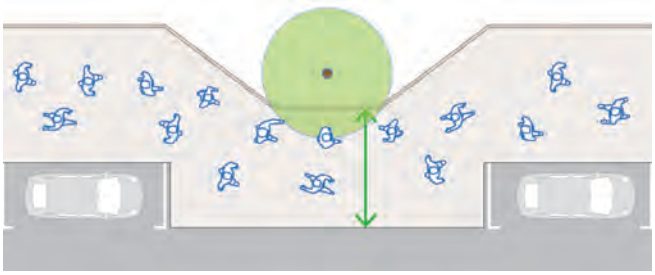


Figure 10. Deviations made around obstructions for continuous walking path.

Walking path continuity

6. Another important design consideration for the walking zone is to ensure a uniform height along the entire length of the sidewalk. This is especially important on the trunk walking routes, because it allows for a faster and more convenient movement of commuters. This is achieved by maintaining the same height for the walking path across property entrances and exits. There are two aspects as to how this can be achieved; the planning aspect – restricting vehicular access on main pedestrian routes; and the design aspect - bringing vehicles up to the sidewalk height through the use of ramps. The space for ramps can be accommodated in the multi-utility zone space on the traffic lane side, and in the frontage zone or within the property on the property edge side.

Streetlights & 'Active' Sidewalks

7. Streetlights contribute towards improved visibility, thereby help in preventing road crashes and injuries. Additionally, they also improve the pedestrian realm by providing a sense of security along with visibility of the walking space. An 'active sidewalk' can be achieved through active frontage from commercial and recreational activities at the street level of the developments as well as encouraging vending and other activities in the multi-utility zone. This ensures there are 'eyes-on-street' and provides a sense of security to pedestrians.

8. Lack of activities on the sidewalk (especially in the frontage and multi-utility zones) and inadequate street lighting can create unsafe experience for pedestrians and force them to use the vehicle travel lanes which are typically more well lit. This raises conflicts between the different road users leading to potential crashes. It must be noted that the lighting needs for pedestrians and vehicular traffic are different and therefore must be designed and integrated within the overall lighting strategy of the street.

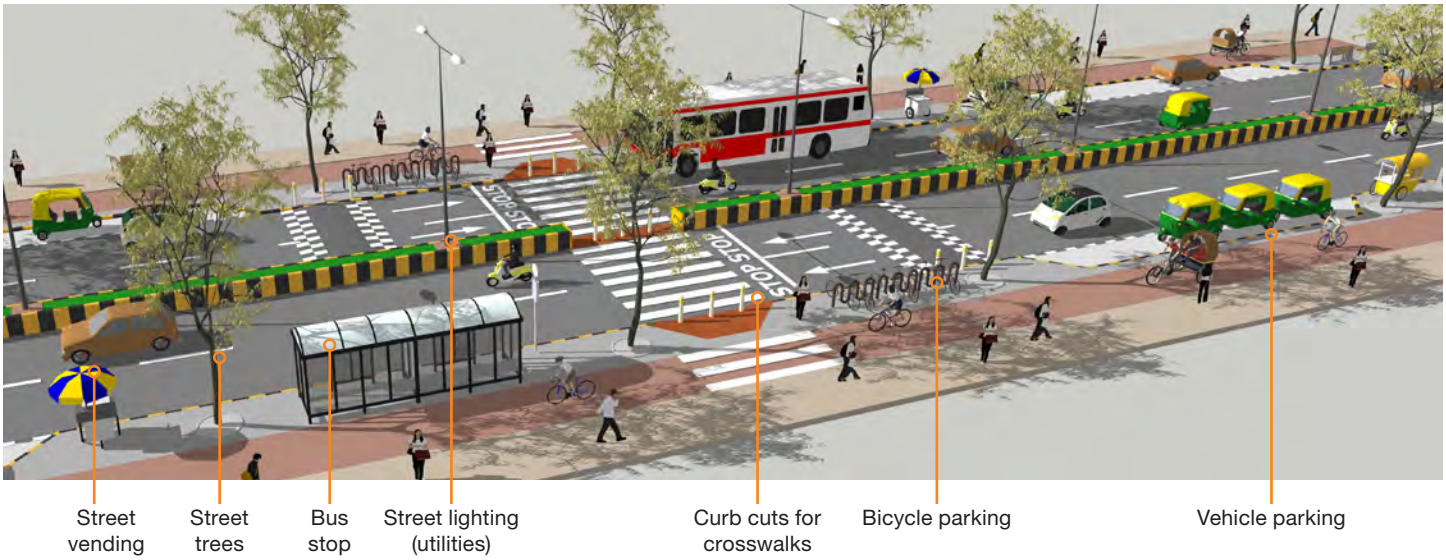


Figure 11. Typical multi-utility zone with different types of uses

Crossing Design

9. Almost every walking trip will require the pedestrian to cross a road at some point along the trip. From the perspective of safety, they are as critical because it is at the crossing that the pedestrian is at the highest risk of collision with other traffic. Hence, the design of safe crossings is a crucial component of the walking network for a TOD zone. There are many important considerations for pedestrian crossings, which are discussed over the following sub-sections. Refer PD-R02

Crossing frequency and location

10. The most important aspects of pedestrian crossing provision are their frequency and location. From the perspective of access to the transit station, crossings must be provided such that the continuity of the walking network is maintained. The crossings are the bridges of the network, and hence, their location and design features should be congruent to its role in the network. If a particular stretch of the walking network cuts through the middle of a block, then a mid-block crossing must be provided to continue the network.

11. A TOD zone with a higher density of crossing opportunities is, typically, safer and better for walking. Crossing infrastructure must be provided at all intersections. Block sizes should be limited such that intersections crossings are not more than 150-200m apart in the high-density areas close to the station. In already developed areas, it may not be possible to modify block sizes. In this scenario, one should consider the provision of mid-block crossings, where necessary.

Crossing width

12. A pedestrian crossing must be at least as wide as the sidewalks that it connects. An even wider crossing width may be desirable, along the trunk walking routes to the transit station, as it allows for more people to cross at the same time, which reduces delay and allows for shorter pedestrian signal cycles. Moreover, a wider crossing is more likely to be distinctly visible to vehicular traffic. We recommend a minimum width of 3m, though a width closer to 5m may be desirable on high volume routes that connect to mass transit stations or BRT stops catering to the pedestrians going towards and coming out from the stations or BRT stops at the same time. Wider crossing would facilitate this opposite directional movement and avoid collisions between pedestrians in the station area with pedestrian traffic specifically due to transit station.

Crossing alignment

13. Deciding on the alignment of a pedestrian crossing raises two questions. Should the crossings be so aligned that it continues the natural walking path between the two adjoining sidewalks? Or should it be aligned perpendicular to the traffic lanes, such that crossing distance is minimized? Based on the type of intersection - right-angled or skewed - the crossing alignment would follow the natural walking path or else the shortest path to avoid increased exposure of crossing pedestrians to the incoming traffic. These alignments are same in right-angled intersections, whereas if the angle of the intersection is skewed, then there will be a deviation in the two paths. These have been compared in Table 3

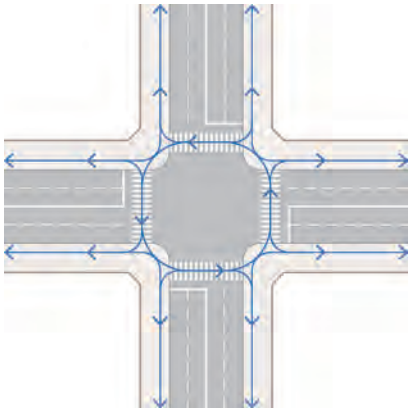
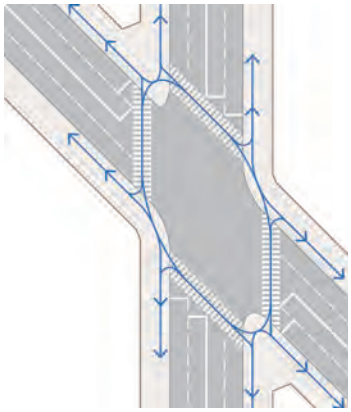
Right-angled intersections	Skewed intersections	
 Figure 12. Natural walking path and desire lines for a right-angled intersection..	 Figure 13. Crosswalks aligned along desired movement patterns in a skewed intersection.	 Figure 14. Crosswalks aligned along shortest crossing distance in a skewed intersection.
The natural walking path and the shortest crossing distance will align at a 4-arm, right angled intersection.	For **signalized intersections**, pedestrians will like to avoid deviations to their natural walking path. It is recommended aligning the crossing to the straight line connecting the two sidewalks. The pedestrian phase in the signal cycle should allow for the safe completion of this crossing distance.	For **non-signalized intersections**, crosswalks are aligned to minimize the crossing distance. This reduces the amount of time that the pedestrian is put into potential conflict with vehicular traffic. Moreover, it positions the pedestrian and traffic perpendicular to each other, which improves their visibility of each other.

Table 3. Comparison between location of crosswalks in different types of intersections.

Intersection corner curvature

14. The curvature of intersection corners has a significant impact on pedestrian safety. A generous curvature allows vehicles to make left turns (in the case where traffic drives on the left), or right turns (in the case where traffic drives on the right), at high speeds, which puts pedestrian at risks, particularly at un-signalized intersections. Moreover, a wide curvature increases the size of the intersection, which increased the area of undefined road space where conflicts may arise. Furthermore, pedestrian crossings get pushed further back and away from the natural crossings path. A wide intersection curvature eats into the sidewalk space, reducing the availability of space to accommodate pedestrians waiting to cross the road.

15. It is recommended to have intersection corner curvature radius approximately 4-6m, which allows for most vehicles to make a safe turn at a slow speed, from the corner-most lane to the corner-most lane. Larger vehicles may require entering into the adjacent lane either before or after the intersection. This is an acceptable design compromise, if this is not a major transit bus-turning route, and there aren't too many large vehicles expected to use this intersection. These differences have been highlighted in Figure 15

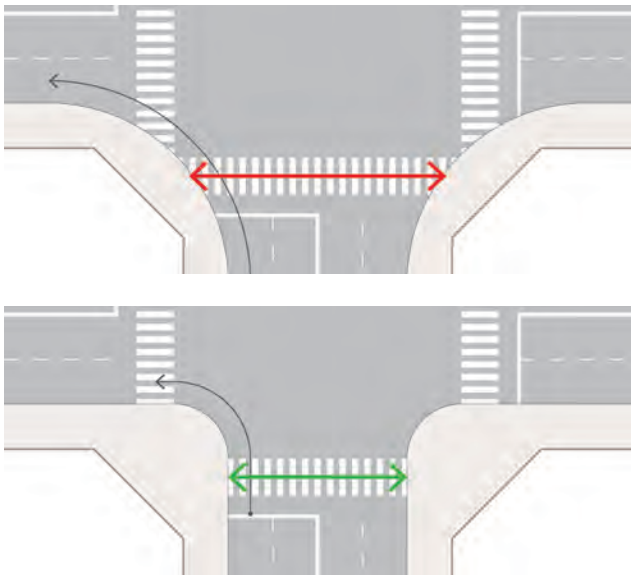


Figure 15. Reduced intersection corner curvature for pedestrian safety

Reducing intersection corner curvature increases pedestrian safety as it enables drivers to turn at significantly slower speeds and also reduce pedestrian crossing time.

Pedestrian waiting area

16. The pedestrian waiting area is an important component of a crossing that often gets ignored in the design of intersections. This space is especially important for signalized intersections to accumulate the build-up of pedestrians waiting for their light to turn green. The space requirement of the pedestrian waiting area is likely to be very high on the trunk walking lines in a TOD zone. Table 4 below indicates different ways of accomplishing this.

