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Raipur Public Transport Scoping Study

December 2015

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Contents

Abbreviations and acronyms

AMC	Annual Maintenance Contract
AVLS	Automatic Vehicle Location System
BAU	Business As Usual
BRT	Bus Rapid Transit
CAGR	Compounded Annual Growth Rate
CFD	Car (Motor-Vehicle) Free Day
DFID	The Department for International Development
DPR	Detailed Project Report
ETM	Electronic Ticketing Machine
EI	External-Internal
EIRR	Economic Internal rate of Return
ER	Emission Reduction
FAR	Floor-Area Ratio
FY	Financial Year
GHG	Green-house Gas
HPC	High Powered Committee
IE	Internal-External
IRR	Internal rate of Return
ITS	Intelligent Transportation System
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
NMT	Non-Motorised Transport
NoMoZo	No Motor-Vehicle Zone
PKT	Passenger Kilometres Travelled
PT	Public Transportation
RTC	Road Transport Corporation
RMC	Raipur Municipal Corporation
RNNTL	Raipur Nagar Nigam Transport Limited
SPV	Special Purpose Vehicle
STU	State Transport Undertaking
SUDA	State Urban Development Authority
TDM	Transportation Demand Management
ULB	Urban Local Body
UMTA	Unified Metropolitan Transportation Authority
UTF	Urban Transportation Fund
VKT	Vehicle Kilometres Travelled

Executive summary

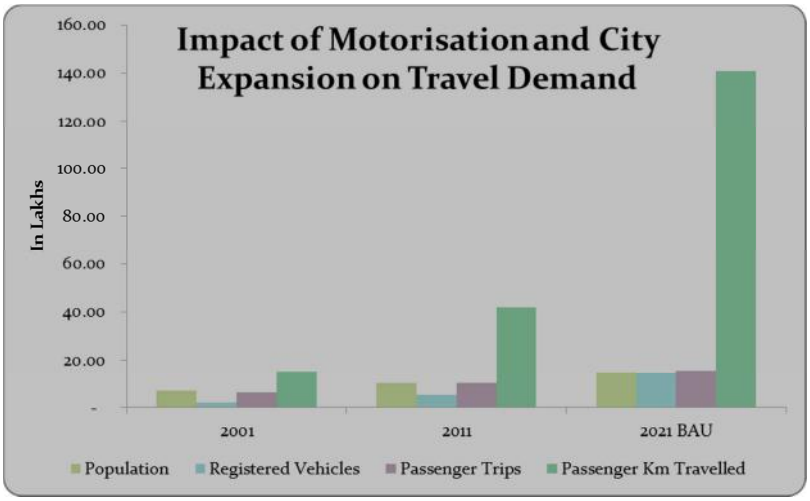
Short summary

Raipur Public Transport (PT) Scoping Study attempts to develop a PT focussed solution for relieving the traffic congestion and thus reduce related emissions in Raipur city. Implementation of travel demand management (TDM) strategies seems to significantly reduce the viability gap associated with providing a good PT system. Further, revenue from TDM programs and climate finance more than cover-up such losses. The preferred solution envisages deploying 568 buses by the year 2021 in conjunction with TDM strategies. This shall potentially reduce about 29 lakh vehicle kilometres each day, reduce emissions by 71 tonnes of CO_2 while saving 1.2 lakh man hours in travel time.

Full summary

The Government of Chhattisgarh is interested in improving PT in Old Raipur and is looking for ways in which the mitigation benefits from public transport can be used to raise additional finance. The Chhattisgarh CC State Action Plan contains 107 actions, of which 16 are related to transport, which demonstrates the priority attached to public transport.

The benefits from public transport are large and include: savings in time; improved productivity; more inward investment; health benefits from reduced pollution; and reduced carbon emissions. The PT Scoping Study analyses the various scenarios with focus on financial implications of various choices and scenarios. In this process, the report attempts to quantify some of the social benefits that can accrue from a good public transportation system and to assess the extent to which such benefits can eliminate the need for subsidy.

