ITDP | RMP

Mobility for all

A strategic transportation plan for Ranchi

Institute for Transportation and Development Policy

for Ranchi Mobility Partnership

July 2015

ITDP | Institute for Transportation & Development Policy

July 2015

Prepared by

Avinash Mishra
Christopher Kost
Dominic Mathew
Harshad Abhyankar
Jaya Bharathi Bathmaraj
Kashmira Dubash
Rajendra Verma
Shriram Ramaratnam
Sriram Surianarayanan
Suraj Bartakke

With generous support from

OAK FOUNDATION

Contents

1. Introduction

Ranchi is the capital of Jharkhand, a state that remains largely rural but is urbanising fast. Ranchi and the other cities of Jharkhand are growing rapidly, attracting people from the hinterland in search of opportunities. These cities must be planned and managed to provide a safe, attractive, affordable, and inclusive environment for their citizens.

Transport plays a key role in defining a city. It touches the life of people daily. Good transport systems connect people and boost the economy. Good transport is sustainable—socially, economically, and environmentally. If not properly addressed, transport can become a nightmare, with growing traffic jams, toxic air and traffic crashes, leading to frustration, reduced productivity and poor health.

The use of personal motor vehicles is expanding rapidly in Ranchi, leading to congestion in central areas and safety challenges. Ranchi lacks a formalised public transport system and people are largely dependent on paratransit for their day-to-day travel. Unfortunately, the majority of new transport initiatives in the city are limited to road widening and flyovers. No concrete efforts have been made to understand and address the real needs of the people and thereby develop genuine solutions to the city's transport challenges.

Figure 1: Much of Ranchi's transport infrastructure prioritises private motor vehicles and does not provide adequate facilities for other road users. Transport planning should provide safe and efficient mobility to all—not just for personal motor vehicle users.

1.1. Envisioning better mobility for Ranchi

To advocate for equitable, affordable, safe, accessible, and sustainable transport in Ranchi, ITDP and other NGOs from diverse backgrounds, including civil society groups, educational institutions and trade associations, came together to establish a joint platform—the Ranchi Mobility Partnership (earlier known as the Ranchi Mobility Partnership). The following organizations working in the respective focus areas constitute the RMP-

1. Action for Community Empowerment (water and sanitation, research)
2. Citizens Foundation (Health, Livelihood, Child Protection & Education)
3. Ekjut (Maternal and newborn health, Urban homeless)
4. Human Rights Legal Network (Legal advocacy and activism)
5. Institute for Transportation and Development Policy (Sustainable and equitable transportation)
6. Mahila Housing Sewa Trust (Low cost housing, Water and sanitation)
7. Maitri (Cycle rickshaw pullers)
8. Manthan Yuva Sansthan (Community empowerment, Capacity building amongst youth)
9. National Hawkers Federation (Street vendors' rights)
10. Video Volunteers (Advocacy through social documentaries)

This document is an outcome of a joint RMP effort led by ITDP.

Ranchi Mobility Partnership (RMP) holds regular consultations on various issues related to mobility, housing, and other aspects of urban development. It leads study tours for elected officials and media representatives to help introduce sustainable transport best practices. It also works to establish greater political support for sustainable transport. In 2014, Citizen Foundation, an RMP member organization, held a Mayoral forum that gave Ranchi Mayoral candidates an opportunity to understand the needs of the citizens and express their views on transport issues in the city. Best practices from different Indian cities were shown and a consensus was built on developing Ranchi as a model city that focuses on clean and safe modes of mobility.

Figure 2: Ranchi Mayoral candidates reveal their positions on sustainable transport during a forum organised by the Ranchi Mobility Partnership.

1.2. The Mobility Charter: a call to action

Based on a series of deliberations among member organisations, RMP developed the Ranchi Mobility Charter, which outlines the coalition's position on mobility issues in the city. The Mobility Charter includes a description of key principles that should guide transport planning in Ranchi:

- **Equity**: The needs of all people (including the differently able), regardless of the modes of transport they use, should be the primary criteria in the design of transport systems.
- **Sustainability**: The transport system should consume as few resources as possible; yet provide attractive, comfortable, and convenient service. The resources in this context include urban space, clean air, fossil fuels and money.
- **Liveability**: Urban landscapes should provide ample public spaces for uses like casual recreation, relaxation, social gathering, and managed street-side vending.

RMP's Charter stresses that transport planning should focus on the movement of people, not vehicles, a goal clearly expressed in the National Urban Transport Policy (NUTP)[1]. This is a major departure from traditional traffic and transport studies that emphasise movement of personal motorised modes.

In light of these principles, the Mobility Charter calls on the city to carry out a specific set of infrastructure initiatives:

- Improve, expand, and manage a high-quality, bus-based public transport system.
- Develop design guidelines for complete streets that take into account all street users, especially pedestrians, cyclists, and various stationary activities.
- Construct complete streets that allocate street space equitably among all users.
- Develop an effective parking management framework.
- Develop compact, pedestrian friendly neighbourhoods around public transport corridors.

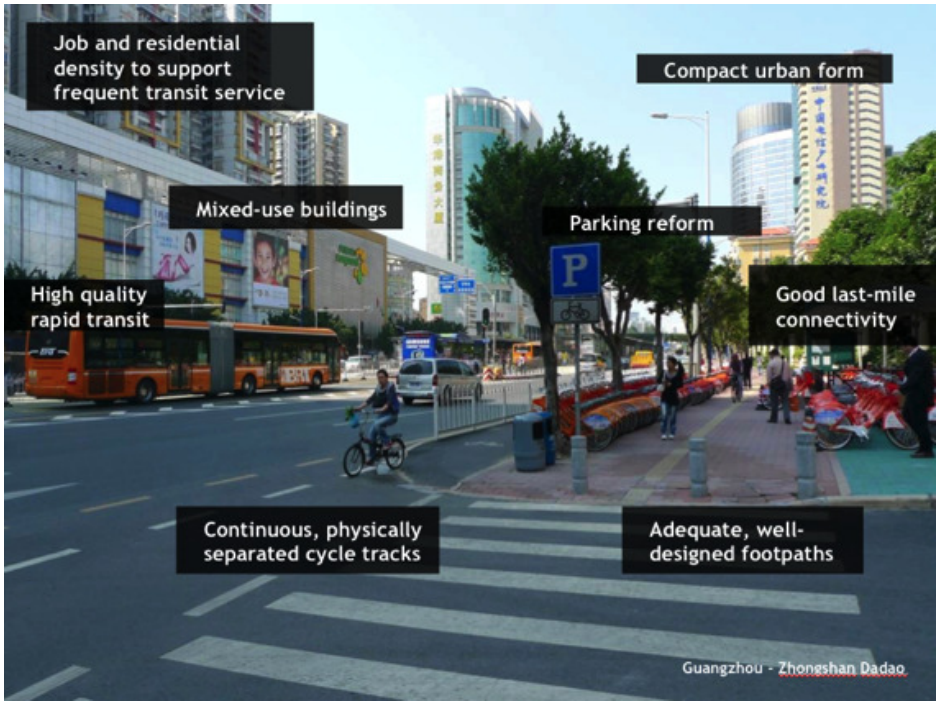

Figure 3: Key sustainable transport interventions identified in the Ranchi Mobility Charter.

[1]Ministry of Urban Development (2006), "National Urban Transport Policy," <http://www.urbanindia.nic.in/policies/TransportPolicy.pdf>.

1.3. Mobility for All: a smart vision for Ranchi

The aim of this report—*Mobility for All*—is to develop a detailed roadmap for Ranchi's sustainable development based on the principles and initiatives presented in the Ranchi Mobility Charter. This report considers a planning horizon of 2031 for these interventions.

To begin, the report takes a stock of the status of transport in Ranchi today based on a series of comprehensive surveys conducted by ITDP and RMP members between June to November 2014. This section identifies existing challenges related to walking, cycling, public transport, private vehicle mobility, and other aspects of the transport system.

Next, the report examines possible development approaches for Ranchi. If Ranchi repeats the mistakes that most cities worldwide made in the Twentieth Century, it will face the same consequences that have plagued those cities—higher congestion, pollution, and traffic accidents. Clearly, that is not the path Ranchi should follow. This report suggests a vision for Ranchi's transport systems that is consistent with the RMP's Mobility Charter and identifies specific goals to realize the vision. The report then suggests some specific projects to achieve those goals, including enhanced facilities for walking and cycling, better public transport, and new measures for controlling and managing the use of personal motor vehicles.

Given the essential role of walking and cycling, also referred to as non-motorised modes, the report recommends developing a network of complete streets with continuous footpaths, separate cycle tracks, and safe intersections. The existing street network can be supplemented by a series of greenways, which would transform Ranchi's waterways into corridors for commuting and recreation by non-motorised modes.

Turning to public transport, *Mobility for All* identifies around 32 km of potential corridors for a high quality, high capacity bus rapid transit (BRT) system. The BRT network is supplemented with a dense bus network covering 225 km of corridors, including the core BRT sections. This document recommends a timeline to implement these projects and suggests sources of funds that can be tapped for them.

It is imperative that all stakeholders involved in the planning and operation of Ranchi's transport system understand that if we do not want Ranchi to repeat the same mistakes made by other cities, we must do something different. The projects suggested in this document are fundamentally different from projects suggested in similar documents from other cities.

2. Transport in Ranchi

2.1. City overview

Ranchi is an important regional hub in eastern India. It is the capital city of Jharkhand, a new Indian state formed in 2000. With a population of 1.4 million, the largest city in the state. Jharkhand is endowed with some of the largest deposits of coal, iron ore, and other minerals in India. The demand for a separate state was premised on Jharkhand's predominantly tribal identity and the poor socioeconomic conditions of the tribal population despite the rich mineral wealth in the region.

Ranchi has a strong industrial base and has seen some of the fastest employment growth among cities of its size. There are 540 industrial units in and around Ranchi.[2] Major industries include steel plants, foundries, and refractory units. Several leading industrial and mining companies such as Heavy Engineering Corporation (HEC) Ltd, Central Coalfields Limited, the Steel Authority of India, and MECON Ltd have their headquarters in Ranchi. Ranchi is also an important commercial, administrative, and educational centre of the region, with leading schools, colleges and higher education institutions.

Ranchi has a metropolitan area population of 14.6 lakhs. The city's population grew 30 per cent from 2001 to 2011, making it one of the fastest growing urban areas in India. Much of the workforce is engaged in wholesale and retail trade (22 per cent), followed by manufacturing and repairs (19 per cent), and other sectors including administration, defence, education, and health.[3]

The city of Ranchi comprises an area of 173 square kilometres. Close to 70 per cent of the land (about 120 sq km) within Ranchi Municipal Corporation (RMC) limits has been developed.[4] The densest part of the city is along Main Road, the commercial core of Ranchi. Larger commercial and retail land uses along Main Road step down to mid-rise shops and residential uses in the inner lanes.

The growth of Ranchi city accelerated in the 1970s, primarily around industrial development. The surrounding district is one of the most urbanised districts in Jharkhand state, with a population of 2.9 million.[5] The city has grown significantly, mostly spreading outward along radial corridors such as Kanke Road (NH 23), Ratu Road (NH 75), and the Dhurwa-HEC Road. Newer residential colonies south of the railway line are single use-low rise with private amenities and infrastructure such as roads, parks and recreational centres.

Between these main corridors, the lack of a complete road network has prevented growth. There is a significant population of labourers and factory workers from adjacent villages and urbanised areas such as Ratu, Khunti, Ormanjhi, Kalamati, and Rampur, who commute into the city everyday or stay and work in the city for extended periods of time. There are large commuter movements toward industrial areas such as Tatisilwai.

The urban poor in Ranchi constitute 30 per cent of the population and largely consist of tribals engaged in activities such as cycle rickshaw operations and daily wage labour. The portion of the total population living in slums—35 to 40 per cent—indicates a severe shortfall of affordable housing options and lack of basic infrastructure for the urban poor.[6]Slums are interspersed all across the city, comprising close to 12 per cent of developed land. They have little or no access to basic amenities like water, sewers, and drainage. A number of these slums were originally tribal villages that are now

[2]http://articles.timesofindia.indiatimes.com/2010-10-13/ ranchi/28223453_1_ top-five-sectors-employment-provider-cities
[3]Meinhardt, 2007, Ranchi Comprehensive Development Plan and repairs (19 percent), and other sectors including administration, defence, education and health.
[4]Space Applications Centre, 2009. Ranchi Utility Information System Project Report
[5]Census 2011.
[6]Ibid.

surrounded by development. About 42 per cent of slum dwellers own their land, while the remaining slums are unauthorised.[7]

Tribal land in Jharkhand state is non-transferable from a tribal community to any non-tribal entity as per the Chota Nagpur Tenancy Act. The amount of tribal land within RMC limits that is subject to this Act is estimated at 30 to 60 per cent.[8] A lot of tribal land is also scattered in smaller parcels all across the city.

Jharkhand has been struggling to establish political stability and sustained leadership. When the state government was formed, the first assembly was comprised of legislators elected in the Bihar elections of 2000. Jharkhand's first independent elections, in February 2005, were closely contested and resulted in a Bharatiya Janata Party (BJP)-led coalition coming to power. Following this election, coalitions have formed successive governments and Chief Ministers have changed every few years. Indian Administrative Service (IAS) officers, who wield considerable power over state and city affairs in most other states, have had short tenures due to political changes. The BJP earned an absolute majority in the recent December 2014 elections, offering the prospect of a more sustained leadership over the coming term.

Ranchi Municipal Corporation (RMC) has limited authority and financial capacity and is slowly finding its grounds as an independent and autonomous urban local body. RMC was first formed in 1979 through a merger of the erstwhile municipalities of Ranchi and Doranda and their Joint Water Board.[9] The city has 55 administrative wards, each represented by an elected councillor. Ranchi has a directly elected Mayor. A Commissioner and an Additional Commissioner, who are IAS officers appointed by the state government, head the civil administration.

The 74th Amendment to the Constitution of India, which aimed at devolving power to urban local bodies, has only been partially implemented in Ranchi. The present functions of RMC are defined in the Ranchi Municipal Corporation Act of 2001. As per the act, RMC's role is limited to construction of roads; provision of parks, markets, and bus stands; and provision of sanitation facilities. RMC is also responsible for administering State and Central poverty alleviation schemes. However, the Act does not mention the planning, provision, and management of public transport services, and the regulation of transport. These activities are currently handled by state government entities. The state government also plays a substantive role in city planning activities, including urban planning, regulation of land use, and granting of building permissions. Many of the important roads in the city are also managed by state agencies.

RMC has limited financial capacity to fulfil its fundamental responsibilities of providing basic services to its citizens. The corporation has limited sources of revenue and is heavily reliant on state and central assistance (see the table below).

Table 1: Revenue and capital receipts in the 2014-15 RMC budget

Heading	Total, Rs cr	State/ central assistance, Rs cr	Share of grants/ state/ central assistance
Revenue receipts	83	33	40%
Capital receipts	670	614	92%
Total	753	647	86%

[7] Ibid.

[8] Personal interviews with government officials and faculty of BIT Mesra

[9] Ranchi Municipal Corporation, 2012. About us. Retrieved from http://www.ranchimunicipal.com/aboutus.aspx

Given RMC's weak revenue base, the City Development Plan (CDP) for Ranchi suggests accounting reforms and improving recovery mechanisms in the short term, as well as tax free bonds, land pooling, and public private partnerships in the long run to become financially sustainable.[10]

There is currently no mechanism to foster planned growth of the city. RMC and the Ranchi Region Development Authority (RRDA) have limited funds and have no incentive to develop basic infrastructure like roads, sewage networks, and parks. In the absence of civic infrastructure, the new development is low density, haphazard, and primarily concentrated around regional arterials.

RMC is working on a new master plan to replace the 1983 plan for Ranchi. The upcoming master plan is the first important step towards managing future growth of the region. The aim of the master plan is to consolidate different transport and development initiatives in the region and set the future direction for growth of the city. Among the city's most critical challenges are developing an integrated, sustainable transport system over the coming decades.

2.2. Travel patterns

In the days when motorized vehicles were not commonplace, Ranchi was also a smaller city and it was easy to commute within most of Ranchi by foot or on a cycle. For longer distances, people used cycle rickshaws and rickety buses. Outward expansion of the city has led to an increase in travel distances and higher demand for motorised mobility. Poor quality public transport has not been able to fulfil this demand. As incomes rise, the use of personal motor vehicles, especially cars, is expanding rapidly.

In 2014, RMP conducted a series of surveys and studies in order to understand how Ranchi travels today and various problems associated with travel in Ranchi. These data collection efforts included:

- A household survey covering 7,100 individuals in a stratified sample across various demographic groups in Ranchi's 55 wards plus three urbanised zones outside the RMC boundary
- On-road, interview-based surveys of pedestrians, cyclists, and shared auto commuters and drivers
- Traffic counts at various strategic locations in the city
- Frequency-occupancy, boarding-alighting, and transfer surveys of public transport
- Documentation of the existing street network and street infrastructure
- Data sourced from government entities, including information on the vehicle population, traffic accidents, and ambient air quality.

With these surveys and studies, we assessed whether traffic congestion is the only major problem the city must solve, or if it is merely a manifestation of other problems that need to be addressed. The analysis of the data revealed a number of pressing and fundamental problems beyond the issue of traffic congestion in Ranchi's transport.

2.2.1. Walking and cycling are twice as common as car and two-wheeler trips

Traffic congestion has become increasingly commonplace in the city. Congestion not only affects personal vehicles, but also affects public transport like shared autos. In absence of segregated road space, congestion affects pedestrians and cyclists. Among all modes, personal vehicles consume the most space per person. However, RMP surveys revealed that only about 22 per cent of trips in Ranchi are by personal motor vehicles. On the other hand, 44 per cent are walk or cycle trips.

[10]Meinhardt, 2007.

Table 2: Trips per day by mode in the Ranchi metropolitan region

Mode	Number of trips	Mode Share (%)
Walk	9,60,000	36%
Cycle	2,15,000	8%
Cycle rickshaw	20,000	1%
Shared auto	7,35,000	28%
Auto	30,000	1%
Bus	1,20,000	5%
2 wheeler	4,35,000	17%
4 wheeler	1,25,000	5%
TOTAL	26,46,000	100%

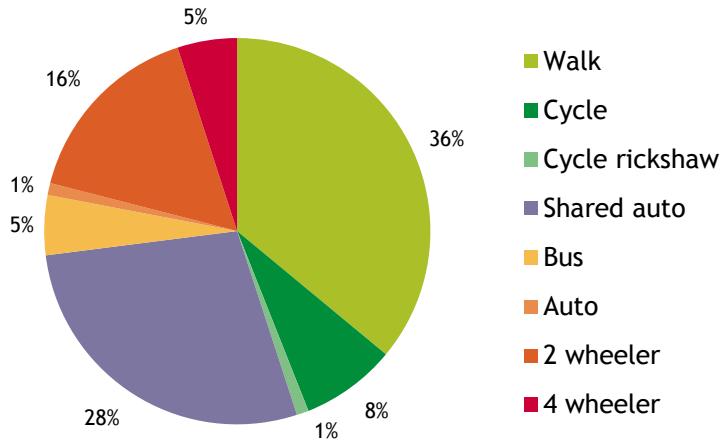

Figure 4: How does Ranchi travel today?

People all ages, income and gender walk. Among the poor, two thirds of trips are on foot or cycle. Even people from households with a monthly income of Rs. 50,000 or more make a quarter of their trips by foot or cycle. Many people walk much longer than one might think. About a third of all pedestrian trips are over two kilometres in length. In addition, 85 per cent of pedestrians are "regulars," that is, they walk to work or school or college five or more times a week. A short walk to or from public transport or a personal motor vehicle is not even included in these numbers.

After walking, public transport is the second most commonly used mode in Ranchi. Public transport in Ranchi comes largely in the form of seven-seat auto rickshaws that carry two-thirds of the motorised trips in the city. These rickshaws operate as shuttle services on fixed routes, offering frequent and flexible bus-like service. The city has recently initiated bus services with funding assistance from JNNURM, but it has received limited state and local government support and suffers from poor image and quality.

Usage of personal vehicles is much lower than it seems. Less than a quarter of all trips are on 2-wheelers and cars (22%). Even for the age group 27-44 years, the modal share of 2-wheelers is slightly more than 25 per cent, while forty per cent trips by people from this age group were on foot

and bicycle. Current vehicular ownership is estimated to be around 22 cars and 144 two wheelers per 1,000 persons in Ranchi[11].

2.2.2. Women's commuting needs are significantly different from men's

The data collected in the surveys was also analysed for various demographic profiles. It revealed various interesting and important patterns for different profiles, like the poor and the rich; the young and the old. However, the most important findings are regarding the women's commuting needs.

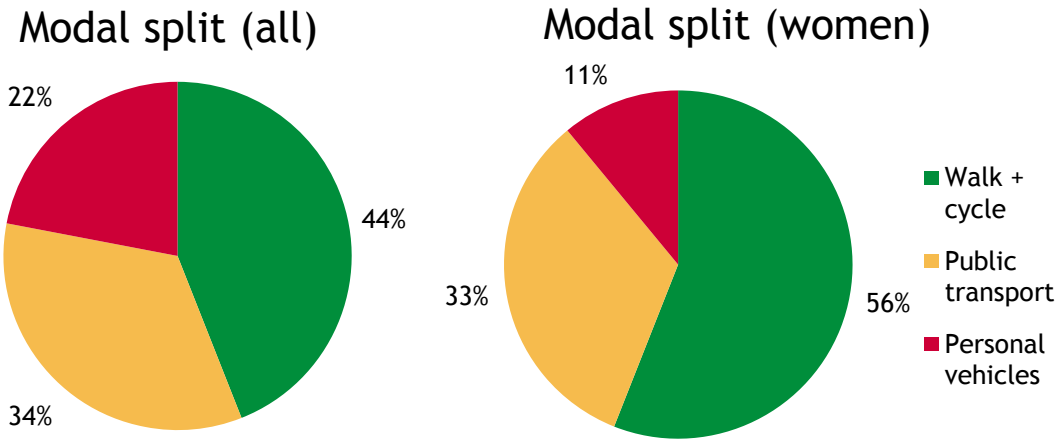

Figure 5: Comparison of modal shares: overall and women's

The surveys reveal that only a tenth of the trips by women are on personal motor vehicles. When women – half Ranchi's population – depend largely on walking and public transport, the city must give topmost priority to initiatives that make walking and public transport safe, accessible, and convenient.

The issues faced by women are also highlighted by the marked difference in the way women answered some questions. These findings highlight that women face significant challenges when walking and taking shared autos—the main modes on which they depend.

Table 3: Issues faced by women

Question/issue	Men	Women
How many people do not feel safe travelling by shared auto at night	61%	91%
People considering using a two-wheeler instead of a shared auto	32%	9%
People considering using a cycle instead of a shared auto	12%	1%
Cyclists who think lonely roads are a problem	26%	59%
Cyclists who are teased	0%	46%

In addition to the quantifiable findings above, women face several issues that are difficult to quantify. Many women working on daily wages walk as much as 10-15 km one way every day in search of

[11] Assuming that 90 per cent of the vehicles registered in Ranchi District are owned by residents of the city of Ranchi.

work in Ranchi, and need to return to their homes before it gets dark – which limits their earning potential. Although the harassment they face on streets could be classified as a "social" problem and not a "transportation" issue, lack of reliable and affordable public transport exposes them to these dangers. This issue is equally applicable to women within the city as well. Freedom of many women in the city is limited for the same reason, as they have to reach home before a certain time.

ITDP has worked in Ranchi with MHST (Mahila Housing Sewa Trust), a women's rights based organization that works on low cost housing, sanitation and skill building, to identify daily wage women workers in the city. We integrated their numbers with existing semi-formal routes and this report proposes a 24 hour formal public bus system that covers the main areas from where inward migration occurs. This system is also cheaper than existing autorickshaws and has established bus stops along with safer bus shelter designs.

2.3. Transport facilities

Even though over three quarters of all trips in Ranchi are on sustainable modes like walking, cycling and public transport, the majority of new transport initiatives in the city are limited to road widening and flyovers that only serve the remaining quarter. No concrete effort has been made so far to develop sustainable transport solutions guided by an integrated transport vision, as revealed by the following discussion of the current state of Ranchi's transport system.

2.3.1. Street network and non-motorized transport facilities

Central Ranchi has a dense fabric of interconnected narrow streets. The narrow widths of these streets keep speeds low and facilitate walking and cycling. Outside the core city, the road network becomes more disjointed and more widely placed, making movement more difficult. Approximately 90 km of the roads are maintained by the Jharkhand Public Works Department. The remaining 470 km of roads are largely sub-arterial and local roads built and maintained by the RMC. Most roads in Ranchi are poorly maintained. The roads are all laid from the centre line out and the edges are all left as unpaved dirt. The drainage infrastructure is obsolete with common open drains for sewage and storm water at the edge of the road.

Although pedestrians and cyclists account for nearly half of all trips in Ranchi, less than 1 per cent of Ranchi's total road network of nearly 560 km has usable footpaths. Cycle tracks are non-existent. Even busy market streets, such as Main Road, Ratu Road, Kutchery Road, Purulia Road lack safe and continuous footpaths and safe pedestrian crossings. People are forced to walk on the road, next to speeding motorised vehicles or on unpaved edges. Nine out of ten pedestrians interviewed by RMP cited the lack of footpaths and insufficient light at night as obstacles to walking.

Large cyclist volumes are observed on various corridors, including Kanke Rd, Main Rd, and Hazaribagh Rd, which have several industrial units. Most adult cyclists are males, largely industrial workers, day wage labourers, or working small jobs in offices. School children, boys as well as girls, also use cycles extensively. Peak cycle movements tend to occur earlier than the peak hour for motor vehicle traffic. In the absence of separate facilities for cycling, cycles and cycle rickshaws share the limited road space with fast moving vehicles. Nine out of ten cyclists interviewed by RMP cited high speeds of other vehicles as a problem. Severe pollution (78 per cent) and uneven road surface (71 per cent) are two other problems cyclists face.

Figure 6: Ranchi only has 4.3 km of usable footpaths.

Figure 7: Most streets in Ranchi lack footpaths, forcing pedestrians to walk in the carriageway.

Figure 8: Although corridors such as Kanke Road see heavy volumes of cyclists, Ranchi does not have any dedicated cycle tracks.

2.4. Public transport

The Government of Jharkhand procured 190 mini buses in 2010 through Jawaharlal Nehru National Urban Renewal Mission (JNNURM) grant. Cities the size of Ranchi got 80% of the bus cost from JNNURM as a grant, the remainder coming from state and city sources. Ranchi received 70 of these 190 buses. In the absence of a government managed or operated intercity bus service, JNNURM buses in Ranchi, Jamshedpur, and Dhanbad were transferred to the Jharkhand Tourism Development Corporation (JTDC), which rented them out to private operators. The service provider supplies manpower—bus drivers, conductors, and attendants—on a fixed daily wage basis. JTDC collected a fixed amount from the operator for each day, and the remaining ticket revenue stays with the operator. However, JTDC gave the operator a fuel allowance of 20 litres of diesel per day per bus. As of date, the Ranchi Municipal Corporation has signed a contract with a private agency to run the buses in the city. The city bus fare structure is based on approximate distance travelled and is charged based on known landmarks.

At present, fewer than 30 buses out of the original JNNURM fleet are operational in Ranchi, and there are only two bus routes in operation (Figure 13). The first route operates from Dhurva to Pahartoli and the second route operates from Ratu Road to Bero. There is no prescribed time schedule for bus operations and no dedicated fleet assigned to a particular route. Buses stop anywhere, anytime as requested by passengers, causing delays. The bus service also is struggling with problems of strikes and unstable institutional support.

Along with privately owned and operated City Ride minibuses, the city bus fleet accounts for 48,000 boardings per day, or around 2 per cent of all trips. They are able to cater to only a small fraction of total public transport demand. Shared auto rickshaws ply parallel to buses on a number of routes and satisfy most public transport demand.

Figure 9: Existing city bus routes in Ranchi.

Figure 10: Ranchi's government-owned city bus fleet is poorly maintained and serves only two routes.

There are two depots in Ranchi. Ranchi Depot near the railway station area provides space for 40 minibuses and for Bihar State Road Transport Corporation (BSRTC) buses. At the second location, the Dhurwa depot, city buses are parked on road as the main depot has been mothballed. The depots lack proper facilities for washing buses and their routine maintenance. The administrative office building is also in a dilapidated condition.

Figure 11: Ranchi's aging city bus fleet suffers from inadequate maintenance. In the absence of a formal depot, the buses are parked overnight on open land near Dhurwa.

2.5. Shared auto rickshaws

Of the motorised trips, two-thirds of trips are performed on shared auto rickshaws (7.4 lakh daily trips). Of the bus and auto rickshaw users in Ranchi, two-thirds are male—largely labourers, workers, and those holding lower-level administrative and government jobs. Shared rickshaws are quite popular with school and college students as they offer a frequent service at relatively affordable rates. However, auto rickshaws present difficulties for some user groups. As documented in recent press reports, women face particular challenges when travelling by paratransit modes.[12]Of the shared auto commuters interviewed by RMP, nine out of ten women said they do not feel safe riding a shared auto at night.

Auto rickshaws in the city have doubled in the last decade. There are three types of auto rickshaws in Ranchi: two types of seven-seat diesel rickshaws (Minidor and Piaggio) and smaller three-seat rickshaws that run on petrol. Regular taxi services by three-seat auto rickshaws are relatively insignificant. The paratransit fleet also includes a small but growing fleet of vans (e.g. Tata Magic) as well as some Jeeps. Most of the auto rickshaws are highly polluting, very likely because of bad maintenance and adulterated fuel. There are several shared rickshaw pick-up points in the city but no dedicated rickshaw stands or facilities. While the official capacity of the larger auto rickshaws is 7, they commonly carry 10 to 12 passengers during rush hours. Such overloading also forces them to use lower gears, resulting in low fuel efficiency and high emissions.

Figure 12: Shared autos play a critical role in Ranchi's transport system but suffer from irregular schedules, overcrowding and frequent instances of sexual harassment.

In contrast to the situation in most Indian cities, there is some regulation of auto rickshaws in Ranchi. The Ranchi Regional Transport Authority (RTA) designates routes within and surrounding the city where shared auto rickshaws may operate. Routes have been allocated on all major roads in Ranchi, except on a part of the Main Road where auto rickshaws are banned. The routes connect several major destinations in and around the city including the University, Kutchery, Project Office, and Railway Station. The routes also extend outside RMC to villages of Rampur, Ratu, Ormanjhi, Tatisilwai and Bero.

[12]Kislaya, Kelly (22 August 2012). Women question safety of auto rides. The Times of India. Retrieved from http://timesofindia.indiatimes.com/city/ranchi/Women-question-safety-of-auto-rides/articleshow/15607020.cms.

As of 2014, the RTA had issued permits to 2,215 7-seater diesel auto rickshaws and 120 3-seater petrol auto rickshaws. As per information received from auto unions, Ranchi has a fleet of 6,500 seven-seater diesel shared auto rickshaws, 2,500 three-seater petrol auto rickshaws and 500 Tata Magic vans. However, surveys indicate that only around 5,000 of these vehicles operate on any given day serving, on an average, 7.4 lakh trips every day.

Figure 13: Diesel shared auto routes

Figure 14: Petrol shared auto routes

The shared auto rickshaws loosely follow a fare structure that is decided by various auto unions. The rates vary based on the distance and the route. The shared auto rickshaw surveys were conducted in October 2014. The minimum fare charged was Rs. 5 and the maximum fare was Rs. 30 for the longest route. The shared auto fares were increased once after the increase in fuel prices but they have not been adjusted after the recent drop in fuel prices. The figure below shows the shared auto rickshaw fares charged throughout Ranchi against the distance travelled. There is less variation in fares for distances beyond 16 km.

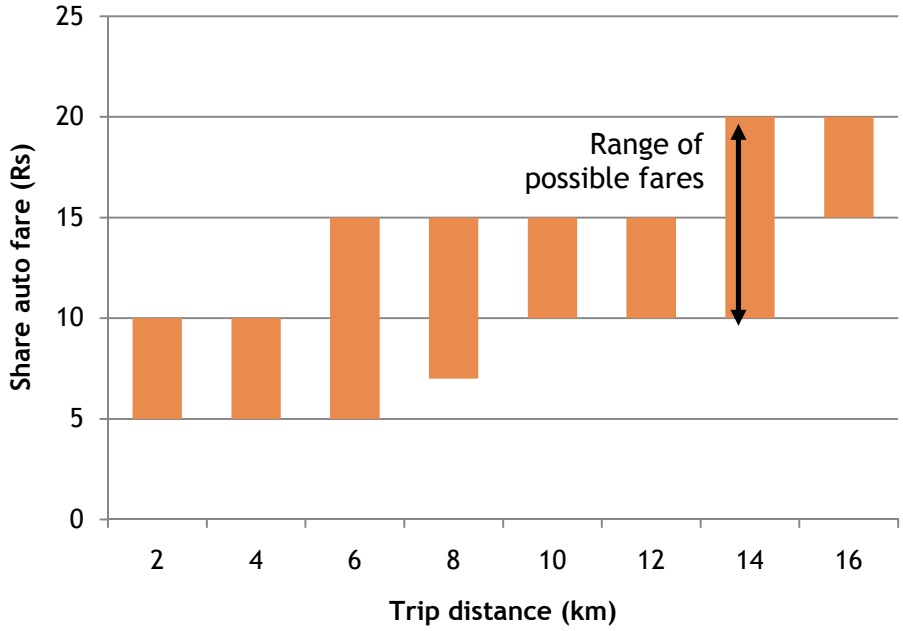

Figure 15: Shared auto fares

2.6. Cycle rickshaws

Middle class individuals as well as families use cycle rickshaws to travel short to medium distances, especially on and around Main Road and other central market areas. The cycle rickshaws are also used to transport goods within the commercial areas.

The total number of registered cycle rickshaws in Ranchi is 5,479.[13] However, as per ground surveys and interviews, up to 8,000 cycle rickshaws currently ply on a given day. About half of the cycle rickshaws are used to carry goods. The remaining cycle rickshaw fleet carries approximately 20,000 passengers every day. Most cycle rickshaw drivers are poor, unskilled migrants from nearby villages who rent their rickshaws for Rs 35 per day. Only 20 per cent of drivers own their rickshaws. The average income of a cycle rickshaw driver is around Rs 200 per day.

Maitri, an RMP member organization, works primarily to provide tangible identification (like voter ids, aadhar cards) to rickshaw pullers in Ranchi, to help them avail benefits from government schemes. As part of Project Adhikar, Maitri has conducted numerous health camps and helped avail insurance schemes for rickshaw pullers.

Maitri has done extensive work to understand the socio-economic issues faced by the cycle rickshaw pullers. Maitri conducted an extensive survey of rickshaw pullers in Ranchi in 2013 that covered

[13] Ranchi Municipal Corporation.

issues like their demographic profiles, earning and saving levels, their accommodation in Ranchi and access to basic services like toilets and electricity, their health and wellbeing, whether they have important documents like identity proofs and a few other issues. It is quite evident from their study that a lot of work needs to be done to bring this important component of Ranchi's society in the mainstream.

There is an established cycle rickshaw union, the Ranchi Jila Rickshaw-Thela Majdoor Sangh, that engages with the rickshaw pullers and works to better their social and economic well-being. The union also functions as a communication link between the government and rickshaw pullers.

Figure 16: Cycle rickshaws are common in central Ranchi, where they serve short trips and improve last-mile connectivity to public transport and paratransit.

2.7. Parking management

Parking is a mystery. Many governments push for more parking, but rather than reducing the parking problem, it leads to massive traffic jams and severe air pollution. Unregulated free-for-all parking or an excessive supply of cheap parking invites people to use personal motor vehicles—even when good public transport is provided. Now, many cities across the world have realised their past mistakes. They now manage parking like a scarce commodity that comes with a price. They use modern IT enabled systems to manage and enforce parking. Parking fees is pegged to parking demand—when demand increases, the fee also increases. And they use parking revenue to build better walking and cycling infrastructure, and to expand public transport.

Free on-street parking is the norm in Ranchi. Double parking is common despite the presence of no parking zones in busy commercial areas such as Main Road, Kantatoli, and Ratu. Parked vehicles often occupy one or more lanes—a third to half of the carriageway—causing congestion and traffic jams that hamper the mobility of all vehicles (especially public transport) as well as pedestrians.

Travel times increase and so do emissions due to excessive idling. Traffic police in Ranchi do not have sufficient towing trucks or personnel or IT systems to enforce parking restrictions.

RMC charges for parking at some locations in the city. RMC auctions around 24 such lots to private operators, including lots at Albert Ekka Chowk, Birsa Bus Stand, Kantatoli Bus Stand, ITI bus stand, Ratu Road, Itki Road, Hanuman Mandir Taxi Stand and Argora Chowk Tempo Stand. These parking lots have about 50-70 equivalent car spaces. The lots at Birsa and ITI Bus Stands may have about 100 equivalent car spaces. The hourly rates set by RMC are Rs 7 per hour for cars and Rs 3 per hour for two wheelers. Operators sometimes charge more—Rs 10 per hour for cars and Rs 5 per hour for two wheelers—indicating that there is a gap between the official rates and the amount that vehicle users are willing to pay. RMC offers monthly passes at a discounted rate of Rs 500 per month for cars and jeeps. Many employees and shop owners who work on Main Road avail the monthly pass. RMC earned Rs 77 lakhs in 2011 and Rs 2 crore in 2013 from parking fees. Besides the RMC parking facilities, some private paid parking facilities exist in the city. RMC is investigating the possibility of building multi-level parking structures on city property along Main Road.