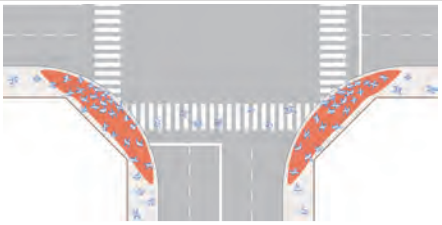
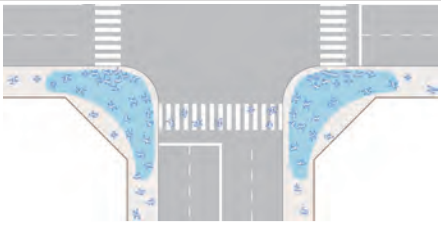
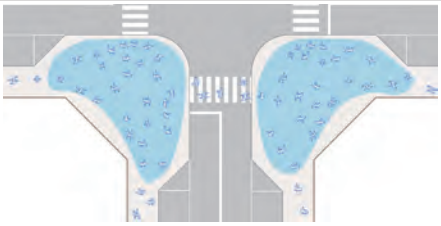
Existing concerns	Tighter curvatures	Curb extensions
 Figure 16. Existing conditions with wider corner radius	 Figure 17. Tighter corner radius provides more waiting area for pedestrians.	 Figure 18. Curb extensions created by removing travel lanes further reduce crossing times for pedestrians.
If adequate space is not provided, pedestrians may spill onto the traffic lane. The pedestrian waiting area must be kept distinct from the walking area, especially along the trunk walking routes; otherwise waiting pedestrians will hold up walkers who just want to pass through.	The pedestrian waiting area must be kept distinct from the walking area, especially along the trunk walking routes; otherwise waiting pedestrians will hold up walkers who just want to pass through. The best way to ensure a large waiting space, is to keep the intersection corner curvature as tight as possible.	Another measure is to eliminate the parking lane, if present, at the intersection, and create a curb extension to accommodate the waiting area.

Table 4. Comparisons highlighting issues of inadequate pedestrian waiting areas and mitigation measures

Traffic Signals

17. All major intersections in the TOD zone must be equipped with traffic signals, which incorporate pedestrian signal cycles. In general, any crossing that has more than two lanes, without the presence of a median, must have a pedestrian signal. The pedestrian green phase must be long enough to allow for most pedestrians to cross the road in one phase.

18. The pedestrian green times may have to be even longer on the main walking routes within the immediate station areas which may be synchronized with the timings of transit services to accommodate the higher volume of pedestrians going towards or coming out from the mass transit stations or BRT stops. These time synchronization are critical where interchanges between one mode to another takes place, and the connections aren't direct and require crossing a road to access the stations.

19. On the major walking routes leading to the mass transit station, one can consider the implementation of signal priority and signal synchronization for pedestrians. This allows for pedestrians to face a "green wave" (uninterrupted green phases as soon as they reach the intersection); which aids in the safe and convenient access to the station.

20. Additional Intelligent Transportation System (ITS) technologies can be incorporated which include use of AE cameras to detect over speeding of vehicles and turning the signal red to ensure speeds under safety limits are maintained within the station area. Saw-cut loop detectors can also be buried at intersections to detect traffic presence and accordingly phase the signal cycles so as to avoid traffic jams that may impede movement of shared modes and feeder services.

21. Normally, right-turning traffic (in right-side driving countries) and left-turning traffic (in left-side driving countries) are allowed to share the phase with pedestrians. However, on the main walking routes in TOD zones, the high volume of pedestrians may warrant that turning traffic be restricted, at least for some length of the pedestrian signal cycle.

Off-road pedestrian paths

22. Off-road pedestrian paths aid in augmenting the walking network in a TOD zone, and also in mitigating network gaps. Normally, at-grade paths will cut through properties, public plazas, gardens, etc. These paths are for the exclusive use of pedestrians and/or cyclists. Motor-vehicle traffic is not permitted entry. Thus, the safety considerations for such paths are limited.

23. Off-road pedestrian paths may also be augmented with the utilization of grade-separated infrastructure. There are broadly two categories for such infrastructure. The first category is infrastructure only meant to cross a single road, such as a FoBs or an underpass. The second category is grade-separated infrastructure of a much longer length that provides direct connectivity to multiple locations including the transit station, and may comprise of a network of interconnected sections. Such infrastructure is normally elevated, and commonly referred to as sky-walks, though there are cases of sub-terrain pedestrian networks as well.

24. As a general principle, FoBs and underpasses are not recommended as crossing substitutes. This infrastructure is very expensive, and impractical to implement at each location where a crossing is needed. Pedestrians also do not prefer them, because of the physical exertion and time delay involved, in comparison to crossing at street level. This infrastructure is unfriendly to the needs of differently-abled users, such as wheelchair-bound pedestrians, senior citizens and people using wheeled units like trolleys and strollers. Moreover, the access points of such infrastructure tends to impede the free movement of the sidewalk, because of the presence of stairwells and elevator shafts.

25. On the other hand, grade-separated pedestrian networks may be useful to augment at-grade pedestrian infrastructure. They are particularly useful in connecting to the transit station, when the station is at the same grade as the network. This eliminates the need to change grades for pedestrian commuters, at one of their trip. Such infrastructure can also provide direct connectivity of major establishments to the transit station, which can be have a positive impact both for walking and for transit patronage.

26. While there are contexts where the provision of such infrastructure has benefits, their provision must only be considered as additional to at-grade infrastructure, intended to provide commuters with more options. It should not be used indiscriminately, or at the cost of providing functional sidewalks. Care should be taken to ensure that this infrastructure is accessible for all users, and its civil structures do not impede the free flow of pedestrians on the sidewalks.

Cycling Infrastructure

27. Cycling is a healthy and sustainable mode of commute that can play an important role in enhancing connectivity to transit. It has a higher reach than walking, which greatly increases the commutable distance to the transit station.

28. The most crucial aspect for cycling safety is the design of street infrastructure. It is recommended to use dedicated cycling infrastructure, because average motor-vehicle speeds tend to be unsafe for cyclists. This is a good guiding principle for greenfield development. However, it is rarely practical to uniformly implement dedicated cycle lanes in most existing developments, due to either the paucity of road widths, or other land-use constraints. In these contexts, the cycling network for the TOD zones will comprise of the judicious use of dedicated cycle lanes where viable, in combination with traffic-calmed, shared streets. As a general principle, cycle lanes are recommended for the trunk routes leading to the station; while feeder lines to the trunk route may comprise of traffic-calmed streets.

Cycle Lanes

29. It is recommended to use dedicated cycle lanes on trunk routes of the cycling network, leading to the station. Normally, the trunk cycling corridors will also contain the trunk transit and motor-vehicular routes, and hence will have a high volume of large vehicles and fast-moving traffic. Thus, the provision of dedicated cycle lanes can have a significant positive outcome on cyclist safety. Table 5 below compares the types of dedicated cycled infrastructure that can be incorporated.

Physically segregated cycle lanes	Marked cycle lanes
Segregated from vehicular traffic, either, by curbs, medians, railings or landscaping.	Normally delineated through the use of road-marking and roadside signage on the main carriageway.
Segregated infrastructure reduce the possibility of a motor-vehicle entering the cycle lane and colliding with a cyclist. It is recommended to avoid use of railings as segregation, because it effectively reduces the usable width of the cycle lane, as cyclists don't tend to ride closer to the railings. Median curbs or landscape strips should be used instead.	A uni-directional cycle lane, marked on the main carriageway, must be at-least 1.5m wide, and it will depend on whether there is parking space or a bus lane on the adjacent space. This allows for some buffer from traffic moving in the adjacent lane; but it does not provide enough width for a faster cyclist to overtake a slower one. For long block lengths, it is recommend the provision of pull-out zones to allow for cyclists to safely overtake.
Can be designed to be either uni-directional or bi-directional. When designed to be bi-directional, the cycle lane acts much like a sidewalk, and cycle crossings can be designed in sync with pedestrian crossings.	Typically, are uni-directional, and cyclists are expected to ride in the same direction as traffic on their side of the road. It is recommended to avoid use of contraflow cycle lanes.

Table 5. Comparing different types of dedicated cycle lanes.

30. There are two kinds of cycle lanes:

- A uni-directional cycle lane, marked on the main carriageway, must be at-least 1.5m wide. This allows for some buffer from traffic moving in the adjacent lane; but it does not provide enough width for a faster cyclist to overtake a slower one. For long block lengths, it is recommend the provision of pull-out zones to allow for cyclists to safely overtake (Figure 19).
- A bi-directional cycle lane must be at least 2.5m to allow for cycling units to pass each other. Keep in mind that the cycle lane is not only for bicyclists, but for all wheeled, active modes of transport, which includes wider vehicles, such as tricycles or cycle-rickshaws (Figure 20).

Figure 19. Uni-directional marked cycle lane.

Figure 20. Bi-directional marked cycle lane.

Cycle lanes positioning across bus stops

31. The overlap of cycling routes and feeder bus routes can create potential safety conflicts. Buses need to stop next to the sidewalk to pick-up and drop-off commuters. This may mean that the bus has to cut across the cycle lane to access the bus stop. This is a potential safety risk, given the mass and speed of the bus in relation to the cyclist. This risk is further heightened by the fact that the bus driver has to change lanes behind the line of sight of the cyclist.

32. It is recommended that, where possible, trunk cycling routes and bus-feeder routes be kept separate. If there are parallel roads leading to the station, then this becomes easier to implement. Where sharing the route is unavoidable, we recommend that the cycle lane be continued behind the bus stop, such that the bus does not have to enter the cycle lane to reach the bus stop. Here, the bus stop area is separated from the sidewalk, and commuters will have to cross the cycle lane to access the bus stop.

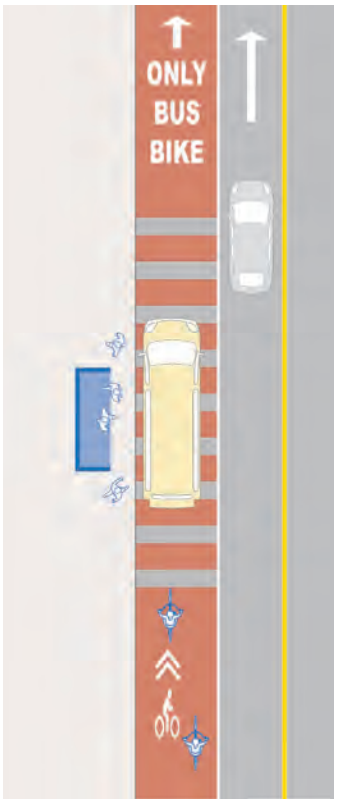


Figure 21. A shared bus and bike lane

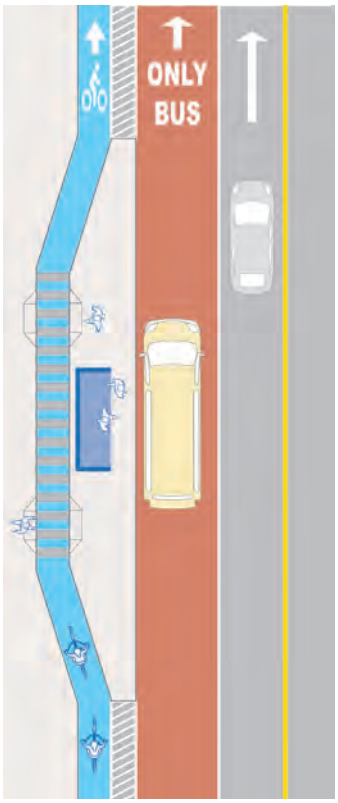


Figure 22. Separate bus and cycle lanes, with cycle lane going behind the bus stop

Figure 23. A bus station bypass in Rio de Janeiro, Brazil that raises the bicycle lane to the sidewalk level while bypassing the bus waiting area. Source: WRI

Cycle lanes and on-street parking

33. It is not recommended to provide on-street parking on trunk access routes leading to the transit station, unless there is enough road width remaining after providing for all feeder network infrastructure. This is generally a very impractical condition for already built-up TOD zones in the developed areas of the city. Often, the creation of a cycle lane is possible only by taking away space from on-street parking.

34. On-street parking creates other potential safety conflicts for cyclists. Vehicles benefit from being parked as close to the sidewalk as possible. This requires them to cut across the cycle lane (Figure 24), creating similar safety concerns as described in the previous sub-section on bus stops. Moreover, when the door of a parked car is suddenly opened on the side of the cycle lane, it creates a safety hazard for the cyclist (Figure 25).