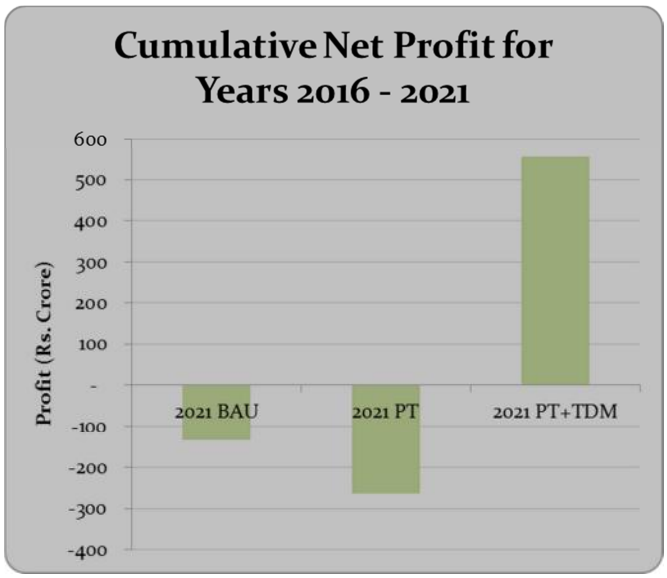


An examination of the transportation parameters from Raipur suggest an alarming increase in private vehicles at 13% annual growth rate over the past decade to cross 9 lakh registered vehicles mark this year. Notably, this is driven by the absence of adequate and convenient public transport system. While this problem has been identified correctly in most of the previous works, the solutions primarily revolve around increasing the road network. Any financial allocation to public transport is limited to big ticket rail projects and that too in the medium to long range. Such approach has led to lack of focus in developing the basic bus transport system.

Hence, while developing the public transport scenarios, the focus has been limited to policies and projects that can be realised in the immediate to short term. This is a macro-

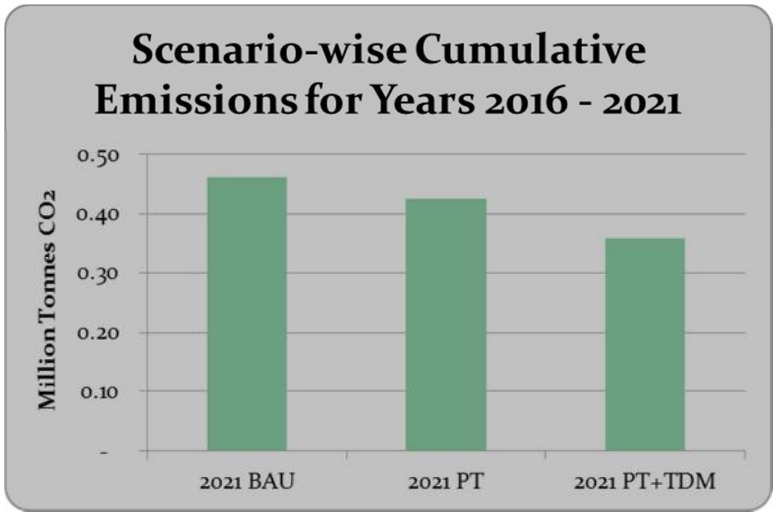
level study that forecasts the key transportation metrics and the financial implications of various choices. The key findings from this work are as follows:

1. The vehicular traffic growth has far out-paced the growth in population. The business as-usual (BAU) scenario till 2021 will result in the travel demand doubling over the current level. This will result in peak hour travel speeds much below 20 km/hr, which is slower than cycling.
2. This is inspite of the projected expansion of the bus system which will include operating 236 buses within the city limits. Though the net cost public-private partnership model makes it appear that the bus operations are profitable, it has a limited coverage both spatially and temporally. Further, the state and the city still incur a cost of Rs. 135.35 crores (upto 2021) by way of procuring buses, and providing the required infrastructure for operations and maintenance.
3. The Internal Rate of Return (IRR) for the BAU scenario considering a 30 year horizon stands at -6.54% suggesting that it will be un-attractive for private participation and will be entirely dependent on budgetary allocation from the government.
4. Considering the current urban growth pattern, the demand estimates for a PT focussed scenario for the year 2021 to achieve a 60% mode share for PT and Non-Motorised Transport (NMT) together requires a PT system with a fleet of 674 buses. To understand this in lay-man terms, this fleet will serve about:
    - 100 km of major road network by standard size buses at 5 minute headway
    - Another 100 km of secondary road network operated by mini buses at less than 3 minute headway
5. However, implementing such a system will incur a financial viability gap of Rs. 357.85 crores until 2021, which is about 2.5 times higher than the BAU scenario but less the proportional increase in fleet.
6. However, over this period, the PT scenario will result in about 10% improvement in vehicular travel speeds due to reduced traffic on the streets and reduce emissions to the extent of 36 thousand tonnes of CO_2 equivalent by the year 2021. The social benefit accrued by way of reduction in man hours lost is Rs. 94.40 crore over the same period.
7. Over a 30 year financial projection, the IRR for the PT scenario turns out to be marginally above zero at 0.79%. The Economic Internal Rate of Return (EIRR) which accounts for the travel time savings stands at 4.89%. This scenario will marginally improve the livability of Raipur city but it may still be very difficult to sustain growth or attract investments over a long term.
8. The third scenario which combines TDM strategies along with the PT implementation