Figure 17: Free, unorganised on-street parking in Ranchi.

2.8. Road safety

Pedestrians are among the most vulnerable road users in Ranchi. As shown in the map of fatal crash locations in Ranchi, most pedestrian deaths occur on radial roads on Ranchi's periphery. Most of these roads are wide, but lack footpaths or pedestrian crossing facilities.

With every passing day, roads in India are becoming wider and smoother, and Ranchi is no exception. This is happening because the entire focus of transportation planning is on speeding up vehicles. Coupled with bigger and more powerful cars and two wheelers entering the market every day, the average speed of vehicles has increased significantly, especially in the peripheral areas of the city.

A pedestrian could earlier cross an undivided 1+1 lane wide road in about 10 seconds. Such roads are being replaced by 3+3 lane roads where it now takes about 15 seconds to cross just one half. Yet, increased vehicle speeds and number of vehicles has reduced the time a pedestrian can get between two passing vehicles to cross such a road. This forces pedestrians to take chances while crossing roads.

Even walking along the roads is not safe when roads do not have footpaths. The road surface used by vehicles is generally paved, but pedestrians have to make way through roadside rubble and uneven surface. A slight waiver in their walk meeting with an equally slight waiver in a speeding vehicle immediately leads to hazardous walking situations.

The map below highlights the importance of traffic calming measures on these corridors.

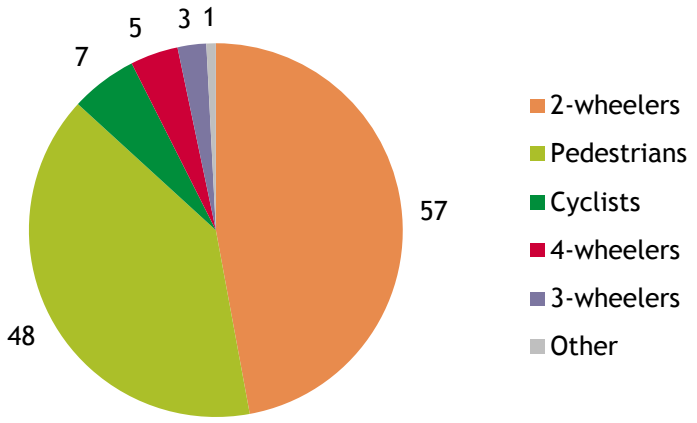

Figure 18: Fatalities from traffic crashes

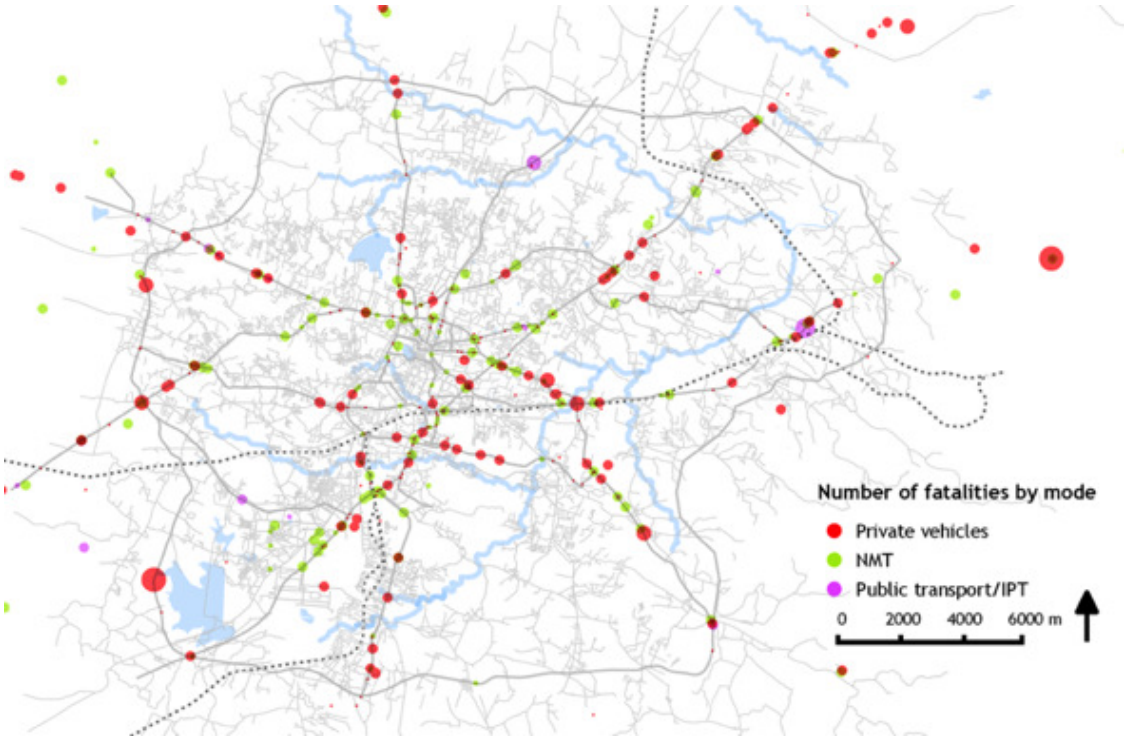

Figure 19: Traffic crash locations

2.9. Pollution

Air pollution from vehicle exhaust contributes to chronic respiratory ailments such as asthma and bronchitis, impaired lung function impairment, cancer, and a number of other ailments. Concentrations of particulate matter pollution in Ranchi greatly exceed permissible limits. Given that ambient PM concentrations are well above acceptable values, road users and residents living within 500 m of major road corridors are likely to experience even higher levels of particulate pollutants. The SO_x and NO_x values are safely within permissible limits. All of these pollutants are found in various degrees in emissions from diesel and petrol engines, so controls on polluting vehicles can play a major role in reducing harmful pollution in Ranchi.

Table 4: Ambient air pollution in Ranchi, January to August, 2013, and permissible limits[14]

Pollutant	RSPM	Total SPM	SO_x	NO_x
Units	µg/ m^3	µg/ m^3	µg/ m^3	µg/ m^3
Permitted limit	100	200	80	80
Average of 8 hr maximum (4 hr maximum for SO_x and NO_x)	269	672	22	42
Ratio with permitted value	2.69	3.36	0.28	0.53
Average of 24 hr maximums	176	457	19	35
Ratio with permitted value	1.76	2.28	0.24	0.44
8 hr or 4 hr peak	379	234	23.5	43.9

2.10. Conclusion

Nearly half of all trips are on foot or cycle. A third of all trips are by public transport. The share of trips by these sustainable modes is high compared to other cities. However, people use these modes due to economic constraints, not out of choice. People face significant challenges while using these modes. If money were not a constraint, many of them would shift to personal motor vehicles. On the other hand, if problems faced by people who walk, cycle or use public transport are addressed, not only will they continue to use these modes, but some people who have switched to using personal vehicles would also embrace these modes again. This would directly reduce the congestion and pollution that Ranchi citizens and visitors face.

[14] Data from Jharkhand Pollution Control Board for January to August 2013.

3. Planning for the future of transport in Ranchi

Transportation system of a modern city is its lifeline. It is the most instrumental factor in determining whether its citizens will spend a lot of time stuck in traffic jams on smoke filled roads or whether grandparents in the city would want to take their grandchildren for a stroll on its roads.

Cities in India have been planning our transportation retrospectively. They allow the traffic to grow uncontrollably and then try to plan for accommodating it – they don't plan how traffic should grow in the first place. Rather than taking such an approach, this document suggests a proactive plan, where we first define how we want the traffic to be in future and plan projects to bridge the gap between today and the planning horizon. This allows us to see which transportation modes we should encourage and also the ones we should discourage.

3.1. Transport scenarios for Ranchi

Ranchi's population is expected to grow from 14.6 lakhs presently to nearly 27 lakhs by 2031. Due to lack of a good public transport system, personal motor vehicle use is estimated to be increasing at twice the rate of population growth. If nothing is done, personal motor vehicle trips will quadRMPle by 2031 as shown in the chart below. Even if all of Ranchi's important roads were transformed to include elevated corridors on top, there would not be enough capacity to meet the anticipated 2031 demand. Clearly, this is an impossible scenario.

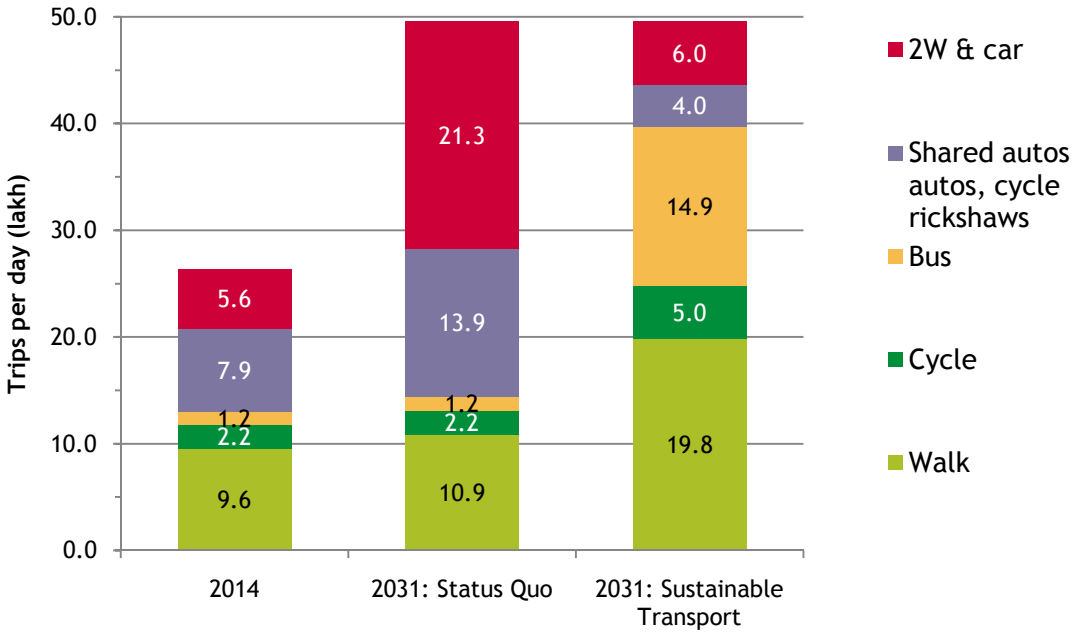

Figure 20: If existing trends continue, Ranchi will see a quadRMPling in personal motor vehicle trips ("Status quo"). If Ranchi invests in better public transport and non-motorised transport facilities, these trends can be reversed ("Sustainable").

Transport interventions should be sustainable: that is, they should meet the needs of the present without compromising the ability of future generations to meet their own needs. To meet that end, it is important to invest in transport alternatives that move large numbers of people efficiently, at a low cost, and with low environmental externalities. Ranchi should improve equity, reduce environmental impacts, and improve mobility and enhance the quality of life for all.

Under a "Sustainable" scenario, the city implements initiatives to promote the use of non-motorised transport (NMT)—a term used for walking, cycling and other forms of human powered transport—and public transport. The city will also control travel demand by personal motor vehicles. With increased investment in NMT and public transport two outcomes are likely: first, an increase in the public transport mode share, and second, a reduction in the mode shares for paratransit and private motor vehicles. The mode shares under the alternate scenarios are summarized in the table below.

Table 5: Mode shares under two scenarios

Mode	2014	2031:Status quo	2031: Sustainable
Walk	36 %	22 %	40 %
Cycle	8 %	5 %	10 %
Bus	5 %	3 %	30 %
Paratransit	30 %	28 %	8 %
Private vehicles	21 %	43 %	12 %

These simple calculations are very helpful in understanding the potential impacts of transport investment priorities. The planned NMT and public transport infrastructure meets the projected 2031 demand and offers the possibility of future expansion to accommodate further increases in travel demand. The following diagram illustrates the differences of capacity and cost between the status quo and sustainable scenarios. In sum, the sustainable scenario provides an appropriate way to move forward as it has significant advantages over the status quo in both capacity and cost effectiveness.

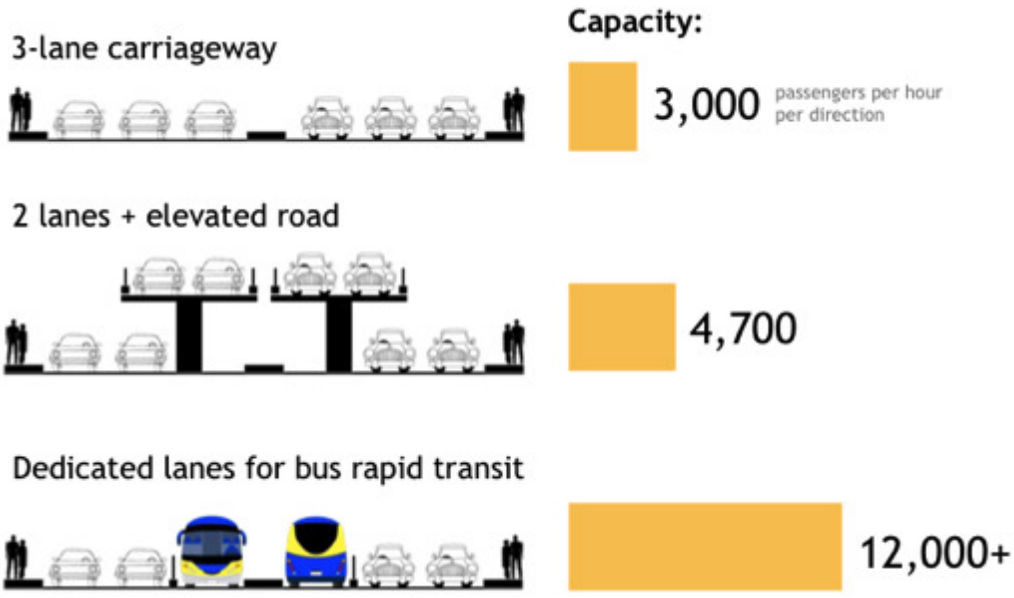

Figure 21: Accommodating increased demand—can we just expand the roads?

3.2. Vision and mission for transport in Ranchi

Based on the key principles espoused in the Ranchi Mobility Charter, which are also in line with the fundamentals of the National Urban Transport Policy issued by the Ministry of Urban Development, Government of India, the RMP envisages that the vision for transportation system of Ranchi should have the following elements:

- Provide mobility for all people, regardless of their age, gender, financial and physical abilities,
- Be "sustainable", i.e. consume as few resources as possible,
- Improve liveability and quality of life in Ranchi,
- And also be attractive, comfortable and convenient.

Therefore it is imperative that any plan for Ranchi's transportation focuses on people rather than vehicles. The following matrix clearly shows which modes support this vision of transportation in Ranchi.

Ranchi should focus on providing high quality infrastructure for walking, public transport and cycling. This will benefit a majority of its residents. Then mobility can be achieved with these modes, making use of personal vehicles virtually unnecessary. That is the only escape from problems like congestion, pollution and increasing accidents.

Table 6: Modes, their beneficiaries, and impacts

	Walking	Cycling	Public transport	Two wheelers	Cars
Can children use?	✓	✓	✓	X	X
Can senior citizens, women use?	✓	●	✓	●	●
Inexpensive to use?	✓	✓	●	●	X
Conserves urban space?	✓	✓	✓	●	X
Low pollution?	✓	✓	●	X	X
No harm to others in accidents?	✓	✓	X	●	X

3.3. Objectives for Ranchi's transportation

RMP recommends that Ranchi adopt following goals for 2031 in order to achieve the sustainable scenario described above:

1. **Support non-motorised transport (NMT)**. Increase the mode share of all trips by cycling and walking from 44% (2014) to 50% (2031)
2. **Improve safety**. Zero fatalities per year from traffic crashes or public transport accidents
3. **Improve formal public transport**. Increase the mode share of formal public transport from 2% (2014) to 35% (2031)
4. **Public transport accessibility**. 75% of residents within a 5 min walk of formal public transport
5. **Keep Ranchi air healthy**. Zero nonattainment days for PM and NO_x emissions
6. **Control personal motor vehicle trips**. Increase of no more than 10% over present levels.

Achieving these goals will require a detailed planning process, along with regular monitoring and evaluation, to determine whether Ranchi is on target to meet these benchmarks. Any effort to implement sustainable transport systems must include a vigorous regime of data collection and performance measurement, so that operations and planning efforts are supported by quantifiable outcomes. Such performance-based planning efforts provide a robust structure to support transport system improvements and corrections.

3.4. Paradigm shift: types of projects needed as well as not needed

Ranchi should undertake transportation projects that are fundamentally different in nature from projects suggested in similar documents from other cities. Ranchi must focus on providing mobility to all people, regardless of their age, gender, physical ability, financial status etc.

At present, only a small subset of the population—young men who are strong, physically and/or economically—has good mobility in the form of personal motor vehicles. The rest of the population—elderly, women, children and anyone who is economically and/or physically challenged—have to make do with very poor quality of transport.

In most cases, people who use personal vehicles can also use one or more of these 3 modes. The only reason for choosing a personal vehicle over these 3 modes is physical comfort and convenience. Unfortunately, personal vehicles are extremely inefficient users of energy and limited street space. Pollution by these modes is an order of magnitude higher than walking, cycling and public transport. Therefore they are not sustainable even if all people in Ranchi were able to afford them.

While physical comfort and convenience is naturally desirable, Ranchi should adopt the following approach while selecting transportation projects.

- Modes that are energy- and space-efficient, low- or non-polluting, and affordable for all, i.e., walking, cycling and public transport, should be promoted. They should be made more convenient, comfortable and accessible for all.
- Modes that are energy- and space-inefficient, highly polluting, unaffordable and inaccessible for all, i.e., personal motor vehicles, should be discouraged. Their use should be made less convenient, through physical restrictions, and expensive, through appropriate pricing.

Moving forward, Ranchi should create and support infrastructure and subsystems that all people can use. These are:

- **Footpaths and safe street crossings**: Walking is the most fundamental mode of mobility. Everybody except the physically weaker or handicapped people can walk. Wheelchair accessible footpaths can satisfy mobility needs of such people to a large extent.

- **Public transportation**: If accessible, it addresses mobility needs of physically handicapped also. Free or subsidized travel can address mobility of poor people.
- **Cycling facilities**: Cycles provide pollution free and healthy mobility. They are the most energy efficient mode of transport. They are accessible to people of all ages, including children, and are a key means of transport for the economically weaker sections.
- **Intermediate public transport:** Taxis and autorickshaws fulfil important needs of a city's transport system by providing point to point mobility when needed urgently. They also provide last mile connectivity for public transport trips, extending the catchment area of public transport service. Improvements like better quality vehicles with electronic meters help make the overall transportation system more easily usable and accessible to all people.

Ranchi should not only prioritise projects that make it easy to use sustainable modes, but also not do projects that make it easier to use personal vehicles, because doing the latter type of projects will quickly nullify any benefits obtained by doing the former type of projects.

4. Facilities for pedestrians and cyclists

Walking and cycling are often considered as a poor man's modes of transport, which leads to an implicit assumption that their usage is declining, and we don't need to provide infrastructure for them. They are usually only considered as feeder modes to public transport. However, these two modes are mainstream modes of transport in their own right. More than a third of the trips in even large Indian cities are on foot and bicycle. In Ranchi, close to half of all trips are by walking and cycling. Moreover, if we want to design our cities such that it should be possible for a person to commute in the city without depending on a personal vehicle, strengthening the facilities for walking and cycling becomes extremely important.

4.1. Footpaths

A significant proportion of trips below 2 km are on foot. In addition, all public transport passengers and many private vehicle users start and end their trips as pedestrians on public streets. Increasingly, engineers and planners are emphasising the need to design 'complete streets' that make walking safe, comfortable, and convenient.

A great walking environment must protect pedestrians from motor vehicles. Streets need dedicated footpaths or vehicle speeds need to be radically reduced in case of a shared space. Footpaths need to be unobstructed, continuous, shaded, and well lit. New Indian Roads Congress guidelines (IRC 103-2012) clarify that all footpaths should have three main zones:

1. Frontage zone,
2. Pedestrian zone, and
3. Furniture zone.

Per IRC guidelines, the pedestrian zone must provide a continuous clear space for walking with a minimum width of 2 m. The pedestrian zone must be entirely free of obstructions. This width may vary as per the adjacent land use and can be as wide as 4.5 m in market areas. Street utilities such as manholes, trees, benches and other potential obstructions should be placed outside the path of travel and in the furniture zone, which should be at least 1 m wide. The frontage zone can vary between from 0.5 to 1 m.

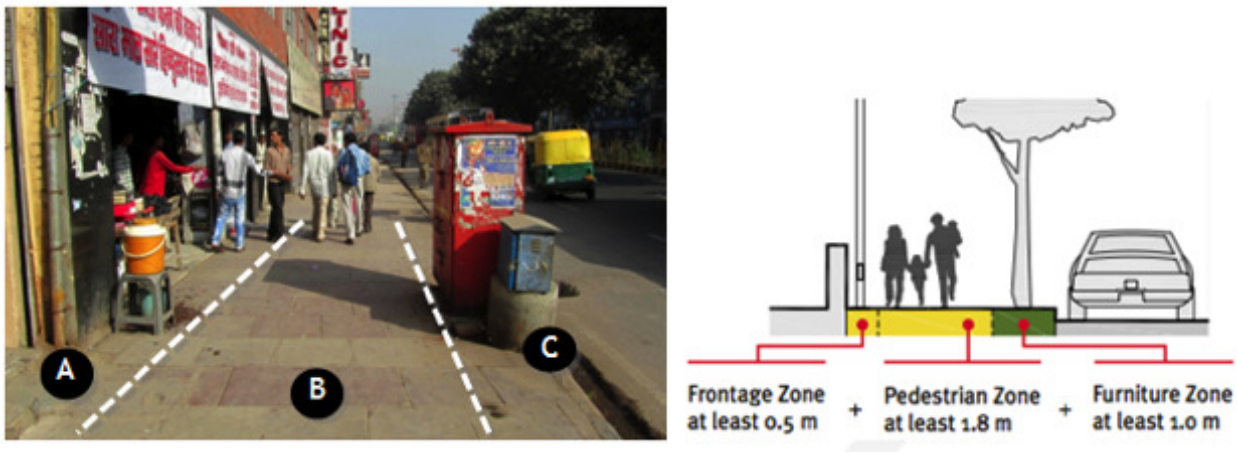

Figure 22: The three main zones of footpaths: A. the frontage zone, B. pedestrian zone, and C. the furniture zone.

Footpaths should be linked with safe pedestrian crossings at regular intervals. Crossings should be made safer with pedestrian islands, curb extensions that minimise crossing distances, signals, and other traffic safety mechanisms. Vehicle speeds at crossings must be slowed down with tighter turns, narrower lanes, restrictions on free turns, and speed bumps. Pedestrian facilities should be accessible through low-gradient ramps to ensure accessibility for all—including a person in a wheelchair or a family using a stroller.

The utility of footpaths as spaces for social and economic activity must not be ignored. Thus they must be designed with dedicated space for seating and regulated street vending besides simply walking. Tree shade makes walking comfortable and pleasing. Sufficient space should be allocated for tree pits next to the footpath. The success of a footpath depends on the integration of multiple elements in a coherent design.

The roads listed in the table and map below need modern footpaths that conform to IRC 103-2012. Any existing footpaths along these roads that do not conform to IRC 103-2012 must be removed and built afresh. In total, Ranchi needs high-quality footpaths on a network of about159 km. While about 33 km of these roads would be included in the BRT corridors proposed in this document, an additional 126 km of roads also need high quality footpaths.

Beyond these priority corridors for footpath retrofits, all new major roads that are constructed in the Ranchi metropolitan area should include IRC compliant footpaths.

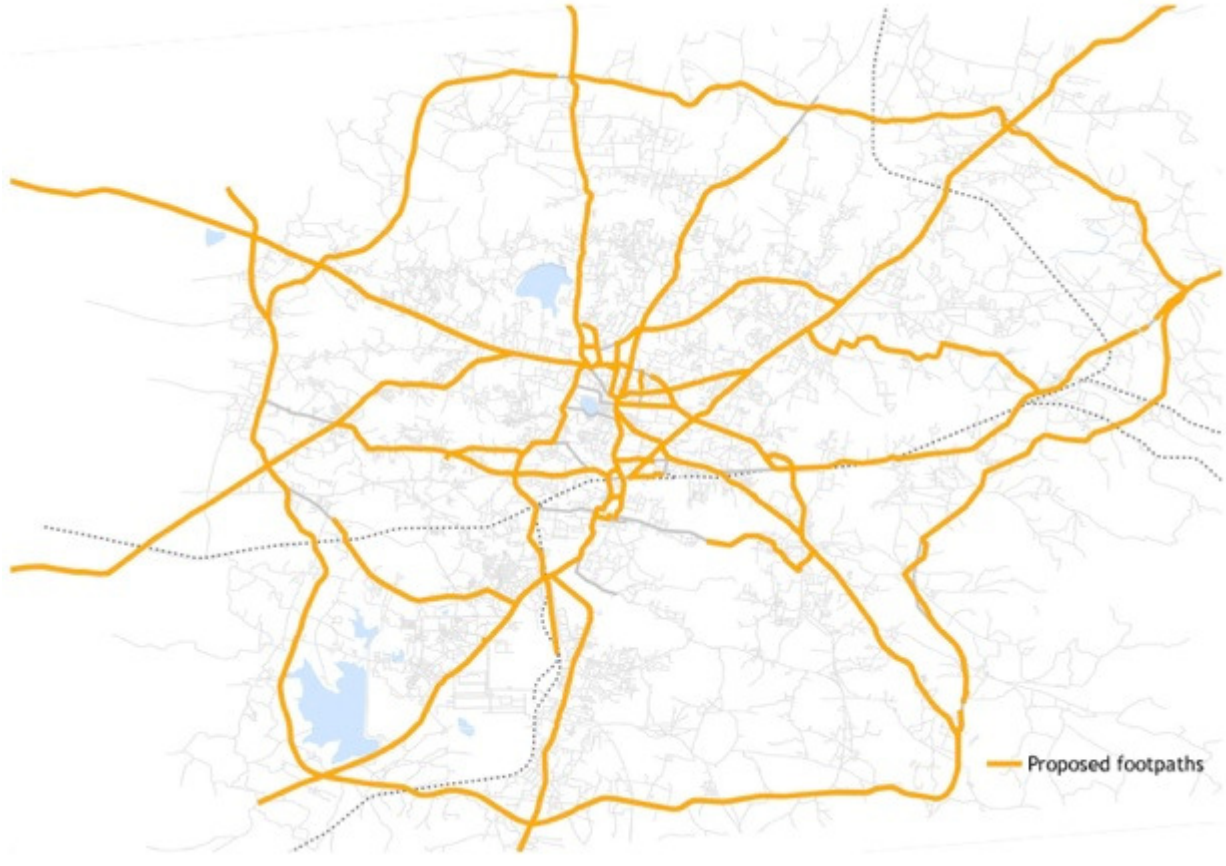

Figure 23: Proposed network of footpaths.

Table 7: Roads that need footpaths

Name of the road	Description	Length (km)	Part of BRT network?
NH-75	Birsa Chowk - NIFFT Chowk - Ring Road	8.5	-
	Tatisilwai to Khelgaon	8.0	-
Circular Road	Jail More - Lalpur	1.5	-
NH-23	Lalpur - Booty More	5.5	-
	Ghutuwa Rd – Kathal Chowk - Piska More	8.0	-
	Kantoli to Ormanjhi	18.0	-
Chutia - Namkum Road	Ranchi - Purulia Road to IINRG Campus	3.1	-
Ring Road	Kanke to Kamre	10.0	-
Ranchi-Purulia Road	Namkum Railway Station - Tatisilwai - Angara	16.0	-
Chutia Main Road	Bahu Bazar to Chutia Namkum Road	4.0	-
Bariatu Road	Kanke Road - Governor House - Booty More	8.0	-
Paramahansa Yogananda Path	Bahu Bazar Chowk – Kantatoli Chowk – Kokar Chowk	3.5	-
Tata Road	IINRG Campus - Rampur	7.0	-
Kanke Road	Ratu Road – Kanke Chowk	6.5	-
Argora	Dugdugia Toli – Argora Chowk - Ashok Nagar - Main Road	5.0	-
Cart Sarai Road, Lalji Hirji Road	NH-75 to Main Road	1.5	-
Church Road	Main Road to Bahu Bazar Road	1.5	-
Club Road	Main Road to Paramahansa Yogananda Path	1.0	-
St Francis School Road	Lala Lajpat Rai School - St Francis School - NH-75	2.5	-
	Junction of Ring Road – Kathal Chowk – Argora Chowk	7.0	-
NH-23	Piska More – Kutchery Chowk - Jail More	3.5	Yes
Line Tank Road	Jail More – Karamtoli Chowk	1.0	Yes
Radium Road		0.5	Yes

Name of the road	Description	Length (km)	Part of BRT network?
Main Road	Kutchery Chowk - Albert Ekka Chowk – Birsa Chowk	7.5	Yes
NH-75, Harmu Road	Ratu Road junction – Birsa Chowk	12.0	Yes
NH-23 and Circular Road	Firayalal - Lalpur - Dangratoli	2.0	Yes
Purulia Road	Between Main Road and Dangratoli	2.0	Yes
NH-33	Dangratoli - Kantatoli - Namkum Railway Station	4.5	Yes
Total		**159.1**	

4.2. Cycle tracks

Cycles allow the convenience of door-to-door travel while using less space and fewer resources than motor vehicles. They are a healthy and more energy and cost efficient alternative to cars, two-wheelers, auto-rickshaws, and taxis. As a major centre of employment, Ranchi attracts many workers from distances of 10-15 km or even more. Since not many of them can afford private vehicles or even shared auto fares, they commute this distance on cycles. Even within Ranchi, many people are seen riding cycles. In the city centre, distances are short and the terrain is flat, providing ideal conditions for cycling. To put things in perspective, the cycling mode share (8.4%) is twice that of cars.

Facilities that make cycling safer will increase use of cycles, control pollution, and reduce traffic injuries and deaths caused by crashes with motor vehicles. Dedicated space for cyclists is essential on streets with moderately fast motor vehicle traffic. Cycle tracks should be physically separated from moving motorised traffic by a barrier such as a curb or landscaping. In the Indian context, cycle tracks demarcated with paint do not work. While physically separated cycle tracks may entail higher construction costs and consume more road space, it is found worldwide that such high quality NMT infrastructure is more effective in promoting NMT use (Pucher and Buehler, 2008).

Most of Ranchi does not have wide roads. Although reserving road space for cyclists would certainly benefit them, narrow ROWs make it difficult to do so. If cycle tracks are built on narrow roads with many competing uses of limited road space, there is a high likelihood that cycle tracks will be encroached by parked vehicles. Furthermore, motor vehicle speeds on these streets are generally low and not very dangerous for cyclists. Street design should employ traffic calming elements on all roads to ensure that motor vehicles travel at moderate speeds, making the carriageway safe for cyclists.

Radial streets in Ranchi where streets are somewhat wide and traffic speeds are higher, dedicated cycle tracks should be implemented. These are listed in the table and the map below.

Table 8: Proposed cycle tracks

Name of the road	Description	Length (km)
NH-75	Birsa Chowk - NIFFT Chowk - Ring Road	8.0
	Tatisilwai to Khelgaon	8.0
St Francis School Road	Lala Lajpat Rai School - St Francis School - NH-75	2.5

Name of the road	Description	Length (km)
	Junction of Ring Road – Kathal Chowk – Argora Chowk	7.0
NH-23	Ghutuwa Rd – Kathal Chowk - Piska More	8.0
Chutia - Namkum Road	Ranchi - Purulia Road to IINRG Campus	3.0
Kanke Road	Kanke to Ratu Road junction	8.5
NH-23	Kantatoli to Ormanjhi	18.0
Ranchi-Purulia Road	Namkum Railway Station - Tatisilwai - Angara	16.0
Chutia Main Road	Bahu Bazar to Chutia Namkum Road	4.0
Tata Road	IINRG Campus - Rampur	7.0
Ring Road	Kanke to Kamre	10.0
TOTAL		100

Figure 24: Proposed network of cycle tracks. Where road space is insufficient for separate cycle tracks, traffic calming measures will help ensure that carriageways are safe for cycling.

Special traffic calming measures should be instituted within 500 m of major schools and colleges to make the surrounding streets cycle friendly. Speed bumps and other measures should be implemented at regular intervals to slow down motorised traffic. Street management practices can also improve safety for cyclists. For example, roads in school zones can be closed for motorised traffic (except school buses) during school and college opening and closing times.

Apart from building cycle tracks, it is important to give ample indications to the people that cyclists are an important component of transport planning and their safety and convenience is looked after. The following steps should be taken:

- Provide designated on-street cycle parking stands in busy localities like marketplaces.
- Provide designated off-street cycle parking stands at bus terminals, railway stations, and all government offices. These facilities should have properly fabricated cycle stands and not merely a designated area to park cycles.
- All pay and park facilities for personal vehicles should reserve 10 per cent space for free bicycle parking.

In all of the cases above, if the bicycle parking is found to be insufficient, it should be increased even if reducing space for parking for motorised vehicles is the only way to provide more space for parking bicycles.

4.3. Completing the network

Street network patterns are extremely important for encouraging walking and cycling. As Ranchi strives to deal outward expansion of the city and increasing vehicles kilometres travelled, the city must take into account the relationship between the built environment and the travel mode choice. A dense street network and additional street connectivity generally encourages more walking, cycling and public transport use.

The old city of Ranchi has dense fabric of interconnected streets that facilitate walking, cycling, and cycle rickshaws movement. As shown in the map below, a block with a perimeter of 400-500 m or smaller implies that the “other side” of the block is only 200-250 m from any location.

Figure 25: Good network of streets with small block perimeter

However, in areas such as Nagra Toli and KK Colony north of Circular Road, a dendritic street network with frequent cul-de-sacs limits connectivity and increases travel distances. In the example below, a shop that could have been a 260 m (4 minutes) walk is now 865 m (12 minutes) away, which would prompt people to use a personal vehicle.

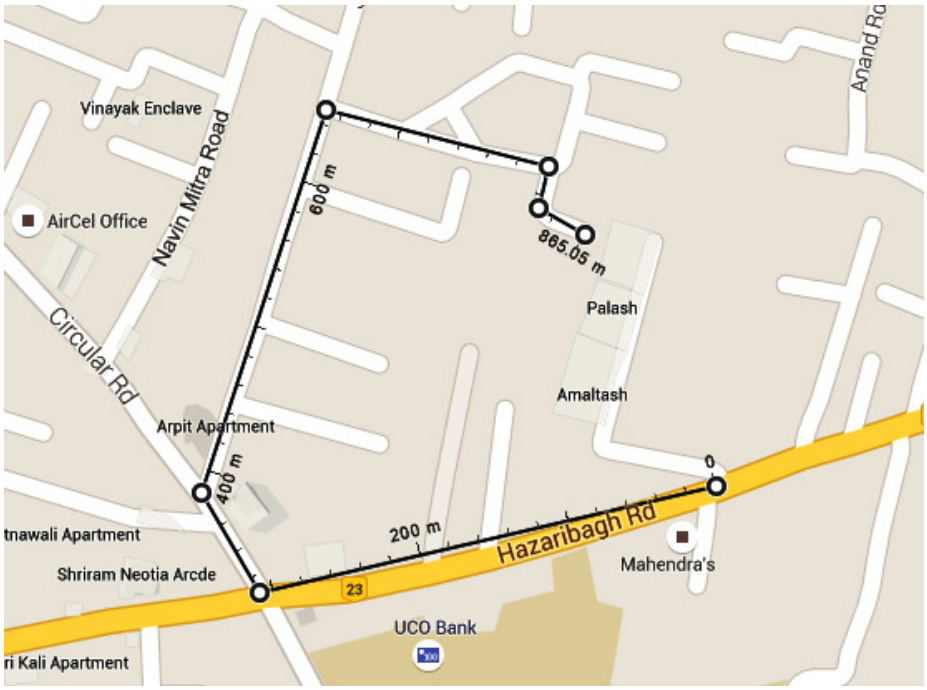

Figure 26: Cul-de-sacs increase distance to urban facilities

Instead, a networked layout could have provided more pedestrian-friendly approach with direct links to the main road, with access to public transport, shops etc.

To promote denser, interconnected street networks, block sizes in Ranchi should be restricted to 1 ha or less. A grid structure achieves efficient connections and allows access throughout the area. Grid spacing of 80-100 m provides optimum network for non-motorised transport users. Major urban blocks may provide motorized vehicle access on a grid of 200 m or more, but these blocks must still have publicly accessible walkways at a frequency of 80-100 m. Opportunities for smaller blocks should be identified in Ranchi's master plan.

4.4. Street design standards

The city of Ranchi should develop street design standards so that the design of transport infrastructure supports and expands the use of sustainable modes. These Standards will cover all transport facilities and services owned, operated, and/or managed by Ranchi Municipal Corporation.

The street design standards should include a clear statement of principles that govern specific design choices:

- Prioritisation of street elements: Adequate space for walking, cycling, and public transport facilities will be given before allocating space for private motor vehicles.
- Street crossing: Priority will be given to at-grade speed-controlled crossings rather than grade-separated facilities such as pedestrian subways and foot overbridges.
- Comfort and safety: Streets should serve as safe, shaded public open space corridors with generous landscaping, lighting, and greenery. Streets also serve as public view corridors and provide light and air.

- Storm water discharge: Decisions regarding street designs must utilise techniques that reduce the impacts on the storm water system and increase the permeable surface area, through the planting of street trees and landscaping, and minimising unnecessary pavement.
- Street vending: Street vending plays a crucial role in the economy of Ranchi. Therefore, it is important to provide dedicated vending zones, particularly in areas close to the rapid transit stations.