35. It is recommended that paid on-street parking be provided on streets with cycle lanes, only where there is a possibility to separate the parked vehicles from the cycle lane by a buffer (Figure 26). This buffer should be at least half a meter wide, to contain the width of an opened car door, and also allow people to enter and exit their car safely, without standing on the cycle lane. It could also be designed as a raised median. (Figure 27).

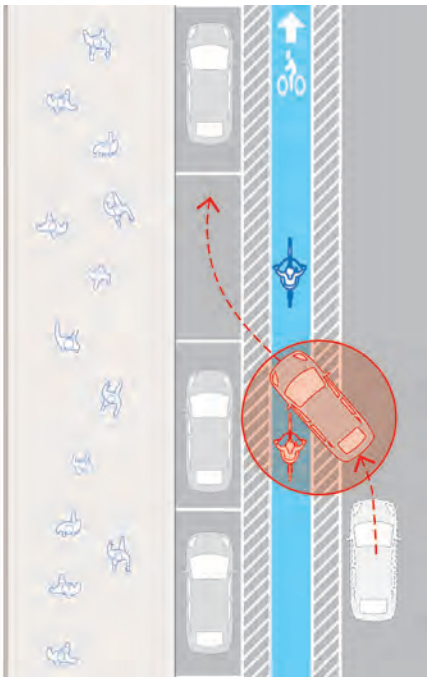


Figure 24. Cycle lane between travel lane and parking lane

Vehicles cutting across cycle lanes to access on street parking adjacent to sidewalk create safety hazards for cyclists

Figure 25. Cycle lane between sidewalk and parking lane without any buffer

Doors of cars opening on the side of cycle lane without adequate buffer may conflict with cyclists

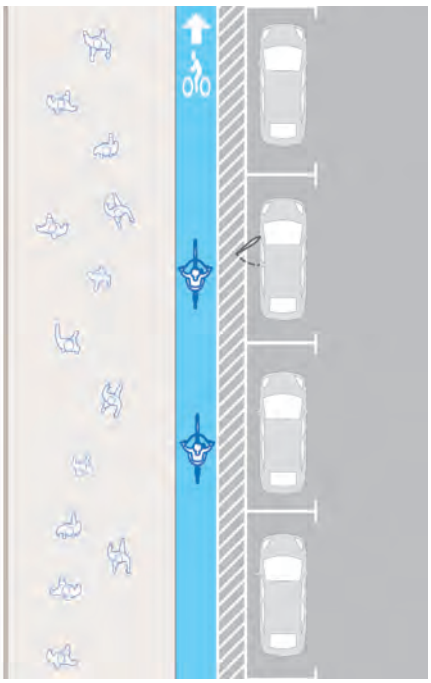


Figure 26. Buffer between cycle lane and parking lane using on-street markings using paint.

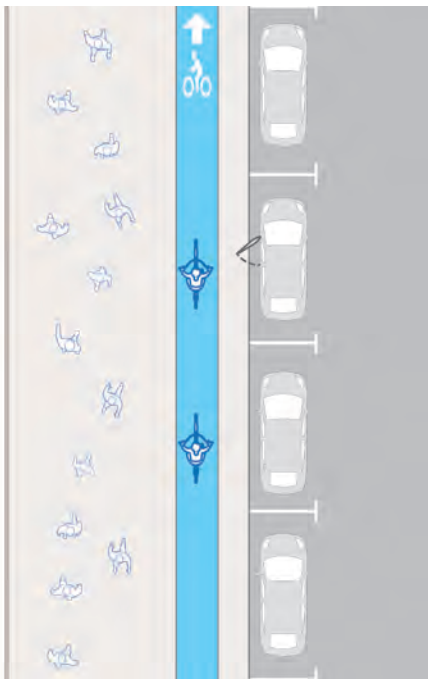


Figure 27. Protected bike lanes with physical separations using raised median as buffers

Intersections and cyclist movement

36. The design of intersections is a crucial aspect for the overall safety of the cycling network. There have been a number of design alternatives that have been developed, which have different benefits and disadvantages with respect to the mobility and safety of cyclists. The traffic lights in such intersections should include a traffic signal for cyclists, which is synchronized with pedestrian lights. In larger intersections with multiple lanes, an advance phase cycle signal may also be provided. These alternatives have been summarized in Table 6 with details explained in TOD Knowledge Product PD-R02, followed by a graphical representation of an intersection with bus priority lanes and a two-stage cycle turn lane (Figure 34).

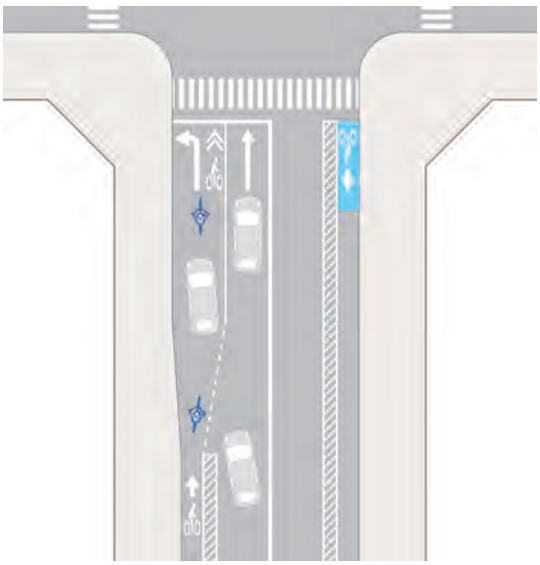
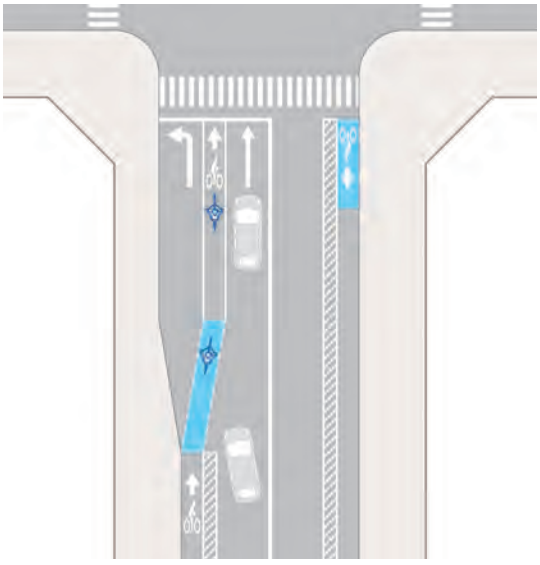
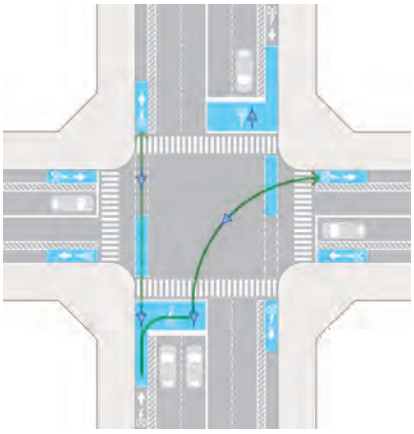
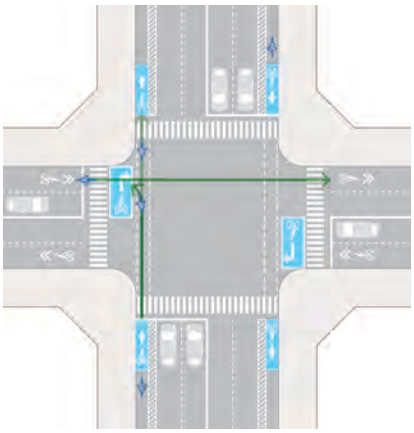
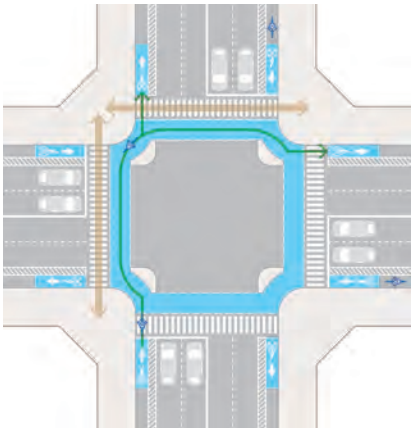
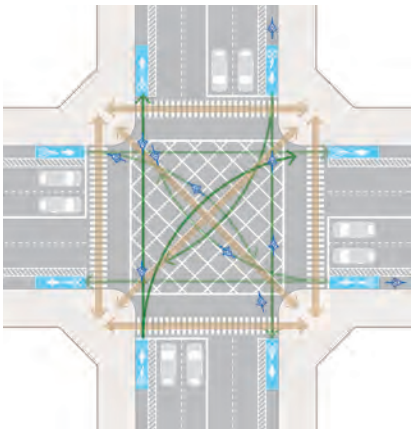
Type	Diagram	Description
Regular, traffic calmed intersection	*Refer diagrams for modified intersections in a shared street: Figure 59 on Page 55, and Figures 60, 61 on Page 56.*	No definitive cycling infrastructure is provided; but intersection is designed with speed control standards of a shared street
Advanced termination of the cycle lane	 Figure 28. Advanced termination of bike lane as it nears an intersection.	The cycle lane is terminated a few meters before the mouth of the intersection.
Provision of a turning lane between the cycle lane & sidewalk	 Figure 29. Turning lane inserted between cycle lane and sidewalk.	A left turning lane* for general traffic is provided between the sidewalk and the cycle lane.

Table 6. Summary table for different types of intersections

Advantage	Disadvantage	Suitability
Easy to implement. Doesn't require much street area.	It is not appropriate for high speed intersections, with high traffic volumes and/or high number of large vehicles.	Suitable for neighborhood, traffic calmed streets, that are normally non-signalized.
It allows motor-vehicles and cyclists to align themselves in the correct position at the intersection, depending upon the direction they intend to go.	No dedicated infrastructure for cyclists, where it's need the most. There is a risk of collision be-tween vehicles & cyclists, while they're changing lanes.	Should be used very sparingly, only after all other options are considered.
It allows cyclists to continue straight through the intersection, without conflict with left-turning motor-vehicles.	There is a risk of collision at the place where the cycle lane and the motor-vehicular lane cross each other.	Should be used very sparingly, only after all other options are considered.

* Description is written on the context of countries where traffic drives on the left side of the road.

Type	Diagram	Description
Cycle boxes with 1-phase right turn	 Figure 30. Advanced stop lines with cycle boxes for cyclists to align in direction of turn	Cyclists align themselves in a cycle box, (provided between the pedestrian crossing & the stop line)
Cycle boxes with 2-phase right turns	 Figure 31. Two-phase cycle turn boxes	During the green signal phase, cyclists intending to turn right enter the intersection and align themselves in the cycle box of the perpendicular street.
Hooked cycle lanes	 Figure 32. Cycle lanes hooked with pedestrian crossing	The cycle lane is slightly deviated at the intersection to align it with adjacent street pedestrian crossing.
Scramble signal phase	 Figure 33. Single phase for cycle movement in all directions. *Can be combined with pedestrian movement in all directions*	A separate signal phase is provided for cyclists to move to and from all arms of the intersection; all motor-vehicular traffic has a red light.