seems to be a clear winner. This scenario is designed to achieve a 75% mode share for PT and NMT combined.

9. Implementation of TDM strategies would result in a slightly compact urban form, thus straight away reducing the overall travel demand by as much as 20%. In this scenario, the actual traffic congestion on the streets by the year 2021 would be lesser than the situation currently experienced in Raipur (2015). The travel speeds would be 25% better compared to the 2021 BAU.
10. Thus, the 2021 PT+TDM scenario requires a fleet of only 568 buses even while the PT mode share increases to 40.46% from the 32.37% in the 2021 PT scenario. As an impact of these phenomenon, the financial viability gap for the years through 2021 is only Rs. 169.53 crore, just marginally higher than the BAU scenario.
11. The emission reduction over the BAU scenario stands at 102 thousand tonnes of CO2 equivalent upto year 2021, a 22% reduction over the BAU scenario. What is more interesting is that the monitory value of the social benefit to the citizens in the form of travel time savings is a staggering Rs. 553.40 crore, more than 3 times the financial viability gap.



12. The IRR for the PT+TDM scenario is 8.96% which is attractive for receiving funding both from private as well as bilateral funding sources. Accounting for the social benefits, the EIRR for this project stands at 412% which indicates the favourability of this scenario.
13. Further, the two easily implementable TDM strategies as parking pricing and cordon tax have the potential to generate Rs. 170 crore to the Urban Local Body (ULB) during the same period.
14. Thus, by way of routing the financial proceeds relating to the TDM strategies to a Urban Transportation Fund (UTF), the necessary investments for operating the PT to achieve the objectives of the PT+TDM scenario can be delivered.
15. Funds from other sources of UTF mentioned in the report can potentially fund NMT and dedicated transit infrastructure too to improve the quality of life.
16. The report also delves into the various bus operating models and recommends the adoption of the pure gross-cost contract mechanism in the short term period till 2021 for best outcomes.
17. Though not directly linked to the objectives of the current work, the report includes an annexure listing some case-examples from various cities from the country and the world on the TDM strategies and ways to engage the citizens for building communities and to bring awareness and consensus on various transportation issues.

Section 1: Background

Raipur is the capital of the state of Chhattisgarh in central India. The 2011 census estimates that over 1 million people reside in this urban agglomeration. Between 2001 and 2011, the population of the Raipur area grew at an annual compounded rate of about 4%. According to The City Development Plan[1] , the city is projected to grow at an even faster pace (5% CAGR) till 2021. A decade ago, the city had 268 registered motor vehicles per 1000 residents, today the number is 756, almost two-and-a-half times the country average of 293[2] for million+ cities. Every year, about 13% more personal vehicles are being added to the roads of Raipur. Vehicle ownership has increased thrice as fast as population in the last 10 years. Further, the rapidly expanding city is resulting in exponential increase in travel demand.

Existing Transport System

Public transportation (PT) system in Raipur is very limited; taxis, autos, shared-autos and cycle rickshaws supplement the bus services to some degree, but there is a high reliance on private vehicles which is leading to congestion, decreasing mobility and deteriorating health and quality of life.

Raipur Municipal Corporation (RMC) launched a city bus service in 2008 with 40 buses, which was later dissolved. A special purpose vehicle, Raipur Nagar Nigam Transport Limited (RNNTL) was formed in 2011 to develop public transport system in the city. In 2012, 100 buses were procured under Phase 1 funding of JnNURM scheme. These buses are run on net cost model of Public – Private Partnership (PPP) model along 10 routes in the city. The city bus service carries around thirty thousand passengers a day on 700 trips. The average trip length of all passenger bus trips is 17 kilometers, which about 5 times the average trip length (3.6 km) of all person trips[3]. The one-way bus route lengths range from 13 to 50 kilometres, indicating long-haul nature of bus services being provided for a compact city like Raipur. This bus service not only serves the municipal limits but also provides services to the adjoining areas also. Except the buses heading to Naya Raipur, all other buses originate at the Raipur railway station. Of the 100 buses, 65 are midi buses and 35 are standard buses. Standard buses serve only on routes destined to Naya Raipur.