After establishing the principles of street design, the standards should provide detailed design guidelines for various street elements, including footpaths, cycle tracks, pedestrian crossings, bus stops, medians, refuge islands, vending, on-street parking, and underground utilities. The standards show how these elements can be combined into overall cross sections for streets of various widths.

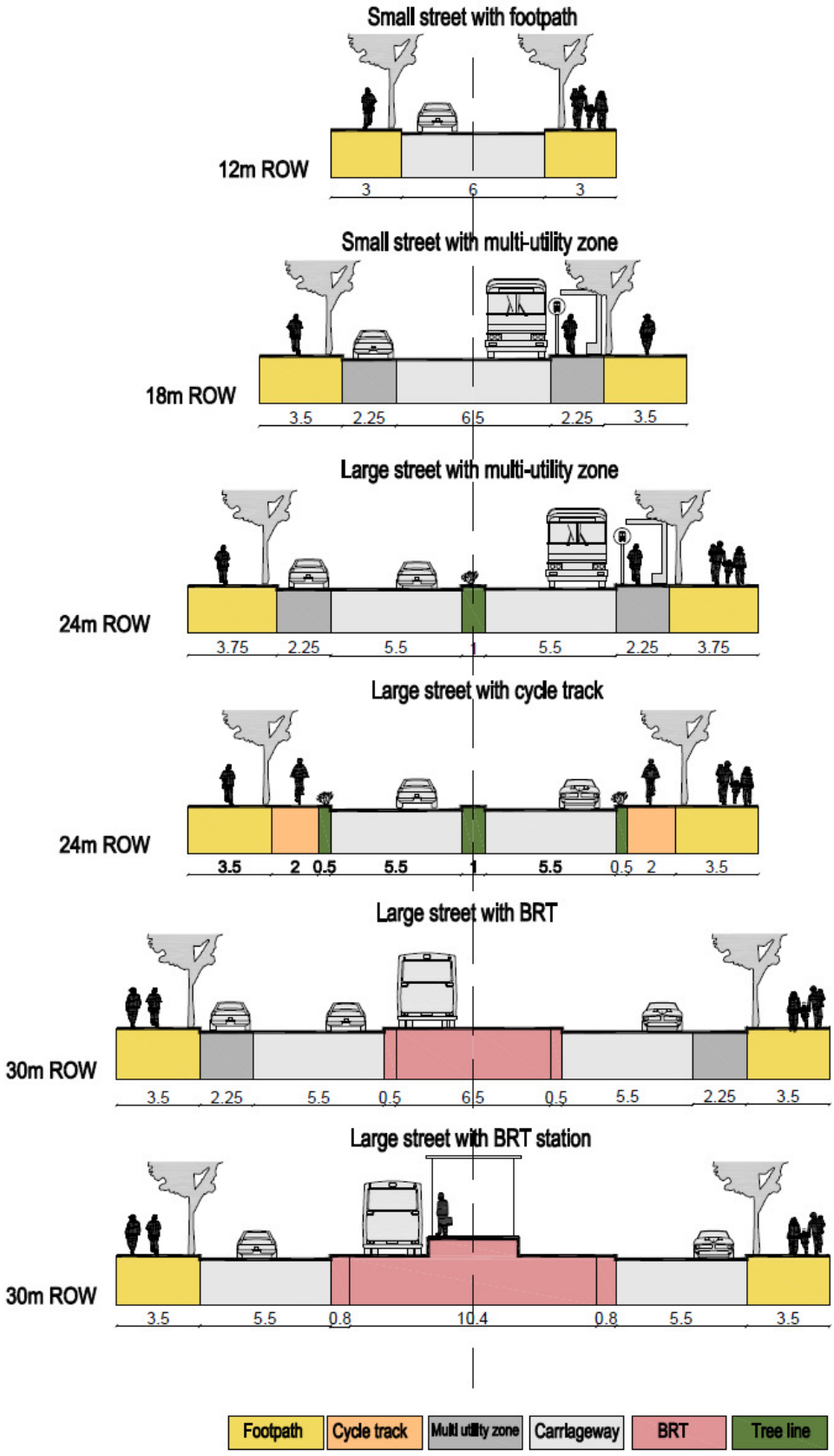

Figure 27: Sample cross sections showing the representative allocation of space among various uses, including pedestrian mobility, cyclist mobility, parking, public transport, and private vehicle mobility.

Street design standards will help ensure that RMC prioritises and channels funds towards projects that improve condition for NMT users. The Ranchi street design standards should indicate a clear process for project preparation and approval. For cases where a project does not meet a specific provision of the street design standards, the standards should describe the review process for getting a design waiver. To facilitate the on-going assessment of the performance of Ranchi's streets, the standard should include clear metrics for evaluating the quality of the pedestrian environment. Interactive workshops and other capacity building exercises can help RMC staff and consultants gain experience in applying the street design standards.


Figure 28: Adoption of street design standards will involve capacity building exercises for transport planners and engineers. Shown here is an RMC street design workshop from September 2012.

4.5. Greenways

To supplement walking and cycling improvements on existing streets, open spaces in the city can be developed as NMT corridors that support long-distance commuting as well as recreational uses. Greenways are managed open spaces that offer improved mobility to pedestrians and cyclists, create new recreational space for city residents, and enhance environmental assets. Greenways feature walkways and cycle paths and utilise an independent ROW, such as in a park, lake, or river.

A greenway project can transform a neglected creek or drainage channel into a high quality public space that becomes part of the city's open space network. Designed with accessibility and safety features in mind, greenways can become a place of enjoyment for residents of all ages and genders. Greenways can also contribute to healthy lifestyles by creating high quality facilities for active transport using non-motorised modes. Given the limitations in the street network, strategic development of greenways can help augment the citywide cycle network in locations where on-street cycle tracks are not feasible or infrequent.

Key features of greenways include the following:

- Continuous paths for cycling and walking,
- Public plazas at cultural landmarks along the waterway or lake,
- Organised vending zones, and
- Playing fields.

Figure 29: Greenways can improve access for pedestrians and cyclists while aiding in the environmental restoration of lakes and waterways in Ranchi.

The planning process for greenways combines analysis of the hydrological features of the waterway with an assessment of the mobility needs of local residents and non-motorised transport (NMT) users in the city as a whole. The design of a greenway must be integrated with a city's transport network, especially citywide pedestrian and cycle networks. In addition, the design should take into account nearby public transport services to improve accessibility to the greenway.

Water bodies will need to be cleaned and cleared to provide space for recreational uses. A sewage management plan must be developed to address outflows of untreated sewage that compromise water quality. Potential solutions include the diversion of sewage to the city's water treatment network or the use of biological systems to purify wastewater before it enters the main waterway. In some cases, RMC will need to address encroachments within the public ROW of these water bodies.

The team has identified a total of 31 km of possible greenways along lakes, canals, and rivers in Ranchi. Priority greenway corridors include the Subarnarekha River and Bada Talab. Proposed greenway alignments are described in the table below.

Table 9: Proposed Greenways

Greenway	Description	Length (km)
Subarnarekha river	Subarnarekha river is the lifeline of Ranchi, literally meaning 'threads of gold' because of the presence of the yellow metal at its origin, Piska. The river is drying up and getting polluted but is still the largest and most important water source for Ranchi. The Kanke, Rukka, Dhurwa and Getalsud dams feed off this river. The river passes south of the Piska-Ranchi-Namkum railway line and north of the airport in the general Eastward direction and then turns north, crossing the railway line near the Namkum flyover. The initial 6 km of this stretch passes through inhabited localities, while the latter 9 km passes mostly through areas that are not yet developed. The river can be cleaned as necessary and a greenway developed along this 15 km stretch. The first 6 km stretch can provide a viable cycling route for daily commute, especially after developing sufficient activity along the stretch to improve safety. The latter 9 km stretch can be developed in an excellent recreational spot.	15.0
Harmu River	A tributary of the Subarnarekha river. A stretch of this tributary, starting from Mukti Dham at NH-75, flowing in a general south-easterly direction, crosses the railway line just west of the Main Road bridge, continues south of the localities of Gosaintola, Amravati and Dwarkapuri, meeting the Subarnarekha river south of Chutia-Namkum Road bridge. This stretch measures about 8 km. The first 5 to 6 km of this stretch passes through some of the most dense areas of Ranchi. If cleaned and developed in a Greenway, this rivulet has immense potential to provide an excellent cycle track.	9.0
Ranchi lake	Also known as Bada Talab, this lake should be cleaned and developed into a public, recreational space. A walking and cycling pathway can be created around the Ranchi Lake. This pathway should be connected to public transport stops on Bypass Rd and Main Rd, either by way of a cycle track or by closing an appropriate lane for all motorised traffic from 6-8 am and 5-7 pm. The distance between Bada Talab and NH-75 and also between Bada Talab and Main Road is only about 400-450 m, with multiple alternatives possible for motor vehicles.	1.5
Kanke Dam	Kanke Dam is approximately 250-400m from the Kanke bus route - SH 2. By building exclusive facilities for walking and cycling around the Dam, the otherwise neglected water body can help enhance the environment and improve the quality of life of the surrounding neighbourhoods. The greenway can be better connected to SH 2 by means of cycle tracks and footpaths.	5.5
Total		31

Figure 30: Water bodies such as Bada Talab (left) and Karamtoli Talab (right) can be improved with dedicated walking and cycling paths.

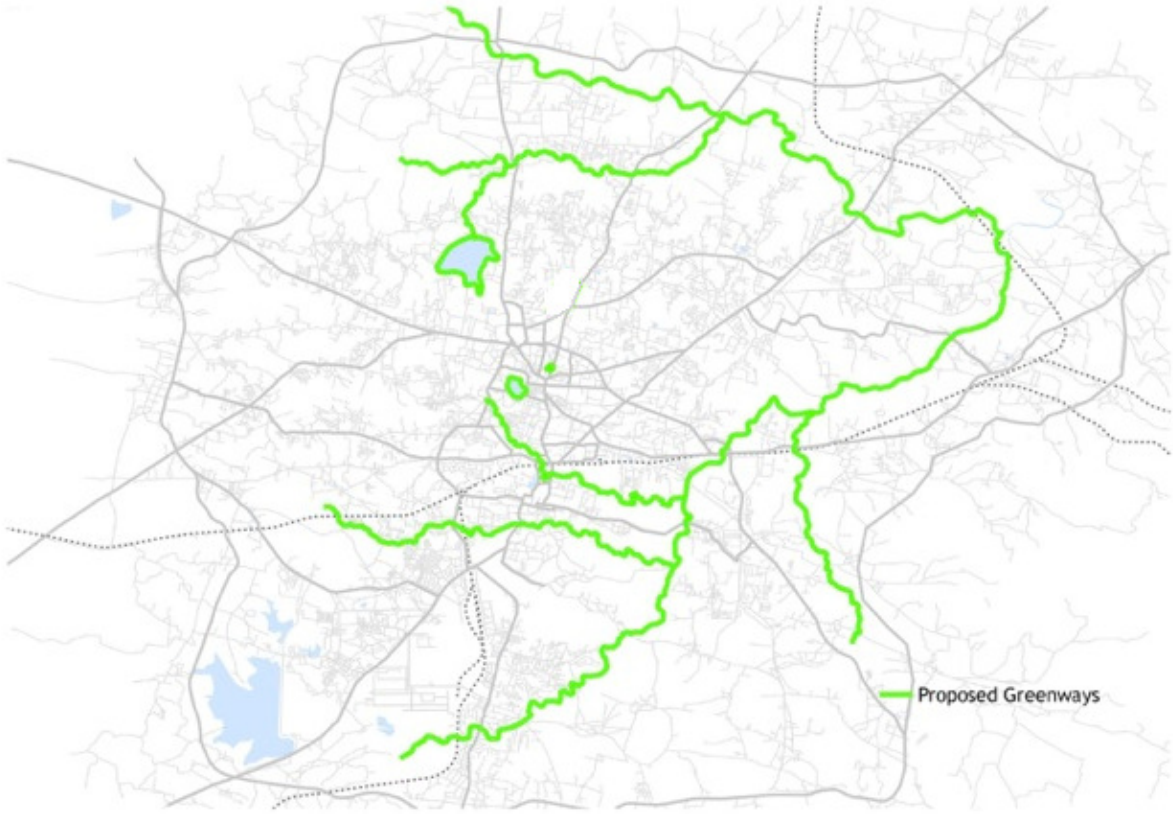

Figure 31: Proposed network of greenways.

5. Public transport network

Ranchi needs a good public transport system to provide mobility to all, because not everyone can afford a personal vehicle. The public transport system should be reliable, fast, and of course comfortable—otherwise people would prefer personal vehicles. Developing a high quality public transport system is the only way Ranchi can reduce congestion and pollution caused by traffic.

5.1. Selecting a public transport system

5.1.1. Criteria for selecting public transport systems

The selection of public transport services is driven by factors such as the potential passenger market, the trip patterns of prospective users, and other socio-economic criteria. When a planning body has to make decisions regarding which mode should be utilised to serve a community, it must base this decision on the following criteria:

- Ability of the mode to meet demand;
- Implementation cost;
- Environmental impact;
- Social equity impact;
- Cost to user;
- Journey time;
- Travel comfort;
- Travel safety;
- Convenience, including the number of transfers;
- Accessibility;
- Flexibility;
- Reliability; and
- Degree of implementation complexity and technical sophistication

Ultimately, the right choice of a public transport solution is governed by local circumstances. Understanding these conditions requires a comprehensive and objective examination of alternatives.

5.1.2. Ranchi corridor demand

To assess potential demand for public transport service in Ranchi, ITDP completed a detailed analysis of existing travel patterns. Public transport demand in Ranchi is largely met by the informal paratransit system. There were hardly any data available on the existing paratransit routes, fleet sizes, and the corresponding demand on these routes. Making matters more complicated, share autos and city buses stop anywhere, anytime, as requested by passengers. There are no prescribed schedules for operations, nor is there a dedicated fleet assigned to a particular route.

Modelling the existing travel patterns allows planners to analyse the impact of specific changes in services and infrastructure. It also provides a means of evaluating the citywide impact of new facilities. A series of surveys, including frequency-occupancy (FO), transfer, and boarding-alighting (BA) surveys, were conducted to provide a detailed assessment of travel patterns on 43 share auto and bus routes in Ranchi. Based on these data, a detailed travel demand model was created using Emme software. The modelling process is described in detail in Appendix 1.1. Public transport modelling.

Figure 32: Existing shared auto routes

The figure and table below show the calibrated passengers volumes along major corridors in Ranchi. Some of the busiest locations included Ratu Rd with 3,800 persons per hour per direction (pphpd), Rajendra Chowk with 2,900 pphpd and RIMS with 2,200 pphpd.

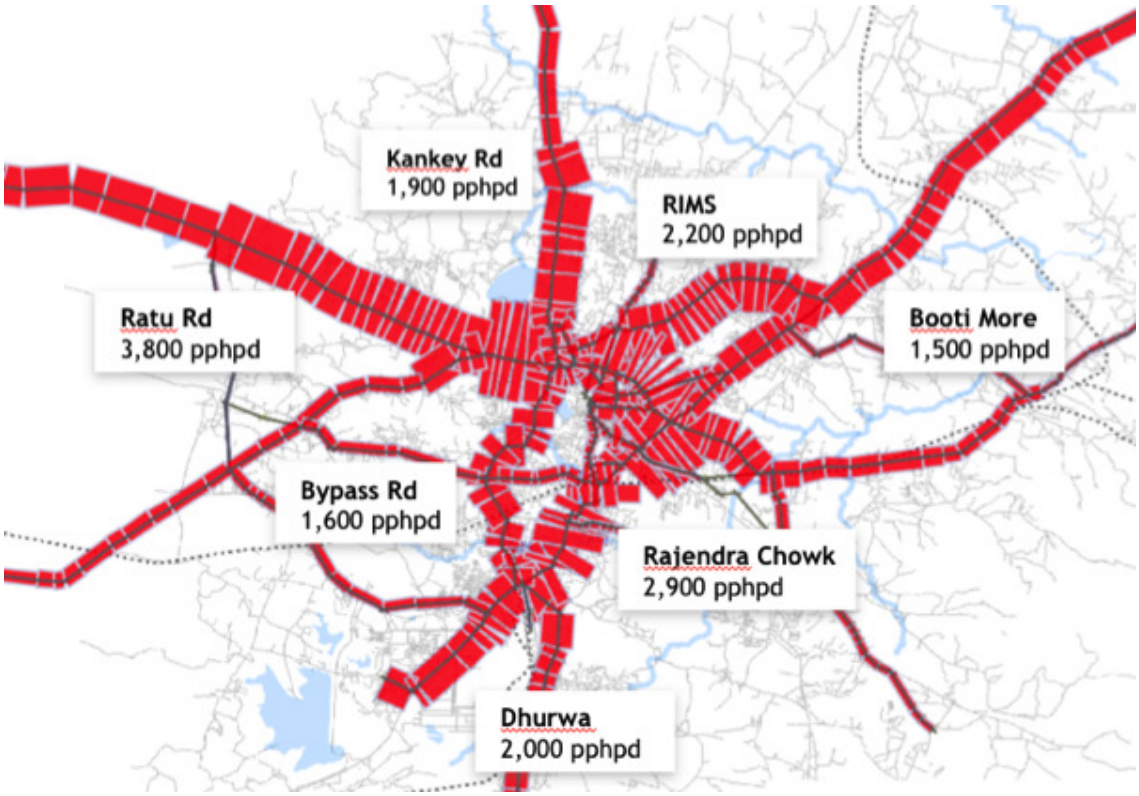

Figure 33: Passenger volumes along major corridors.

Table 10: Passenger volumes along major corridors

Corridor	Load (pphpd)	Frequency (share autos/hr)
Kathitand-Ratu Road	3,800	625
Kutchery-Kantatoli	3,650	730
Kantatoli-Birsa Chowk	3,650	540
Booti More-Jail More	2,200	350
Kanke-Ratu Road	1,900	320
Ratu Road-Birsa Chowk	1,600	275
Kantatoli-Namkum	1,550	225
Ormanjhi-Booti More	1,500	93
Kantatoli-Booti More	1,400	310
Dasmile-Birsa Chowk	1,400	205

The existing shared auto rickshaw routes operate on short, disjointed routes, resulting in a high volume of transfers at key interchange locations in the city. A detailed analysis of the existing travel patterns revealed that around 14 per cent of all passengers take two or more share autos to reach their destinations. As a result of these transfers, passengers face increased travel times and higher fares.

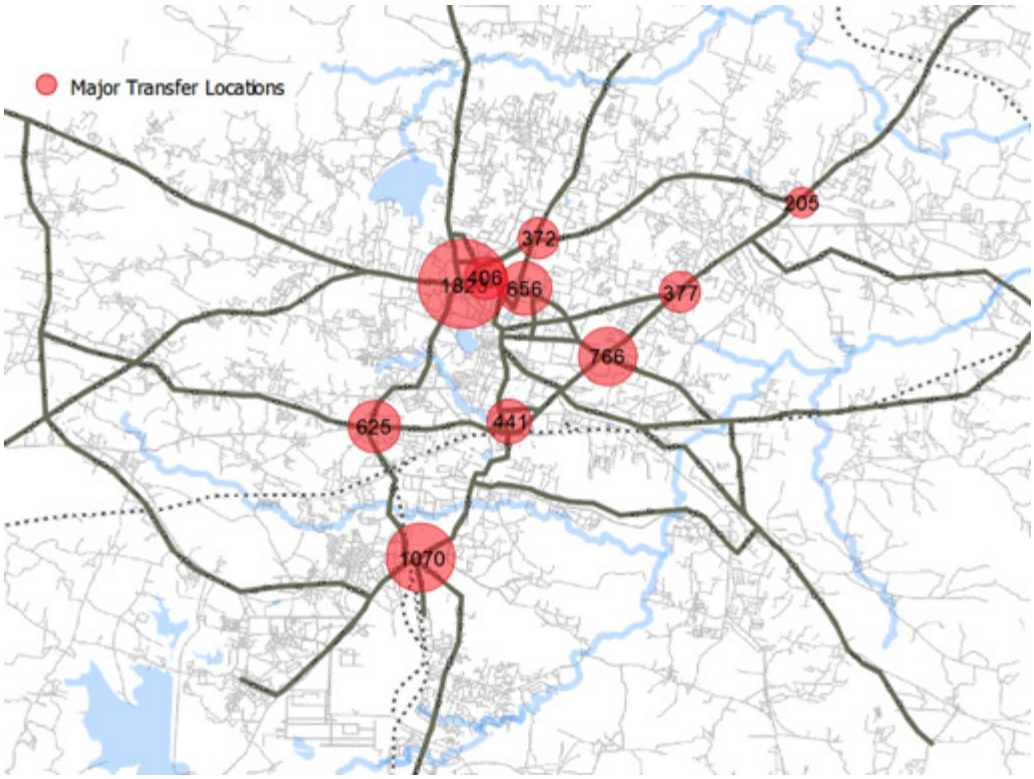

Figure 34: Number of passengers transferring at major interchange locations

5.1.3. Choosing the right public transport modes

As shown in the previous section, Ranchi has several public transport corridors with passenger demand over 1,000 pphpd. The formal city bus fleet should be expanded to provide more reliable service on these corridors. Where demand exceeds 2,000 pphpd, Ranchi should consider implementing a mass rapid transit system to streamline service, provide better quality for passengers, and accommodate future growth. For these corridors, several MRT technologies are available, including:

Bus Rapid Transit (BRT): A bus-based MRT system typically operating at-grade with dedicated bus lanes, special stations and bus fleet, and IT systems, with capacities ranging from low to high, depending on the station design, bus configuration, and presence of passing lanes.

Light rail transit (LRT): A rail-based MRT system typically operating at-grade on low- to moderate-demand corridors.

Monorail: A rarely used grade-separated MRT system with coaches that run on a single track, based on proprietary technology, typically employed on used for low- to moderate-demand corridors.

Metro: A grade-separated, rail-based MRT system for corridors with very high demand.

Successful rapid transit systems attract ridership by offering a high level of efficiency, safety, affordability, and convenience to their customers. To achieve these qualities, rapid transit systems combine a minimum set of design features, including dedicated lanes; step-less boarding, electronic fare payment, and real-time passenger information. These features are common to all MRT technologies, whether rail- or bus-based, and should be part of any future MRT system in Ranchi. Together, they ensure that service is fast, comfortable, and convenient—qualities that help attract riders from personal motor vehicles.

Table 11: Key features of high quality rapid transit systems

	BRT	Metro	LRT	Monorail
Dedicated ROW	Yes	Yes	Yes	Yes
Step-less boarding	Yes	Yes	Yes	Yes
Electronic fare payment	Yes	Yes	Yes	Yes
Real-time passenger information	Yes	Yes	Yes	Yes
High quality service that can attract users from personal vehicles	Yes	Yes	Yes	Yes

Beyond these common features, MRT technologies have important distinguishing characteristics that impact the choice of the best technology for a particular context:

Capacity: An appropriate technology must have sufficient capacity—typically expressed in terms of the number of passengers per hour per direction (pphpd)—to handle existing demand and should also be able to accommodate future growth. Current passenger demand in Ranchi is in the range of 1,000 to 4,000 pphpd. At-grade systems such as BRT and LRT typically accommodate up to 12,000 pphpd with a single lane or track per direction. Monorails are lower capacity systems, handling around 8,000 pphpd on the busiest known system. To achieve higher capacities, two approaches are typically employed: grade separation in the case of rail-based systems, and passing lanes in the case of BRT. With passing lanes, BRT can carry up to 45,000 pphpd, the capacity of Bogotá's Transmilenio. Grade separated metros can achieve volumes of 60,000 pphpd. These values are compared in the figure below. Clearly, Ranchi does not require a high capacity system at present. Medium capacity systems can serve the need more effectively.

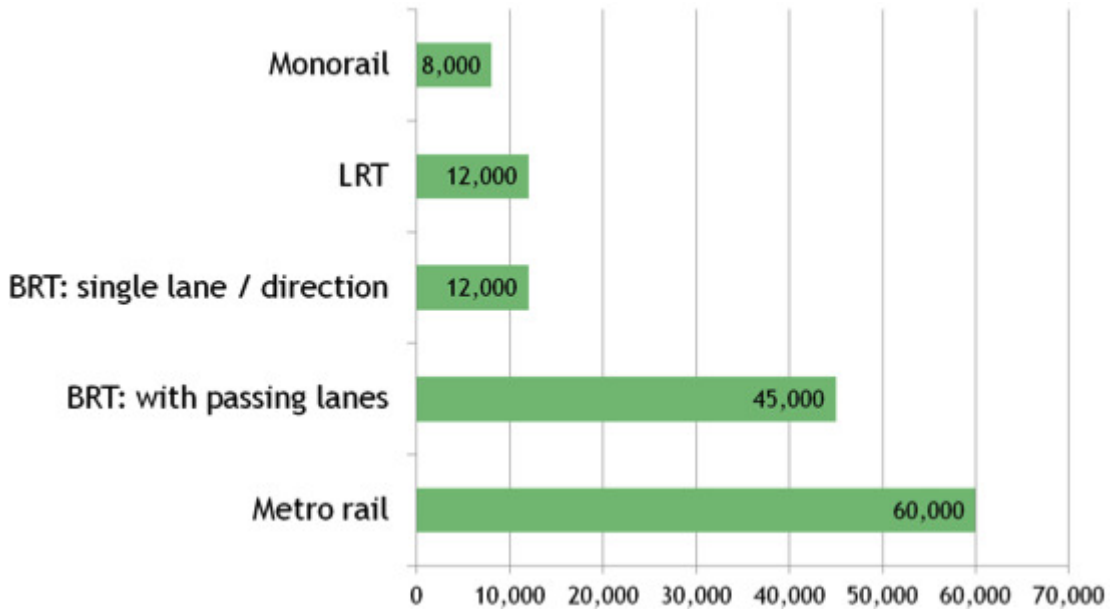

Figure 35: Typical capacity of MRT systems.

Implementation cost: Capital costs vary considerably among MRT technologies, ranging from around Rs 20 Cr per km for BRT to upwards of Rs 400 Cr for a metro system. Given the cost differential, it is advisable to choose the least expensive mode that adequately meets the travel demand requirements of the city. When viewed on a per passenger basis, the

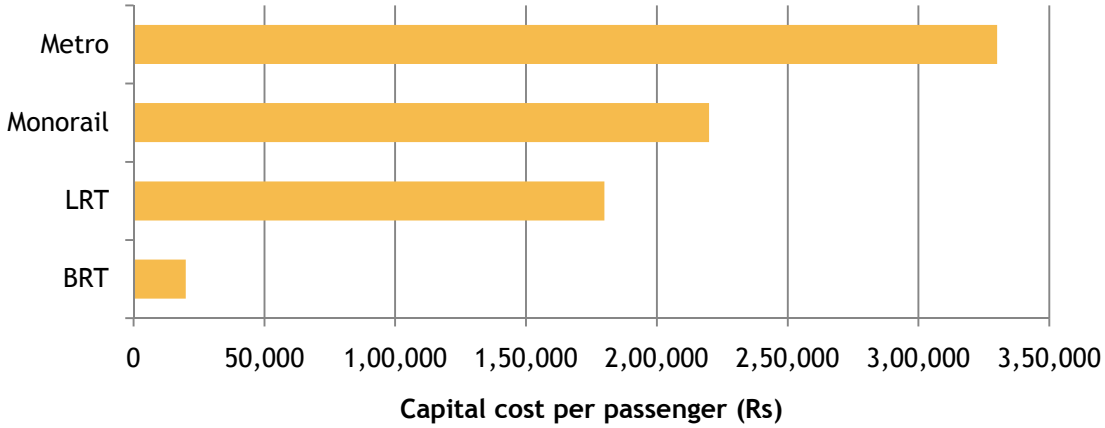

Figure 36: Implementation cost per passenger of rapid transit technologies

Implementation time: Implementation time is another critical factor in the decision among competing MRT technologies. The longer it takes to implement MRT corridors, the longer the city has to wait to present a compelling public transport option to customers. In the absence of any improvements, more and more public transport and NMT users will switch to personal motor vehicles. Once they do so, it is more difficult to convince them to return to using public transport. Given adequate political support, BRT can be implemented in under three years, from the planning stages through to construction and operations. The Janmarg system in Ahmedabad demonstrates how fast a BRT system can become the backbone of a city's transport network. What began as a 12.5 km pilot corridor in 2009 has expanded to 82 km, providing cross-city connections. Some of the world's most successful BRT systems, including those in Bogotá, Rio de Janeiro, and Mexico City, have been implemented in 2 to 3

years. Rail-based systems can take upwards of 8 years to plan and construct. Some of India's major metro rail projects, such as those in Bangalore and Chennai, are expected to take up to a decade to fully implement their first phases.

Figure 37: Mexico City's initial BRT corridor was implemented in 2 years (left), while the TransCarioca BRT in Rio de Janeiro was built in 3 years (right).

Convenient station access: Stations should be easy to access, particularly for passengers with disabilities. Stations of a BRT system or LRT (provided it is at-grade) are easier to access compared to the elevated or underground stations of a grade separated monorail or metro system. Station spacing of at-grade systems like BRT is typically small (i.e., 400-500 m), compared to over a kilometre in case of grade separated systems. Therefore, people have to walk less to reach systems like BRT and surface LRT, not only making them more convenient but also reducing door-to-door travel time.

Frequency of service: BRT systems with smaller vehicles and headway (time between two vehicles) of one minute or less provide by far the most frequent service. The headway of most rail systems is 3 minutes. For lower demand system, the headway tends to be higher, upwards of 10 minutes, resulting in longer wait times for passengers.

Flexibility and reduced need for transfers: BRT is unique as an MRT system in terms of its flexibility with routing options. Unlike rail-based systems, BRT buses can turn from one corridor to another, allowing passengers to stay on the same vehicle all the way to their destination rather than having to make multiple transfers. Since buses can move freely among multiple corridors, direct services can be provided for all of the major origin-destination pairs in the system, resulting in significant savings in waiting time for passengers. With buses of the right specification, the BRT routes can go beyond the network of dedicated corridors where needed, as described below.

Street Footprint. BRT stations occupy less space and are less visually intrusive than the large elevated structures of monorail and metro stations.

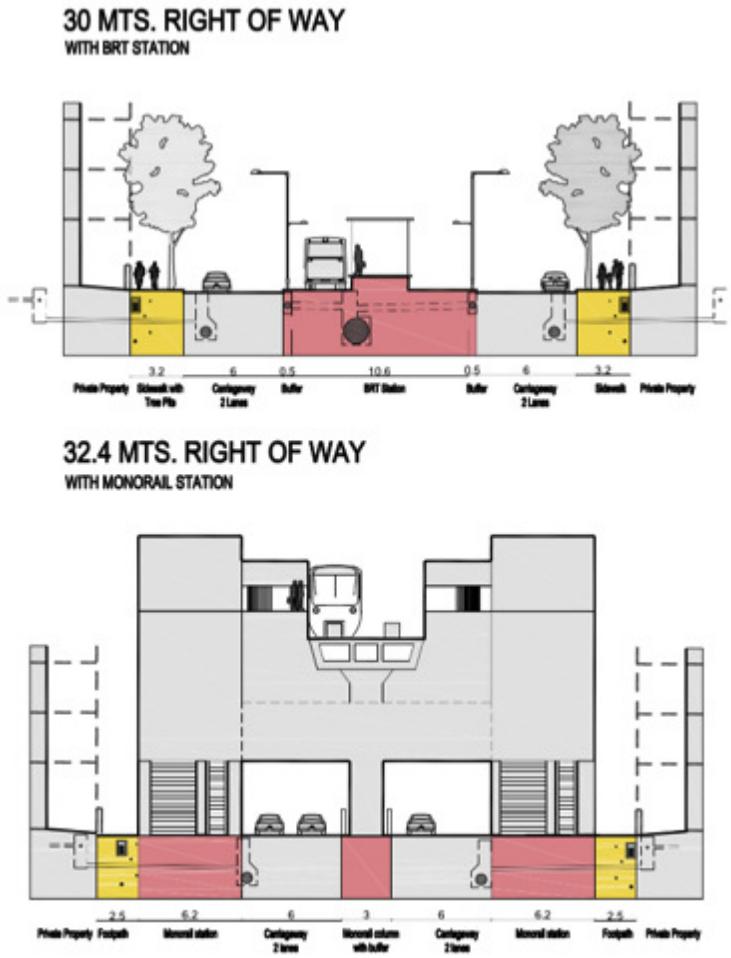

Figure 38: Comparison of space requirements of BRT and monorail stations.

Travel speed: Rail systems are typically associated with higher speed. However, frequent stops in urban rail systems, along with safety considerations, results in average speed of 30kmph. The best performing BRT systems have speeds ranging from 20-26kmph. However, shorter walk to BRT stations because of more frequently placed stations, shorter wait time at station because of more frequent services, and reduced need for transfers translates into faster trip from door-to-door.

Integration with existing bus-based public transport. In cities around the world, buses are the main form of public transport. This is true even in cities with extensive rail systems, including London, Mexico City, Hong Kong, and Singapore. Similarly, road based public transport (buses and paratransit) forms the backbone of Ranchi's public transport network and will remain so even after an MRT system is implemented. Therefore, it is important to evaluate how easily the MRT system can be integrated with the city bus system. In this respect, BRT has a definite advantage over rail-based systems. Not only can the system provide cross-platform transfers between BRT and non-BRT services at integrated terminals, but BRT services themselves can leave the corridors to reach closer to passenger destinations. Such "direct services" bring the system closer to the user's doorstep, eliminating the need for transfers to intermediate modes or feeder buses. In the Guangzhou BRT system, all but one of the 40 BRT routes provides direct service outside the segregated corridor.[15]

[15]http://www.chinabrt.org/en/cities/guangzhou.aspx

Safety: Because the dedicated corridor segregates buses from smaller vehicles, minor as well as major accidents come down dramatically. With appropriately spaced pedestrian refuges, conflict between BRT buses and pedestrians crossing the street reduces dramatically. Extensive safety measures need to be incorporated in case of elevated and underground rail systems, whether it is metro-rail, LRT or monorail. During a recent technical failure on the Mumbai monorail, stranded passengers were evacuated using fire brigade cranes because there was no way for passengers to leave the train.[16] The Government of Maharashtra is now considering a costly retrofit to equip the corridor with catwalks to allow passengers to escape during emergencies.[17] BRT systems do not have such complications. In case of an emergency, passengers are easily evacuated.

Size of maintenance facilities: Since buses are flexible, greater freedom is available in locating maintenance and parking facilities. These depots are also much smaller than rail system depots and thus need smaller land resource to place them. Average BRT depot holds 100-300 buses and requires a space of 5-12 acres. A system of 1,000 buses, which can serve around 1.5 million passenger trips daily, can be managed out of 6-8 facilities spread across town. This reduces the number of dead kilometres (i.e. nonrevenue earning km). The system can serve a larger distributed network.

Reliability. Rapid transit technologies offer varying degrees of reliability. While BRT, LRT, and metro systems have been implemented in many cities around the world, monorail technology is relatively untested. In Mumbai, only 2 of 11 original train sets were operational in late 2014.[18] As a result, the system could operate only at severely reduced headways of 22 minutes between trains. One train set needed such extensive repairs that it was returned to manufacturer Scomi in Malaysia. In light of the system's poor record, the Government of Maharashtra has announced that it will not build any more monorail lines.[19] Monorails elsewhere in the world have become obsolete after an operational run of only two decades. Sydney, Australia, recently scrapped its monorail system, and another monorail in Newark, U.S.A., is slated for demolition.[20]

Table 12: Contrasting elements of MRT systems

	Metro	Monorail	LRT	BRT
Sufficient capacity to meet projected corridor demand in Ranchi	Yes	No	Yes	Yes
Investment cost for Ranchi MRT network (cr Rs)	12,800	6,400	5,200 (at-grade)	640

[16]http://www.deccanherald.com/content/465817/passengers-evacuated-snag-hits-mumbai.html
[17]http://www.hindustantimes.com/mumbai/chembur-wadala-monorail-platforms-to-be-constructed-between-tracks-at-five-spots/article1-1349747.aspx
[18]http://www.dnaindia.com/mumbai/report-dna-exclusive-monorail-epic-fail-just-2-trains-fit-to-operate-2026794
[19]http://articles.economictimes.indiatimes.com/2015-04-16/news/61217883_1_mumbai-monorail-wadala-and-chembur-jacob-circle
[20]http://www.abc.net.au/news/2012-03-23/last-stop3a-sydney27s-monorail-to-be-scrapped/3908166, http://www.nj.com/news/index.ssf/2015/04/newark_airport_monorail_targeted_for_scrap_heap_cost_354m_to_build.html

	Metro	Monorail	LRT	BRT
Easy-to-access stations	No	No	Yes, if at-grade	Yes
Flexibility in route planning	No	No	No	Yes
Integration with bus-based transport	Limited	Limited	Limited	Yes
Implementation time (years)	6-8	6-8	6-8	2-3

5.1.4. The right mode for Ranchi: An integrated city bus and BRT network

Taking into account the increasing demand for a better quality transport system, Ranchi has the potential to implement an MRTS system. A bus-based system is more appropriate for the city where it is easy, cost effective, and quick to implement. ITDP specifically recommends BRT over other systems such as metro, LRT, or monorail based on the following advantages:

- Ability to meet existing passenger demand and scale up to meet future demand;
- Ability to provide flexible services, and change service design for increase in capacity;
- Adaptability for narrow streets; and
- Low implementation cost.