Advantage	Disadvantage	Suitability
It provides dedicated infrastructure right up to the intersection mouth. It allows cyclists to complete a turn in one signal phase.	It creates some ambiguity on where the cyclist should wait if it reaches the intersection during the green signal phase for vehicular traffic on the same arm of the intersection	Suitable for trunk cycling routes with a high volume of cyclists. It is especially useful when the majority of cyclist movement makes a right* at the intersection
It provides dedicated infrastructure right up to the intersection mouth. The design is more intuitive to both cyclists and motorists.	It needs 2 signal phases for cyclists to complete a right turn.	Suitable for trunk cycling routes with a high volume of cyclists. An appropriate universal design principle, as it is likely to fit most contexts.
It slows down cyclists as they enter the intersection area. It provides better visibility for cyclists and motorists of each other.	It creates some deviation from the shortest path across the intersection for cyclists. It requires a larger intersection area to be implemented.	Appropriate and safe option wherever there is adequate inter-section area. It can be used for both signalized and un-signalized intersections.
An intuitive design that allows for the free movement of cyclists in any direction.	The addition of a signal phase may affect intersection through-put which may result in longer delays for both motorists and cyclists.	Appropriate when there is a high volume of cyclist, with no single dominant direction of movement. Suitable for intersections with more than 4 arms

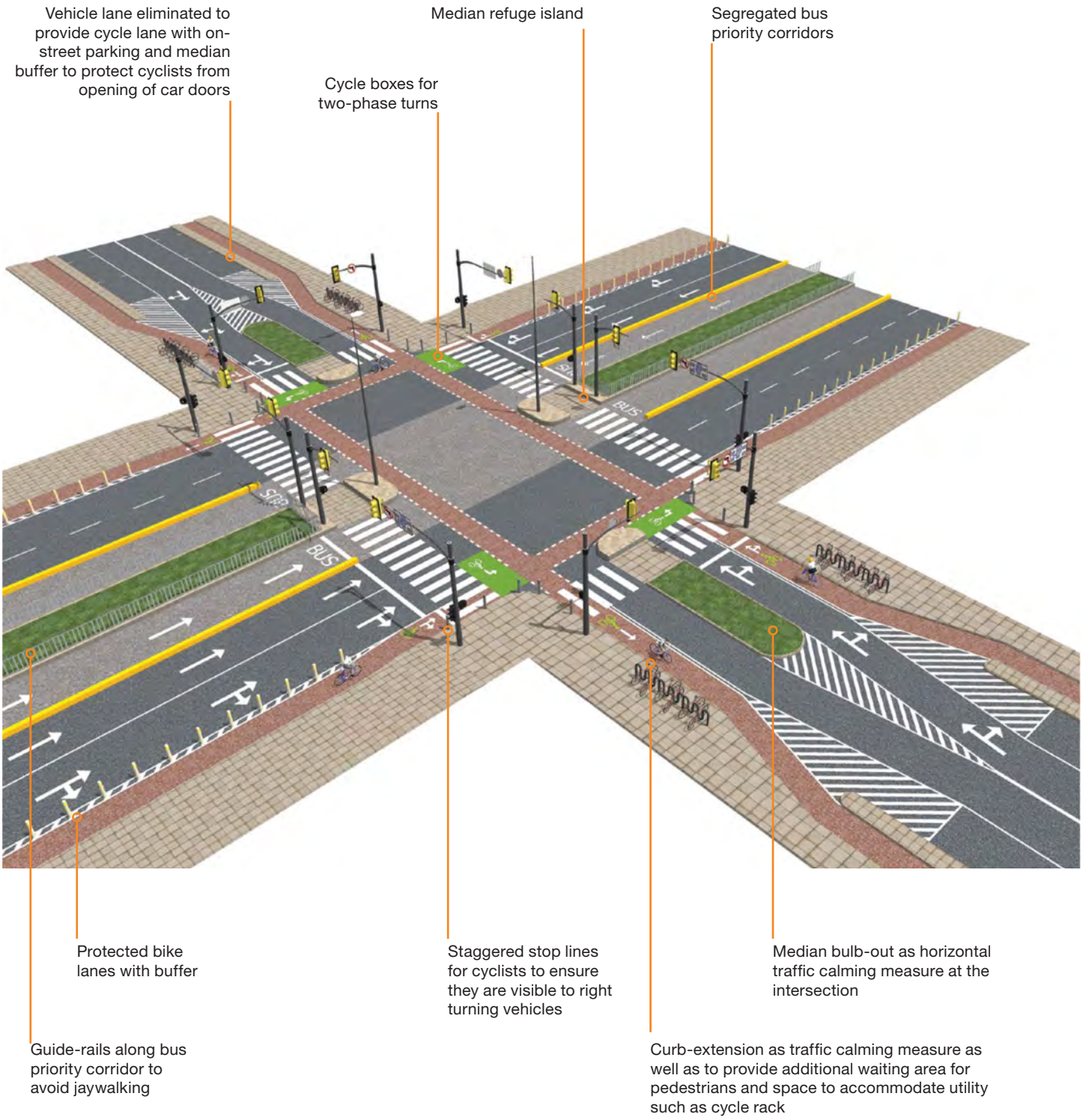


Figure 34. Two-phase cycle turn at intersection with Bus priority lanes (Source: WRI)

Feeder Transit and Para-transit Infrastructure

37. Feeder transit (generally in the form of buses) and para-transit (in the form of vans, taxicabs or auto-rickshaws) provide a valuable service in enhancing the commutable distance for transit users. This is particularly important for TOD zones in lower density area, where distances from the station may be too long for walking and cycling to be the only feeder alternatives.

38. In most cases, feeder transit and para-transit services will share the same road infrastructure as general motor-vehicular infrastructure. As such, the general design principles for safe streets will apply here. However, there are a few additional guidelines that have to be kept in mind, particularly with respect to the design of locations where these vehicles stop to pick-up and drop off passengers. These guidelines are discussed in the following sub-sections.

Bus stops near intersections

Service area for bus stops near intersections

39. The intersection is an optimal location for a bus stop for two important reasons:

- A bus stop located at an intersection is likely to have a larger area within walking distance as compared to a mid-block stop, because of the intersection of streets moving in different directions (Figure 34 and Figure 36 below).
- It reduces the walking distance to transfer between two intersecting bus routes, if their respective bus stops are located at, (or near) the same intersection (Figure 37 and Figure 38)

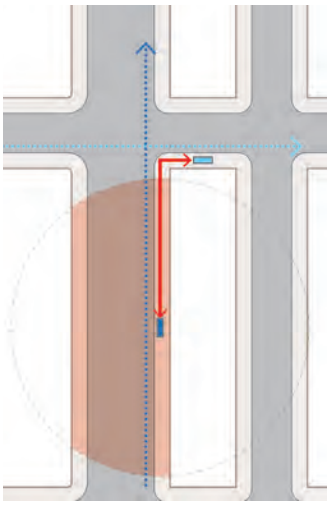


Figure 35. Bus stop location at mid-block has a limited reach and longer interchange distance

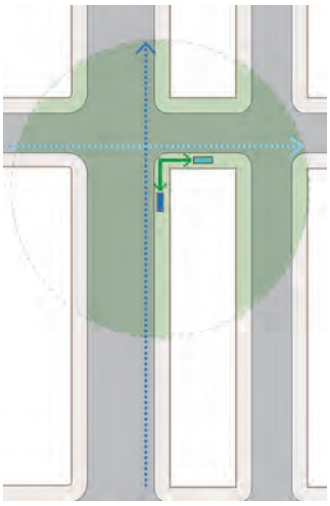


Figure 36. Bus stop located near an intersection increases connectivity and reduces the interchange distance.

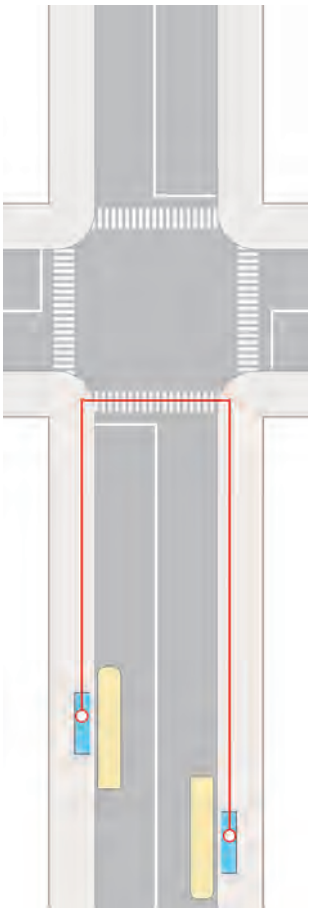


Figure 37. Transfer distances of two stops positioned at mid-blocks

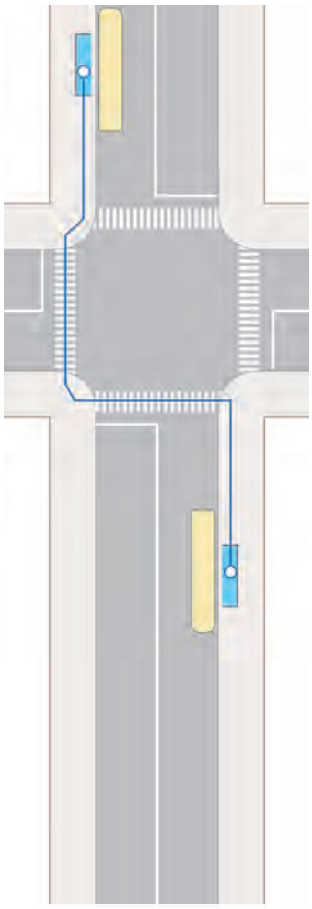


Figure 38. Transfer distances of stops near the intersection

Position of Bus stop with respect to intersection

40. The presence of a bus stop in close proximity to an intersection can create certain challenges for traffic mobility and for safety. A bus waiting at its stop may hold up traffic trying to clear the intersection, which affects intersection throughput capacity. Furthermore, the waiting bus may act as a visual impediment for motorists and crossing pedestrians, which can have a negative impact on safety. These issues raise some crucial concerns with respect to the design and positioning of bus stops at intersections.

41. Normally, a bus stop is best positioned a few meters after the intersection. In this way, the bus would have to cross the intersection before reaching the stop. The advantage of this positioning is that it does not hold up traffic that wants to go through or make a turn at the intersection. This is especially important for signalized intersections. If the bus stop were to be located just before the intersection, then, if a bus happened to reach the stop during the green signal phase, it would unnecessarily hold-up traffic behind it even though the light is green. Motorists cannot overtake the bus from the other side if they plan to turn left at the intersection (in contexts where traffic drives on the left), so they would end up queuing behind the waiting bus (Figure 39).

42. Locating the bus stop after the intersections allows all traffic, (including the bus) to queue up in the correct lane, depending on which direction they intend to move. It mitigates the risk of motorists trying to overtake or cut across the bus in order to make a turn (Figure 40).

43. Another safety advantage of locating the bus stop after the intersection is that the pedestrian crossing for this intersection (which will also service the bus stop) will be located behind the bus. A bus is a large vehicle and can block the view of motorists and crossing pedestrians of each other. By positioning the bus stop after the intersection, it ensures that most bus commuters will walk back to the intersection in order to cross the road, putting them out of the blind-spot created by the bus.

Distance of bus stops from intersections

44. The bus stop should be located some distance away from the intersection to allow for vehicles entering this arm of the road to move out of the lane occupied by the bus in order to overtake the waiting bus (Figure 41 and Figure 42).