Additionally, 95 buses have been recently procured with Phase 2 funding of JnNURM scheme. Some of them are yet to be deployed for operations at the time of publishing this report. Sixty[4] of these buses are planned for operating within the RMC area, whereas the remaining 35 are for neighboring areas of Gobranwapara, Mahasamund, Baloda Bazar and Dhamtari. These 60 new buses will provide public transportation connection from Raipur to

[1] Raipur, Chhattisgarh – City Development Plan, Under JnNURM (2006-2013)
[2] National Transport Development Policy Committee, 2013, http://planningcommission.nic.in/sectors/NTDPC/voulme3_p2/urban_v3_p2.pdf
[3] RITES survey, conducted as a part of the Long term traffic and short term traffic and transportation plan for Raipur Urban Agglomeration, April 2010
[4] Notification No. F-5-11/viii-Trans/2015 issued by the State Government of Chhattisgarh on August 7, 2015

Urla, Tarighat, Kharora, Bilaspur, Durg, Nandan van, Mandir Hasaud, Ahiwara, Aarang, Champaran, Abhanpur, and Chandkhuri.

Stakeholders and Role

Providing a clean, efficient, self-sustaining, financially viable public transportation system can only be achieved by promoting a public-transportation friendly environment; an eco-system comprising of civil infrastructure, municipal planning, transportation planning, transit operations, traffic operations, community involvement, public outreach, pollution control and parking management.

In Raipur, like in most Indian cities, these functions are carried out by multiple agencies, often with overlapping functions. DPR[5] for Phase 2 funding of JnNURM scheme discusses how insufficient coordination between the various stakeholders of the transportation system is causing delays in providing a better PT options for the citizens of Raipur. Each agency has its own priorities, procedures, lines of accountability, financing mechanisms, which may not necessarily be in tandem to promote PT with the larger picture of easing congestion and improving the productivity of citizens of Raipur. The following public agencies have a major role to play in the public transportation realm of Raipur

Raipur Nagar Nigam (Municipal Corporation)

Raipur Nagar Nigam is the key governing body for municipal and planning functions in the Raipur urban area, to meet the basic needs of the citizens of Raipur. The main function of the Nagar Nigam is to construct and maintain basic civic infrastructure including those required for transportation such as roads and flyovers.

Raipur Urban Public Transport Society

Nine urban public transport societies have been incorporated in Chhattisgarh in May 2014 to empower the urban transport system with their urban areas. These state/central government funded agencies' role is to develop the necessary urban transportation plans and provide necessary guidance to other local bodies. The Society will also be responsible for overseeing the maintenance and operation of city buses within their jurisdiction.

It is understood that the existing Raipur Nagar Nigam Transport Limited will be absorbed into Raipur Urban Public Transport Society.

Unified Metropolitan Transportation Authority (UMTA)

Urban Municipal Transportation Authority is being set-up to coordinate all land transport matters in the greater Raipur area (Raipur-Naya Raipur-Durg-Bhilai). Draft legislation for constitution of UMTA for greater Raipur area has been formulated and is awaiting approval by the state government, it is understood that the notification is in progress.

[5] Raipur, Chhattisgarh: DPR for Financial Assistance Under JnNURM Scheme for Purchase of Buses, September 2013

Bus Rapid Transit (BRT)-High Powered Committee

BRT- High Powered Committee[6] was set-up in July 2013 to coordinate different agencies working in the field of transportation and provide directions to the related departments so that public transportation can be more effective

UMTA and BRT-HPC together are expected to provide:

- Rational traffic and transport policy for the city in line with land use policy
- Fair and level playing field for different modes of transport modes
- Fair competition and satisfactory level of services for urban commuters

State Urban Development Authority

State Urban Development Authority (SUDA) is the master agency in the state for developing all urban areas in Chhattisgarh including, Raipur.

Chhattisgarh Environment Conservation Board

Chhattisgarh Environment Conservation Board's main aim is to prevent, control and abate air and water pollution. Its responsibilities are limited to informing and advising the transport authorities and police department regarding vehicular pollution control and assessment but it has no authority in enforcing the standards set by them.