Taking into account the corridors with high public transport demand and areas with low to moderate demand, a comprehensive network of BRT corridors used by direct and feeder services that extend high quality public transport to areas surrounding Ranchi was identified as the right mode for Ranchi's MRT system. The BRT component of this system should be implemented in two phases.

Phase 1:

- **Ratu Road** from Piska More to Kutchery Chowk
- **Main Road** from Kutchery Chowk to Dhurva
- **NH-75** from Ratu Road to Birsa Chowk
- **Purulia Road** from Firayalal to Namkum Railway Station

Phase 2:

- **Kanke Road** from Pahad colony to Reliance Market
- **Hazaribagh Road** from Main Road to Kabristan
- **Nagri Road** from Piska More to Lalghutuwa
- **Pathiyatola Road** from Jail More to Beda Chowk
- **Lodhma Road** from Doranda to J.M. Chowk

This BRT network must have a set of key features in order to provide a high quality service. Compromising on any of these features will not save much money but will significantly lower the quality of the service.

5.2. Public transport system design

Public transport services are designed to address specific customer needs. A customer may attach value to a wide variety of system characteristics: economic affordability, reliability, system aesthetics

and attractiveness, travel time saving, ease of accessibility, and comfort level. The operational and physical design of the system determines how effectively these valued characteristics are prioritised and implemented. Thus, the design must balance various factors, including customer service and cost efficiency.

5.2.1. Ensuring quality: The BRT Standard

As implementing agencies begin the planning process for Ranchi's public transport network, it is essential to establish consistent design standards to ensure that the system meets international best practices in BRT design. One resource that can guide this process is the BRT Standard,[21] which was developed to create a common definition of bus rapid transit and recognize high-quality BRT systems around the world. It also functions as an evaluation tool to guide municipalities as they move through the design process.

The Technical Committee of the BRT Standard comprises globally renowned experts on BRT. This committee serves as a consistent source of sound technical advice with respect to BRT and is the basis for establishing the credibility of The BRT Standard. The BRT Standard will serve as the basis of ITDP's corridor design recommendations for Ranchi. The Ranchi BRT system should, at the very minimum, include the BRT Basics as outlined in the BRT Standard 2014. The BRT Basics are essential features of a BRT system: dedicated right-of-way, median busway alignment, off-board fare collection, intersection treatments, and platform level boarding. These elements are described in more detail later in this section.

Dedicated Right-of-Way
Bus-only lanes fully segregated from mixed traffic

Busway Alignment
Bus-only lanes aligned to the middle, not the curb, of a road

Off-Board Fare Collection
Turnstile-controlled or proof-of-payment fare collection system

Intersection Treatments
Mixed-traffic is prohibited from making turns across the busway

Platform-Level Boarding
Station platforms level with bus floors when boarding and alighting

Figure 39: The BRT basics

ITDP recommends that Ranchi aim higher than just achieving the Basics: all corridors in the city be built and operated as silver or gold-standard BRTs. Gold standard features are fully justified in the high-demand corridors in Ranchi. The phase 1 network has the potential to become an important catalyst for expansion of the BRT system and other sustainable transport projects in Ranchi.

5.2.2. Public transport service planning

Average public transport trip lengths in Ranchi are relatively short—around 6 km. Therefore, it is especially important that the city's public transport system avoid increasing the number of transfers that customers are required to make. Any intervention that adds a transfer in such a short trip is likely to increase overall travel time, even if a new mode of transport offers somewhat higher commercial

[21] http://www.brtstandard.org

speeds. Thus, a public transport service plan for Ranchi should improve speed and reliability while minimising the need for transfers.

A hybrid BRT system with a dedicated fleet of buses that operate in the network of dedicated lanes and as well as service extensions can help meet these objectives. BRT routes must operate as "direct services" that travel a distance outside the dedicated BRT track to reach important destinations. In doing so, the system can offer one-seat journeys for as many customers as possible.

To summarise, the Ranchi BRT system will consist of the following services:

Direct services. Operating in trunk corridors and then extended beyond the trunk corridor in mixed traffic lanes to provide better connectivity and attract ridership.

Feeder services. Operating in mixed traffic, bringing passengers to terminals and stations on BRT trunk corridors.

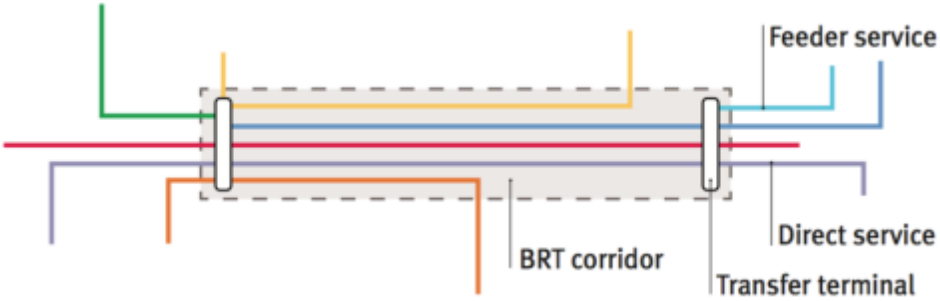

Figure 40: The Ranchi BRT will provide direct and feeder services.

Only the fleet of custom-built BRT buses will use the network of dedicated bus lanes and special BRT stations, in contrast to an "open" BRT system in which any bus may enter the bus lane. Best practice BRT systems such as Bogotá's Transmilenio and Ahmedabad's Janmarg maintain high performance by operating all BRT services with designated BRT vehicles.

Ranchi is characterised by narrow streets in the core area and wider road widths in the immediate neighbourhoods and outlying areas. Despite width constraints in the core area, it is possible to implement BRT on narrow streets, as many cities across the world have demonstrated. Specific BRT corridors for Ranchi were determined after carefully evaluating a number of parameters including:

- Existing conditions peak hour passenger travel demand patterns
- Future year travel demand and proposed projects
- Right-of-way (ROW) availability along various corridors
- Eliminate traffic congestion on highly congested roads
- End to end connectivity and ease of access
- Ensure equitable access to the system to people across all socioeconomic groups
- Minimal passengers transfers
- Minimal land acquisitions

The existing conditions peak hour passenger travel demand patterns were analysed and high demand corridors were determined. The right-of-ways (ROW) of all major roads in Ranchi were determined using Google Earth and confirmed with field measurements at critical locations.

Existing share auto and bus routes have significant overlap with the suggested BRT corridors. The proposed BRT routes and direct services will operate and replace all existing public transport and shared-auto routes. The 23 proposed services provide access to a number of major origins and

destinations, minimise transfers, and connect the main commercial and educational area of Ranchi to all other parts of the city. The final operations plan has 23 BRT routes. Another round of route rationalisation may be performed in the future once the proposed system stabilises. Electronic fare collection data can provide the necessary input for further rationalisation.

Most trunk corridors in the Ranchi BRT will comprise two-way dedicated median bus corridors with central stations (for more details on physical designs, see Appendix "1.2. Physical design, 1.2.6. Corridor cross sections"). The proposed BRT corridors to be implemented in Phase 1 are shown in the map below. Phase 1 trunk corridors include high demand corridors wherever ROW is available. In Phase 2, the BRT Corridors will include corridors that have been proposed for lane widening as per Ranchi's 2037 Master Plan.

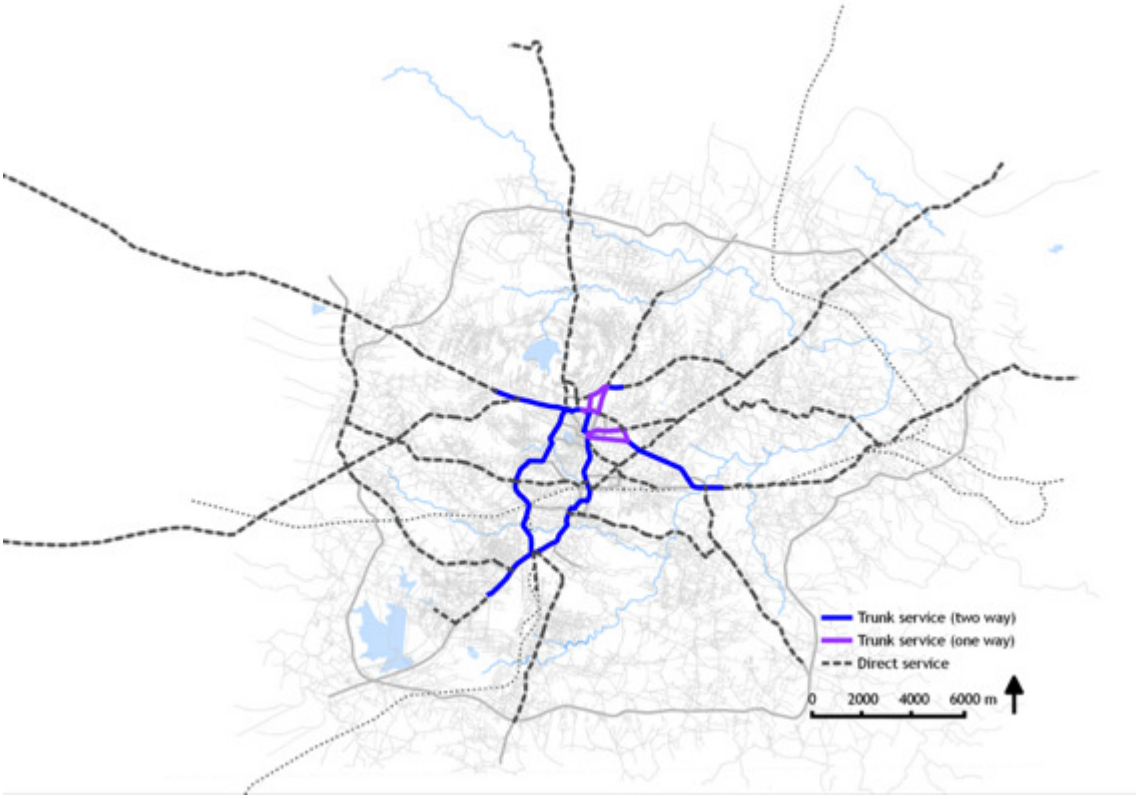

Figure 41: The proposed public transport network combines a core BRT network with direct services to all major public transport corridors in the city. The majority of public transport passengers will be able to complete their journeys without transfers.

The proposed BRT corridors and 23 direct service BRT routes were coded in the Emme BRT scenario and model runs were performed for the existing passenger demand. The route rationalisation was an iterative process, which aimed at optimising the service plan (number of routes, frequency, fleet type, fleet size, load factor) and also minimising the number of passenger transfers. The table below lists the BRT routes, route length, modelled peak hour passenger demand along each route, fleet type, size, and required headway.

Peak hour passenger volumes justify the use of a combination of 18 m articulated buses (with a capacity of approximately 140 passengers) and 12 m buses (with a capacity of 72 passengers). Based on peak hour passenger demand along each route, it is estimated that the bus services will require a total vehicle fleet of 457 buses in the opening year (415 plus 10 per cent contingency). The proposed service plan ensures that the services do not increase overall corridor loads beyond a combined frequency of 60 buses per hour.

Table 13: Proposed BRT and bus services

No	BRT Route Description	Length (Km)	Maximum Boardings/Hr	Maximum Volume/Hr	Headway required (Mins)	Fleet Size	
						12 m	18 m
1	Mandar-Kantatoli	29.6	2,760	1466	5.7	-	28
2	Kathitand-Boreya	17.1	764	394	11.0	10	-
3	Kathitand-BootiMore	18.4	1,106	426	10.1	11	-
4	Kathitand-BirsaChowk	17.4	1,083	411	10.5	10	-
5	Piska Mode-Dasmile	19.9	1,029	528	8.2	19	-
6	Pahartoli-Kanke	39.6	1,854	842	5.1	40	-
7	Ghutuwa-Kantatoli	10.9	1,348	557	7.8	10	-
8	Nagri-Booti More	24.4	1,417	694	6.2	23	-
9	Nagri-Sadabaahar Chowk	25.2	1,284	525	8.2	19	-
10	Kanke-Dhurva	33.8	5,951	1,830	4.6	-	44
11	Kanke-Hatia Railway	16.0	873	309	14.0	7	-
12	Kanke-Dasmile	23.9	1,558	534	8.1	21	-
13	Kutchery-Chutia	5.8	1,082	987	8.5	-	6
14	Kutchery-Angara	24.0	2,239	1,004	8.4	-	16
15	Boreya-Dhurva	18.6	1,366	564	7.7	15	-
16	Ormanjhi-Kutchery Chowk	21.4	1,547	1,108	7.6	-	16
17	Ormanjhi-Dhurva	31.3	2,311	1033	8.1	-	23
18	Booti More-Hatia	17.4	1,534	736	5.9	22	-
19	Booti More-Doranda	11.5	1,285	845	5.1	15	-
20	Kantatoli-Dasmile	16.9	1,028	412	10.5	14	-
21	Tatisilwai-Birsa Chowk	22.7	1,909	587	7.4	21	-
22	Ratu Road-Rampur	16.3	1,454	708	6.1	17	-
23	Dasmile-Dhurva	14.9	661	270	16.0	8	-

It is essential that feeder services be planned and integrated to support (but not compete with) any MRT system. Therefore, developing and supporting an efficient network of feeder routes will be an important task of implementing Ranchi BRT. Licensed share autos can still operate as feeder routes to the proposed BRT services and also operate along low demand corridors. The unlicensed share auto

rickshaw operation should be regulated. The share auto drivers can be employed in the proposed bus and BRT system operations and maintenance.

The table below provides the fleet size requirements for the existing and BRT scenario for all public transport vehicle types. The BRT scenario suggests a fleet size of 310 regular 12 m buses and 147 articulated buses (18 m).

Table 14; Existing vs. required public transport fleets

Vehicle type	Fleet size according to secondary sources	In Operation	Required	Required
Diesel auto	7,000	4,483	2,715	-
Petrol auto	2,500	347	262	-
Electric auto	30	24	30	-
Trekker	200	51	104	-
CRB/RMC1/RMC2 Bus	110	59	68	-
12 m BRT Bus	-	-	-	310
18 m BRT Bus	-	-	-	147

The operational statistics for the existing and BRT scenario are presented in the table below. For the same number of peak hour trips, the transfer rate reduces from 13.6 per cent to 8.8 per cent in the BRT scenario. The reduced transfer rate can be attributed to the direct services to major destinations that have been proposed. This benefits the people in terms of travel time savings, fare and convenience. The proposed BRT network will help in reducing the average travel time per passenger by 16 per cent and the average vehicle speeds also increase by 17 per cent.

Table 15: Peak hour operational statistics for existing and BRT scenarios

Indicator	Existing	BRT Scenario
Public transport trips (peak hour)	60,784	60,784
Total boardings (peak hour)	69,038	65,547
Estimated transfer rate	13.6%	8.8%
Total vehicle kilometres (km)	89,076	31,145
Average vehicle speed (km/h)	18.0	21.0
Average “in vehicle” travel time per passenger (min)	19.9	16.6

5.2.3. Corridor designs

The design of the integrated public transport corridors in Ranchi requires careful planning towards addressing accessibility for passengers, traffic management, integration with other infrastructure, and provision for public utilities and landscaping. The Ranchi BRT network will have a variety of different cross sections, depending on the available ROW and the nature of street uses.

ROWs of 24 to 30 m are available on many sections of the proposed corridors, allowing for two-way median BRT lanes, two carriageway lanes per direction, large footpaths with shade trees, and area for parking and for social uses such as public plazas or vending. Since BRT stations are so close together (at most 500 m), NMT improvements, such as footpaths, street furniture, landscaping, kerb ramps, and table-top crossings, must be provided continuously along BRT corridors. Thus, with BRT, Ranchi will be able to transform these streets for all potential users. BRT becomes not simply a new public transport service, but it emerges as a system through which urban areas are transformed and urban development is strengthened through increases in accessibility and mobility.

For narrower ROWs, some elements must be reduced in width or omitted from the cross section. In general, these modified cross sections should prioritise pedestrian mobility, ensuring a minimum 1.8 m of clear space throughout the corridor. In some cases, one-way movements may be introduced for mixed traffic to ensure that there is sufficient space for BRT and pedestrian elements. Detailed cross sections for the entire BRT network are presented in Appendix "1.2. Physical design, 1.2.6. Corridor cross sections."

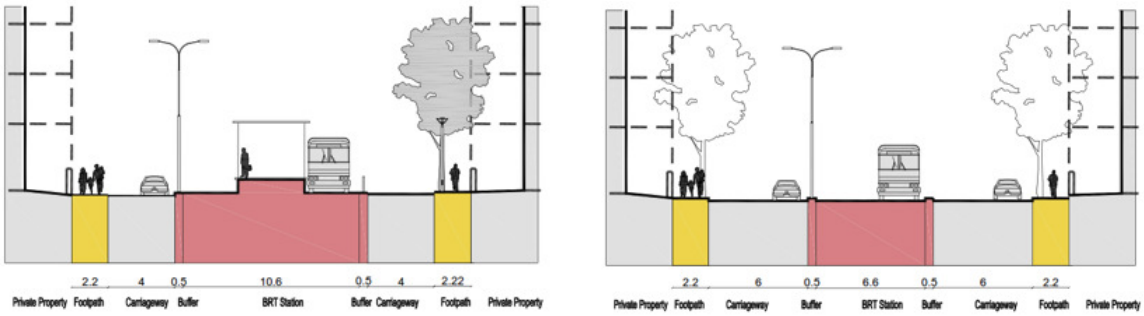

Figure 42: 24 m BRT corridor sections with (left) and without (right) a station

Figure 43: BRT can be implemented even on narrow streets, as demonstrated in these cross sections from Medellin (top) and Mexico City (bottom).

5.2.4. Station design

An experienced architect should be hired to create beautiful stations that bring pride to Ranchi. The aesthetic design of a station is important as they demonstrate to the public that BRT is a lasting investment that providing tangible benefits to the area in which it is implemented. Each station will serve as a point of introduction for the system so it is important to leave riders with a lasting positive impression. A prominent, attractive station has the potential to inspire the communities around it while encouraging further improvement in the surrounding neighbourhood.

Figure 44: Iconic station designs, such as those in Rio de Janeiro's TransOeste corridor, can raise the profile of the BRT system.

In addition to aesthetics, stations and terminals must be carefully planned together with the vehicle design to ensure that level boarding is provided for all customers. This means that important vehicle characteristics such as interior floor height and vehicle width must be identified and verified as the station is being designed. Similarly, station platform dimensions must be determined well in advance of the bus fleet procurement to ensure that the floor levels of bus and station platform are sympathetic. Construction error tolerance is equally important, and must be vigilantly monitored so that the detailed project designs are appropriately implemented. Finally, once the system is operational, all vehicles must be consistently maintained so that tire-pressure and vehicle suspension performance do not create gaps between the vehicle floor height and the boarding platform level.

Figure 45: The design of stations and buses must be coordinated to provide level boarding.

It is important that Ranchi plan for the infrastructure required by all BRT phases. Phase 1 terminals should be designed with extra capacity to accommodate future public transport demand. Stations and terminals should be designed in a modular format to facilitate future expansions.

BRT station design requires including basic aspects like platforms, transition areas and integration infrastructure to access stations. The station design and size can vary based on demand. In general, BRT station design is largely a function of user requirements:

- **Comfort**: Seats, leaning bars, and space for passenger movement
- **Safety**: Adequate lighting, visible interiors
- **Accessibility**: Minimal level differences and ramped access from street level
- **Aesthetics**: Attractive to passengers, giving a sense of ownership
- **Provision of customer information**: Both static and real-time

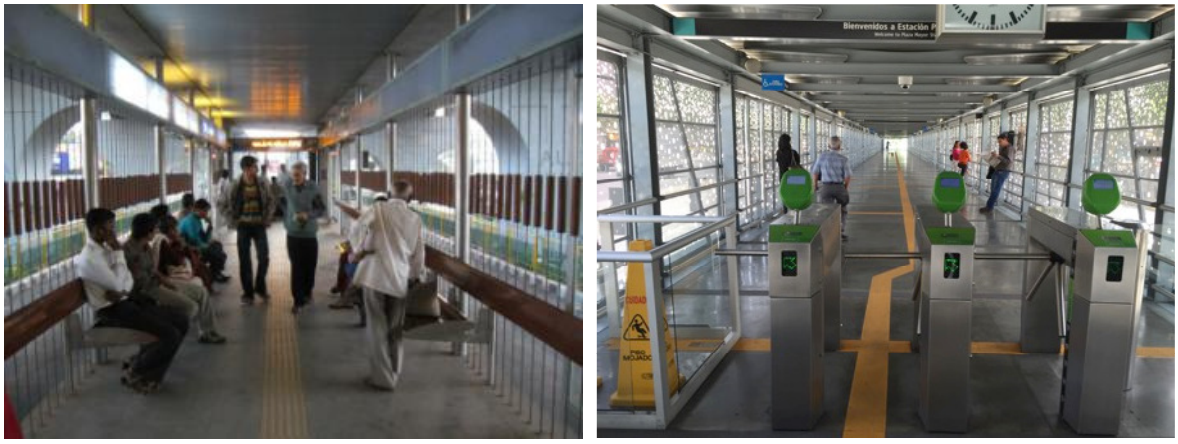

Figure 46: Station interiors should provide sufficient space for boarding, alighting, passenger circulation, and waiting.

5.2.5. Bus stops on direct service corridors

The proposed direct services will not include dedicated busways or centrally located median stations with dual side boarding. The dedicated bus stops will be provided on the curb at the left side. Most BRT services will utilise high-level boarding platforms, and require doors with a high floor on the right side. Because BRT vehicles will also need to utilise extension bus stops, they must be also be equipped with doors on the left side. Extension stops will not be high-floor stops, so the vehicles will require stairs at the left side door.

Extension stops should include the following key features:

- Kerb bulb-outs (where the pavement extends out to the travel lane) are recommended to reduce the gap between the kerb and vehicle, as well as maximize the space available for the shelter and street furniture for waiting customers.
- Shelters that provide protection from the elements (sun, rain, etc.), ample seating, and a waiting area that is facing the travel lane and adjacent to the boarding area.
- Static stop name, system map and general customer information signage as well as dynamic visual and auditory displays to deliver in real-time vehicle arrival timings and system messages (service delays, temporary service route adjustments, emergency messages, etc.)

It is especially important that advertising kiosks, if provided at shelters do not encroach on the 1,200 mm clear path of travel described above. Advertising placement must not obstruct the view of approaching transport vehicles and traffic. Similarly, a clear 1,800 mm path of travel is necessary behind the bus stop so that pedestrians travelling along the corridor are able to seamlessly pass the bus stop without interRMPtion.

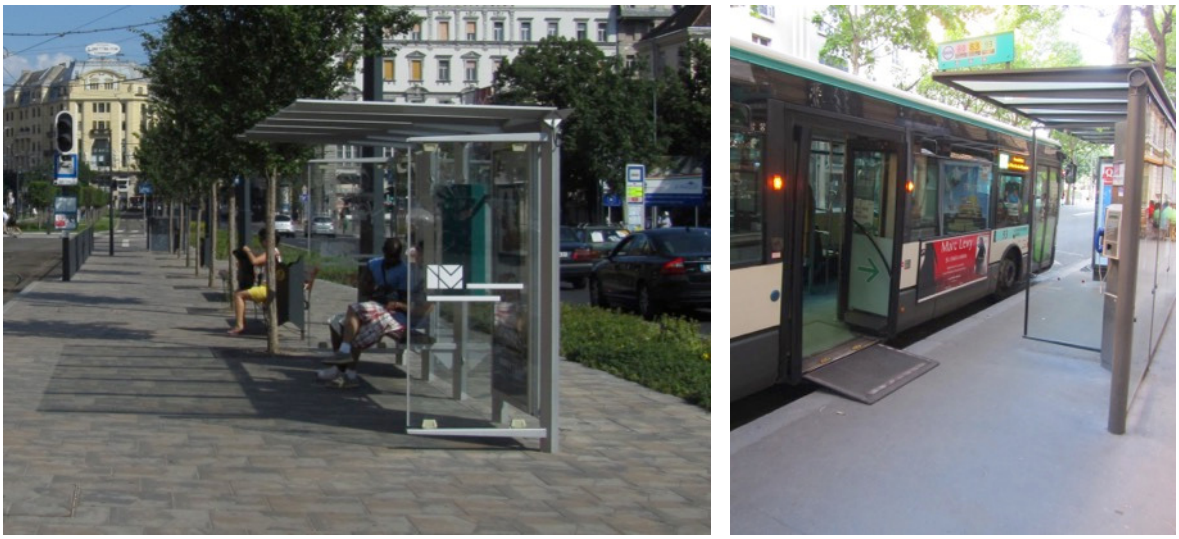

Figure 47: Corridors with direct services require high quality bus shelters that are accessible to all users.

5.2.6. Fare collection

A modern fare collection subsystem is an essential component of a modern public transport service planning. It is important that the Ranchi public transport system utilise off-board fare collection at BRT stations. Smart cards use embedded microchips to electronically store data. This technology enables payments to be tracked, and also monitors the ticket's validity and use. Off-board collection of fares facilitates quicker boarding times, keeps the buses on a consistent time schedule, and makes the system simpler and easier for customers to use.

The Ranchi fare collection system will include the following components:

- Off-board fare collections with smart cards in BRT sections: Electronic, off-board fare collection will help prevent revenue leakage, reduce operational cost and simplify customer transactions.
- Smart tokens and electronic ticket machines (ETMs) for transactions with a conductor, for non-BRT sections.

For Ranchi, a pre-paid smart card system should be designed in such a manner that they may be used in multiple transport services and essentially function as a common mobility card across whole region. This would offer functionality similar to London's Oyster card, or Hong Kong's Octopus card.

Oyster Card - London

Operating Agency: Transport for London
Single card used across trains, buses, ferry, parking, etc.

Octopus Card - Hong Kong

Operating Agency: Hong Kong Mass Transit Railway
Single card used across trains, buses, ferry, parking, etc.

Figure 48: Smart cards used in two successful integrated ticketing systems

5.2.7. Passenger information

In modern public transport systems, accurate, real time and authentic information on a journey plays a key role in attracting and retaining commuters. Passengers are provided this information not only through printed timetables and maps, but also via live displays and announcements at bus stops, in the buses, on mobile phones. Access to such information is helpful for daily commuters as well as visitors, not to forget the vision and hearing impaired.

Figure 49: Real-time passenger information keeps customers up to date on bus destinations and departure times (left). Clear schedules and maps summarize system information.

Real-time information is especially important, as it creates a bridge between a passenger and the system administration and establishes reliability in operations management.

- Inside stations, electronic displays inform waiting passengers when the next bus will arrive.

- On the buses, displays and audio announcements indicate the upcoming stop. Effective customer information systems help make the system accessible to all users, particularly people who are new to public transport.
- A call centre, SMS-based alerts and route information, web-based information, and smart phone apps should provide on-demand trip planning advice and other types of system information.

The passenger information system must be supported by a control and data processing centre that collects real time information on the location of buses, processes it, and provides it to commuters in the format they find useful. Information gathered as part of this system will be an excellent planning resource internally, but also should be made available to the public to facilitate the development of innovative services by third party developers. It is also important that Ranchi public transport system follow the Open311 standard to allow private software developers to create innovative products with the transport data that the organization collects.[22]

5.2.8. Branding and marketing

In this day and age, people are acutely concerned about lifestyle and image. Being efficient and utilitarian is not sufficient. Attractive branding and constant outreach is essential for the successful adoption and patronage of a new public transport system, especially by the growing middle class. As prosperity rises, public aspires to be associated with products and services that exude style and class. The marketing team needs to create a buzz that BRT is more than just another bus.

A powerful brand of a bus system is much more than an attractive logo and a catchy name. A brand stands for various special services a system renders to commuters, and thus instils a sense of pride in the commuters, the staff from the system and the city as a whole. The public transport system of Ranchi should meticulously develop a brand of its own.

Figure 50: Logos add to the identity of BRT systems (from left to right): Metrobus, Mexico City; Rea Vaya, Johannesburg; MyCiti, Cape Town; Metropolitano, Lima; Transjakarta, Jakarta.

Figure 51: In Los Angeles, U.S.A., distinctive bus colours to convey information about services (e.g. local vs. express) and contribute to the identity of the system.

[22] For more information see open311.org.

5.2.9. Information management system

IT systems are necessary to manage the large amount of bus operations and financial transactions data is that generated through every day activities. For Ranchi public transport operations reporting and performance assessment, developing a robust information management system (IMS) is critical. The primary output of the system is generating reports for various levels of public transport system managers.

Ranchi public transport IT service provider must develop a graphical dashboard which will give output of real time information pertaining to bus operations and financial transactions. The dashboard should be adjustable to display key real-time operational details (summary of real time passenger boardings at various stations, tickets issued, buses on road, live bus tracking, bus speeds, etc.) visible to senior officers of transport authority and management staff at the centralised control facility.

5.2.10. Corridor management

It is critical that traffic along the corridor be monitored and controlled in such a way that BRT operations are not impacted by non-BRT traffic (of any and all modes). Effective corridor management will require close coordination with Ranchi Traffic Police and the public transport agency, as well as dedicated traffic management personnel employed by responsible to the BRT operating body. Such BRT-focused traffic police must ensure that junctions are not blocked by traffic regardless of signal activation or intersection design. BRT-junction guards are key gatekeepers to the system, and must be vigilant to prevent private vehicles, pedestrians, animals, and others from accidentally entering the bus way. Corridor management also includes a detailed assessment and review of the existing legal framework for traffic management and the existing capacity of the Traffic Police and public transport agency.

During the initial phase of BRT operations, in order to sensitise vehicle users and prevent the BRT corridors from being encroached personal motor vehicles, it is recommended that each opening of BRT corridor have security guards to ensure bus corridor safety and ensure bus priority at junctions. The primary duty of these guards will be to keep motorised vehicles from entering the corridor and ensuring that vehicles give priority to BRT buses at intersections. Even at present, the existing Traffic Police presence is insufficient to enforce discipline of traffic signals in Ranchi; hence for BRT operations traffic management manpower must be strengthened.

5.2.11. Multi-modal integration

For Ranch's public transport system to function as a coherent network, passengers need to be able to transfer easily from one mode to another. Integration does not merely mean placing stations for multiple public transport modes close together. Instead, it involves the detailed design of stations incorporating the following features:

- Short, direct walking paths for transferring passengers
- Minimal level differences
- Adequate clear space to prevent bottlenecks
- Protection from sun and rain
- Public information

It is envisaged that Ranchi railway station, airport, and regional bus service stations will be the major multimodal integration locations wherein BRT services will be fully integrated with and supported by other modes of transport (feeder services, shared auto rickshaws, and private rickshaws).

Figure 52: Designated paratransit stands should be provided at BRT stations to facilitate easy transfers.

5.2.12. Future system planning

To ensure that future streets are planned with public transport, the following corridors have been identified where BRT can be implemented in the future. Ranchi Master Plan 2037 has identified lane widening along a number of important radial corridors. Phase 2 corridors will include these major radial corridors proposed for lane widening.

Kanke Road from Pahad colony to Reliance Market

Hazaribagh Road from Main Road to Kabristan

Nagri Road from Piska More to Lalghutuwa

Pathiyatola Road from Jail More to Beda Chowk

Lodhma Road from Doranda to J.M. Chowk

It is essential that all current and future BRT corridors be included in the current Ranchi Master Plan. Space must be reserved in the median lanes on designated BRT corridors. Also, space for future terminals and depots must be reserved and specifically included in the Master Plan.

6. Paratransit regulation and management

Even as Ranchi expands access to formal public transport services, paratransit modes, including cycle rickshaws and auto rickshaws, will continue to play an important role in the city's multimodal transport network. Therefore, these modes require a supportive regulatory environment.

6.1. Cycle rickshaws

Cycle rickshaws serve as a dominant mode of transport in dense commercial areas such as Main Road and narrower, pedestrian priority streets. The cycle rickshaw is an efficient and low-cost vehicle that can serve as an excellent transport option for short-distance trips. Pedal powered vehicles are used extensively in Indonesia and other South Asian countries and are gaining popularity in Europe and America as modern, eco-friendly "pedicabs." RMP supports measures to encourage the use of cycle rickshaws as a non-polluting alternative to motorised paratransit and private modes.

Punitive measures intended to restrict the use of cycle rickshaws must be replaced with a supportive regulatory environment that recognises the important role of cycle rickshaws in Ranchi's mobility system. Shared autos running on fossil fuels are already banned on Main Road, because of which that road sees a higher concentration of cycle rickshaws. There is a belief that too many cycle rickshaws clog Main Road, and the number of cycle rickshaws plying on main road should be restricted. Instead, some or all of the following measures may be considered after a focused study and discussions with all stakeholders:

- Expand the "no fossil fuel autos" zone on Main Road or create similar zones in other parts of the city
- Restrict the number of cars entering this zone instead of restricting the number of cycle rickshaws
- Implement a congestion charge on cars entering the zone, at least during rush hours

It should be noted that the decision to ban cycle rickshaws in certain parts of New Delhi was rejected by the Delhi High Court[23].

The measures suggested above are in line with the decision to ban shared autos running on fossil fuels on Main Road, and will contribute to reducing pollution and congestion on Main Road.

6.1.1. Cycle rickshaw vehicle design

The rickshaws currently plying in Ranchi are old, rickety, and uncomfortable for drivers as well as passengers. Fleet modernisation can make the cycle rickshaw lightweight, safer, and more comfortable. Contemporary cycle rickshaws use an ergonomic tubular frame and have optional multi-gear systems. These vehicles are 30 per cent lighter and also have a longer life span with lower maintenance and repair costs. They are priced at par with the traditional rickshaw. The comfortable passenger seating, easy step-in boarding, canopy overhead, luggage space, and jerk-free ride make for a better customer experience.

[23] http://www.hindustantimes.com/newdelhi/cycle-rickshaws-may-be-back-on-delhi-main-roads/article1-1065516.aspx

Figure 53: Modern rickshaws are lightweight and ergonomic.

The Cycle Rickshaw Improvement Programme, an effort initiated by ITDP in 1996 to introduce modern rickshaw designs, resulted in the widespread adoption of contemporary models in north India. At present, 600,000 modern cycle rickshaws ply on the streets of Delhi, Jaipur, and Agra. Government-supported purchase programmes can help to introduce these newer models to Ranchi and extend financial assistance to drivers who wish to obtain a new vehicle.

Figure 54: Close to 500,000 modern cycle rickshaws ply in several Indian cities including Agra, Delhi, Brindavan, Vrindavan, and Fazilka. Such vehicles can be introduced in Ranchi.

6.1.2. Cycle rickshaw fleet management services

RMP recommends a pilot implementation of a streamlined cycle rickshaw service that is available via phone call, SMS, mobile apps, website, or at doorstep through a simple network of call centres. It would operate similar to a call taxi service. Such a service can bridge the gap between the high demand for transport and the low supply of intermediate public transport operators willing to make short journeys.

One such formal network is the Ecocab system in Fazilka, Punjab, which provides on-demand dispatching of rickshaws via a call centre and facilitates driver benefits such as healthcare plans and educational resources for family members. Ecocabs is a dial-a-rickshaw service, the first of its kind in India. It was started by a nonprofit organization, the Graduates Welfare Associations, Fazilka (GWAF), in 2008. In many cities, rickshaws cluster around high intensity commercial areas and are harder to find in residential areas. To address this issue, Ecocabs established call centres that dispatch cycle rickshaws in various zones of the city. Each centre serves close to 1,500 households and an Ecocab reaches a given destination within 10-15 minutes.

Ecocabs has also been successful in improving the socioeconomic conditions of the rickshaw pullers by providing social and financial security to the rickshaw pullers in the form of an insurance policy, health check-ups, medical aid, and support for children's schooling. The Fazilka Municipal Council has supported the Ecocabs initiative, and the Punjab Heritage and Tourism Promotion Board is exploring the possibility of replicating the model in Amritsar and Patiala.

In Ranchi, RMP member Maitri has been working to expand the social services available to cycle rickshaw drivers. Maitri led efforts have helped cycle rickshaw drivers to register for universal identification cards and voter IDs and have disseminated information on health issues of relevance to cycle rickshaw drivers, including the prevention of sexually transmitted diseases such as AIDS.[24] Maitri is also exploring ways to expand access to bank accounts and insurance schemes.

A regularized rickshaw fleet can be designed to accommodate ample space to display paid advertisements. A program coordinator, call centre staff, and dedicated repair service are also required. To make the service more consistent and dependable, facilities should include covered rickshaw parking, a puller hostel and canteen. To implement an initial phase of this service in central Ranchi, it is estimated that Rs 20 lakh in capital costs and Rs 30 lakh in annual operating expenses are necessary.

6.2. Auto rickshaws and taxis

Private auto rickshaw and taxi services offer the convenience of a personal motor vehicle without the need for ownership or daily use. It is strongly desired that the auto rickshaws follow the most modern emission norms that would be in force from time to time. The rickshaws should also provide seating comfort to both passengers and the driver alike, while also providing better visibility of the surroundings.

The fare charged by the auto rickshaws should track the price of inputs such as vehicle payments, petrol, and insurance in order to provide a fare that is affordable for customers and economically viable for drivers. In addition, there should be transparency in the fare being charged to the commuter. This can be achieved by mandating electronic meters as are commonly found in several Indian cities.

Private call taxi services such as Ola have recently entered the market in Ranchi. The government should provide a constructive regulatory environment for these services, which offer a convenient mobility option for customers. However, adequate measures are required to ensure safety of users.

[24] http://issuu.com/goenka.parul/docs/maitri_annual_report_final

7. Personal vehicles and travel demand management

It is not possible to provide completely or even mostly segregated facilities for all modes. It is inevitable that the paths used by pedestrians, public transport, cyclists and personal vehicles will intersect. How these intersections are treated speaks volumes about whether the city values people or vehicles. As explained earlier, this document focuses on making it easier to travel in the city by using sustainable modes: walking, public transport and cycling.