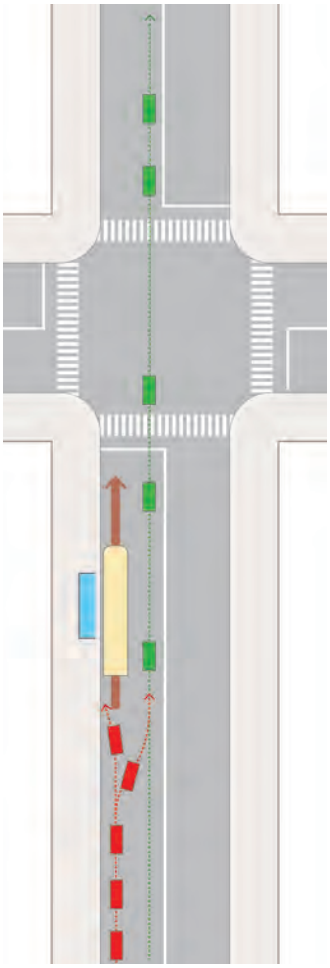


Figure 39. Impact on traffic due to stop positioned before intersection

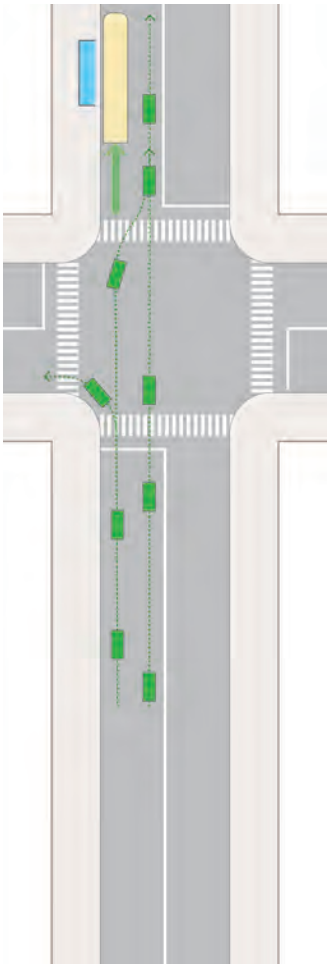


Figure 40. Impact on traffic due to stop positioned after intersection

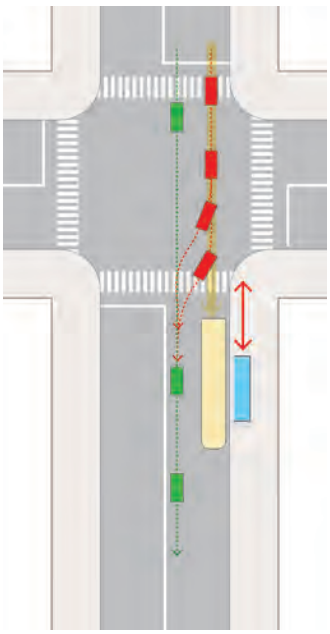


Figure 41. Impact on traffic due to stop positioned close to intersection

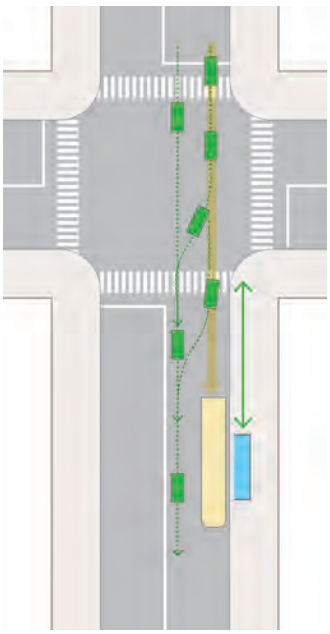


Figure 42. Impact on traffic due to stop positioned short distance from the intersection

Mid-block bus stops

45. In some context, locating a bus stop along the mid-block of a road may have some advantages. The intersections in the near vicinity may have certain complications that make it difficult to locate the stop there. In some cases, the distance between successive intersections may be very far, warranting the need for a mid-block stop. In other cases, adjacent land-use conditions may dictate the location of the stop. For instance if a prominent node, such as an educational institution or a hospital, is located at the mid-block, then it may warrant the positioning of the stop as close to this node as possible.

46. There are certain aspects to be kept in mind regarding the provision of mid-block stops. Avoid locating the bus stops along curves or slopes in the roadway, as this effects visibility of crossing pedestrians (Figure 43). As a general principle, try to locate the bus stops on opposite sides of the road, such that they share a common pedestrian crossing that is located behind both stops (Figure 44). The safety implications of locating a crossing in front of a stop were already discussed in the previous section, that is, the waiting bus blocks the visibility of motorists and crossing pedestrians of each other.

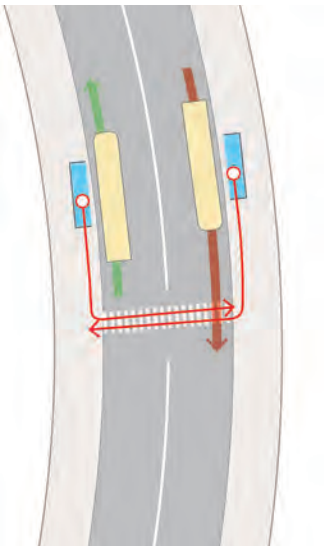


Figure 43. Incorrect location of mid-block bus stops along curved roads

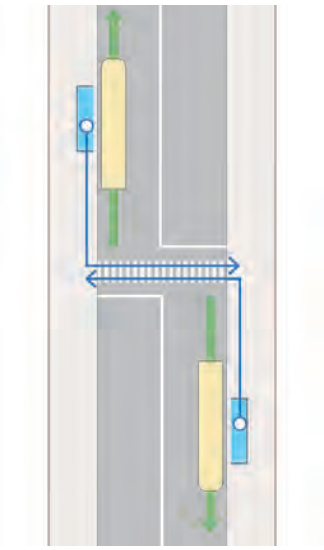


Figure 44. Ideal mid-block location of bus stops with common crosswalk

Para-transit nodes

47. Para-transit normally operates along the general traffic roadway in mixed traffic conditions. Typically, pick-up and drop-off happens all along the roadway, except where there are legal restrictions against stopping. As such, para-transit commuters do not normally require specific street infrastructure elements.

48. However, certain locations may warrant the provision of specific para-transit, where there is a high demand for para-transit services. These include nodes of high commuter footfall, such as shopping malls, educational institutes, office complexes, etc. Where demand is high, there tends to be a concentration of para-transit vehicles waiting to pick-up passengers. If adequate infrastructure is not provided, this can result in the haphazard stalling of vehicles along the roadway, which affects both traffic throughput and safety.

49. It is recommended that the provision of dedicated pick-up and drop-off infrastructure at all such nodes, to facilitate the orderly alignment of para-transit vehicles, which allow for passengers to embark and disembark these vehicles safely. The pick-up and drop-off zones function best when they are physically separated from each other, in a manner that allows for a para-transit vehicle to quickly move from the drop-off zone to the pick-up zone, (in order to pick-up new passengers). The length of each zone should be adequate to meet demand and operational conditions.

Traffic-Calming Measures for Shared Streets

50. A shared street is one where the infrastructure is designed to meet the mobility and safety standards of all road users. These standards are very different for motor-vehicle traffic than for non-motorized traffic. Thus, if a street is to be designed for all road users, it is essential that is meets the safety standards of the most vulnerable road users - pedestrians and cyclists.

51. The implementation of traffic-calming measures is an essential component of creating safe, shared streets. In most built-up urban areas, it is impractical to provide dedicated lanes to every feeder mode due to pre-existing constraints, like availability of right-of-way, traffic dynamics or adjacent land-use conditions. Where possible and practical, one may consider off-road connectors, (through parks and public places); or off-grade infrastructure. However, the opportunities for such interventions are limited, or their installation is immensely expensive. They cannot be considered as a blanket resolution for all areas where street right-of-way is limited. The most practical solution then becomes the implementation of shared streets.

52. The most important aspect of developing safe, shared streets is to slow down traffic speed. A slower street reduced the probability of conflicts between road users, while also reducing the severity of a crash when it happens. A second aspect of developing shared streets is the reduction of traffic volume, achieved mainly through the diversion of non-local traffic.

53. In some contexts, certain motor-vehicle user groups may prefer a slower street. For instance, local traffic accessing adjacent properties, will have a slower speed expectation than thoroughfare traffic. Similarly, feeder buses may also prefer slower streets, due to their need to frequently stop to pick-up and drop-off passengers. This is also true of para-transit services that may prefer slower movement, while scoping for passengers.

General design measures

Lane diet

54. The total width of the section of the road reserved for vehicular movement is often referred to as the carriageway. The width of this carriageway is a crucial factor in influencing traffic speed. There are two aspects to be considered here:

    - **The traffic lane width- Wider traffic lanes allow motorists to drive faster, because of perceived lower conflict risk with traffic in other lanes.**
    - **Number of traffic lanes- Greater number of traffic lanes result in increased carrying capacity, which improves traffic free-flow conditions, which further allows for faster travel.**

55. Streets in urban areas are still being designed as per inter-city highway standards, where lane width of 3.5m and more, are considered the norm. This standard allows for a design speed in excess of 50km/h, which is an extremely unsafe speed for urban conditions. Figure 45 illustrates a typical four-lane street.

56. If a street has to be shared with vulnerable road users, then the design speed should be closer to 30km/h. For local, neighborhood streets, and even lower design speed is desirable.

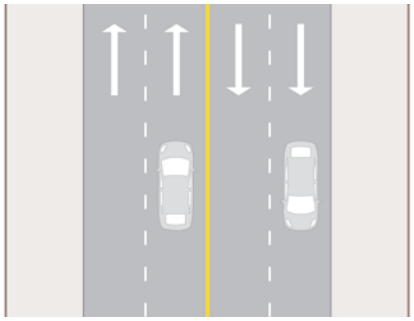


Figure 45. Existing typical distribution of ROW with wide travel lanes

57. A shared street must not have more than 2 traffic lanes in either direction. Anything more than 2 lanes makes it difficult to implement a design speed close to 30km/h. In most cases, 1 lane in each direction is adequate for local, neighborhood streets. If an existing road of more than 2+2 lanes is to be redesigned along shared street principles, then consider converting the additional lanes into a parking lane; or utilizing the additional road width to increase space for other street elements, such as sidewalks. Table 7 below includes some alternatives for re-distributing the street ROW.

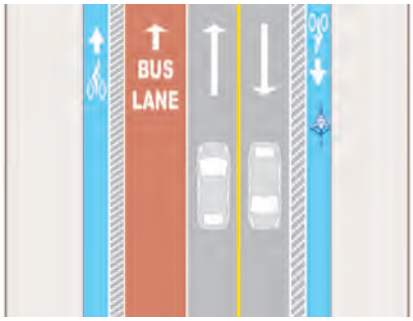
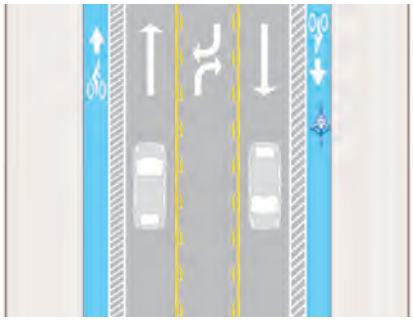
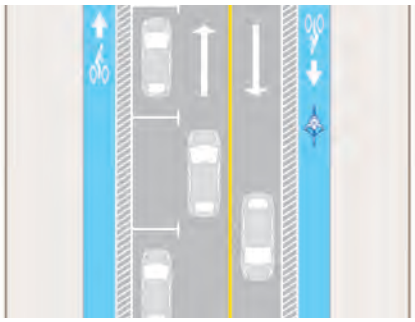
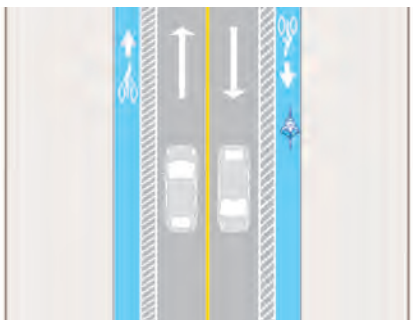
Diagram	Description
 Figure 46. Redistributed ROW with narrower travel lanes, cycle lanes, and bus lane	A traffic lane width of 3m (upper limit) is recommended for all shared streets. An exception may be made for roads that are part of the transit bus network, where the lane utilized by the bus, (in most cases adjacent to the sidewalk), may be as wide as 3.5m. For neighborhood streets, and even narrower lane width than 3m is desired, especially if this street is meant to cater primarily to local traffic movement.
 Figure 47. Redistributed ROW with narrower travel lanes, cycle lanes, and center turn lane	Travel lanes rearranged to have a center turn lane and unidirectional cycle lanes.
 Figure 48. Redistributed ROW with narrower travel lanes, cycle lanes, and on street parking	Additional on-street parking lane
 Figure 49. Redistributed ROW with narrower travel lanes, cycle lanes, and wider sidewalks	Extended sidewalk widths to provide space for pedestrians.

Table 7. Alternatives for ROW redistribution

Urban design measures: Streetscapes and gateways

58. Traffic-calming measures include several engineering interventions to slow down of traffic. In addition, there are many urban design measures that act as visual cues, encouraging motorists to select the appropriate speed for this zone.

59. The presence of setbacks along the road front have a psychological impact on speed selection. A street where buildings are set nearer the road edge are perceived to be narrower than streets of similar widths, but where the buildings are further apart. This induces motorists to drive slower on the former kind of street, due to the narrower visibility range. Trees planted close to the carriageway edge have a similar impact on speed selection. From a TOD zone planning perspective, regulations can be implemented to relax frontage setback norms, (where appropriate), to encourage more compact development

60. Another measure to encourage motorists to slow down when entering a traffic-calmed street is to include more diverse road users, such as on-street parking and street-vending. These uses increase the perceived disruptions to the motorist, which encourages them to slow down. In addition, softer streetscape elements may also be considered to signal to the motorists that they have entered a traffic-calmed street. This include measures such as change of carriageway surface material and color, as well as the increased use of landscaping and other street furniture.