Transport Department

The state transport department is the agency in charge of all motor vehicle registrations and fitness tests. However, they also have the authority over issue of route permits for public transport and also for fixing of fares for stage carriage vehicles. The department also is the authority on notifying the use-purpose for streets in the state, as will be the case for BRT and Non-motorised Transport (NMT) zones.

Chhattisgarh Infrastructure Development Corporation (CIDC)

Chhattisgarh Infrastructure Development Corporation was incorporated under the Companies Act in. March 2001. It is a planning organization that is entrusted with promoting and catalyzing private investments in infrastructure. It is a planning organization and implementation or execution of projects was not in its mandate. Now efforts are being made to include this role in its constitution. The presence of such a body would assist in a) facilitating a reform discussion at a city level and b) to also support the reform process. CIDC has prepared various sectoral policies for Government of Chhattisgarh. CIDC is now preparing plan regarding development of city center of Raipur. It is also working on the concept and plan of development of satellite towns. CIDC also manages the State Housing Board and State Transport Corporation.

[6] Notification No. F 5-5/18/2009 issued by the State Government of Chhattisgarh on July 10, 2013

Section 2: Past Studies

One of the first steps towards achieving the objectives of this work was to review the existing work, gather the base data relating to transportation and understand their objectives and consider the recommendations made that relate to transportation. Following are the various data sources and reports referred to:

Data Sources

1. Population Census Data
2. Registered Vehicle Data from the Transport Department
3. Urban Transport Fund – Policy Document

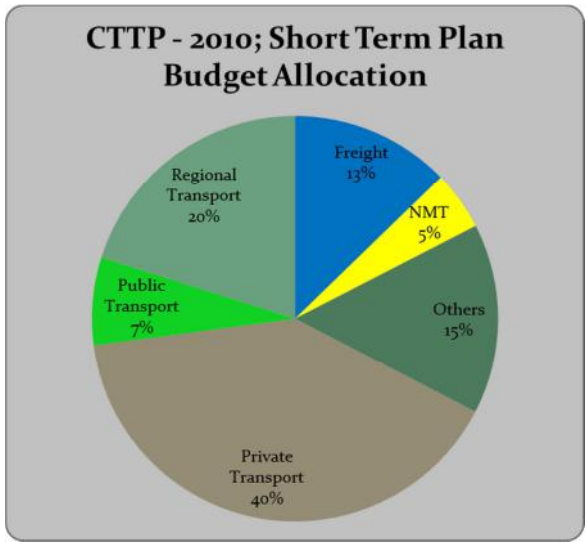
Reports

a) DPR for Financial Assistance under JnNURM – Phase 1 and 2
b) Traffic and Transportation Plan for Raipur Urban Agglomeration
c) DPR for Bus Rapid Transit System in Naya Raipur Under GEF-UNDP-World Bank Assisted SUTP India
d) Traffic and Transportation Policies and Strategies Study – by MoUD
e) Project Monitoring and Evaluation of Naya Raipur BRT Corridor and Operations
f) Naya Raipur Transit Oriented Development Study
g) Naya Raipur Development Plan 2031

Some of the salient points that relate to the scope of current work are discussed briefly in this section.

DPR for Financial Assistance under JnNURM Scheme, September 2013
(for Purchase of Buses to Operate in Raipur)
This project report was prepared to procure funds under Phase 2 of JnNURM scheme. As a part of the financial viability of the public bus system in Raipur, a number of measures have been proposed to make the system more self-sustaining and financially viable; they are mentioned in later sections of this report.

Traffic and Transportation Plan for Raipur Urban Agglomeration, April 2010
This report was prepared as a long term (2031), medium term (2021) and short term (2015) transportation and traffic plan for Raipur. The study was conducted by RITES, a Government of India Enterprise. This study has undertaken an extensive primary data collection exercise which included household surveys, cordon vehicle survey, parking demand surveys, etc. This has been the primary source of transport data used for demand estimation and financial assessment done in the current work. Primary data collected as part of this study is here after referred to as 'RITES survey' in this document.



While this study rightly points out that for a good public transportation is key to the sustainable development of the city, unfortunately, all the short term recommendations are geared towards promoting private transport. A pie chart of proposed short term investments is shown here to illustrate this point. Additionally, the report recommends building more parking spaces; a measure that promotes only private vehicle usage and entails enormous cost to the public. The recommendations on parking fee also stand contrary to the Union Ministry of Urban Development's recommendation not to subsidise parking and levy a high parking fee that represents the commercial value of land occupied and cost of parking structure.