As cities around the world have shown, it is futile to try to accommodate an ever-growing number of personal vehicles by expanding the roads. Traffic simply expands to occupy all the available space. Speeds return to the same low levels they were earlier—but with more vehicles stuck in traffic. The key to successful transport management lies not in providing facilities to accommodate all the burgeoning traffic, but in using the available road space as efficiently as possible. In order to improve the commuting experience of personal vehicles, it is necessary to take measures that control and manage the demand for their use.

Specific measures that should be taken to manage vehicle use include:

- Sound design and efficient operation of junctions, with priority given to public transport and NMT modes
- Management of public parking, including fee collection and enforcement

7.1. Junction design and management

Junction design involves weighing the potentially conflicting goals of safety and vehicle throughput. The design should take into account a variety of mobility options—however, this should not be confused with mobility of private vehicles only. Instead, a desirable outcome of junction design prioritises throughput of public, cycles, pedestrians, and private motor vehicles.

The physical layout of a junction must be designed in conjunction with the signalling plan. In Ranchi, many junctions were designed for much lower traffic volumes. Junctions such as Birsa Chowk, Sujata Chowk, and Kantatoli have physical elements such as traffic circles to organise vehicle movements in the absence of signalling systems. As vehicle volumes grew, traffic lights were installed. However, the physical designs were not modified to reflect the new operating pattern. The conflict between physical elements and signalling makes these junctions difficult for the traffic police to manage, leading to inconvenience for pedestrians, cyclists, and vehicle users alike.

Figure 55: Chowks with roundabouts as well as signals lead to chaos.

While traffic circles can improve safety at low-volume, non-signalised junctions, they contribute to unnecessary delays at signalised junctions such as Sujata Chowk (left) and Kantatoli (right). These junctions also lack pedestrian elements such as crosswalks, refuge islands, and pedestrian signals.

Further adding to the management challenges faced by the traffic police, pedestrian elements such as crosswalks, refuge islands, and pedestrian signals are completely absent at most junctions in Ranchi. As a result, pedestrians are forced to intermingle with vehicles, leading to chaos and safety risks. In addition, large junctions such as Birsa Chowk and Sujata Chowk have excessive corner turning radii that encourage speeding by motor vehicles.

All major junctions in Ranchi should be redesigned to incorporate refuge islands and medians to mitigate conflicts between pedestrians and fast moving vehicles. Tall, bushy plants, large statues, and any other sizable obstruction should be avoided in medians because they obstruct pedestrian visibility. Pedestrian Island should also be free of landscaping and fencing in order to provide sufficient clear passage for pedestrians. Tighter turning radii—preferably 4 m or below—can improve safety for pedestrians and cyclists. Tighter radii force vehicles to reduce their speed and minimise pedestrian crossing distances, as shown in the figure below. However, turning radii should take into account the size of the vehicle that is expected to pass through the junction.

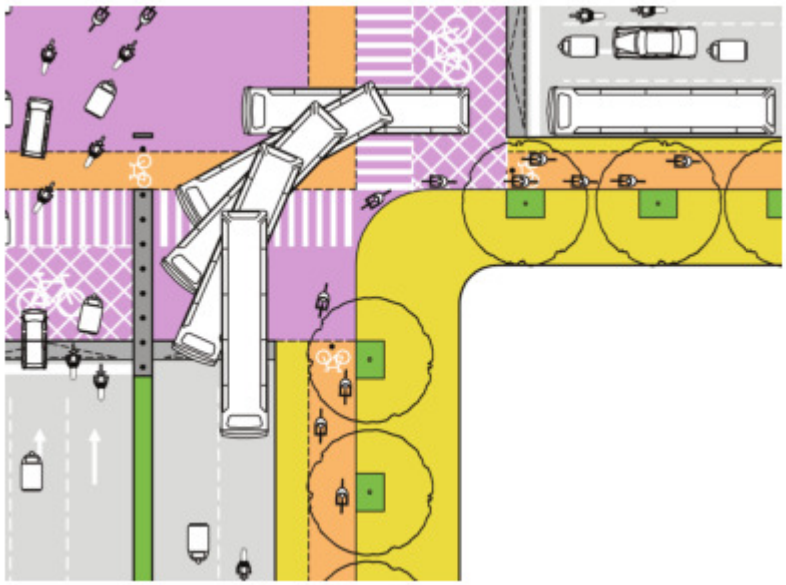

Figure 56: Intersections should be sized to minimise pedestrian crossing distances while still accommodating left turns of large vehicles.

Table 16: Priority junctions for traffic and pedestrian improvements

Junction	BRT	Signal required	Notes
Kantatoli Chowk	Yes	Yes	Remove traffic circle
Ratu Road junction	Yes	Yes	
Sujata Chowk	Yes	Yes	Remove traffic circle
Albert Ekka Chowk	Yes	No	
Birsa Chowk	Yes	Yes	
Kutchery Chowk	Yes	Yes	
Dangra Toli Chowk	Yes	Yes	
Kadru More	Yes	No	

Special measures to ensure pedestrian safety are required at non-signalised intersections. Level tabletops are desirable in such circumstances. The level of the carriageway and pedestrian crossing can be raised to that of the footpath to improve safety and convenience for pedestrians. Vehicles are compelled to slow down to give priority to pedestrians.

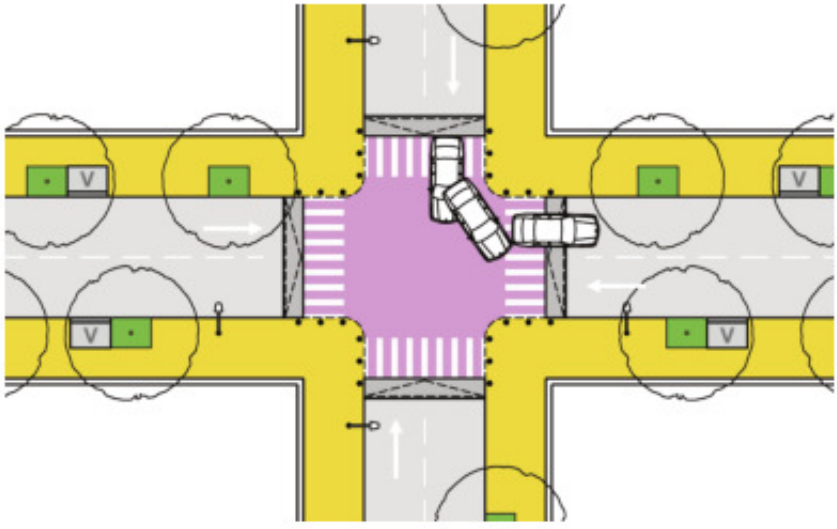

Figure 57: Raised tabletop crossing help to slow down vehicles at non-signalised junctions.

Special treatments are also required along BRT corridors in order to reduce delays and maintain system capacity. The aim of junction design for a BRT system is to:

- Minimise delay for the BRT system;
- Improve safe and convenient access to the station by pedestrians;
- Minimise delay for mixed traffic.

Junction design will vary according to the number of passengers boarding and alighting the system, turning vehicles, and the bus operations. In general, BRT junction operation should focus on reducing turning movements across the busway to improve safety and reduce signal delays. One way of simplifying BRT intersections is to substitute right turns for changes at the network level. For example, right turn can be substituted by three left turns. Vehicles can still make the right turn at the circled junction by turning left three times and then crossing perpendicular to the corridor. Alternatively, right turns can be completed by taking a left turn followed by a U-turn.

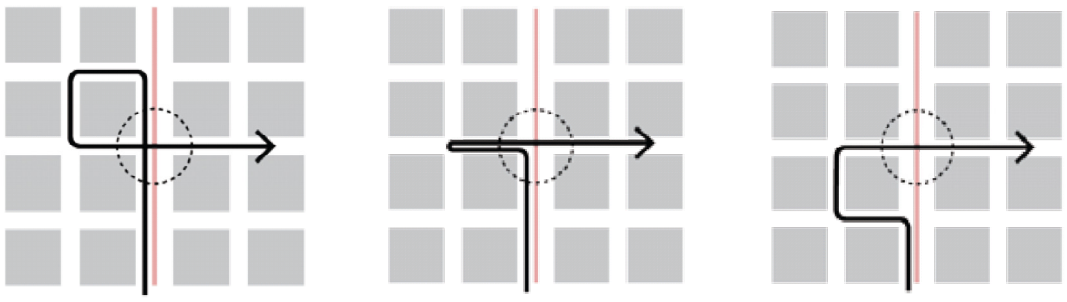

Figure 58: Alternatives to right turns across BRT lanes (red) at the circled intersection.

Squareabouts are a means of managing right-turning traffic at large intersections while minimising signal cycle time. Squareabouts make the right-turn phase obsolete by creating right-turn queuing space within the intersection itself. Vehicles queue in this space during one phase and exit during the next phase. Squareabouts are a valuable option on BRT corridors. While the BRT would require the addition of extra phases to a typical four-phase signal cycle, the squareabout accommodates all turning movements in only two phases.

Figure 59: The signal phasing plan for a squareabout. Right-turning vehicles enter the queuing spaces during the first phase and exit the ahead of straight-moving traffic during the next phase.

Figure 60: Two-phase squareabout intersection in Ahmedabad, India.

7.2. Parking management

Transport planners across the globe have come to an understanding that roads cannot be built fast enough to keep up with rising travel demand induced by the road building itself and the sprawl it creates. Therefore, along with creating high quality accessible and integrated public transport system that serves the needs of city residents, it is equally important to discourage people from using private modes of transport. Municipal areas and cities have turned to land-use planning integrated with effective transport policies to shift the demand for travel to more sustainable modes. In this capacity, parking management policies and techniques have proven to be especially effective. For Ranchi, this means that parking must be tightly restricted in areas well served by the integrated public transport system so that people are encouraged to use public transport.

Presently, parking occupies up to half the street width on many commercial streets. Effective on-street parking management will be needed to ensure that parking does not conflict with other activities along public transport and NMT corridors. Parking is not an inevitable need at the end of a trip. By contrast, the availability of parking at the destination results in a trip by personal vehicle. If implemented on a citywide basis, parking fees can become a major source of revenue that can help fund public transport operations and streetscape improvements. Parked vehicles encroach on pedestrian space, making it harder for passengers to access public transport.

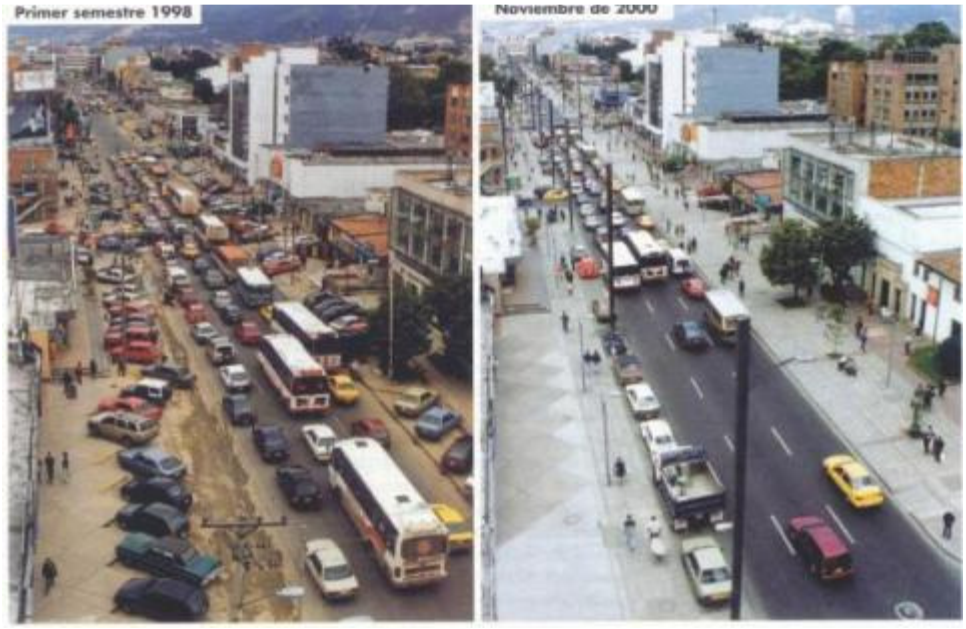

Figure 61: Clear designation of parking and no-parking zones is an essential step in effective parking management. All streets should have clearly marked parking slots. Shown here is a street in Bogotá, Colombia, before and after the delineation of parking slots.

Several dimensions of parking management will need to be addressed:

- Clear designation of parking and no-parking areas. Demarcation of parking areas is a prerequisite for enforcement.
- Introduction of appropriate parking fees. In areas with high parking demand, parking fees can help reduce the pressure on on-street parking facilities. Parking fees create an incentive for the use of off-street lots, and they also encourage people use alternate modes, including public transport. Parking fees need to be calibrated to the size of the vehicle (e.g. cars should be charged 4 to 5 times as much as two-wheelers).

- Enforcement of no-parking zones. A robust system for parking enforcement is needed to ensure that parked vehicles do not compromise pedestrian footpaths and vehicle movement in the carriageway. At present, parking occupies a great deal of the right-of-way on many streets in Ranchi. Where space is limited, priority should go toward public transport, pedestrian access, cycling, and mixed traffic. Parking can be limited through appropriate management and pricing.

Going forward, a clear policy on parking that takes an integrated citywide approach will be pivotal to the success of the integrated public transport system. On-street parking should be discouraged near public transport stations, where people have the option of using sustainable modes of transport. If absolutely required, such parking should be priced at premium rates to discourage the use of private vehicle use.

Park-and-ride facilities may be considered only at terminal stations in city outskirts. In other locations, intensification of land use through mixed-use residential and commercial development is a more effective long- term means of generating public transport ridership.

The design and management of all parking facilities must also reflect new mobility as well as "safe design." Priority should be given to non-motorized vehicles, paratransit, energy-efficient vehicles, and car-share companies—all in advance of single occupancy cars.

Parking management in Ranchi will help facilitate efficient traffic operations, generate revenue and will help ensure that the city can make the most of its investments in public transport systems. Ranchi has approximately 90,000 cars and 570,000 two-wheelers as of 2015, which amounts to about 204,000 equivalent car spaces of parking area. The city can generate Rs 39 cr per year even if parking fees apply to only 5 per cent of the personal vehicles in Ranchi at any given time. Revenue from parking fee should be used to augment the city bus service and improve the quality and service of public transport.

Table 17: Revenue potential from on-street parking management

Time	Parking spaces (ECS)	Occupancy (%)	Hours per day	Charge (Rs per hour)	Revenue per day (Rs lakh)	Revenue per year (Rs cr)
Peak	10,000	70	8	15	8.4	27.7
Off-peak	10,000	35	8	10	2.8	9.2
Night	10,000	15	8	5	0.6	2.0
Total					7.1	38.9

Figure 62: Better enforcement is needed to regulate vehicle parking.

7.3. Road safety

Ranchi should aim to ensure zero fatalities per year from traffic crashes. While user awareness is an essential element of a holistic approach to road safety, it is only one component of an effective strategy to address road safety. Such an approach must also address existing design of streets, which seriously compromises the safety of citizens on any transport mode. Most streets in Ranchi lack footpaths, forcing pedestrians to walk in the carriageway. Wide, dedicated footpaths along with cycle tracks along major streets are essential to improve safety for NMT users. The introduction of a BRT also can improve road safety by separating buses from slower moving non-motorised vehicles.

While providing dedicated NMT facilities is crucial for ensuring safety of its users, pedestrian safety is hugely compromised by the physical design of carriageways prioritising private vehicle movement. In order to increase vehicle speeds, barriers are erected to prevent pedestrians from crossing. Pedestrians are forced to use foot-over bridges or subways, which are inconvenient to use, by most people regardless of age or gender. Due to the difficulties associated with the use of this infrastructure, pedestrians continue to cross at ground level.

Good pedestrian crossing measures should be undertaken to allow pedestrians to cross busy streets safely and conveniently. Formal raised pedestrian crossing, where pedestrians remain at the same level as the footpath and vehicles pass over ramps will enable safe crossing for pedestrians. Raised crosswalks should be located at all intersections and at 150-200m intervals. Where fences are installed to prevent crossing, informal crossing in the form of breaks in the fencing should be provided wherever there is demand.

8. Transit-oriented development

The potential for TOD is to reduce the volume of total travel, measured as vehicle-kilometres travelled (VKT). TOD often results in replacing motorised vehicle trips by encouraging shifting travel modes to walking, cycling and public transport. Thus, these developments mean safer journeys, reduced air pollution, less congestion, and less time wasted in traffic.

To meet the above aims and objectives, this study will emphasize a development path for Ranchi that follows a set of widely accepted principles of integrated land use and transport, collectively known as transit-oriented development (TOD). At its core, TOD recognizes that successful transport systems cannot be planned separately from the land use context.

When addressed together, these urban development principles foster efficient spatial configurations that enable high-quality, and car-independent lifestyles. The focus of transportation policy is increasingly on reducing greenhouse gas emissions, air pollution, traffic congestion, injuries and deaths from vehicle crashes.

Much of the land in central Ranchi is reserved, making planned development difficult. This has pushed new development to peripheral areas. In order to accommodate future growth of the city in a sustainable manner, Ranchi should optimise the use of its scarce land resources by encouraging transit-oriented development (TOD) along mass rapid transit corridors.

TOD refers to development that results in intensification of housing and jobs within walking distance of mass rapid transit stations. In addition, the urban design and land use characteristics of TOD facilitate the use of public transport, walking, and cycling. TOD is actively *oriented* toward, rather than simply adjacent to, public transport. Well designed and fully realized TOD areas can play a key role in the city's economic and cultural wellbeing, creating vibrant, lively places for people of all ages and income groups. A strategic concentration of compatible activities in conjunction with high quality transport systems can help reduce dependence on personal motor vehicles and curb emissions of harmful smog-forming and greenhouse gas (GHG) pollutants.

As part of TOD, a higher floor space index (FSI) can be permitted at strategic locations that have high land value and are easily accessible by high-quality public transport (i.e., within 400 m, or a 5-minute walk). Selective intensification of land use can reduce trip lengths by creating compact, mixed- use neighbourhoods that combine housing, offices, educational, centres, and public space. Government and institutional buildings should also be located in these mass rapid transit zones. Where government land is available along these corridors, it can be used to increase the supply of housing for low-income groups. Enhanced open spaces and other social amenities are required to support increased residential and visitor populations.

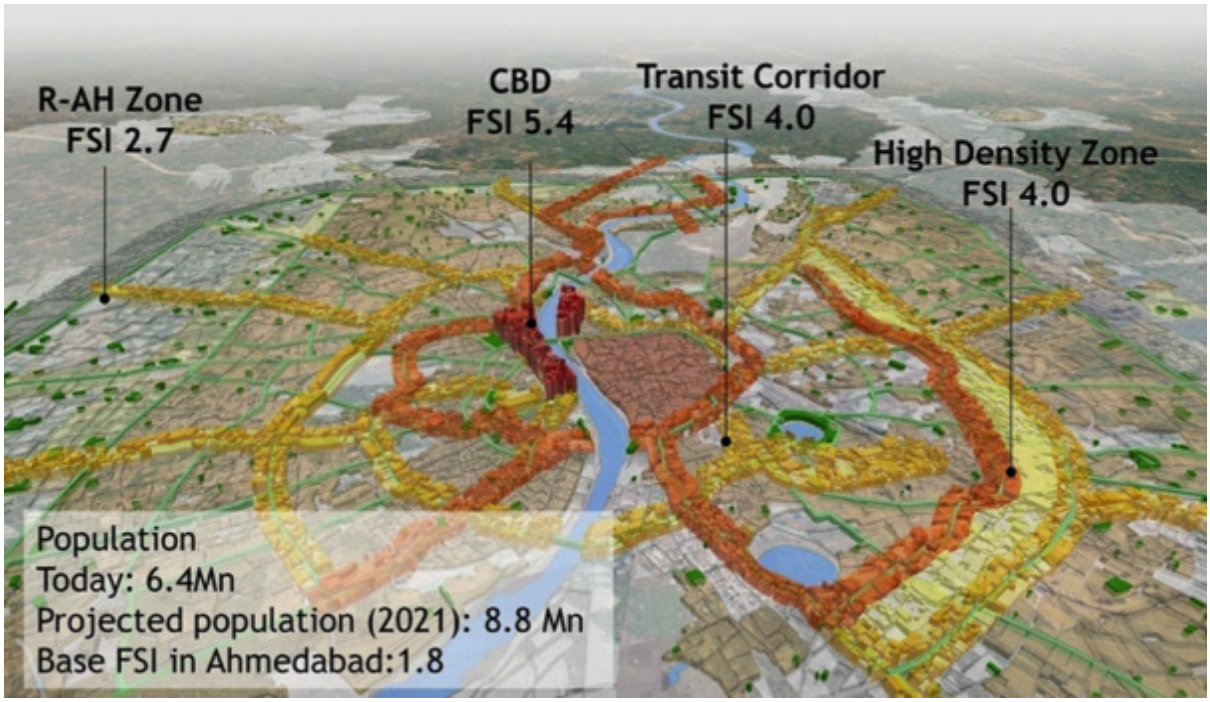

Figure 63: Ahmedabad's development plan encourages denser development within walking distance of BRT corridors.

TOD should incorporate pedestrian-friendly built form. For example, building control regulations should encourage active uses rather than compound walls or parking podiums at the street edge. Setbacks should be minimised to ensure that there are "eyes on the street."

Successful TOD requires complementary restrictions on the supply of on- and off-street parking to limit the number of personal motor vehicle trips generated by new development. Walking and cycling facilities should be improved in TOD zones to allow residents to access nearby services without making use of personal vehicles. Block sizes should be limited to 1 ha to reduce walking distances.

Implementation of TOD will involve several activities:

- Delineation of a TOD overlay zone as part of Ranchi's revised Development Plan.
- Reform of Ranchi's Development Control Regulations related to density, urban design, and parking.
- Preparation of Detailed Development Plans to guide the provision of amenities, infrastructure improvements at the local level.

9. Benefits of sustainable transport

The benefits of the transportation improvement plan suggested in this document are on two fronts: Social and environmental.

It is customary to think of evaluate transportation improvements in terms of improvement in network speed. However, such plans then focus mostly on providing wider, high speed roads. Experience suggests that such roads benefit mostly personal vehicles and that too only for a short period till the growth in personal vehicles outruns these roads.

The RMP, on the other hands, considers a city's transportation system as a means towards earning a living for the entire city. Therefore this plan focuses on improving mobility for as many demographic groups as possible.

Another goal of the city should be cleaner, healthier air. Therefore this plan focuses on measures to improve the system for modes that consume little or no fossil fuels, and at the same time taking measures that discourage modes that consume more fossil fuel.

Since the modes that are accessible to the majority of people and consume lesser fuel also consume lesser road space, RMP believes that the measures suggested in this document will also reduce traffic congestion and improve the overall network speed.

9.1. Social benefits

As our data shows, Ranchi depends on walking, cycling and public transport for about 78% of its travel. Improving the conditions of these modes will certainly benefit people who use these modes. It is important to note that the system suggested in this document will also benefit people who use personal vehicles, as explained below.

9.1.1. Walking

Well-designed and safe footpaths along with intersections with safer crossings will reduce pedestrian fatalities. Many pedestrians do not use any other mode of transport today because they cannot afford it. Saving a few pedestrian lives will therefore also save primary breadwinners for some families.

Good footpaths also give a position of pride to the pedestrian, helping bridge social divides.

9.1.2. Cycling

Ranchi is an educational as well as employment hub. A cycle provides mobility to many students and workers. Good cycle tracks provide the same benefits mentioned above for footpaths. Better cycling facilities can stop some people from borrowing money to buy 2-wheelers, saving them enough money to impact their lifestyles.

Attractive cycle tracks also entice financially well-off people to use modern cycles more frequently, starting from shorter distances and moving on to longer rides. Fortunately, using "green" modes of commute has also started attracting glamour in many cities around the world and in India. Excellent cycling facilities can accelerate that process. And of course, higher levels of cycling will improve the city's overall health quotient, because of increased physical activity as well as reduced pollution.

9.1.3. Public transport

The proposed public transport network will have a direct benefit to people from all strata. Such a system provides excellent mobility options to the "public"—the rich and the poor alike. The following maps clearly show this.

A number of schools and colleges in the city are within a few minutes' walk from the suggested BRT corridors.

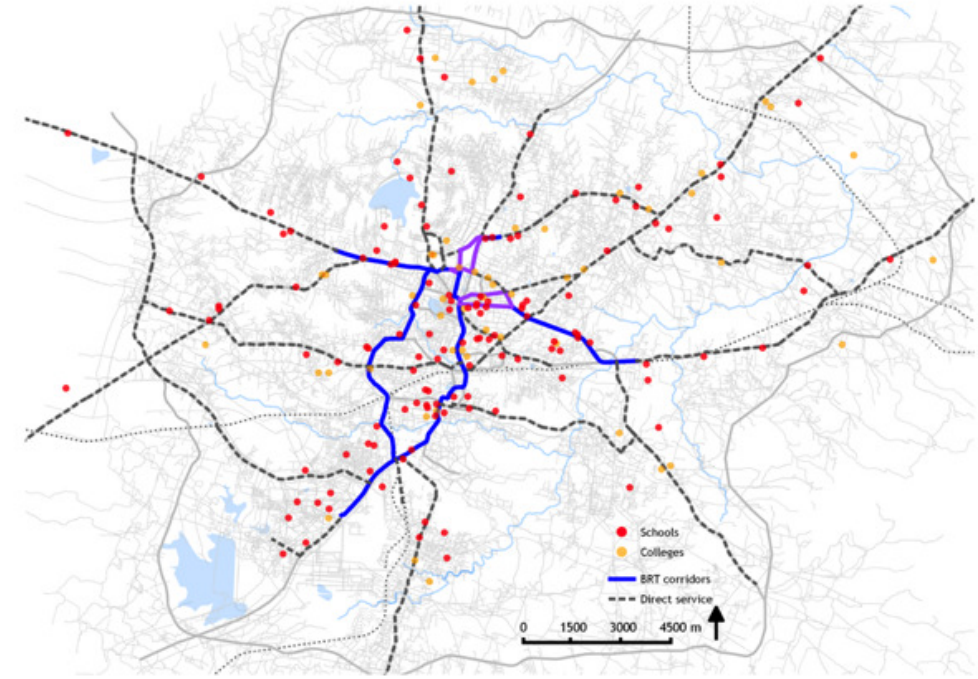

Figure 64: Schools and colleges along the proposed Phase 1 BRT corridors

Ekjut - an NGO with strong roots in Jharkhand, Orissa and Madhya Pradesh working in the field of improving maternal and newborns' health. In Ranchi, Ekjut's urban homeless wing has done commendable work in identifying and drafting policies for this neglected group. Many of the urban homeless people in Ranchi live in night shelters, find work at the labour chowks and work on daily wages.

Most of the labour chowks and night shelters in the city lie within a 5-minute walk from this proposed network. This will greatly extend earning opportunities for people on daily wages.

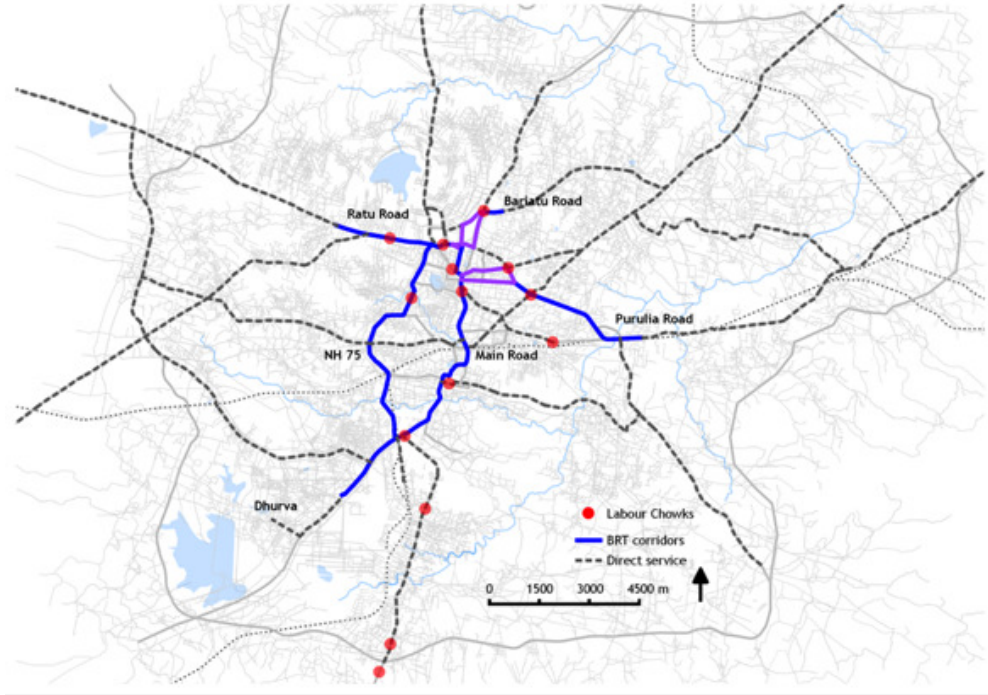

Figure 65: Labour Chowks along the proposed Phase 1 BRT corridors.

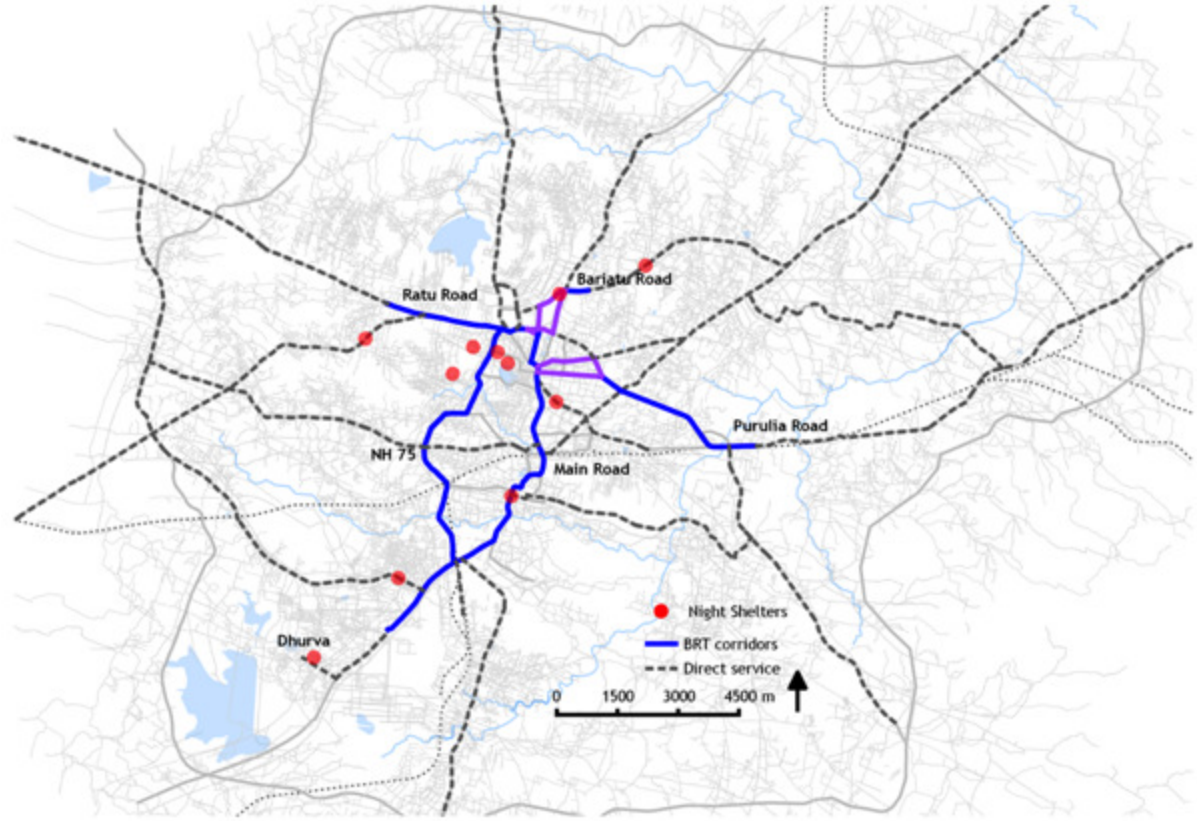

Figure 66: Night shelters along the proposed Phase 1 BRT corridors.

9.1.4. Personal vehicles

The middle class has started owning and using personal vehicles, but often times uncomfortably, because there is no other good mobility alternative. This class may continue to buy and own personal vehicles, but will no longer have to use them out of compulsion. This will save them substantial money spent on fuel and maintenance, which can now be spent on other needs or even entertainment.

Even for the financially well off, an attractive system like the one proposed provides an option to commute without facing the stress of driving and parking their cars.

9.1.5. Improved safety

Most of the traffic fatalities are pedestrians and two wheelers. Cyclists are also very vulnerable road users. In most cases, the deceased are bread winners from lower economical strata of the society. As a result, a fatal traffic accident has a very adverse impact on the entire family of the deceased. Therefore traffic fatalities are frequently considered as a social problem.

The factor that perhaps has the most prominent impact on how many accidents happen is the amount of vehicular travel. The more a vehicle travels, the more likely it is to meet an accident.

Traditional measures of transportation planning tend to increase vehicle-kilometres travelled. Our calculations indicate that the proposals in this document will reduce the overall vehicle-kilometres travelled when compared to such traditional plans, contributing to a proportional reduction in traffic collision fatalities. This factor alone could save 45 per cent of fatalities from traffic crashes.

Another important measure to avoid accidents is to segregate the vulnerable road users from heavier vehicles. The segregated BRT corridors, cycle tracks and footpaths suggested in this proposal will reduce fatalities even further.

9.2. Environmental benefits

Personal motor vehicle are a major source of particulate matter, nitrogen oxides, and other critical pollutants that compromise respiratory function and are associated with chronic diseases such as lung cancer and asthma. In Ranchi personal motor vehicles account for 22 per cent of daily trips in the city, yet they produce 74 per cent of carbon dioxide emissions. These figures clearly indicate a need to encourage sustainable travel by making public transport, walking and cycling more attractive and effective.

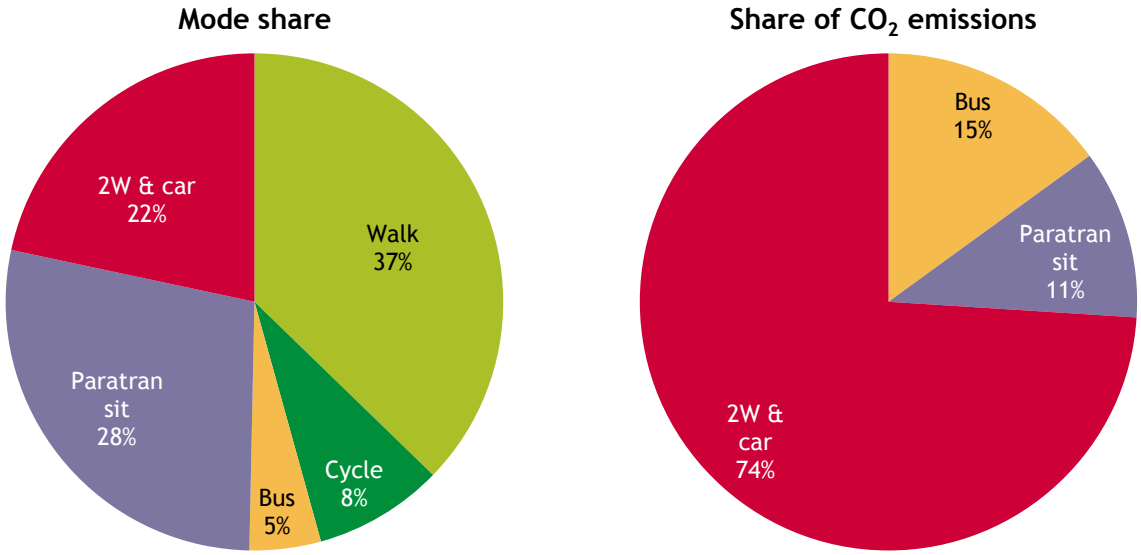

Figure 67: While private vehicles account for only 22% of trips in the city, they produce fully 74% of the CO_2 emissions (right).

If travel behaviour in Ranchi continues with under business as usual trends, carbon dioxide levels will increase significantly by 2031. However, investing in sustainable transport, and helping residents make better transport choices will deliver the shift in travel behaviour. From the estimated vehicle kilometres travelled by various modes in 2031 under the "business as usual" scenario vis-a-vis the "sustainable transport" scenario, it is estimated that in the latter scenario, carbon emissions by transport could be lower by as much as 50% as compared to the former.

10. Funds needed

10.1. Capital cost

10.1.1. Facilities for pedestrians and cyclists

As described earlier in this report, Ranchi needs to build 160 km high quality footpaths (apart from footpaths for 33 km roads that are included in the proposed BRT network) and 100 km of cycle tracks. This would need a capital expenditure as described in the following table.

Table 18: Cost of walking and cycling proposals

Item	Quantity	Cost per km, Rs. Cr	Total expenditure, Rs. Cr
Footpaths	160 km	2.10	336
Cycle tracks	100 km	2.40	240
Greenways	31 km	4.00	124
Total NMT infrastructure	226 km		700

10.1.2. Public transport network

The capital cost estimates for the Ranchi BRT show the outlay required for a fully equipped system with appropriate technology and rolling stock. The cost of IT equipment was estimated based on experience in BRT systems elsewhere in India. The capital cost and a summary of components is presented in the following table.