61. If there are definitive entry points into a neighborhood from a main street, it is a good practice to install a gateway feature across the entry point, which informs motorists that they're about to enter a different kind of right-of-way. This encourages them to slow down and choose the appropriate speed for this zone.

Mid-block design measures

Vertical speed controls: Speed humps, speed tables and speed bumps

62. There are three kinds of vertical deflectors, that are effective in controlling vehicular speed as shown below in Table 8. They have slightly different design features which also impacts their functionality and applicability.

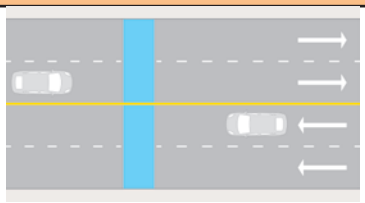
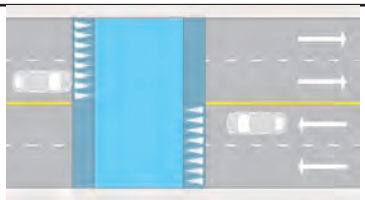
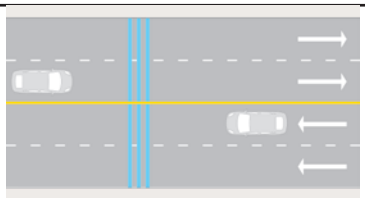
Type	Diagram	Description
Speed Hump	 Figure 50. Speed hump	Curved, raised area, along the width of the carriageway, which causes a vertical deflection for vehicles as they traverse it, which induces motorists to slow down in order to cross the hump comfortably.
Speed Table	 Figure 51. Speed table	Refers to an elongated speed hump, with a flattish section between the up and down slopes of the hump. A pedestrian crossing may be included along the flat section of a speed table.
Speed Bump	 Figure 52. Speed bump	Significantly narrower in cross-sectional width than a speed hump, which causes a more striking vertical deflection for a vehicle. A vehicle, normally, has to come to a near stop, in order to cross the bump comfortably.

Table 8. Vertical speed control alternatives

63. Speed humps or tables are recommended for local, neighborhood streets as a traffic-calming device. Speed bumps are normally not recommended for public streets, because of their abrupt impact on vehicles. They are more suitable for driveway or parkway entries. The frequency of speed humps along a stretch of road should be such that it discourages speeding in-between two humps.

64. Speed humps may be provided before pedestrian crossings, especially in cities where motorists are unlikely to slow down for a crossing pedestrian (Figure 53).

65. If there is no median barrier on the roadway, it is better to locate the pedestrian crossing on top of the speed table (Figure 54).

66. If such vertical speed controls are needed near to an intersection, it is recommended to use a speed hump instead of a speed table so that pedestrians don´t confuse it with a pedestrian crossing.

67. Speed humps must be avoided along curved sections of the road, or in sections where forward visibility of the roadway is low. Speed humps should also be avoided on sloping sections of the road. Normally, a speed hump should not be installed just before a traffic signal, as it affects the green phase traffic throughput for this signal.

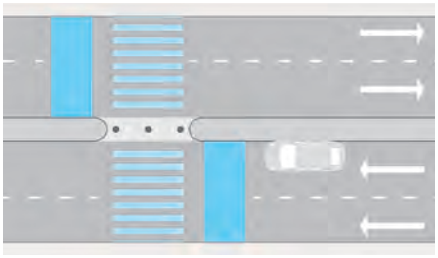


Figure 53. Speed humps before pedestrian crossing.

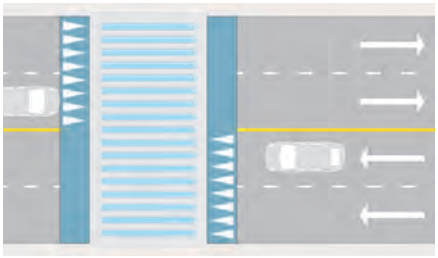


Figure 54. Pedestrian crossing on top of speed table

Figure 55. Speed table doubling up as a mid-block crossing with safety bollards in New Delhi, India. (Source: The World Bank)

Horizontal speed controls: Chicanes, curb-extensions, bulb-outs and staggered on-street parking

68. Table 9 below discusses the various types of horizontal speed control measures.

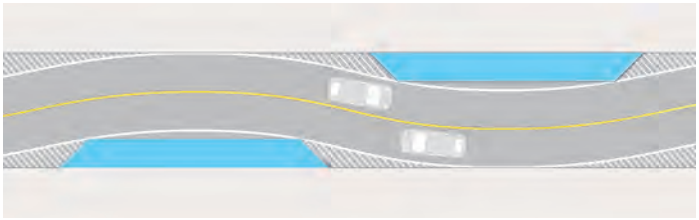
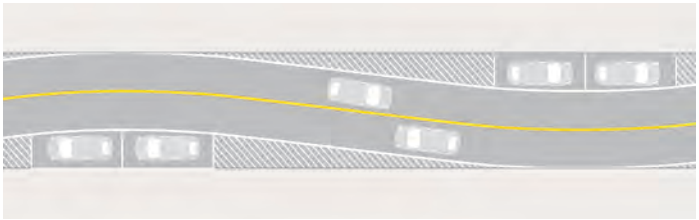
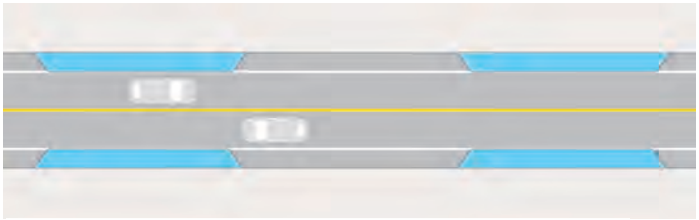
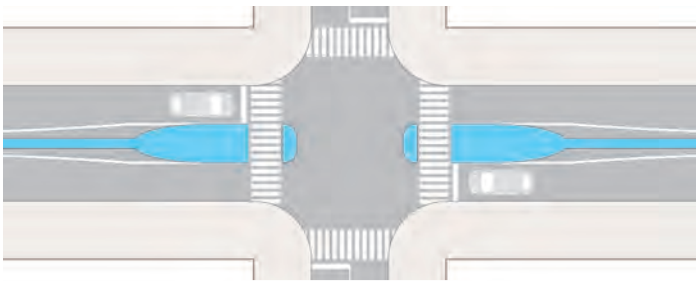
Type	Diagram	Description
Chicanes	 Figure 56. Chicanes	These refer to the series of physical deflectors that are installed along alternating sides of the road, which result in the creation of a serpentine-like roadway. This forces motorists to slow down as they steer left and right through the successive chicanes. Chicanes are a useful retrofit for long, neighborhood streets, though consideration should be given to their impact on cyclists and emergency vehicle movement.
Staggered on street parking	 Figure 57. Staggered on-street parking	A similar traffic-calming impact that chicanes provide can be achieved by staggering the provision of on-street parking. The presence of on-street parking has the added advantage of increasing perceived traffic disruptions, which induces motorists to drive slower.
Curb Extensions	 Figure 58. Chokers	This refers to the physical extension of the curb, (normally the sidewalk curb) into the carriageway, partly or fully cutting out a traffic lane. Curb extensions are also referred to as chokers, because, they, in effect create a physical bottleneck, with the intention of choking traffic. This induces motorists to slow down while driving through the curb-extension area.
Median bulb-out	 Figure 59. Median bulb-out	Curb-extensions may also be provided along a curbed median, which then creates, what is called a bulb-out in the center of the road. The advantage of such a bulb-out is that is allows for the inclusion of a pedestrian refuge area between the crossing, where pedestrians can stop and wait while crossing the road.

Table 9. Horizontal speed control alternatives

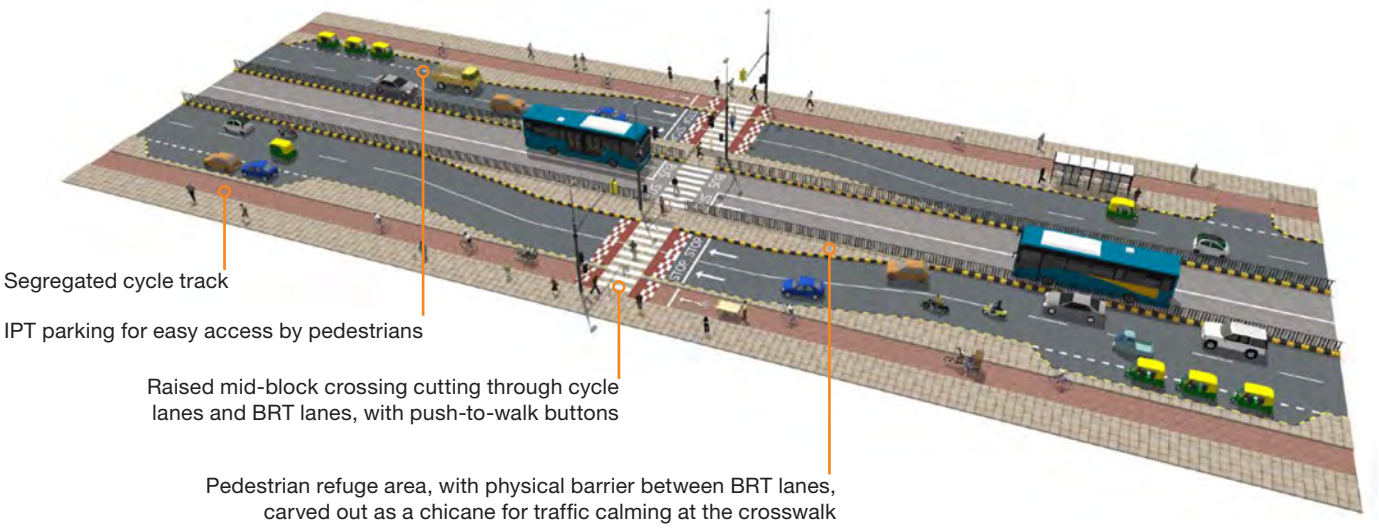


Figure 60. Mid-block crossings in BRT lane as a combination of horizontal and vertical traffic calming measures

(Source: © WRI India)

Intersection design measures

Tightening and/or extending curb corners

69. The most important measure to reduce traffic speed at intersection is to minimize the radius of curb corners at intersections. A tighter corner induces motorists to slow down to make a turn, which adds to safety. It also increases the available sidewalk area at the intersection and decreases the crossing length, which allows for safer crossings.