The desire to increase public transportation usage and control congestion is well-founded and widely accepted, but the actions for achieving this have to be handled head on immediately instead of pushing such interventions into future years. This report of course does not delve into the issues relating to making public transportation system financially viable.

Traffic and Transportation Policies and Strategies in Urban Areas in India, May 2008
Wilbur Smith and Associates prepared this study for the Ministry of Urban Development. This study was conducted to establish the urban transport scenario in 30 cities of the country; the comprehensive data collected as a part of this study was used to review the Nation Urban Transport Policy of 2006. One of the cities selected for this study was Raipur. The population forecasts and the total trips projected for 2021 have been adopted for this scoping study. This study is here after referred to as MoUD study in this document.

Naya Raipur Development Plan 2031, June 2008
This plan was prepared for Naya Raipur Development Authority by City and Industrial Development Corporation and Consulting Engineers (I) Pvt. Ltd. to guide the overall planning process of the new capital region. The plan recommends policies for land use, housing, transportation, sewerage, communication, leisure, and physical and social infrastructure. Forecasted demand of inter-city trips to Naya Raipur and the corresponding mode share from this plan has been adopted for this scoping study.

Section 3: Problem Identification

Existing Infrastructure

Raipur traffic is very mixed in nature; with many slow and fast moving vehicles sharing the same road space. The highly heterogeneous nature of traffic, combined with haphazardly parked cars and motor-bikes causes a lot of commotion leading to congestion and conflict.

Results of RITES survey conducted in 2009 indicate that more than half of the trips in Raipur are made by walk or cycle, about a third are made by 2-wheelers and cars and the remaining by other modes such as auto, cycle rickshaw, school bus and public bus etc. The survey also indicates that non-motorized modes of walk, cycle and cycle rickshaw are most common for trips shorter than 3 kilometers; private modes like 2-wheelers and cars are more popular for longer trips.

Although Raipur had historically enjoyed a high share of walk and bicycle trips, the steep increase in motor vehicle ownership in the past decade has become a great threat for NMT usage. With increasing income, the mobility quotient in Raipur is also constantly increasing; the average number of trips made per person has increased by about 0.9%[7] between 2001 and 2011. As cities are expanding, people also have to make longer trips to reach their destinations. Currently, about 100 public transport buses are plying in Raipur; about 1/5th of the number recommended for a city its size. Lack of adequate public transportation facilities combined with infrastructure development focused on facilitating movement of motor vehicles, is clearly giving rise to a motor vehicle dependent society that can soon become a hindrance to the development of Raipur.

Identification of Potential Solutions

Travel demand grows exponentially with the uncontrolled expansion of the underlying parameters. A purely automobile oriented infrastructure can never keep pace with the ever increasing demand. Some of the impacts such as traffic congestion, accidents, pollution and chaos on the roads are already experienced in the Raipur area. The key to “fixing” this congestion is to increase overall transportation system efficiency by either reducing the amount of travel and/or make public transit more attractive. A shift from single-occupied private vehicle to public transit can be achieved by increasing travel options, providing information and incentives to encourage individuals to alter their travel behaviour. The DFID funded Climate Change Innovation Programme aims to support the government of Chhattisgarh in this direction.