Table 19: Capital cost for the Ranchi BRT

Component	Total (Rs Cr)
Corridors	482
BRT stations	51
Terminals	20
Depots	40
ITS & control centre	33
Automatic doors	80
Consultancy	10
Buses	333
Total	**1049**

10.1.3. Public transport network

The operating costs for the proposed BRT system includes costs of bus operations, administration and operations management, and maintenance of IT systems and infrastructure. From the good experience of Ahmedabad's Janmarg, it is proposed that the entire bus operations be outsourced. The providers of "bus operations" would provide drivers and operate and maintain the buses. In order to estimate the cost of bus operations for the Phase I of corridors, it is assumed that each bus will operate at least 220 km per day. The duty of drivers, supervisors, and mechanics will be scheduled in 2 shifts per day. The cost of bus operations is estimated to be Rs 91.5 Cr per year.

Additional operating expenses include cleaning, security, and maintenance of IT systems. To estimate such costs, information from the Ahmedabad BRT was extrapolated to generate estimates for Ranchi. Staff salaries and maintenance of hardware and software for the IT systems is expected to cost around Rs 2.0 Cr per year. Security, maintenance, and administrative expenses will amount to around Rs 9.0 Cr per year. Overall operating expenses total Rs 104.0 Cr per annum or Rs 47.2 on a per-km basis.

Table 20: Annual operating expenses

Component	Crore Rs
Bus operations	91.5
IT system operations	9.0
Maintenance, security, and administration	2.0
Total	102.5

10.1.4. Farebox revenues

The fare box revenues are estimated based on the potential BRT ridership data for the future public transport scenario and the optimal fare structure for various stages within the BRT network. The current ridership estimate for the BRT scenario will provide revenue of Rs 142 Cr per annum. The proposed fare structure will charge Rs 2 as the base fare and will charge an additional Rs 0.50 per kilometre travelled.

10.1.5. Junction improvements

Eight junctions are proposed to be improved to facilitate movement of all modes while safeguarding the most vulnerable road users. A typical junction redesign costs about Rs. 5 Cr. Therefore about Rs. 40 Cr will be needed for these projects.

10.1.6. Parking management

The overall parking system can be managed by a contractor who will install the parking meters and also take care of necessary road markings. Therefore there is no capital cost as well as operations and maintenance cost involved with this project. On the other hand, the system will generate revenue of about Rs. 39 Cr annually. About 1/4th of this amount is paid to the system vendor and the remaining amount of Rs. 29 Cr remains with RMC.

10.1.7. Ongoing maintenance

It is important to allocate funds for regular maintenance of all of these projects. The maintenance cost is estimated at 10% of the capital cost.

10.2. Summary of funds needed

The table below shows the capital cost of the projects suggested in this proposal. These projects will generate sufficient revenue to take care of operations and maintenance expenses, so it is only the capital cost that the state needs to arrange for.

Table 21: Summary of funds needed

Item	Capital cost, Rs Cr	O&M (annual), Rs Cr	Fare box revenue (annual), Rs Cr
Facilities for pedestrians and cyclists	700	70	-
Public transport network	1049	103	142
Parking management	-	-	29
Junction improvement	40	4	-
TOTAL	1,789	177	171

10.3. Potential funding sources

The capital expenditure for implementing the package of sustainable transport projects outlined in this report is much lower than any other form of mass rapid transit but can still be possible by the Government of Jharkhand. However, other funding opportunities exist. Development banks like Asian Development Bank (ADB) and The World Bank actively support implementation of BRT through soft loans for capital expenditure and grants for system planning and outreach. ITDP can help Government of Jharkhand in reaching out to the appropriate divisions at these organizations to explore funding options. ITDP played a key role in case of Pimpri-Chinchwad BRT for the city to procure funding from The World Bank under the World Bank-MoUD Sustainable Urban Transport Program (SUTP).

11. Implementation plan

The ultimate sustainability of the sustainable transport initiatives described in this document depends as much on the system "software"—the institutional, business, and regulatory structure—as on the "hardware"—the footpaths, cycle tracks, buses, and other infrastructure.

11.1. Non-motorised transport cell

At this time, there is insufficient institutional support to manage the transport infrastructure and services in Ranchi. To improve the planning and implementation capacity for NMT infrastructure, RMC should create an NMT working group that takes responsibility for all policies and projects to implement the Ranchi NMT network. The NMT working group will require qualified staff, a clear mandate and sufficient budget to support their mission.

The following measures are urgently required:

- Reallocation of responsibilities to make use of existing capabilities,
- Training to develop individuals' capabilities,
- Direct involvement of relevant personnel at all levels in the implementation of all urban transport projects, and
- Adoption street design guidelines: RMC should adopt detailed street design guidelines that specify minimum design standards and standard materials for street design elements. The appendix to this report specifies basic standards for major street elements that should become part of these guidelines.

11.2. Special purpose vehicle for transport system management

Considering the present structure of administration and operations of city bus services in Ranchi, it is advisable to establish a separate entity whose primary job is to oversee the operation of bus-based public transport in Ranchi. This entity, known as a special purpose vehicle (SPV), should take the form of a limited company under State Transport Department. The SPV will plan and implement the integrated BRT and bus network. Once operations begin, the SPV will oversee operations and ensure a high standard of service quality. Specific services such as bus fleet operations and maintenance, IT services, and electronic fare collection, would be procured by the SPV from the private sector to ensure that service of the highest quality can be maintained at the lowest cost to the government.

11.2.1. SPV structure

The SPV needs qualified, professional staff and the independence to make swift decisions during the implementation process. An IAS officer should serve as the CEO of the SPV. A competent team with specializations in the areas shown below will support the CEO as shown in the figure below. A board chaired by the CEO and including the Mayor, Standing Committee Chairman, opposition party leader, the Deputy Commissioner of Police for Traffic, the Regional Transport Officer, and a representative of the Urban Development Department, will oversee the SPV. The Board plays an important role in decision of fare structure, system expansion and implementation of policy-level decisions.

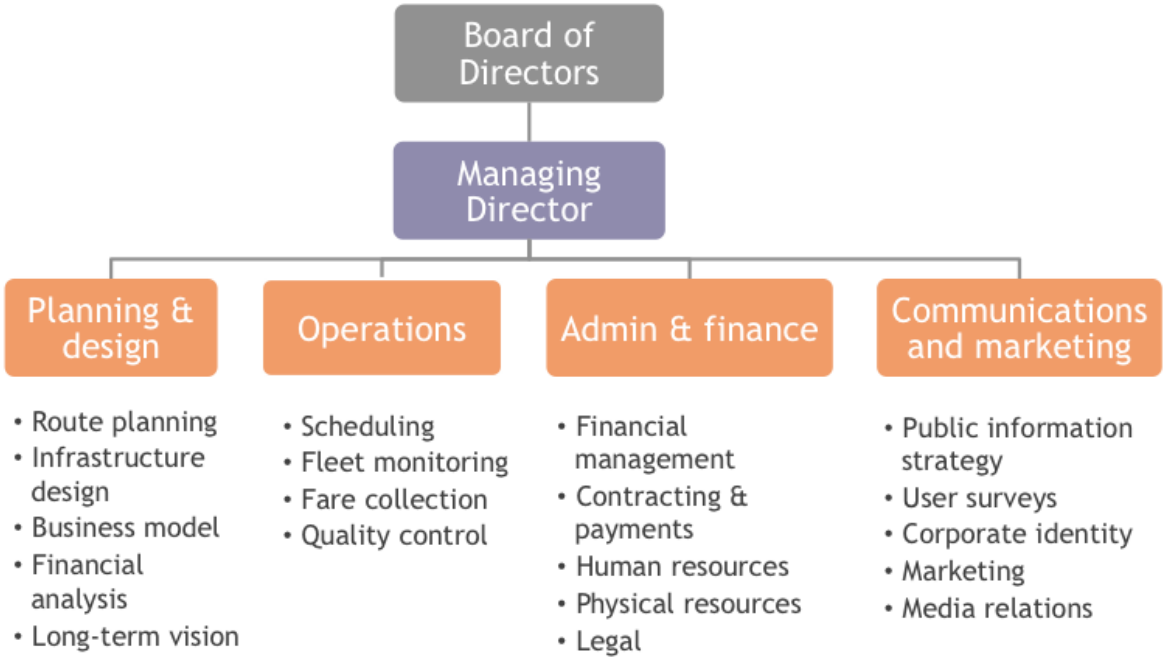

Figure 68: Special purpose vehicle structure.

It will also be necessary to coordinate closely with the existing public transport service provider, JTDC. In addition, The SPV will need to enter agreements regarding infrastructure construction with the line agencies that own each stretch of corridor (such as the Jharkhand State Department of Highways and the National Highways Authority of India). The following table lists the major responsibilities of the agencies that will be involved in public transport planning and operations in Ranchi.

Table 22: Responsibilities of various agencies in public transport planning and operations

Agency	Responsibilities
Transport Department	• Seek required approvals from state as well as national government for BRT project implementation; garner local support and consensus. • Form SPV • Construct the required infrastructure for BRT and bus services (BRT corridors, stations, bus shelters, etc.) • Finance the capital cost of the project, with assistance from the state and central governments • Create a dedicated UTF in form of annual budgetary allocation reserved for public transport operations. Generate additional revenue from parking management by means of parking and advertisement.
RMC & Highways Department	• Construct the required infrastructure for BRT system (BRT depots and terminals, Control centre etc.) • Oversee and monitor DPR and BRT project implementation process
SPV	• Monitor implementation process • Contract private players to operate buses, IT systems, station maintenance, and other services • Define BRT service parameters and monitor service quality • Determine BRT fares
Contracted Service Providers	• Operate respective services such as buses, IT systems, or maintenance • Give timely inputs to SPV for improving operations management

Traffic Police	• Ensure law, order and discipline • Safeguard public transport operations and infrastructure • Prevent incursions in the BRT lanes and encroachments on footpaths and cycle tracks
RTO	• Form policies and regulations oriented towards promotion of sustainable transport. • Review public transport routes and fares

The SPV will select the bus operator through a competitive bidding process in which the operators will quote the lowest per kilometre charge for bus operations that they are able to offer. The SPV and bus operator will enter an agreement specifying number of buses to be operated, routes, contract period, and other responsibilities. A list of penalties and fines will be developed for bus operator to ensure that the required performance is achieved. The bus operator will be responsible for hiring drivers, supervisors, and maintenance crews. The operator will provide bus services as per a daily schedule provided by the SPV, subject to a guaranteed minimum number of daily km.

The revenue from ticket sales will belong to the SPV. The operator will have no other income from any of the source within the public transport system. The operator will raise the bus operations bill periodically (e.g. every 10 days), which shall be approved and paid by the SPV after verification using data generated by the IT systems. The operator shall be paid as per the actual operated km, with adjustments made in accordance with minimum assured km as per specific formulae. The formulae for calculating payments to the operator will also include provisions for considering variations in fuel prices and other variables.

The SPV will hand over depot space to the bus operator, who in turn will maintain it through the end of the contract period. The operator will be responsible for procuring tools and equipment for bus maintenance. The operator will carry out bus cleaning regularly as per the agreement with SPV. It is recommended to have a separate housekeeping contract for cleaning of stations, terminals and interchanges at least twice a day.

11.3. Implementation process

The table below is a representative project timeline for implementation of the sustainable transport initiatives by Ranchi. Footpaths, cycle tracks, pedestrian zones, and greenways will be implemented in annual packages, while BRT design and planning will last approximately 3 years for each phase. The parking and paratransit management systems have relatively short implementation periods.

Table 23: Suggested timeline

Project	2015-16	2016-17	2017-18	2018-19	2019-20
Street design, pedestrian and cyclist facilities: Phase 1					
Street design, pedestrian and cyclist facilities: Phase 2					
Street design, pedestrian and cyclist facilities: Phase 3					
Greenways: Phase 1					
Greenways: Phase 2					
Public transportation: City bus					

Project	2015-16	2016-17	2017-18	2018-19	2019-20
Public transportation: BRT Phase 1					
Public transportation: BRT Phase 2					
Paratransit improvements					
Parking management: Phase 1					
Parking management: Phase 2					

11.4. Next steps

The following next steps can help advance the transport planning process:

Stakeholder consultations: Street design improvements, BRT, parking management, and other initiatives will require strong and dedicated political will. With sustained communication of a positive vision for the future of the city, implementing agencies can build widespread support for these projects. Consultations are an essential step in gaining buy-in from relevant public agencies, citizen groups, and other stakeholders.

Establish the public transport SPV: Creating an empowered public transport implementing agency is a key step toward ensuring rapid and effective implementation of BRT and bus services. Notification and staffing of the SPV is an urgent priority.

Seek funding for DPRs: Government of Jharkhand/RMC should initiate the process of preparing DPRs for specific projects and identifying funding sources.

Hire design consultants: Hire consultants to developed detailed corridor designs.

Begin on-street parking management and enforcement: A robust on-street parking management system will support NMT improvements and public transport operations by ensuring that carriageways, footpaths, and cycle tracks remain free of encroachment by parked vehicles. RMC can initiate the planning of a formal parking system so that it is ready for rollout as BRT corridors reach completion.

ITDP and RMP will support the Government of Jharkhand in the following activities as the planning process proceeds:

Facilitating national and international study tours for project stakeholders

Determining the institutional structure of the SPV and training SPV staff

BRT service planning

TORs for consultants: engineering and architecture consultants for design of corridors, stations, terminals, depots, and other infrastructure; communications and passenger information

RFPs for service providers: bus operations, IT services, marketing and communications

Monitoring of consultant work

11.5. Conclusion

The transport projects as proposed in this report have the capacity to transform Ranchi's mobility system. By providing citizens with high quality and environmentally and economically sustainable transport, Government of Jharkhand can ensure that the city is able to provide convenient access to all as the city grows. NMT and public transport networks can integrate the city core with expanding areas in the periphery, helping to structure growth along corridors with good public transport access. Sustainable transport is the only key to securing a vibrant and prosperous future for Ranchi.

Appendices

1.1. Public transport modelling

1.1.1. Base map and route definitions

A geographic information systems (GIS) base map of Ranchi was prepared using ArcGIS. The street network was prepared in Google Earth by tracing all major streets where share autos and buses ply as well as streets where public transport service can be extended in the future. The road network was then further refined and imported into Emme 4.1.2.

To determine the specific public transport routes in the city, initial surveys focussed on identifying all share auto and bus routes and the stops in greater Ranchi. The process was accomplished by place marking the stops and routes using GPS instruments. A number of iterations were performed along each route to identify the routes and stop locations. The surveys revealed a total of 43 routes in the entire city across various public transport modes. The following maps show the existing public transport routes and stops. The table that follows the maps lists the public transport routes available in Ranchi by mode type.

Figure 69: Existing public transport routes.

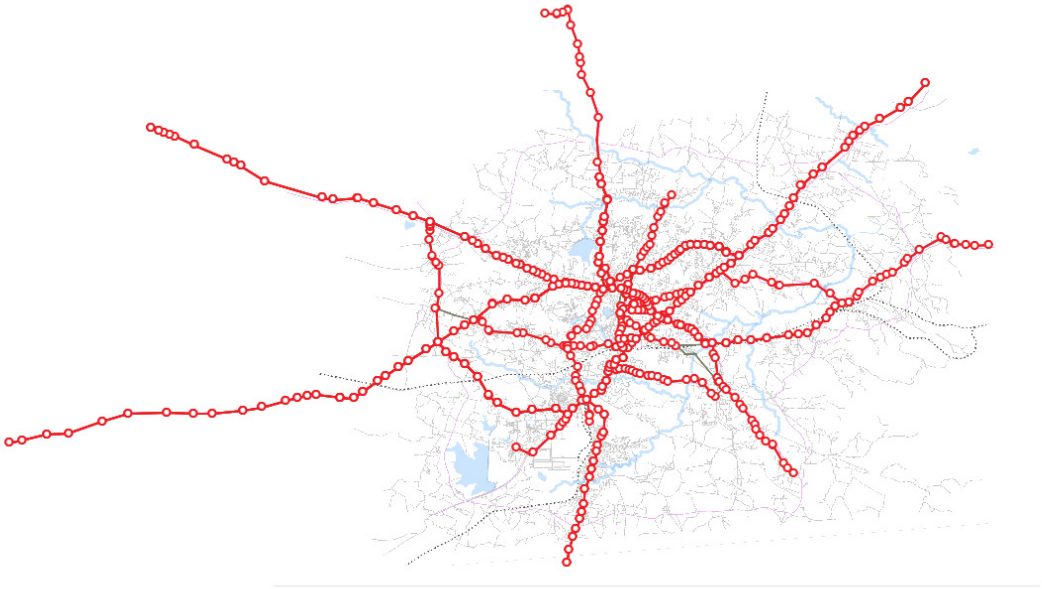

Figure 70: Existing bus stops.

Table 24: Existing public transport routes in Ranchi

S.No	From	To	Mode
1	Ratu Road	Pithauriya	Share Auto Diesel
2	Ratu Road	Mandar	Share Auto Diesel
3	Ratu Road	Booti More	Share Auto Diesel
4	Ratu Road	Nagri	Share Auto Diesel
5	Ratu Road	Birsa Chowk (via Argora)	Share Auto Diesel
6	Ratu Road	Kanke	Share Auto Diesel
7	Ratu Road	Kathitand	Share Auto Diesel
8	Ratu Road	Pahartoli	Share Auto Diesel
9	Raj Bhavan	Kanke	Share Auto Diesel
10	Kathitand	Mandar	Share Auto Diesel
11	Kutchery	Dhurva	Share Auto Diesel
12	Kutchery	Hatia	Share Auto Diesel
13	Kutchery	Kanke	Share Auto Diesel
14	Kutchery	Namkum	Share Auto Diesel
15	Jail More	Booti More	Share Auto Diesel

S.No	From	To	Mode
16	Jail More	Ormanjhi	Share Auto Diesel
17	Karamtoli	Boreya	Share Auto Diesel
18	Firayalal	Kokar	Share Auto Petrol
19	Kokar	Booti More	Share Auto Petrol
20	Khelgaon	Tatisilwai	Share Auto Diesel
21	Kali Mandir	Bahu Bazaar	Share Auto Petrol
22	Bahu Bazaar	Chutiya	Share Auto Diesel and Petrol
23	Kadru Mode	Argora Chowk	Share Auto Petrol
24	Kantatoli	St. Xavier's	Share Auto Petrol
25	Kantatoli	Ormanjhi	Share Auto Diesel
26	Kantatoli	Tatisilwai	Share Auto Diesel
27	Kantatoli	Angara	Share Auto Diesel
28	Kantatoli	Rampur	Share Auto Diesel
29	Kantatoli	Namkum	Share Auto Petrol
30	Kantatoli	Booti More	Share Auto Diesel and Petrol
31	Doranda	Sadabaahar Chowk	Share Auto Diesel and Petrol
32	Birsa Chowk	Ghutwa Talaab	Share Auto Diesel
33	Birsa Chowk	Dasmile	Share Auto Diesel
34	Birsa Chowk	Nagri	Share Auto Diesel
35	Birsa Chowk	Hatia Railway Station	Share Auto Diesel
36	Hatia	Dasmile	Share Auto Diesel
37	Nagri	Bero	Share Auto Diesel
38	Argora Chowk	Kathal More	Share Auto Diesel and Petrol
39	Ghutwa Talaab	Kathitand	Share Auto Diesel
40	Shahid Maidan	Ghutwa Talaab	Share Auto Diesel
41	Ratu Road	Bero	RMC Bus/Private Bus
42	Amar Shah Deo Chowk	Pahartoli Bus Stand	RMC Bus
43	Firayalal	Kadru Mode	Electric Auto

1.1.2. Travel demand

Passenger demand data were collected on all public transport corridors to get a sense of the existing demand. The passenger demand is determined from frequency-occupancy surveys (FO), transfer surveys, and boarding-alighting (BA) surveys. These surveys are later processed to obtain the OD matrix for the base year, 2014.

The FO surveys were performed in October 2014 at a total of 41 locations to determine the public transportation vehicle frequencies and passenger volumes along various corridors (see Figure 95). Prior to performing FO surveys, traffic video counts were performed at 4 key locations for 16 hours to determine the peak period during the day. Based on these observations, the peak period is from 9:00 a.m. to 12:00 p.m. The FO surveys for the 41 locations were conducted during the peak period (9.00 a.m. to 12.00 p.m.). Figure 96 shows all major FO count locations. Further analysis of the FO data revealed that peak hour for outer locations generally occurred from 9.00 a.m. to 10.00 a.m., while the peak hour for some locations within the city occurred from 10.00 a.m. to 11.00 a.m. Volumes observed in the FO survey were used to estimate the frequency of each of the 43 public transport and paratransit routes.

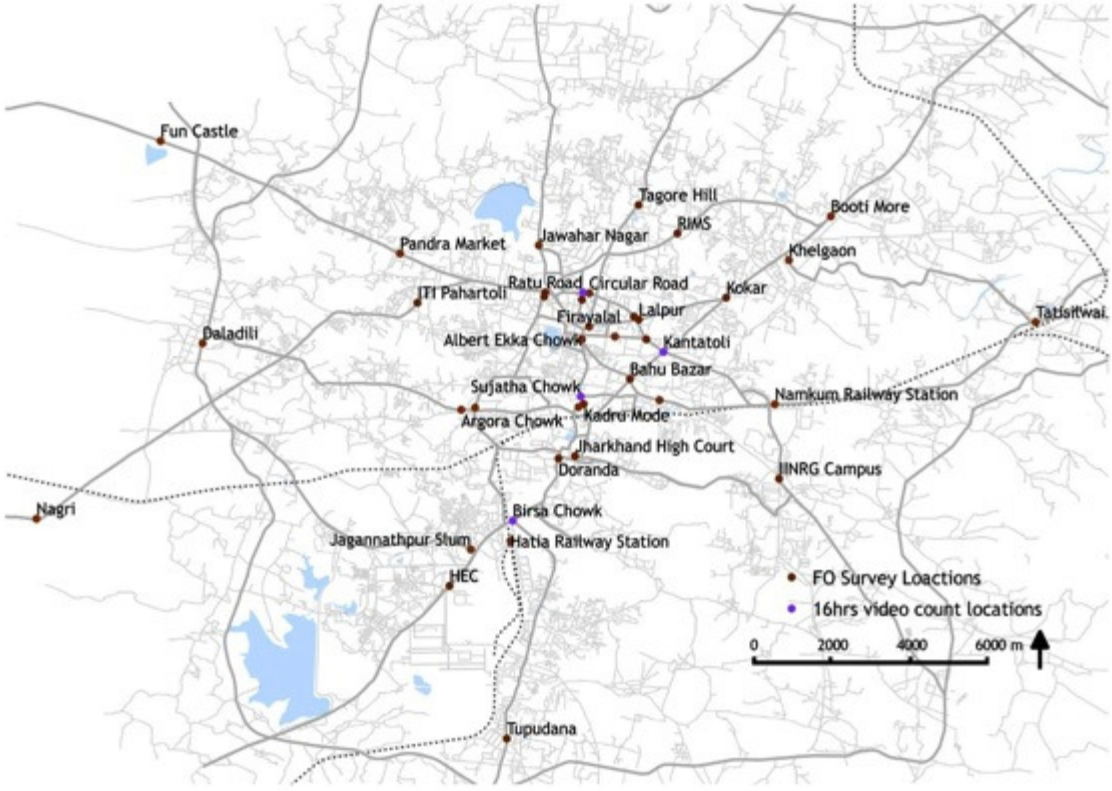

Figure 71: Locations of frequency-occupancy count surveys.

An interview-based transfer survey was performed at 17 key locations (see Figure 96). Transfer surveys help to distinguish passengers are beginning their trips from the survey location from passengers who are transferring from some other route. The survey gathered the origin and destination of each segment on the passenger's journey, as well as the waiting time at each boarding point. Survey results showed that a number of passengers were transferring to other public transport routes at Ratu Road, Birsa Chowk, Kantatoli, Argora Chowk, Jail More, Kadru Mode, and Kutchery Chowk.

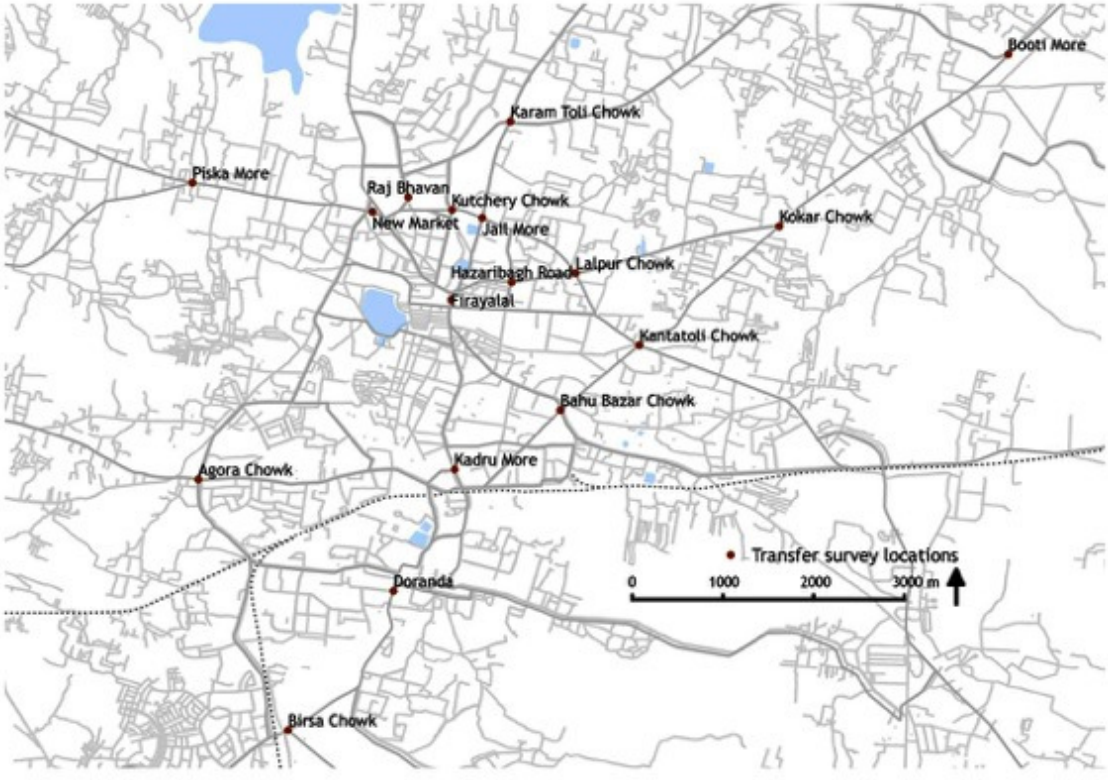

Figure 72: Locations of transfer surveys.

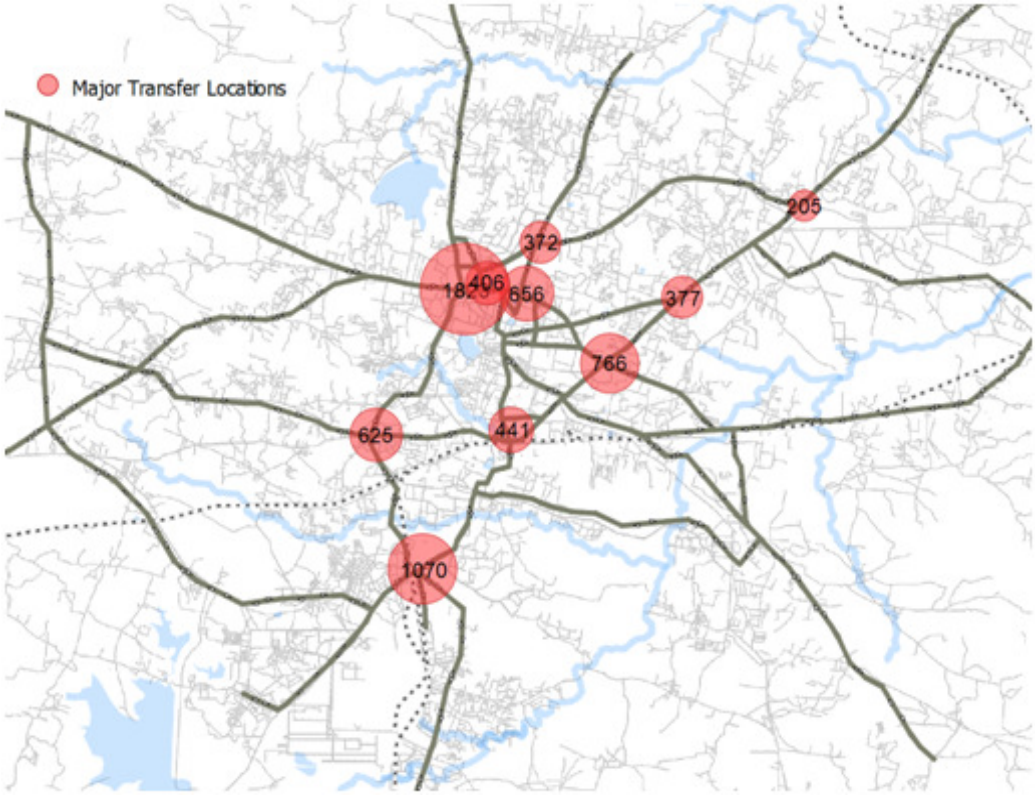

Figure 73: Number of passengers transferring at major transfer locations.

The BA survey helps determine the passenger demand on each existing route, including the number of passengers boarding at alighting at each stop. It also provides the average speed of the various modes along the corridor. Average speeds were calculated based on these observations and saved in the Emme model. At least three round-trip BA surveys were performed for each of the identified 43 public transport routes during the peak period.

The BA data for each route were expanded based on the observed peak hour frequency to obtain a baseline origin-destination (OD) matrix representing all of the trip segments taken on the network.

1.1.3. Model calibration

With the initial matrix prepared, a standard transit assignment in Emme was performed to begin calibrating the model. The transit assignment is based on the computation of an optimal strategy for each OD pair that minimizes the generalised cost of the trip—a combination of various factors including the travel time, waiting time, and fare.

Model calibration is a process in which model parameters such as speed, travel time, cost, boarding penalties, and waiting times are adjusted to ensure that the model matches field conditions. As a primary check of the accuracy of the model, the directional peak hour passenger volumes predicted by the model were compared to the actual passenger loads along each corridor, as observed in the FO survey. The demand matrix was calibrated for two iterations to achieve a better fit with the observed passenger volumes.

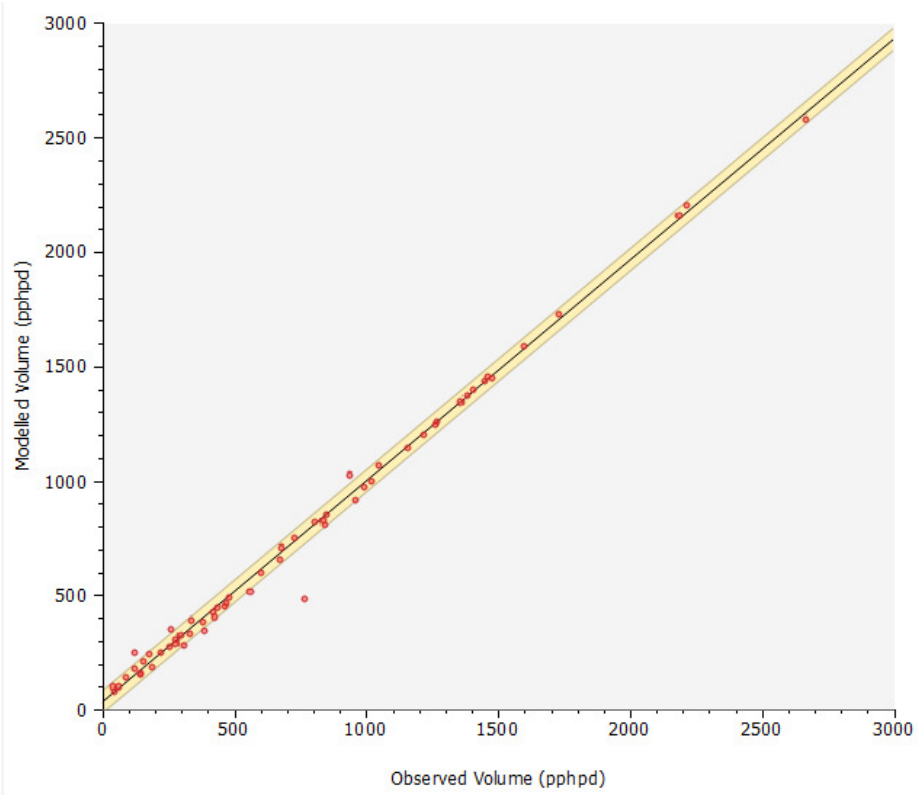

Figure 74: Scatter plot of modelled vs. observed boardings at FO survey locations

After the initial calibration, the OD matrix was modified to account for passenger transfers. Based on the information gathered in the transfer survey, individual trip segments that actually represented a single trip were removed from the OD matrix and replaced with a single trip representing the passenger's initial origin and final destination. After this modification, the model was again calibrated

to the FO counts using two iterations of the Emme matrix adjustment macro. The final assigned volumes are displayed in the figure below.

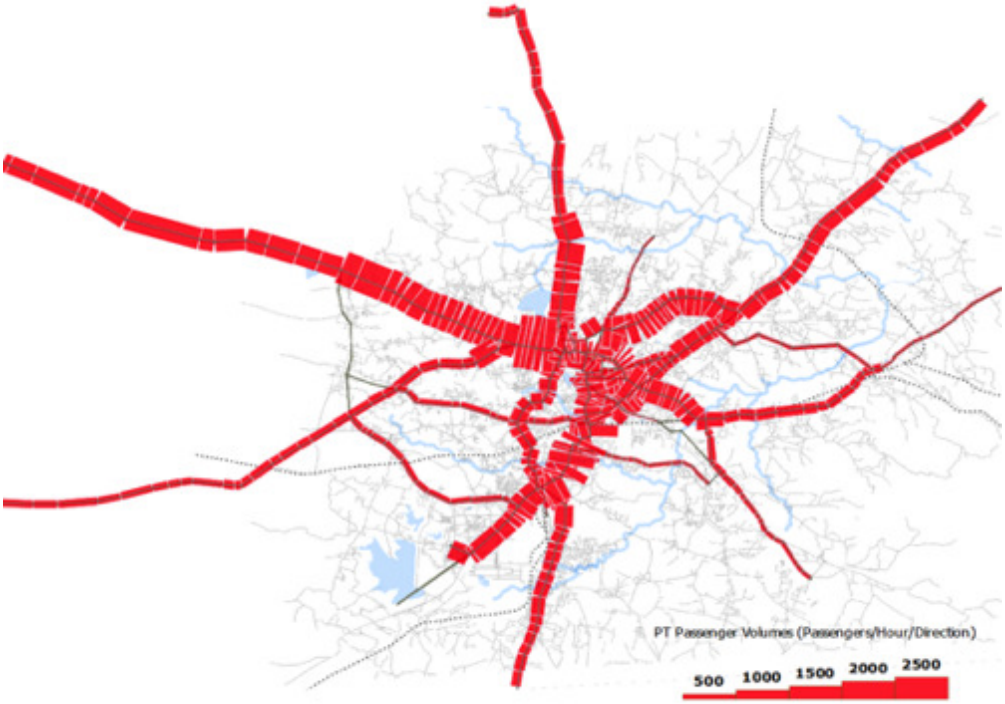

Figure 75: Public transport scenario peak hour passenger volumes (pphpd)

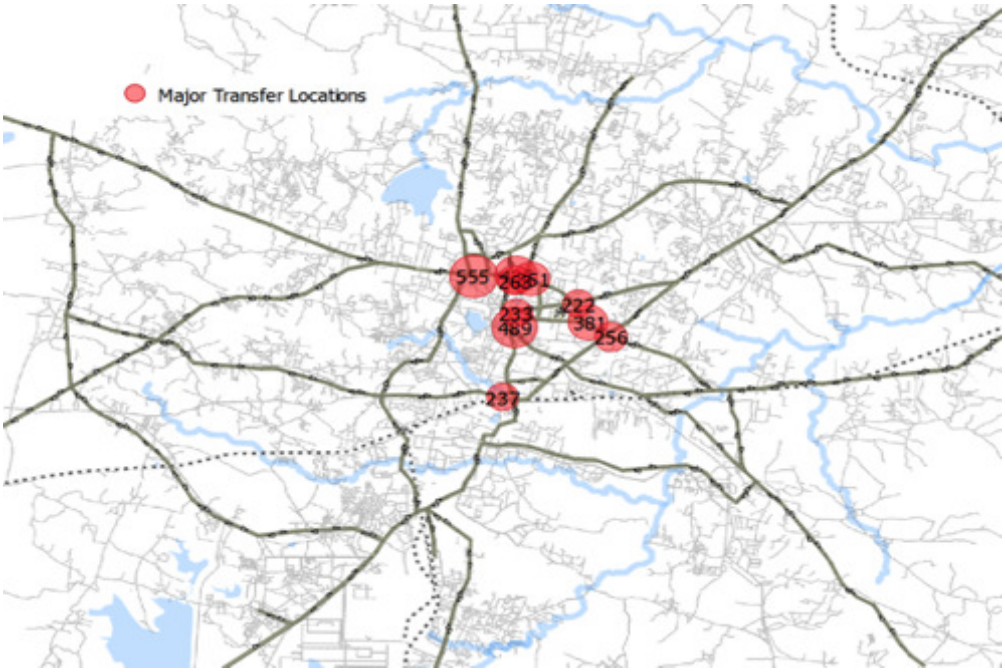

Figure 76: BRT scenario transfer locations

1.2. Physical design

Physical design of a BRT corridor includes not only the bus lanes and bus stations, but also the entire road, edge to edge. Elements like passenger access, other lanes, footpaths and cycle tracks, provision for public utilities and landscaping must be planned in detail and implemented accordingly. This section provides design guidance on specific BRT elements.