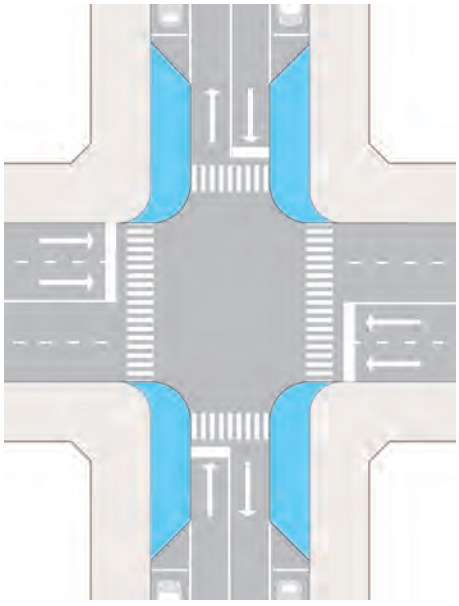


Figure 61. Extending curb corners at intersections to create gateways

Modified intersection

70. Table 10 below highlights features of different types of modified intersections.

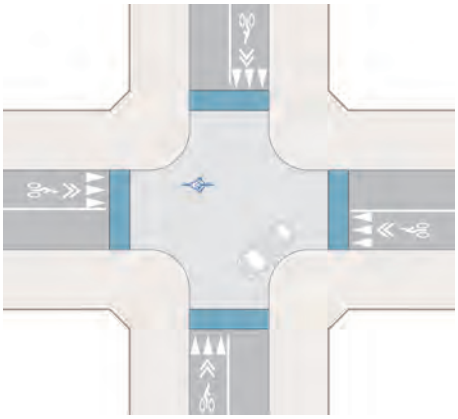
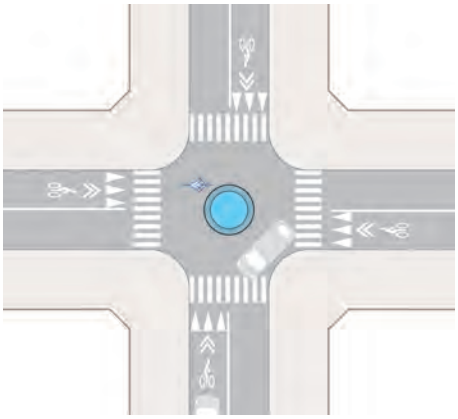
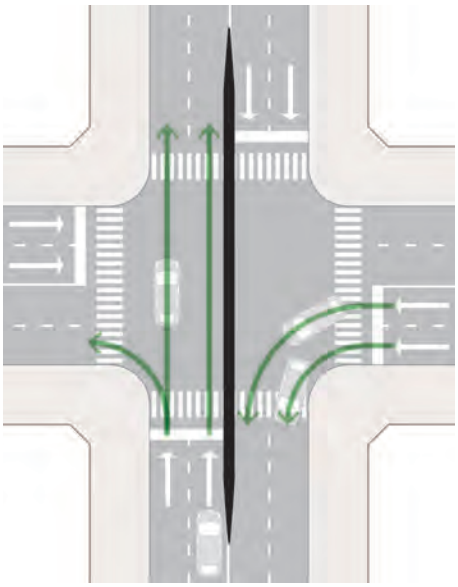
Type	Diagram	Description
Raised intersection	 Figure 62. Raised intersection, at the level of sidewalk	A raised intersection is an effective traffic-calming measure, applicable for un-signalized intersections between neighborhood streets. They are similar in profile to a speed table, wherein the entire intersection area is slightly raised to create a vertical displacement for vehicles.
Mini roundabout	 Figure 63. Mini roundabout	Mini-roundabouts consists of a small circle located within the intersection area, which creates a lateral displacement for vehicles, forcing them to slow down. They differ in form and function from conventional roundabouts, which are much larger, and their primary function is to channelize traffic circulation, rather than slowing down traffic.
Physical barriers	 Figure 64. Restricting movement at intersections using barriers	Restricting movement at intersections through the installation of physical barriers (median barrier across an intersection), impacts the volume of traffic using this intersection, (and the adjoining streets), by curtailing thoroughfare traffic. Another measure is to install a diagonal barrier across the intersection, preventing through movement in either direction.

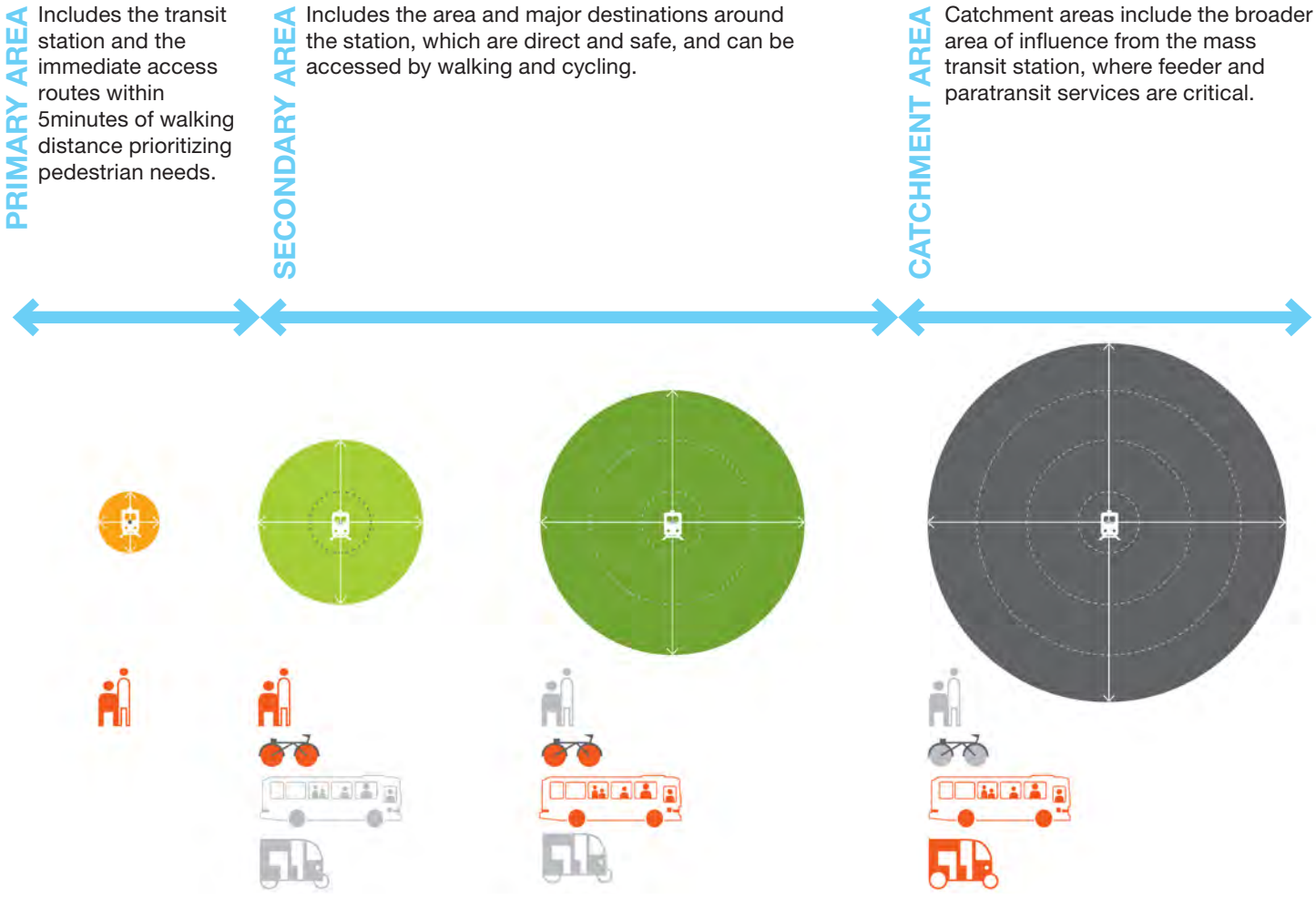
Table 10. Alternatives for a modified intersection

Primary Station Area Design

71. The primary station area in the context of TOD, refers to the area immediately surrounding the transit station i.e. within 0 – 400m or 5 minutes walking, where the transfer of commuters between feeder modes and the main transit line takes place. This is the meeting point for the trunk routes of all feeder modes. Hence, safety and mobility challenges are the most crucial at the station area, given the high concentration of commuters and traffic into a relatively small space. Infrastructure for the transfer of pedestrian commuters should be provided nearest to the station gates, followed by infrastructure for cyclists and feeder buses, then para-transit, and finally, for personal motor-vehicles.

Figure 65. Cycle parking facility and pedestrian only area at the entrance of Transmilenio in Bogota, Colombia (Source: The World Bank)

Figure 66. Transit station access using segregated sidewalks, Mexico (Source: The World Bank)



72. It is important to ensure that transit infrastructure, including station structures, do not impede the movement of any mode. It is commonly observed that the pillars of elevated transit stations completely block the sidewalks below them. In other cases, elevator shafts and stairways to the stations are placed across the sidewalk, forcing pedestrians to walk on the roadway.

Station access points

73. A transit station with one access point can become a potential bottleneck for commuter movement, especially during the peak commuting hours of the day. For a high-volume station, it is recommended to provide multiple entries and exits to the station, ideally connecting to different roads and different directions of the station areas as can be seen in Figure 67

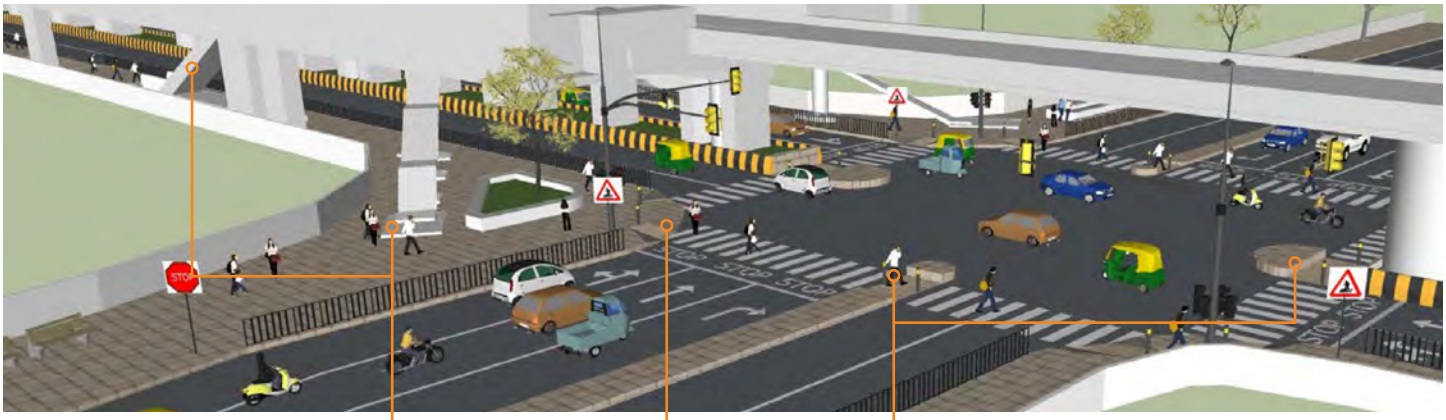


Figure 67. Designed access to DN Nagar Metro Station Mumbai near an intersection (Source: WRI India)

74. Often local access needs are combined with station access points. Access to underground mass transit stations also double up as underpasses to cross major roads. Similarly, BRT stops located in the middle of a highway do not typically have at-grade access. FOBs with ramps or elevators to access the stops are provided. However, if these stations are not functioning during some hours or closed, then the local access can get impeded due to closing of the access facility as well. It is advisable to have these FOBs or underpasses to remain functional all day long and have a connection made from these off-road connectors to the transit facility.

75. BRT services requiring dedicated lanes must be protected to avoid jay walking, with access to stops provided at intersections with wider crosswalks or at mid-block crossings. Additional button-activated mid-block crossings must be provided in the station area where the blocks are large or a high volume of pedestrian movement is expected.

76. Station access points can also be separated according to the transfer mode (Figure 68, Figure 69). A direct access link may be provided, connecting the station to the feeder bus routes separating the movement of bus commuters from other commuters.

77. Grade separated infrastructure can be utilized in conjunction with sidewalks, to increase access points to the stations. This is particularly useful when the grade separated infrastructure connects directly to important nearby land-uses that are likely to generate a high footfall of commuters, such as a shopping center or an office complex. However, such infrastructure must only be provided in addition to at-grade infrastructure, and must never come at the expense of at-grade sidewalks.

Pedestrians crossing along the median, especially with longer BRT Green phase.

(Many Latin American BRT Systems have such design including Macrobus in Guadalajara)

Wide at-grade refuge island in the median to accommodate passengers entering and exiting the BRT station using a protected ramp.

Figure 68. Pedestrian access to a raised BRT station in the center of the ROW (Source: WRI)

Cycle rack on sidewalk along the road perpendicular to the BRT lane, allowing riders to lock the cycles and transfer to BRT system.

Figure 69. Facilities for cyclists to access the BRT station along with pedestrians (Source: WRI)

Transfer facility design

78. As far as possible, transfer zones in the vicinity of the transit station, should be provided such that it eliminates, or reduces the crossing requirement.

    - Traffic management at the Thane suburban railway station in the Mumbai Metropolitan Region, India involves grade separated infrastructure for public bus services and IPT infrastructure. The bus services are on an elevated deck and connect to the railways station through skywalks, and the IPT services are available at grade with pick-up, drop-off and queuing areas (Figure 70).