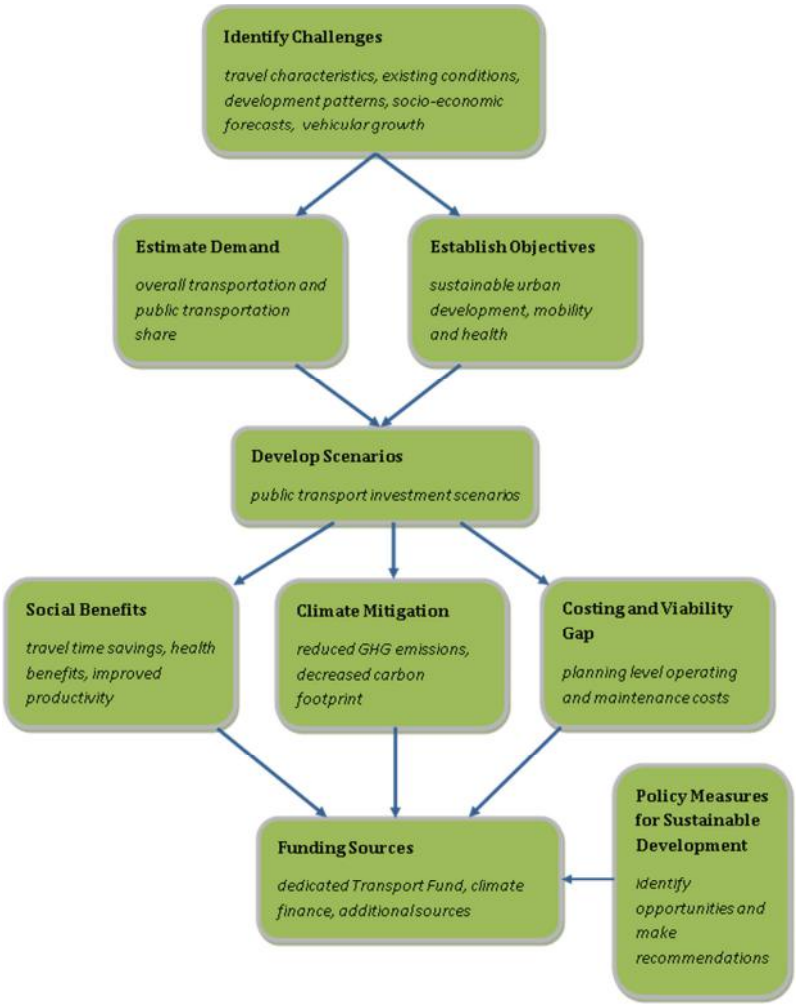
Public transport is often included as a key element of low carbon urban development. The Chhattisgarh Climate Change State Action Plan contains 107 actions, of which 16 are related to transport, which demonstrates the priority attached to public transport by the state of Chhattisgarh. The benefits from public transport are large and include: savings in time; improved productivity; more inward investment; health benefits from reduced pollution; and reduced carbon emissions.

[7] Traffic and Transportation Policies and Strategies in Urban Areas in India, May 2008

While the overall benefits of a public transportation system far outweigh the costs, the practical execution and operation of public transport system entails a significant financial subsidy. This study attempts to identify various sources of funding that can be generated, including that of climate finance to suggest a comprehensive approach that helps in providing a reliable, convenient and comfortable public transport for the city. The objectives of this study are:

1. Understand the exact quanta of need for public transportation based on existing conditions and forecasted demand
2. Assess the implementation challenges and viability gap of recommended congestion relief measures
3. Establish emission benefits and sources of climate change; quantify likely mitigation benefits arising from reduced CO_2 emissions
4. Layout a systematic approach that will facilitate the success of an expanded public transportation system through travel demand management measures
5. Suggest a framework to identify additional sources of funding including climate finance as a means to bridge the viability gap.

The methodology of this study is outlined in the figure shown below.



Section 4: Needs Assessment for Transport

This section uses all the background data available to estimate the travel demand in the city and further compute the public transport facilities required to cater to that demand over the next five year period. Typical transportation studies extend to about 20 years into the future with suggestions for short and long term but experience suggests that the recommendations are rarely implemented in total even for the short term. Given the focussed nature of this work with the single point agenda to understand the measures necessary to improve the mobility scenario for Raipur, most of the recommendations and decisions will be applicable for immediate to very short term implementation. Thus, this study limits the horizon year to 2021. Implementing the final recommendations would set the mobility scenario in a sustainable transport trajectory over the next 2 to 3 year period.

Scenario Development

Based on input received from conversations with the stakeholders and the consultants' experience, the following three scenarios were developed for horizon year 2021:

1. **Business As Usual (BAU)** scenario represents the conditions that are expected in 2021 based on currently planned programs and projects. In this scenario, it is assumed that urban development will follow past trends with no significant change in planning policies. It also takes into consideration the transportation related projects that are under consideration to be implemented within the horizon year. Hence, the BRT services to Naya Raipur and commuter rail project between Raipur and Durg-Bhilai are assumed to take shape by 2021 to cater to the inter-city passenger travel between these cities.

   Raipur city had a sizeable mode share of NMT in the past which is fast deteriorating. With urban sprawl, inadequate bicycling and walking facilities and associated safety concerns, a "do-nothing" scenario means a significant shift from NMT to personal motorised modes in the near future. It is forecasted that the mode share of private vehicles will grow astronomically to 55.9% and the NMT mode share will plummet to 27.9% by 2021 in this scenario.