1.2.1. Relationship between vehicles, stations and corridors

BRT is not just about physically separated busways. BRT system design is an act of balancing the needs of three different components: vehicles, stations, and corridors. The design must consider the needs of each component so that each can optimally serve the goals of providing sustainable transport for Ranchi by 2018 (23 per cent of all trips by public transport; maintain existing share of all trips by cycling and walking of 40 per cent; zero fatalities per year from traffic crashes; 75 per cent of residents within a 5 min walk of formal public transport; zero nonattainment days for PM and NO_X emissions).

The design of stations, corridors and buses must be well coordinated to ensure that level boarding is provided for all customers. This means that important vehicle characteristics such as interior floor height and vehicle width must be identified and verified as the station is being designed. Similarly, station platform dimensions must be determined well in advance of the bus fleet procurement to ensure that the floor levels of bus and station platform are sympathetic. Construction error tolerance is equally important, and must be vigilantly monitored so that the detailed project designs are appropriately implemented. Finally, once the system is operational, all vehicles must be consistently maintained so that tire-pressure and vehicle suspension performance do not create gaps between the vehicle floor height and the boarding platform level.

1.2.2. BRT lanes

What distinguishes BRT from other bus systems are the dedicated bus lanes, which are physically segregated from mixed traffic lanes. The bus lanes are usually placed in the middle of the roadway, flanked by regular traffic lanes, in order to reduce conflicts with left-turning vehicles and to avoid parking encroachments in the bus lane. The dedicated busways are separated from other modes to allow for high-frequency schedules as well as a smoother ride without stops in traffic. In peak hours, buses can arrive at stations every couple of minutes, or even every minute, and can carry passengers much faster than any other form of motor transport; this dramatically reduces travelling time.

Dedicated lanes offer a significant operational advantage for bus systems. Increased travel speeds mean that a public transport provider can provide service at a given frequency with fewer vehicles. Busways also reduce bus interaction with other traffic, reducing the potential for accidents or damage from day-to-day operations. This means reduced resources are required to keep the bus fleet maintained and in top service. Operating buses in median lanes also eliminates the conflicts between buses and non-motorised transport vehicles that occur in systems where buses are required to access bus stops at the left side of the carriageway.

Figure 77: Examples of segregated bus lanes in Ahmedabad (left) and Mexico City (right).

1.2.3. Stations and terminals

Stations and terminals must be carefully planned. The following figure shows the entire planned Phase 1 BRT network in Ranchi including:

47 regular stations (two-way)

8 regular stations (one-way)

4 terminals

It is important that Ranchi plan for the infrastructure required by all BRT phases. Phase 1 terminals should be designed with extra capacity to accommodate future public transport demand. Stations and terminals should be designed in a modular format to facilitate future expansions.

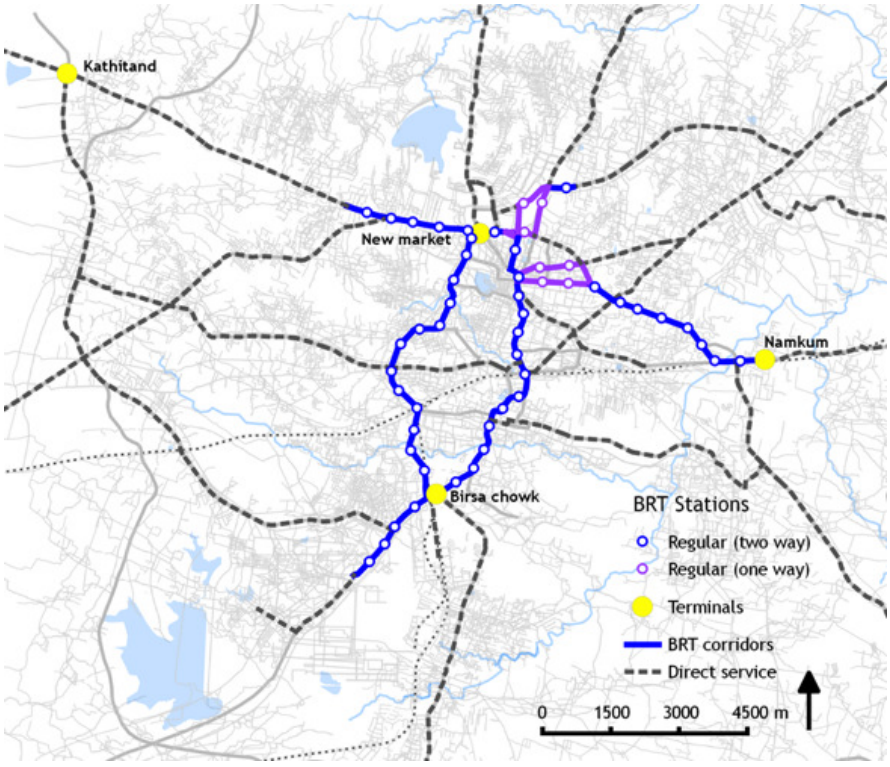

Figure 78: BRT Phase 1 showing Terminals and Interchanges

BRT station design requires including basic aspects like platforms, transition areas and integration infrastructure to access stations. The station design and size can vary based on demand. In general, BRT station design is largely a function of user requirements:

Comfort: Seats, leaning bars, and space for passenger movement

Safety: Adequate lighting, visible interiors

Accessibility: Minimal level differences and ramped access from street level

Aesthetics: Attractive to passengers, giving a sense of ownership

Provision of customer information: Both static and real-time

High performance BRT systems utilise a single centrally located common station for both directions (like a typical railway platform) rather than having two bus stops, one for each direction. Such stations are positioned in the verge between the two directions of movement and offer access to buses moving in both directions. To access these stations, BRT buses with doors on the right side and no steps are required. More details on the vehicles are provided below (See Section "1.2.4. Vehicles").

There are many advantages of central stations:

Cheaper to construct and maintain: Central stations are smaller and are up to 40 per cent cheaper to build and operate than two bus stations on either side of the central bus lanes.

Optimal use of street space: Central stations require a single entry area and single set of turnstiles; whereas the two bilateral stations each require their own entry.

Easier customer transfer between routes: Central stations make it easier for customers to transfer from one bus route to another without having to exit the station and cross a street, irrespective of the direction of the two routes.

Facilitates two-way bus access: Platforms in each direction allow two buses to dock simultaneously at any given time.

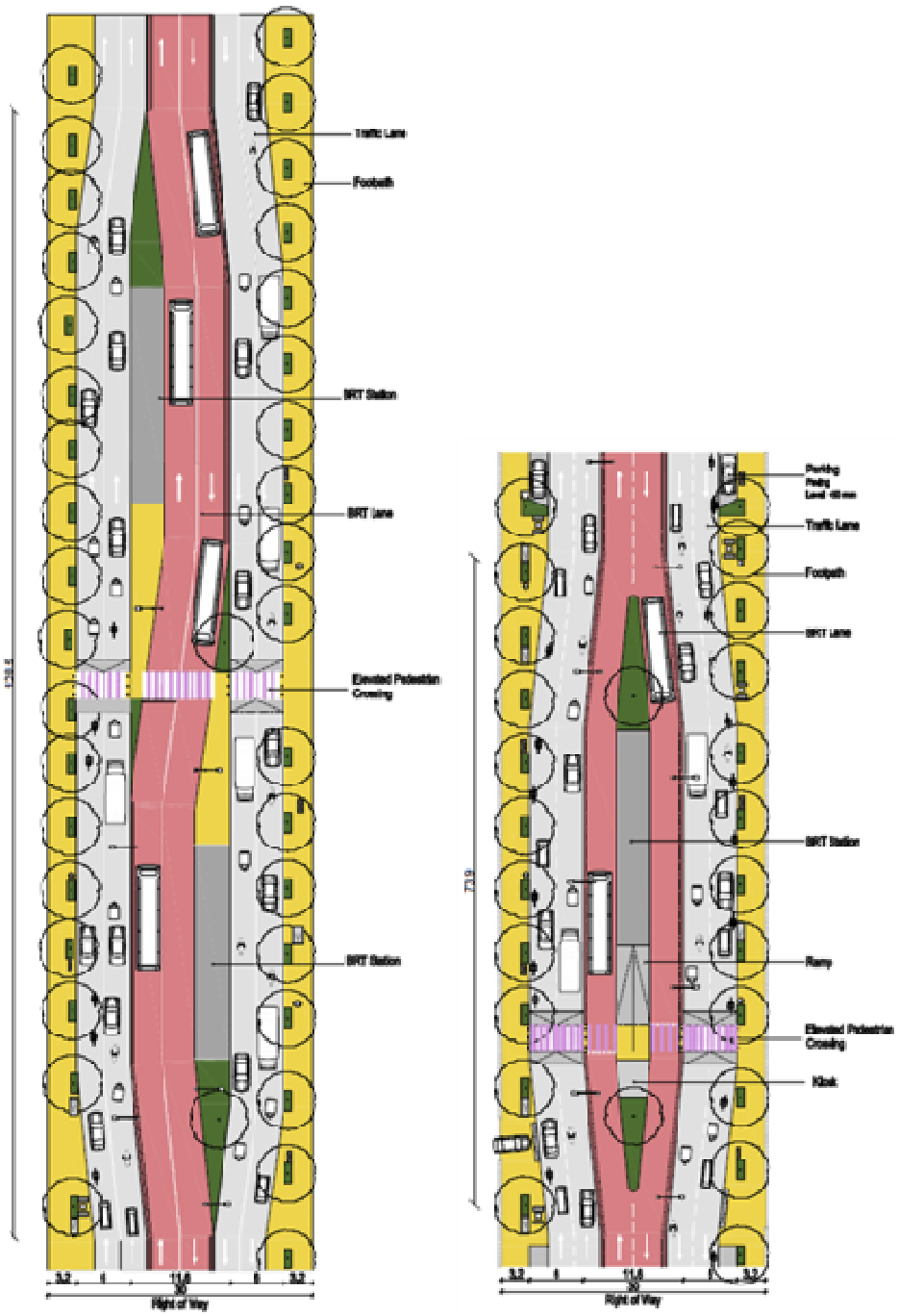

Figure 79: Kerb-aligned stations split for each direction takes away more ROW (left). Median station serving both directions makes transfers easier and tends to reduce both construction cost and ROW (right).

Station sizing will largely be a function of peak passenger load expected for the future years. Stations in Ranchi will generally require two docking spots per direction, one behind the other, but no overtaking lane. A high capacity BRT station has multiple docking spots, called sub-stops. Each of the sub-stops may be independently accessed from the overtaking lane, without being obstructed by a bus docked at an earlier sub-stop.

Thus, depending upon the location and peak passenger demand, the length of stations, width and number of boarding platforms will vary. To allow greater flexibility, BRT stations are typically

designed in such a way that new modules can be added as passenger demand increases. Extra space should be reserved in the median for adding additional modules in the future. Modules of 4.8 m x 4 m are the most appropriate to accommodate both 12 m and 18 m buses. The four stations are designated interchange stations that provide connectivity between BRT corridors or between BRT and feeder services. These stations may require additional modules to handle expected passenger demand. The sizing of these stations will be determined after a detailed service plan is prepared.

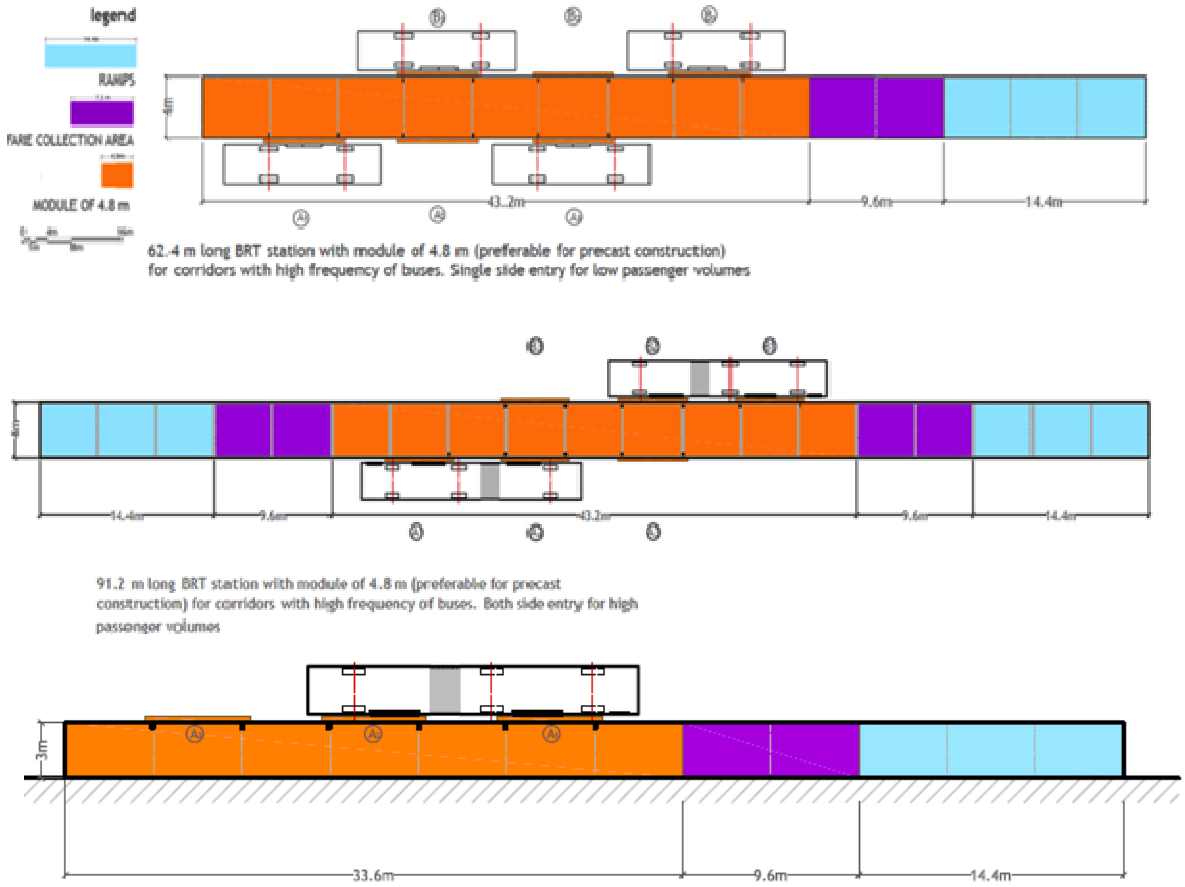

Figure 80: Functional areas of BRT stations: ramps, fare collection, and waiting/boarding.

Since Ranchi will have 12 m and 18 m buses on proposed corridors, the recommended station length shall be 60 m to 100 m with three main components: an access area (with wheelchair accessible ramps), a fare collection area, and a passenger circulation / boarding / alighting module. This requires that the station have at least two docking bays per direction for docking regular (12 m) buses. On corridors where 18 m buses are expected to ply, stations should be designed with extra doors to allow boarding and alighting simultaneously into the front and rear coaches of the 18 m buses.

It is recommended that stations be at least 4 m wide to provide room for waiting and circulation. In case of a single direction or one-way BRT lane, the station should have minimum width of 3 m and the station length depends on the number of docking bays and bus type. Key to the effectiveness of this station design is the staggered nature of the boarding areas. This maximizes the use of interior space and prevents customer congestion that may occur when vehicles travelling in opposite directions arrive at the station at the same time.

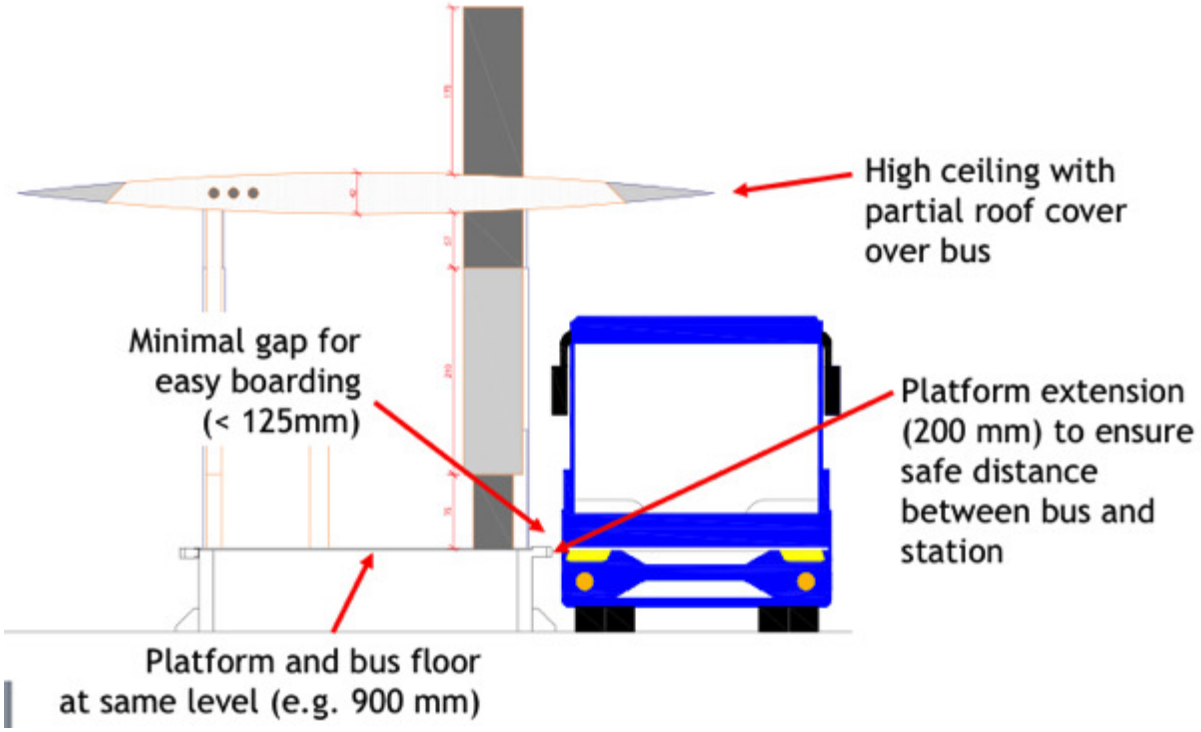

Figure 81: Station cross section of station-bus interface illustrating key station features

The figure above illustrates four key design features of Ranchi's BRT stations. Coordinating the height of the vehicle and boarding platform, as well as minimizing the gap between the vehicle and the station are especially necessary. Also to enhance customer comfort and provide a much different experience than the traditional urban bus, it is important to protect the waiting and boarding area from rain and sunlight. The roof should provide adequate shade and be protective from rainwater blowing or seeping into the station. A direct rainwater collection and transfer system is necessary to easily route water from the roof to the ground without overwhelming the bus lane or the station facilities.

Figure 82: Stations require adequate space for boarding, alighting, and internal circulation

The terminal areas in Ranchi will be large sized stations essentially located on off-street land pockets in close vicinity to depots. The terminal area will have BRT docking positions similar to station docks, with platform at 650 mm height from ground floor. Terminals generally will have more than one route, requiring an adequate number of platforms and passing lanes. Terminals will also have lower boarding platforms providing access to feeder services.

Figure 83: Transfer station between feeder and trunk BRT in Bogota, Columbia.

Ranchi's BRT terminal areas will be based on the following design principles:

- Provide maximum circulation area for pedestrians and commuters in and around the terminal
- Limit vending spaces inside the terminal. Some spaces can be officially allocated on annual auction basis to make the terminal area a vibrant place and provide commuters with extra services like pay and use toilet block, refreshment and books stalls, fruit and vegetable vendors etc.
- Restrict entry of auto rickshaws and private vehicles within the terminal area
- Provide proper directional signage throughout the terminal area guiding the passengers. Ample static (printed) and dynamic (electronic) signage is very necessary in places with large volumes of travellers.
- Ensure quality infrastructure for administrative staff and those controlling bus operations.
- Provide facility of real time passenger information system with announcement and display
- Provide durable and large-scale fare collection system. Terminals must be able to handle the large volume quickly for which more than 3 tickets counters and more than 10 flap gates may be required.
- Provide shelter and protect waiting customers from rain, sunlight and adverse climatic conditions.
- Provide adequate furniture for seating and secure waiting spaces (especially for women travelling in the evening) must to be included within these facilities.
- Clean and hygienic wash rooms and toilet facilities for men and women
- Co-locate terminal and depot facilities to minimise dead kilometres and provide space for off-peak parking

Detailed architectural design reports must be prepared for all of the terminals, incorporating the features listed above.

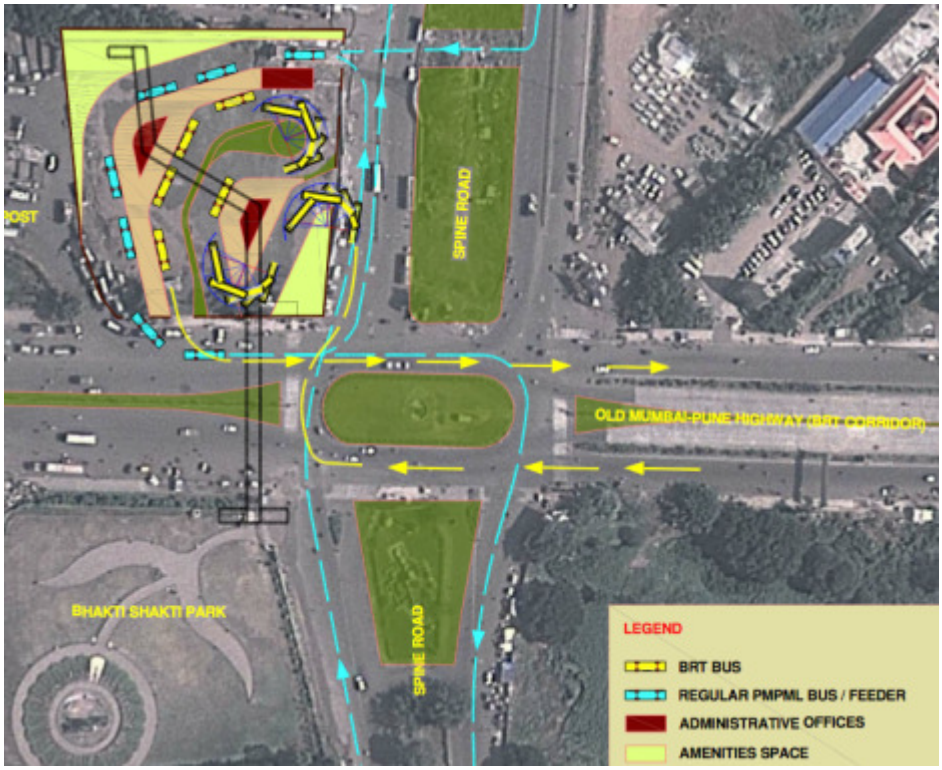

Figure 84: Conceptual design for a trunk-feeder transfer facility in Pimpri-Chinchwad

Facilitating transfers between public transport services is critical to improving all public transport usage. Therefore, it is important to assess how Ranchi BRT terminals can be co-located with key intercity bus terminals. The locations for Phase 1 terminals are presented below.

Table 25: Proposed transfer station locations for Ranchi BRT Phase 1

Terminal location	Interchange modes
Kathitand	BRT-BRT BRT -Feeder BRT- Intercity Buses
New Market/Raj Bhavan	BRT – BRT BRT-Feeder
Namkum	BRT-BRT BRT -Feeder BRT- Intercity Buses
Birsa Chowk	BRT-BRT BRT -Feeder BRT- Intercity Buses

Some locations do not require full-fledged terminals, but the station size should be increased to accommodate expected pedestrian volumes. Such large stations should be constructed where customers may switch between different trunk BRT services or to other modes. Potential locations for large stations are listed in the table below.

Table 26: Phase 1 large stations

Location	Interchange modes
Ranchi Railway Station/Overbridge	BRT- BRT BRT - Railway
Firayalal	BRT-BRT
Karamtoli	BRT-BRT
Piska More	BRT-BRT BRT - Feeder
Kutchery Chowk	BRT-BRT
Kantatoli	BRT-BRT BRT - Feeder

1.2.4. Vehicles

The Ranchi BRT vehicles must be compliant with the urban bus design standards, as developed by the MOUD. Median stations with a high floor are demanded secondary to the characteristics of Ranchi's streets and the estimated high demand for public transport. Therefore, Ranchi BRT requires high quality, modern buses with a 650 mm floor height with two centrally located doors on the right side as well as left side boarding via steps.

Figure 85: BRT vehicle with right side, high-level boarding. Pune – PMPML

Two doors on the right side of the bus at 650 mm will allow for level boarding and alighting from the station (width of at least 1.2 m each and separated by at least 250 mm). Two doors on the left side with stepped entry will allow kerbside boarding and alighting when the vehicle leaves the dedicated bus ROWs (over the course of the BRT service extensions).

Similar to BRT stations, BRT vehicles must also be designed so that they are usable by all persons regardless of their abilities, age, gender, or income. The following access features (beyond the urban bus design standards) must be included on all BRT vehicles:

- Stanchions, grab bars and handholds, must be provided so that people who are standing are able to safely react to bumps or sudden stops that the vehicle may encounter.
- Priority seating must be provided that is clearly identified as being reserved for people with disabilities, seniors, and mothers with small children, or pregnant women.
- Approximately 800 mm x 1,200 mm of space on board BRT vehicles must be dedicated for wheelchair users (or other mobility device users). This wheelchair positioning area must be located adjacent to vehicle entry doors to facilitate right-side, high-level station access.
- Stop request buttons must be installed at locations of priority seating and wheelchair positioning.
- Auditory announcements of stop names and key destinations will ensure that people who are blind or visually impaired will reach their destinations
- A manual ramp of sufficient slope (length) must be provided, so that conductors can provide assisted boarding from bus stops and from the ground level for seniors, wheelchair users and other people with physical disabilities.

Similar to station personnel, all Ranchi BRT vehicle operators, conductors and service field supervisors, must receive sufficient training in working with people with disabilities. This will ensure that the policies and technology that is invested in facilitating access will be appropriately utilised and that no one will be denied service secondary to discrimination, or wilful ignorance of policy by staff.

1.2.5. Access to stops and stations

BRT interventions offer a great potential for transforming cities—but it is important to think about for whom the city is being transformed. RMP strongly believes that when properly implemented, a modern BRT system for Ranchi will follow the spirit of universal design[25], which advocates against "one design fits all." Universal design involves a fundamental shift in thinking about design, particularly with regard to designing to address social difference.

It is important to design all BRT facilities so that they are usable by all persons regardless of their abilities, age, gender, or income. Inaccessible infrastructure in particular ensures that people with disabilities remain invisible in the public arena. To provide consistent and safe accessibility, the built environment and transportation systems must comply with 1995's Persons with Disabilities (PWD) (Equal Opportunities, Protection of Rights and Full Participation) Act. The PWD Act specifically entrusts the government with the task of appropriately allocating public resources so that plans and programs do not discriminate against persons with disabilities.

[25]http://en.wikipedia.org/wiki/Universal_design

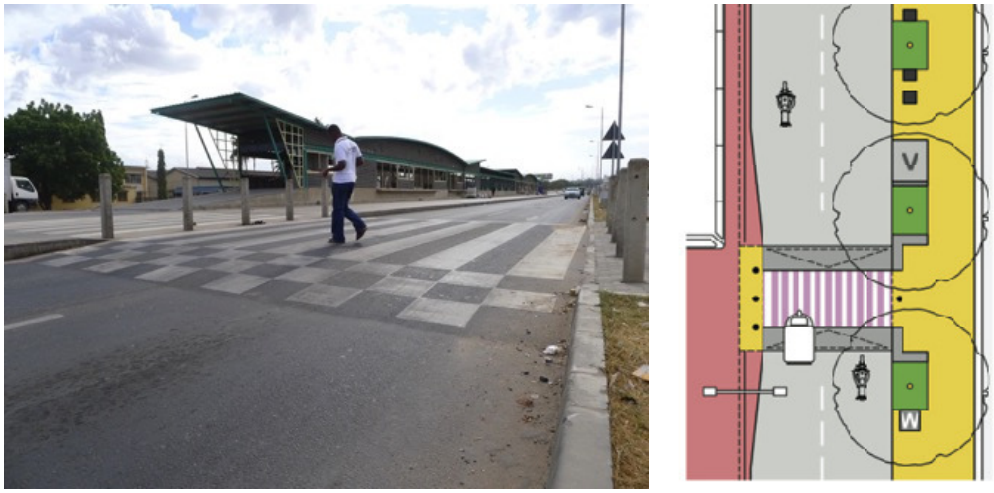

Figure 86: Access to midblock BRT stations should be provided through tabletop crossings at the same level as the adjacent footpath to improve accessibility.

It should also be noted that as of March 2007, India signed the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD). The UNCRPD requires that signees take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation. This it is necessary that buildings, roads, transportation and other indoor and outdoor facilities be designed and implemented in such a manner that enable persons with disabilities to "live independently and participate fully in all aspects of life."[26]

To provide access for all people, Ranchi BRT stations must be vigilant to include the following features:

- Station pedestrian crossings that provide an accessible path of travel that is at least 1,200 mm wide and preferably with level or have the gentlest possible gradient that does not exceed 1 in 20.
- The accessible path of travel should have a continuing common surface not interRMPted by steps or abRMPt changes in level. Ramps, fare gates and boarding platforms must accommodate wheelchairs.
- Obstacles such as lighting columns, bollards, signposts, seats and trees, should be located at or beyond the boundaries of walkways. Where unavoidable, protruding objects should not reduce the clear width of an accessible route or manoeuvring space.
- Free-standing columns that support an entrance canopy and low level posts, e.g. bollards, should not be positioned within the width of an access route.
- Tight bollard spacing and kerbed-medians that have been utilized by some systems to exclude 2 wheelers from the bus-way pose great challenges to people with disabilities. These techniques deny customers from accessing the system and are unacceptable.
- The required minimum clear unobstructed width of a ramp (i.e. between handrails) is 1,200 mm for ramps up to 3.6 meters long. For ramps longer than 3.6 m and up to 9 meters the minimum width should be 1,500mm. For ramps more than 9 m long the ramp should be minimally 1,800 mm wide.
- The materials selected for the surface finish of a ramp should be firm and easy to maintain. These must also be slip resistant, especially if surfaces are likely to become wet due to location or use, or if spillage occurs. The use of shiny, polished surface materials that cause glare should be avoided.

[26]http://www.un.org/disabilities/default.asp?id=150

- A ramp shall have a level platform at the top that is at least 1,800 mm long, if a door swings out onto the platform or toward the ramp. This platform shall extend at least 300 mm beyond each side of the doorway. Each ramp shall have at least 1,800 mm of straight clearance at the bottom.
- A uniform illumination level of 150 lux should be maintained throughout the station.
- Visual information in all transport facilities should be supplemented with audible information. Station PA systems should be clearly audible.
- High-contrast, tactile warnings should warn customers with visual impairments of the approaching danger of the boarding platform. High contrast, tactile guide blocks should also be provided within stations to provide a path for visually impaired customers between the entrance, the fare windows / information kiosk and the boarding areas.
- Where auditory announcements are utilized, supplementary visual information should be provided to assist customers with hearing disabilities.

Figure 87: A man with crutches easily accesses Janmarg stations (left). Tricicycle users benefit from BRT corridor cycle tracks (right). (Photos by Meena Kadri)

All Ranchi BRT personnel that interact with the public (such as ticket sales professionals, security staff, fare inspectors, conductors and *especially* vehicle operators, etc.) must receive sufficient training in working with people with disabilities. Specific capacity building initiatives must be completed to ensure that future policies, programs and infrastructure do not discriminate against any customers. For additional details regarding the most recent guidelines for accommodating Indians with disabilities, please see the "Draft Indian Standards: Recommendations for Buildings and Facilities for Persons with Disabilities" completed by AccessAbility, a Delhi-based NGO.[27,28]

To make customer access safe and convenient, speed tables and raised pedestrian crossings must be constructed at each customer entrance ramp. It is very important that the height of the ramp and the speed table level are the same so that level access to the boarding ramp from the raised crossing is ensured.

[27]http://uncrpdindia.org/files/reports/Core-Group-Accessibility-Physical-Access-Standards-Revised.pdf
[28]http://www.accessability.co.in/

1.2.6. Corridor cross sections

Based on site visits and GIS mapping of ROW using Google satellite imagery, ITDP developed appropriate cross section designs for each corridor.

Table 27: Phase 1 Corridor ROWs

Corridor Name	Section Name	Average ROW (m)
Ratu Road	Piska More to Metro Gali	18
Ratu Road	Metro Gali to Pahari Mandir	21
Ratu Road	Pahari Mandir to Ratu Road	24
Ratu Road	Ratu Road to CCL Guest House	20
Ratu Road	CCL Guest House to Kutchery Chowk	18
Ratu Road	Kutchery Chowk to Radium Road	12
Ratu Road	Radium Road to Karamtoli	22
Ratu Road	Karamtoli to Jail More	14
Ratu Road	Jail More to Kutchery Chowk	16
Main Road	Kutchery Chowk to Shaheed Chowk	22
Main Road	Shaheed Chowk to Firayalal	17
Main Road	Firayalal to Sudha milk parlour	35
Main Road	Sudha milk parlour to Kali Mandir	24
Main Road	Kali Mandir to Daily market	18
Main Road	Daily market to Urdu library	14
Main Road	Urdu library to Glitz cinemas	26
Main Road	Glitz cinemas to Sujata Chowk	24
Main Road	Sujata Chowk to Rajendra Chowk	20
Main Road	Rajendra Chowk to A. G. More	18
Main Road	A. G. More to Hinoo Chowk	24
Main Road	Hinoo Chowk to Birsa Chowk	19
Main Road	Birsa Chowk to Jagannathpur Thana	11
Main Road	Jagannathpur thane to Dhurva	30
NH 75	Ratu Road to Shivaji Chowk	24

Corridor Name	Section Name	Average ROW (m)
NH 75	Shivaji Chowk to Shahjanand Chowk	22
NH 75	Shahjanand Chowk to Harmu Chowk	19
NH 75	Harmu Chowk to Argora housing colony	28
NH 75	Argora housing colony to Dibdih Bridge approach	20
NH 75	Dibdih Bridge approach to Delhi public school	27
NH 75	Delhi public school to Check post	23
Purulia Road	Firayalal to Sudha Milk Parlour	35
Purulia Road	Sudha Milk Parlour to St. Xavier's College	14
Purulia Road	St Xavier's College to Dangratoli	18
Purulia Road	Dangratoli to Lalpur Chowk	16
Purulia Road	Lalpur Chowk to Firayalal	13
Purulia Road	Dangratoli to Kantatoli	23
Purulia Road	Kantatoli to Durga Soren Chowk	24
Purulia Road	Durga Soren Chowk to Namkum Railway Station	18

Based on site observations, the ROW on the proposed corridors were found to vary from 11 to 35 m. Given the width constraints in some sections, BRT is still possible by having one way system on narrow sections. Two-way BRT corridors can be implemented on streets of any width starting at 18 m. BRT corridors do require a wider cross section to accommodate stations. An additional 3 m to 4 m is needed at station locations; this width can be gained by temporarily discontinuing the parking lane on streets with on-street parking.

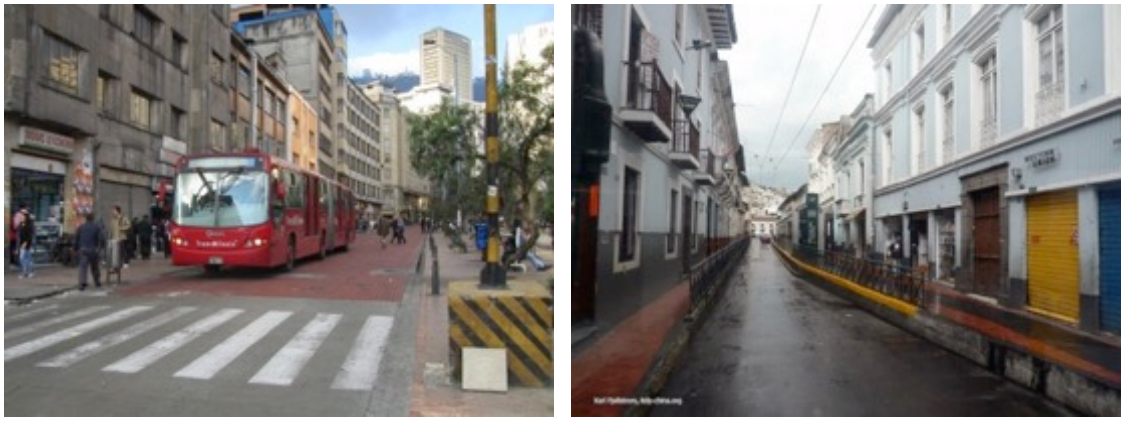

Figure 88: Example of BRT systems in narrow streets of Bogota (left) and Quito (right).