Figure 70. Thane Suburban station in India with lower level for auto-rickshaws and upper levels for bus bays. It connects to the road level via elevated walkways (Source: WRI India)

79. Wherever possible, the transfer stop should be provided on the same side as the transit station access point. For instance, a feeder bus-loop / terminal may be located near the transit station. In such a case, it is a good idea to ensure that there is no road in between the feeder bus-facility and the station access point. Similarly, a para-transit facility is best located on the same side of the transit station.

    - A typical transfer station along Bogota, Colombia's TransMilenio BRT corridor includes an integrated transfer facility between the trunk BRT route and the feeder service (Figure 71). These terminals are designed to have a common central platform where both the services can dock on either side of the platform allowing the passengers to transfer by crossing across it.

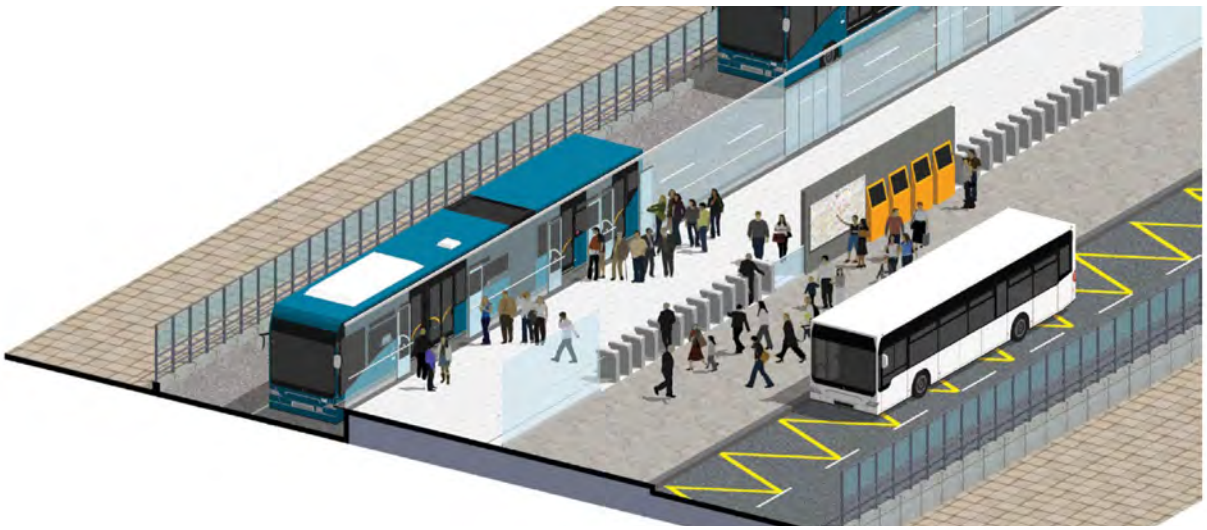


Figure 71. Typical transfer platform at station along Bogota, Colombia's TransMilenio BRT corridor with height differences on either side to accommodate the different floor heights of BRT bus (on left side) and feeder services (right side) (Source: WRI)

80. It may not always be possible to locate all transfer facilities on the same side of the transfer station. This may be the case, for feeder buses plying in opposite directions, in which case, only the stop for one direction can be located on the station side. In such contexts, it is essential that safe crossing infrastructure is provided to access the station. Given the high expected transfer volumes, a signalized crossing may be warranted.

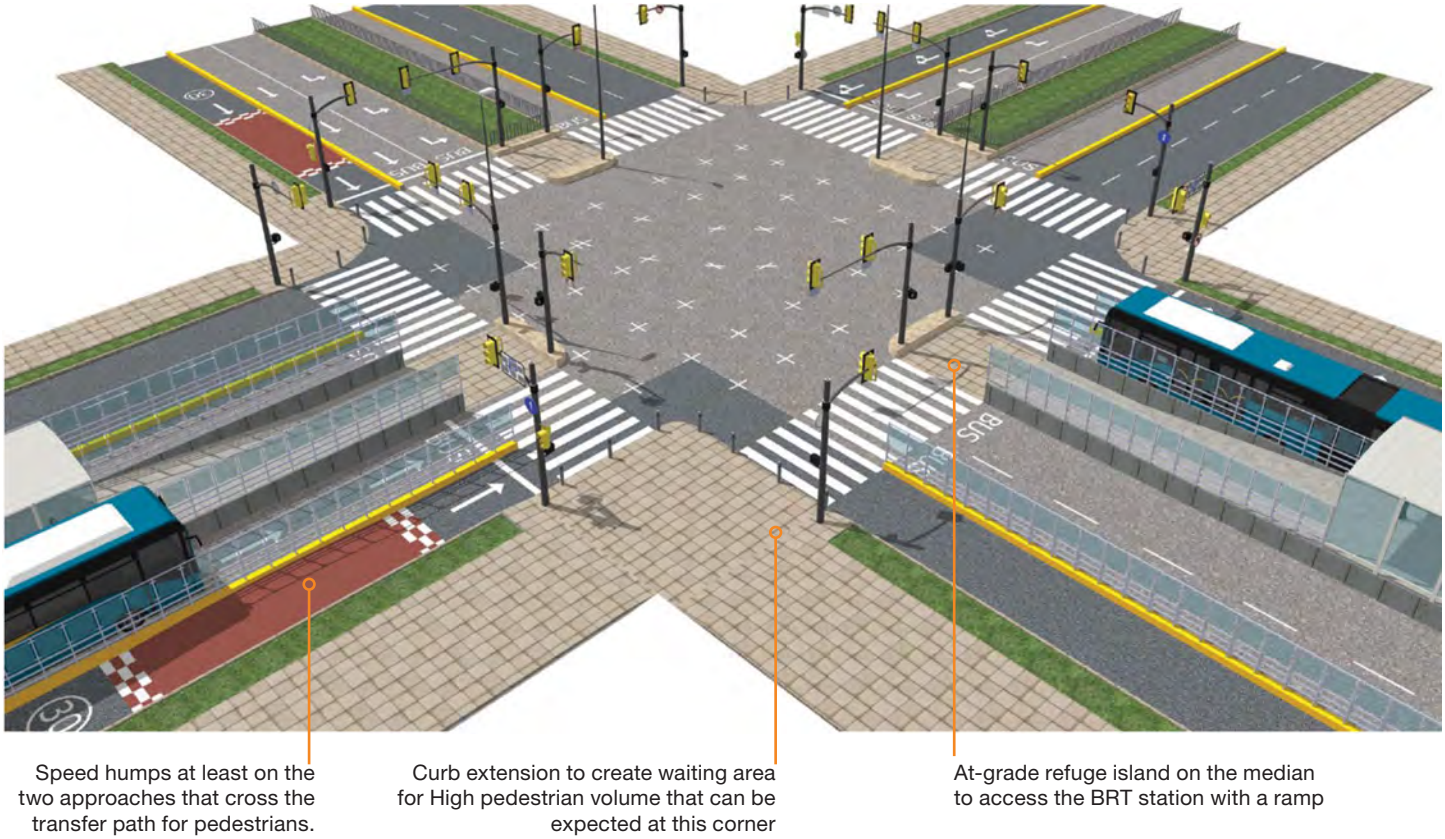


Figure 72. Transfer facility between two intersecting BRT Lines (Source: WRI)

81. If the transit station is located at a different level than the road, it may be a good idea to extend the grade-separated connector across the width of this road. In normal circumstances, grade-separated structures are not recommended for crossing the road. However, if they provide direct connectivity to a the grade-separated station, then this becomes acceptable.

82. When designing para-transit zones in station areas, it is important to separate the drop-off zones from the pick-up zone, to allow for the smooth functioning of such facilities. Normally, the drop-off zone should be located before the pick-up zone, which allows for the para-transit driver to enter the pick-up zone after dropping off passengers. There should also be a provision for the vehicle to leave the drop-off zone, in case the driver does not want to pick up new passengers.

83. Care should be taken to ensure that the movement of para-transit vehicles does not impede the movement of feeder bus services. This can be achieved through the physical segregation of both zones, which add to safety, while also creating more access points for the transit station.

Grade-separated feeder service stop and access to station and connection to developments using non-motorized shared streets

IPT parking and waiting area, separate from vehicle parking.

Motor-vehicle free shared streets to access the transit station

Figure 73. Para-transit access and transfers to transit station, with connections for vehicular traffic, and with connections through motor-vehicle free shared streets (Source: WRI India)

REFERENCES

Bertaud, Alain , and Harry W. Richardson. 2004. *Transit and Density: Atlanta, the United States and Western Europe*.

CEREMA. 2014. *Signs and signals for cyclists and pedestrians: Comparison of rules and practices in 13 countries.*

Global Road Safety Partnership. 2008. *Speed management: a road safety manual for decision-makers and practitioners.*

IRTAD. 2018. *Road Safety: Annual Report*. OECD.

ITDP. 2018. *Pedestrians First: Tools for a Walkable City*. ITDP.

ITDP. 2018. *Streets for Walking & Cycling: Designing for safety, accessibility, and comfort in African cities.*

ITDP. 2017. "*TOD Standard 3rd Edition.*"

ITDP. 2018. *Walking and it's links to transportation: Practical Guidance and Good Practice examples*. World Bank Group.

Kidokoro, Tetsuo. 2019. *Transit-oriented development policies and station area development in Asian cities*. ADBI.

Litman, Todd. 2014. *A new transit safety narrative.* Journal of Public Transportation 17.

Ministry of Urban Development Government of India. 2016. *TOD City Specific Plan - Mumbai*.

NACTO. 2016. *Global Street Design Guide*. New York City, NY: NACTO.

NACTO. 2011. *Urban Bikeway Design Guide*. New York City, NY: NACTO.

NACTO. 2013. *Urban Street Design Guide*. New York City, NY: NACTO.

NACTO. 2016. *Urban Transit Design Guide*. New York City, NY: NACTO.

Ollivier, Gerald, and Gunes Basat. n.d. *Transit-Oriented Development for Sustainable Cities*. World Bank Group.

Ollivier, Gerald, and Serge Salat. 2017. *Transforming the Urban Space through Transit-Oriented Development: The 3V Approach*. World Bank.

Santos, Valerie. 2016. *An overview of common Land Value Capture tools*. World Bank Group.

Shah, Sonal, Shahana Goswami, Lubaina Rangwala, Robin King, Himadri Das, and Akhila Suri. 2014. *Safe Access Manual: Safe Access to Mass Transit Stations in Indian Cities*. Bangalore: EMBARQ India.

Suzuki, HIroaki, Robert Cervero, and Kanako Iuchi. 2013. *Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development*. World Bank.

Suzuki, Hirosaki, Jin Murakami, Yu-Hung Hong, and Beth Tamayose. 2015. *Financing Transit-Oriented Development with Land Values: adapting Land Value Capture in Developing Countries*. World Bank.

The Department of Infrastructure, Transport, Cities and Regional Development, Government of Australia. n.d. *National Road Safet Strategy*. www.roadsafety.gov.au/nrss/safe-system.

The World Bank. 2013. *Road Safety Management Capacity Reviews and Safe System Projects Guidelines*.

The World Bank. 2018. *TOD Implementation Resources and Tools*. Washington D.C. The World Bank Group.

UNEP. n.d. *Share the Road: Design Guidelines for Non-Motorised Transport in Africa.*

United Nations Economic Commission for Europe. 2018. *Road Safety Audit and Road Safety Inspection on the TEM network.* Geneva.

Wegman, Fred, Atze Dijkstra, Govert Schermers, and Pieter van Vliet. 2005. *Sustainable Safety in the Netherlands: the vision, the implementation and the safety effects.* Leidschendam: SWOV.

World Bank Group. 2018. *Disability Inclusion and Accountability Framework.* The World Bank.

World Bank, and World Resources Institute. 2015. *TOD Corridor Course.*

World Health Organization. 2018. *Global status report on road safety*. Geneva.

World Road Association (PIARC). n.d. *Road Safety Manual.* https://roadsafety.piarc.org/en/planning-design-operation.

WRI EMBARQ. 2015. *Cities Safer by Design: Guidance and Examples to Promote Traffic Safety through Urban and Street Design*. WRI.

WRI EMBARQ. 2018. *Sustainable & Safe : A Vision and Guidance for Zero Road Deaths.*

WRI EMBARQ. 2014. *Traffic Safety on Bus Priority Systems*. WRI.

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