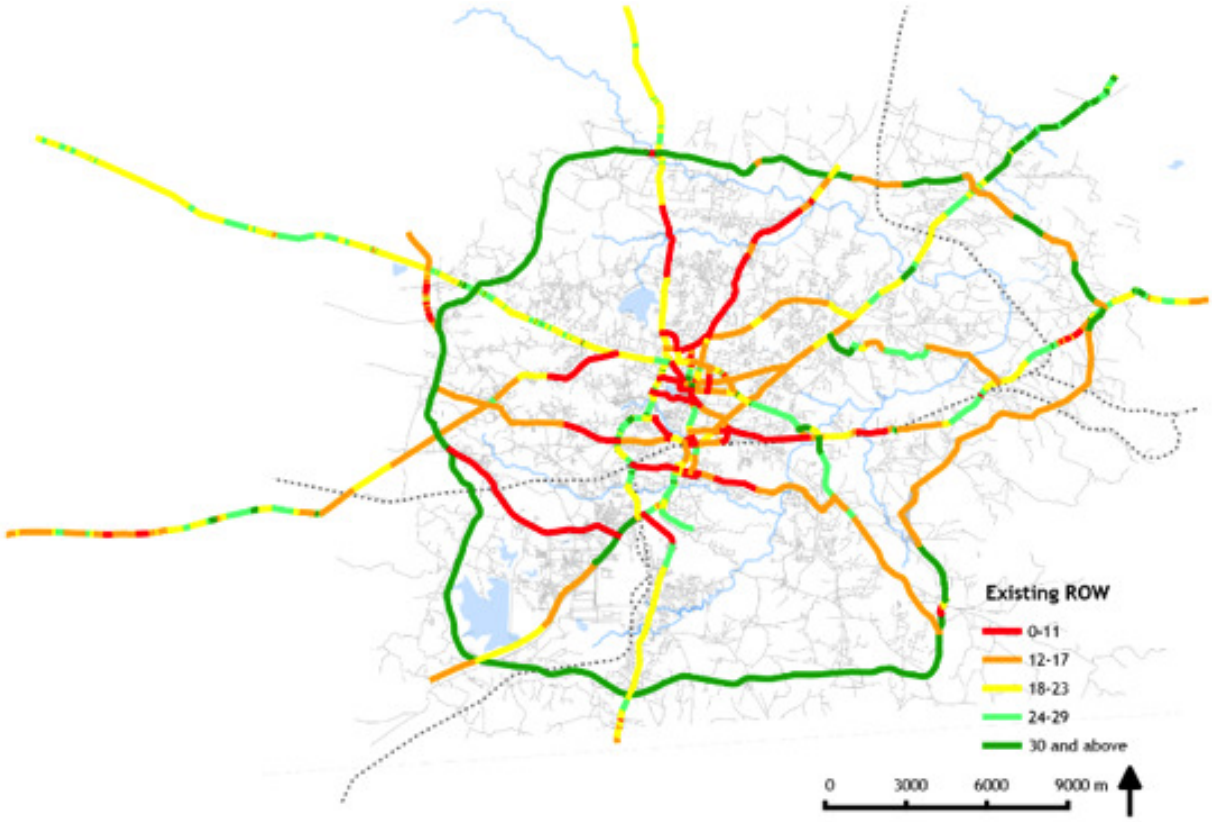

Figure 89: ROWs in Ranchi.

To introduce the proposed BRT corridor design sections, the importance of high quality pedestrian access must be again emphasized. If Ranchi's public transport system is to facilitate the movement of *people not vehicles*, then BRT corridors must benefit all pedestrians— not just BRT customers. For example, existing pedestrian infrastructure, such as footpaths, plazas and crossings, must not be narrowed when corridors are redesigned to accommodate BRT busways and stations. Similarly, raised table-top pedestrian crossings must be provided along corridors (and at stations) to allow all to cross carriageways safely. In addition, median refuges between the bus and carriageway lanes will provide a place for pedestrians to wait before crossing the next stream of traffic.

The following figure illustrates a key organising principle to the BRT section designs, providing equal priority to NMT. For NMT modes to be viable and convenient, NMT users need adequate infrastructure—slow-speed shared spaces, footpaths, cycle tracks, and greenways—on which to travel. This means that BRT streets must need dedicated pedestrian footpaths or vehicle speeds need to be radically reduced in case of a shared space. Footpaths must be unobstructed, continuous, shaded, and well-lit. On BRT corridors with larger ROWs, cycle tracks are provided. In addition, the corridor designs will include provisions for street furniture and other elements like vendors, autorickshaw standing points, public toilets, city bus stops, and seating.

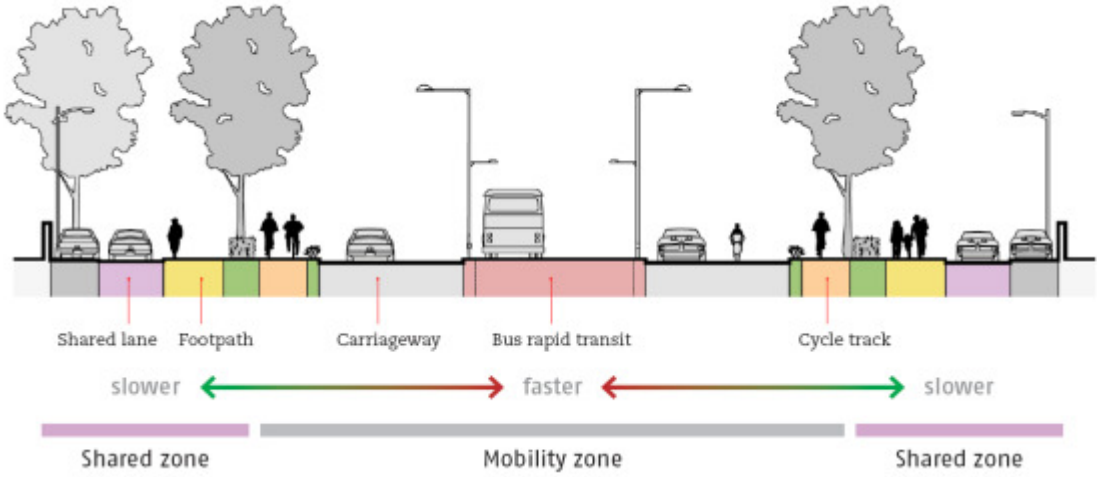

Figure 90: All streets require a slow zone that provides a safe space to walk.

Ranchi's streets are public spaces for socialization and commerce as well as mobility. The *slow zone*—whether the entire right-of-way of a small street or a separate space on a larger thoroughfare—is space for liveability[29]: for people to walk, talk, and interact, for doing business, for children to play. The provision of an adequate slow zone recognizes that street themselves are destinations. It also enables streets to provide safe and uninterRMPted mobility for all users regardless of their travelling speed. This results in a more pleasant street for everyone.

This section includes street design sections for wider road widths from 30 m, 24 m, 18 m, 16 m and 14 m. Two types of sections are presented for each ROW width: one shows the cross section at BRT stations and other one showing the regular midblock section. The 4 m width required for the station is generally provided by temporarily discontinuing the parking lanes. Wherever the width is less than 10 m, the station width is taken as 3 m.

All sections include footpaths, carriageways, buffers and bus lanes for both one way and two-way BRT service. The mixed traffic carriageways immediately adjacent to the bus ways will be separated by physical barriers through the length of the corridor. In addition, the corridor designs will include provisions for street furniture and other elements like public toilets, city bus stops, seating, and spaces for formalized vendors.

All sections that include BRT station areas should also plan to include elements that support multi-modal integration. Autorickshaw standing points, secure cycle parking, or connections to Bus terminals or to Railway facilities will ensure that Ranchi people can safely and easily use these systems to access Ranchi BRT stations and stops.

A right of way with 30 m wide is available on certain sections of Main Road, NH-75 and Purulia Road allowing for large footpaths with shade trees, area for parking and for social street uses such as public plazas or vending.

It is important to note that the 3.3 m for single BRT lane in each direction and 4-4.5 m carriageway width for two lanes each direction is taken as standard for the remaining (much larger) ROWs. Even as larger ROWs are available, it is recommended that this dimension be frozen and the additional space be prioritized for other uses besides traffic (such as pedestrians and cyclists). Keeping consistent carriageway widths will help prevent traffic bottlenecks.

[29]Liveability implies that street designs recognize the relationship between the street and all of its users. Liveable streets are designed as public spaces that allow people to get from point A to B, but also support and encourage the activities people pursue in public spaces. Such streets are inclusive, multicultural, socially cohesive, economically vibrant, and full of life.

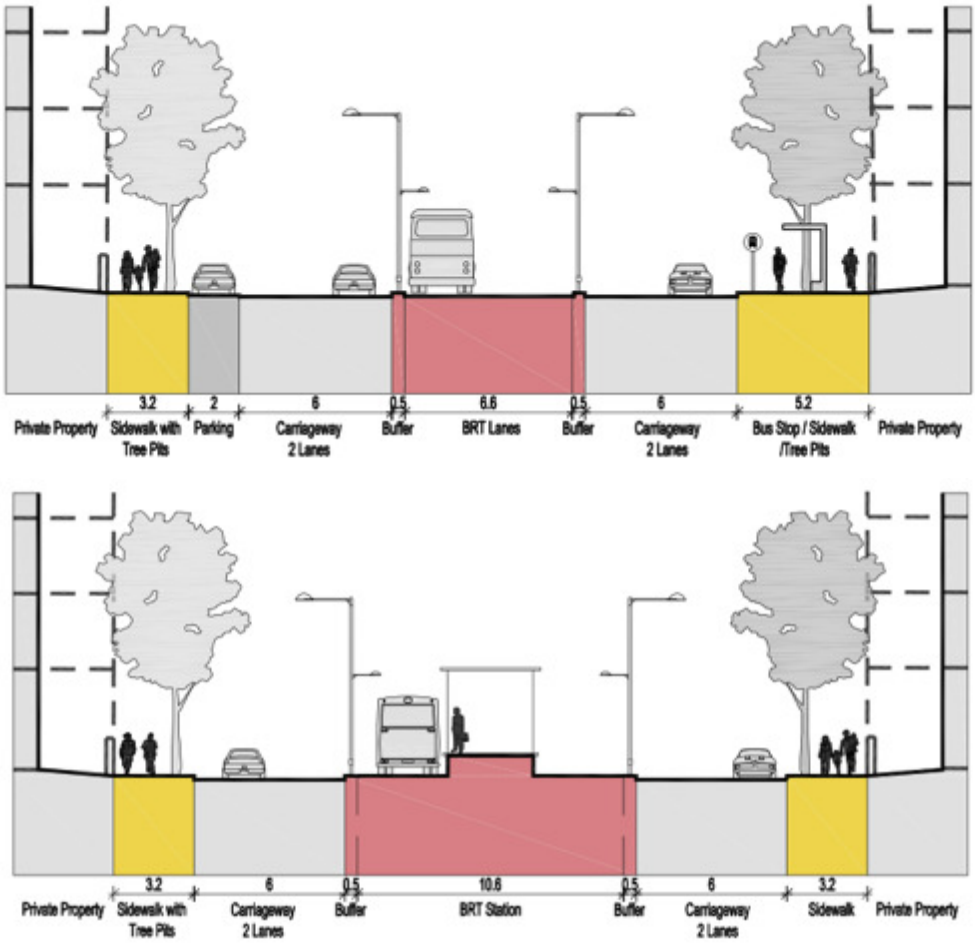

Figure 91: 30 m BRT corridor sections: without station (top) and with station (bottom).

Some stretches on Ratu Road, Main Road, and Purulia Road have width of 24 m, allowing for two-way traffic and includes wide carriageways and footpaths on each side of the bus lanes.

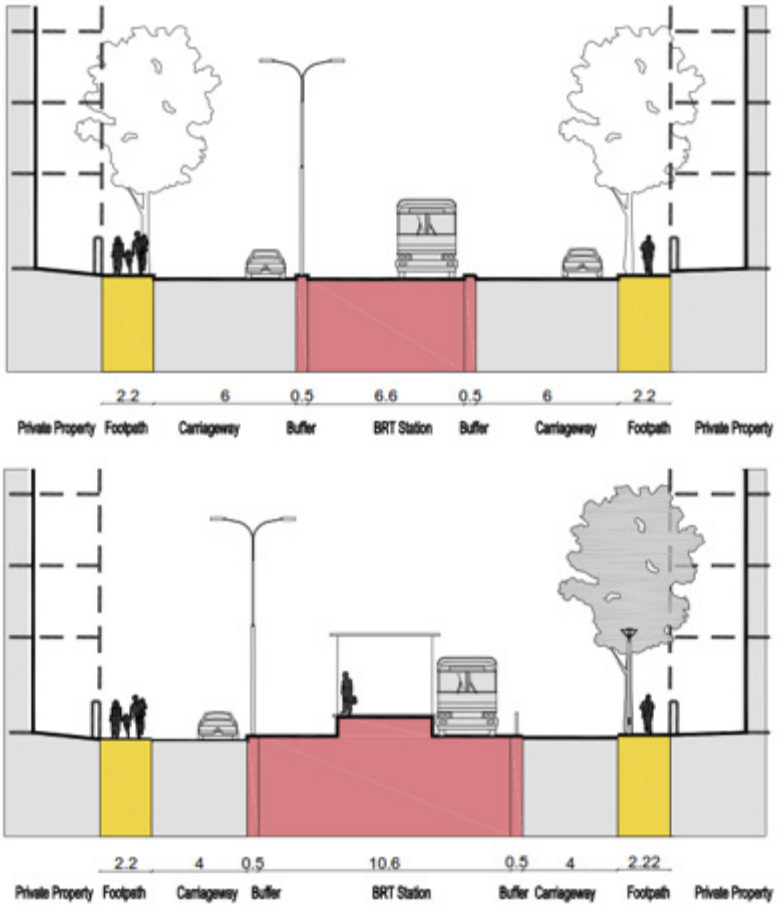

Figure 92: 24 m BRT corridor sections with station

Similar to the 24 m cross section, the 18 m cross section along sections of Ratu Road and Main Road will accommodate two way BRT and two way mixed traffic movement without a BRT station. Both sides of the street feature minimum of 1.8 m footpaths.

Figure 93: Radium Road to Karamtoli: 18 m BRT corridor sections with one way BRT lane and two way mixed traffic lanes without a BRT station.

Figure 94: Rajendra Chowk to Doranda High Court: 18 m BRT corridor cross section with two way BRT lanes and one way mixed traffic lane.

Wherever there is width constriction or ROW less than 18 m, the sections only allow mixed traffic movement in one direction or BRT lane in one direction. Some stretches have narrow street widths with a right of way of 16 m. In such sections, two way mixed traffic and a one way BRT lane can be accommodated. In case of ROW less than 16 m, a dedicated one way BRT lane with one way mixed traffic and pedestrian paths is proposed.

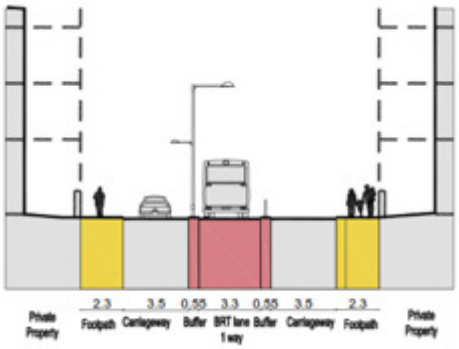

Figure 95: Ratu Road (Kutchery Chowk): 16 m BRT Cross section with two-way mixed traffic and one-way BRT lane.

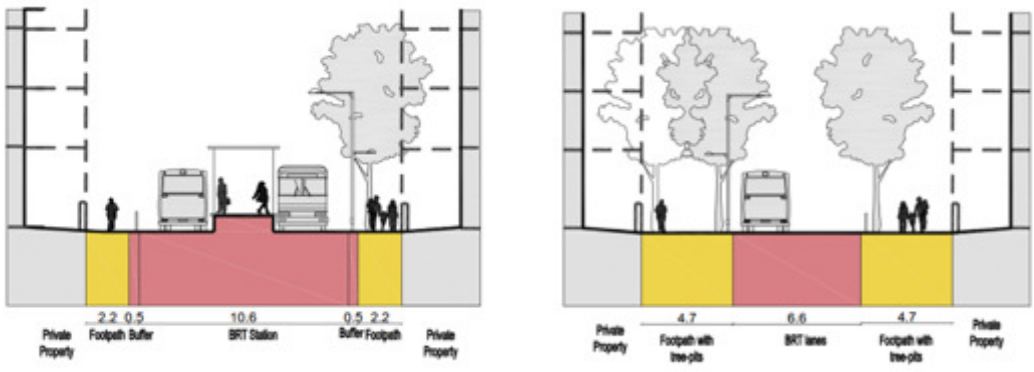

Figure 96: 16 m BRT cross section with two-way BRT lanes and footpaths on both sides.

Presently, the traffic movement in the city centre is a two-way on most roads with some exception for share autos. The share auto rickshaws are prohibited on Main Road, and west bound travel is prohibited from Dangratoli to Ranchi Womens College. Purulia Road, Hazaribagh Road, and Church Road that provide access to Main Road operate two way despite narrow street widths.. Due to heavy commercial activities and narrow widths, these roads are mostly congested and encroached with hawkers and on-street parking and high pedestrian movement. With these constraints, BRT can be implemented only if it is made one way and alternative roads are proposed to route the other directional traffic. This way it helps to improve the travel time for both mixed traffic lane and dedicated BRT lane.

Based on ROWs and field observations, Hazaribagh Road (from Lalpur Chowk to Firayalal) and Purulia Road (from St. Xaviers College to Dangratoli) were identified as one-way pairs. Inbound mixed traffic and BRT buses will be allowed on Hazaribagh Road and outbound traffic will be routed on Purulia Road. This will help the BRT buses to operate at higher speed and reduces the delay on these stretches.

A similar one-way street pair has been identified between Kutchery Chowk and Karamtoli. A loop system will be created where vehicles going northbound from Kutchery Chowk to Karamtoli will take Radium Road. Similarly vehicles going southbound from Karamtoli to Kutchery Chowk will travel on the parallel road via Jail More.

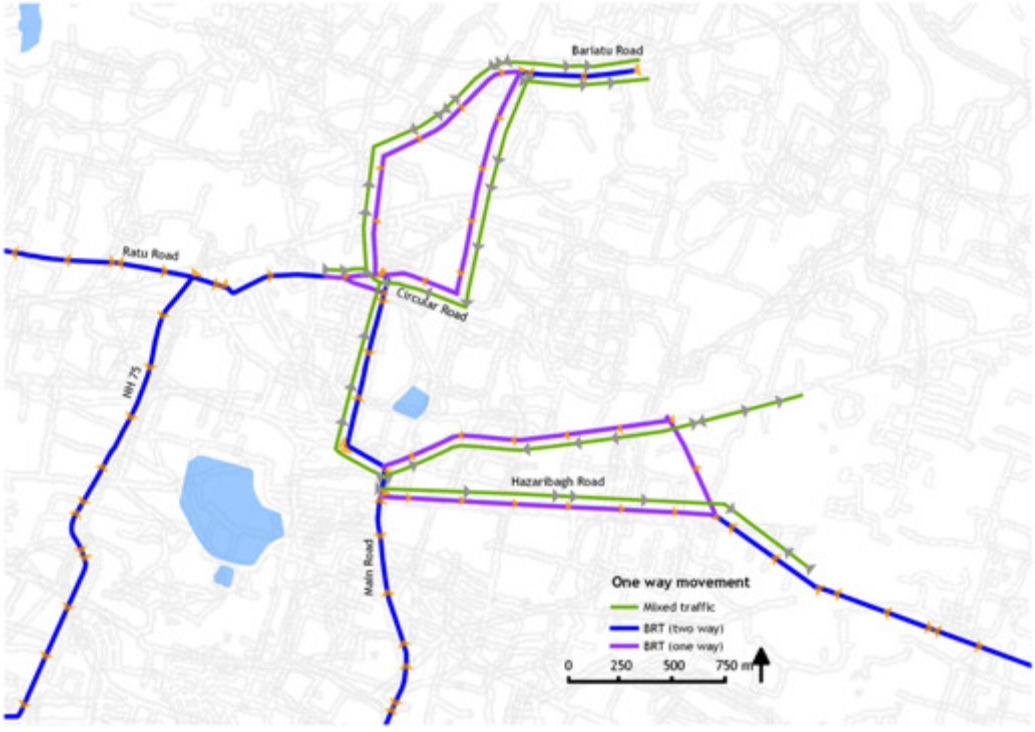

Figure 97: One way movement in Ranchi for BRT (blue) and mixed traffic (green).

Figure 98: Two-way BRT lanes and one-way northbound mixed traffic from AG More to Rajendra Chowk. The southbound mixed traffic will be made one-way from Rajendra Chowk to AG More via Doranda High Court

1.2.7. Pavement design

BRT corridor infrastructure consists of important components like bus lane, station area, mixed traffic carriageway, service lanes, and footpaths, cycle tracks, landscaping, parking and vending area. The implementing agency shall carry out a detailed assessment analyse soil conditions and, in cases where the existing pavement is to be retained, the pavement quality. All the geometric standards will be set based on recommended IRC guidelines and as per site-specific conditions suiting the operational requirements of the proposed BRT system. Existing medians will be dismantled and all the fixed objects such as kerb stones, electric poles, and sign boards will be removed. Excavation will be done up to required depth. Corridor elements will be redeveloped as follows:

- Footpaths, public activity areas and parking areas shall be paved using concrete or concrete paver blocks. Interlocking concrete block paving on footpaths and parking areas are designed as per recommendations of IRC: SP: 63-2004. A typical design would consist of 65 mm thick interlocking blocks over a 30 mm sand bed and 75 mm brick bat cement concrete (or the reinforced cement concrete storm water drain). Parking areas shall have interlocking blocks of 85 mm thickness (minimum compressive strength of a single block 50 MPa), sand bed of 40 mm, base of WMM 250 mm, and granular sub base 200 mm of thickness.
- Cycle tracks will be made of cement concrete.
- Carriageways and service lanes will be developed with flexible pavement considering the high subgrade strength, low traffic loading, ease of construction, and low initial costs. The cross section design shall be based on the formulae for design of flexible pavements as per IRC: 37:2001.

It is recommended to have cemented concrete pavement for BRT lanes throughout the entire Phase 1. BRT services will be operated at close frequencies and the repetition of the loading on the bus lane will be continuous. The area requiring more attention is at bus station where the bus will dock in the same position every 2 to 3 minutes. Experience from Ahmedabad's Janmarg BRT system has revealed that having flexible pavement at bus station area will lead to pavement failure and potholes

will be developed within 3 months of BRT operations. Improper workmanship even leads to cracking of concrete pavement.

Figure 99: Effect of repetitive bus movements at BRT stations in Ahmedabad (left) and Mexico City (right).

1.2.8. Depots

The major function of depots is to provide adequate parking to bus fleet and accommodate facilities to carry out regular maintenance and up keep. Separate workshops may be developed to carry out major repairs in the buses, but most repairs should be accommodated by depot facilities.

Bus depot locations that are far from the starting points of bus trips may result into increased operating costs. Therefore, the process of determining depot locations aims to minimise so-called "dead kilometres." Depot locations are also a function of real estate availability and pricing. For Ranchi, we propose locations that balance the requirements of reducing dead kilometres and the availability and cost of depot land.

There are two depots in Ranchi. Ranchi Depot near the railway station area provides space for 40 minibuses and for Bihar State Road Transport Corporation (BSRTC). At the second location, the Dhurwa depot, city buses are parked on road as the limited space is mostly occupied by BSRTC buses. The depots lack proper facilities for washing and routine maintenance.

Per observations and experiences with other Indian BRT system depots (Janmarg and PMPML), ITDP anticipates that 214 sq m of space will be required for 12 m bus and 327 sq m for 18 m. Thus, for Phase 1 of the Ranchi BRT, the following depots are planned:

Table 28: Proposed depot locations for Ranchi BRT Phase 1

Depot location	Minimum area required (sq m)	Buses 12 m	Buses 18 m
Dhurva	35,000	52	60
Kathitand	37,500	31	55
Namkum Railway Station	20,000	68	
Chiraundi	37,500	46	55
Gutuwa @ Ring Road	37,500	91	
Total	**167,500**	**288**	**170**

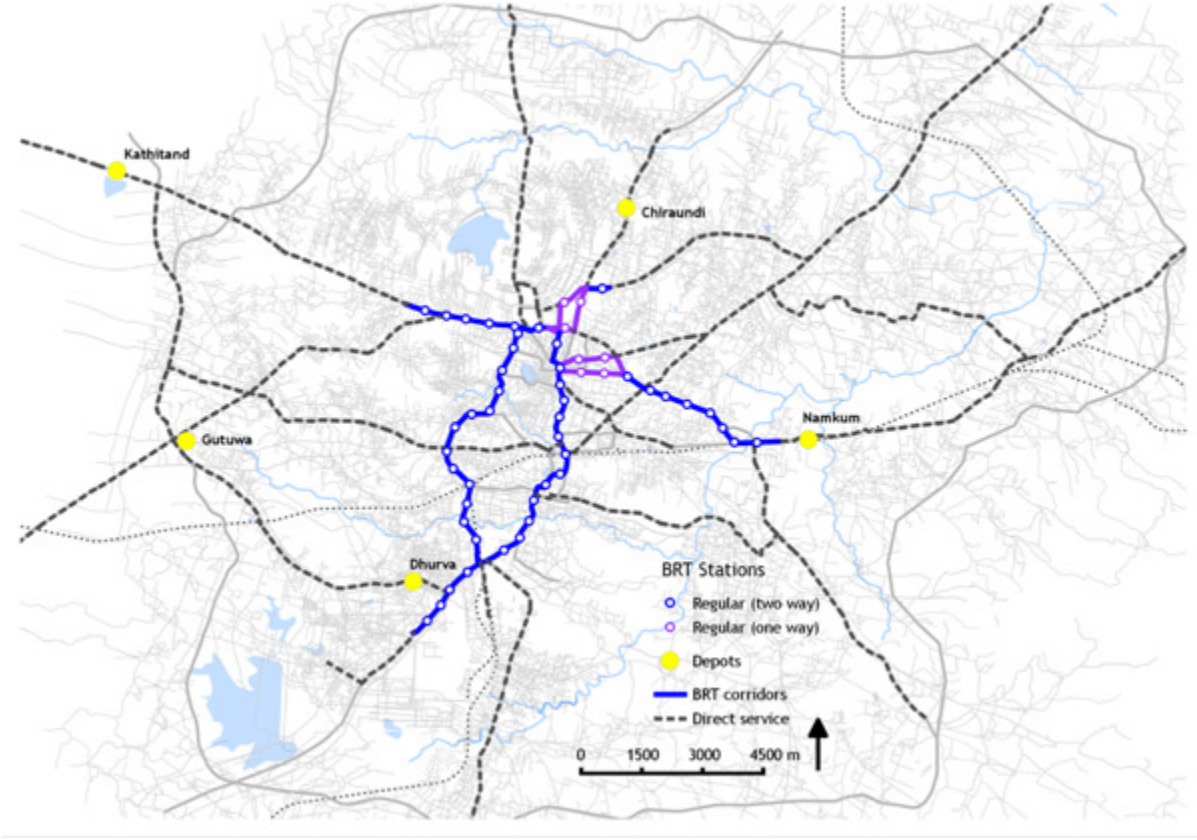

Figure 100: Ranchi BRT Phase 1 Depot locations

In addition to the bus requirements, a depot also houses facilities such as rest rooms, refreshment canteens, and stay arrangements for drivers, conductors, supervision, and maintenance staff. A depot space has to be large enough to cater existing as well as future fleet additions. The implementing agency needs to identify land to accommodate the entire bus fleet in Phase 1.

The important components of a depot facility are enlisted below:

- Bus parking area
- Bus washing area with a ramp and a water flow channel
- Bus maintenance area
- Inspection pits and bays
- Storage of maintenance tools, equipment, materials etc.
- Store of tyres, batteries etc.
- Fuel pumps and fuel tanks
- Staff amenities like rest rooms, guest rooms, refreshment areas
- Staff Training and Meeting halls
- Manger's cabins and Security
- Landscaping
- Treatment of hazardous chemicals and toxic wastes before disposal in open environment.

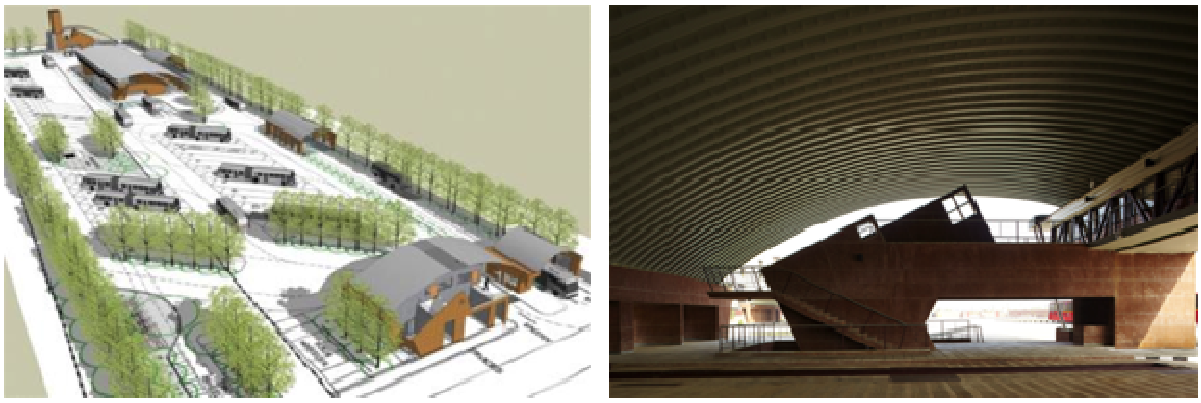

Figure 101: Conceptual diagram for depot facility to accommodate BRT vehicles (CEPT) (left) and BRT workshop in Surat (right).

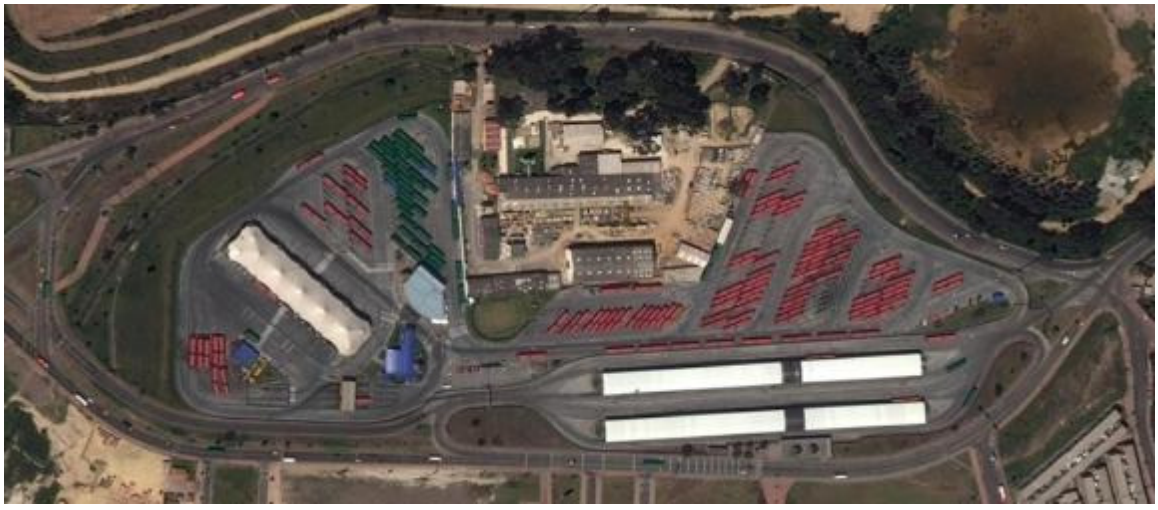

Figure 102: Co-located Bus depot and terminal of the Transmilenio BRT system, Bogotá (Google maps)

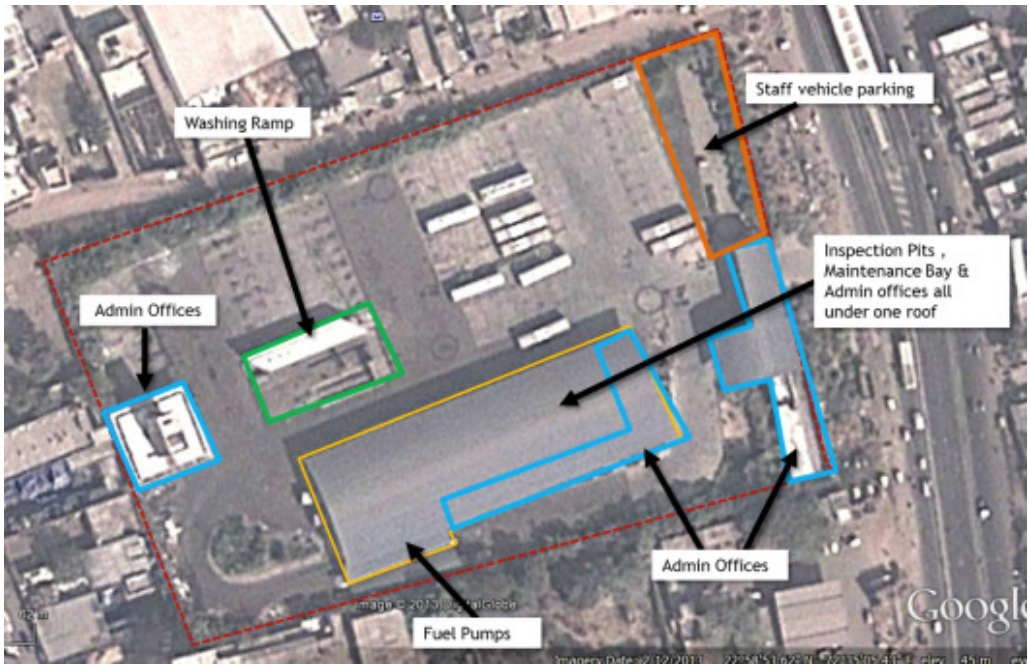

Figure 103: Chandola lake BRT depot, Ahmedabad.

1.3. Underground utilities

Shifting of utilities is one of the most critical aspects during road construction. It is recommended to dig trial pits to identify utilities prior to start of site clearance and dismantling existing roads of the accurate maps of utility alignments are not available. It is possible that different utility lines may exist below earth crust at varying depths. It is recommended to have all the utilities in a single utility corridor underneath the footpath or parking/vending area and ensure that they are not spread out throughout the entire right of way.

Old water supply and sewer pipelines shall be removed and new lines shall be joined to main connection with new alignment wherever required. During site clearance, care shall be taken that communication lines (optical fibre cables) and other underground cables/lines for telephones, electricity, and gas are not damaged.

Electricity and communication boxes should be shifted and fixed at the edge of the ROW or in the parking/multi-utility strip to avoid creating an obstruction on footpaths. Similarly transformers and electricity poles should also be shifted to edges.

Adequately sized storm water drainage systems should implemented on all roads corridors in Ranchi. Storm water drains can be constructed beneath the footpath or cycle track, depending on the cross section. It will be a box type concrete drain or RCC pipe drain, whichever is suitable for each corridor. A representative storm water design section is shown in the following figure.

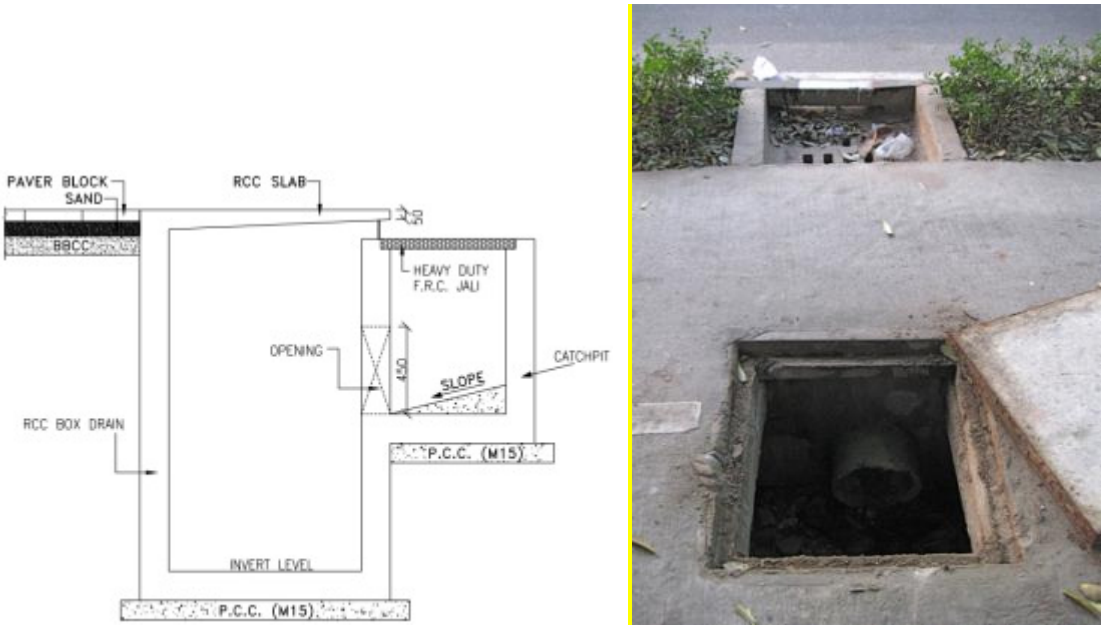

Figure 104: Typical storm water drain with catch pit.

Access shall be provided with manholes at regular intervals. The manholes shall be covered with airtight inspection covers. Care must be taken to ensure that the manhole cover and the joint between the drain access and the surrounding pavement are flush to ensure that these elements do not obstruct pedestrian movement.

Electrical components like streetlights must be upgraded to ensure that roads, and especially the mobility corridors, are safe for all users at night. Pay and use toilet blocks should be constructed at regular intervals. Additional street furniture elements such as benches, tables, and dustbins should also be installed wherever required.