   BAU scenario will also serve as a point of comparison for the other two public transport (PT) focussed scenarios formulated.

2. **Public Transportation (PT)** scenario represents the conditions in 2021 which are required to achieve a targeted mode share of 60% for PT and NMT combined. The project report submitted to JnNURM for financial assistance under the bus funding scheme suggests a 60% mode share for PT alone as ideal. While that is true for large cities, given the compact size of Raipur, a sizable share of travel will still continue to be done by NMT, which is a positive thing. More than half the trips made in Raipur in the reference year 2011 are made by walk or bicycle. Hence targeting a 60% PT+NMT mode share is neither unreasonable nor unachievable for 2021. This scenario aims to achieve this by focussed investments into public transport

infrastructure to offer a convenient, reliable and affordable bus transport in the city, to cater to more 32% of the trips as against just 16.2% catered by the BAU scenario.

3. **Public Transportation + Transportation Demand Management (PT+TDM)** scenario represents the conditions that are closest to a sustainable urban transport scenario. This scenario will serve as the first step towards making Raipur a transit-oriented city and stresses the importance to travel demand management measures in finding a long term solution to relieve congestion. This scenario adopts a comprehensive approach and builds on the PT scenario to achieve a combined PT+NMT mode share of 75%, which is more or less representative of the vehicular traffic demand that was experienced in the year 2011.

   Travel demand management (TDM) measures are aimed at changing people's trip making behaviour, by influencing their mode of travel. Over the years, cities across India have catered to the movement of private vehicles that has resulted in the rise of motor vehicle use. TDM measures like parking pricing, equitable allocation of road-space and creating dedicated non-motorised zones attempt to reverse this trend. Reduced use of motor vehicles further leads to shorter trip lengths, thus reducing the overall quantum of travel in the area. Further, some of the TDM strategies also generate a steady stream of income that can help in compensating for the viability gap in provision of public transport. Thus, this scenario attempts to address the urban mobility issues comprehensively.

   This scenario is in line with the National Urban Transport Policy 2014 which is the key guiding policy for urban transport at the national level. It states that "Priority to PT and NMT is essential to control the use of personal vehicles and hence congestion and to improve mobility in the city"

The scope of this study doesn't entail developing a detailed TDM strategy for the Raipur area, but common TDM strategies that have been found effective in India and cities worldwide are discussed briefly in the Annexure. Certain revenue generating TDM strategies that are applicable to Raipur are discussed in Section 7. The travel mode share for all scenarios is shown in Table 1.

Table 1 – Forecasted Mode Share

Mode	2011	2021 BAU	2021 PT	2021 PT+TDM
Private Vehicles	32.2%	55.9%	39.7%	24.6%
NMT	55.4%	27.9%	27.9%	34.9%
PT + Intermediate PT	12.5%	16.2%	32.4%	40.5%

Demand Estimation

The reference year data for years 2001 and 2011 has been gathered from the various reports mentioned in Section – 2 (Past Studies). For the 2021 scenario, the population and the total trips forecast have been adopted from the MoUD study. The total trips forecast of 15,53,000 in 2021 represents a 0.9% increase in person trip rate from 2011. Looking at

experience from other cities, the rate of increase does seem to be on the lower side. However, in the absence of any more authentic forecasts, this same value is used, which serves as a conservative estimate for demand forecasts for PT.

The second source of travel demand is created by the floating population that arrive from outside of Raipur itself. People come into the city by a network of roads and by rail. Data from the RITES survey indicate 93,942 and 1,55,536 person trips entering (EI) and exiting (IE) the city by rail and road respectively. These trips have been forecasted to increase at the rate of growth in the state-wide population, which is 2.06% annually.

Through trips which do not have either ends of the trip in the city were not considered for this study as they would not be typically be catered to by the city bus system which is the focus of this work.

The total input travel demand in terms of the number of trips undertaken in a day does not vary by various future scenarios as travel is understood as an activity that is undertaken for fulfilling a certain purpose. Hence, the infrastructure and policy interventions are assumed to only influence the mode of travel and the travel distance and not the number of trips itself. The forecasted number of total trips for all scenarios is shown in Table 2.

Table 2 – Total Trips Forecasted

	2011	**2021 BAU**	**2021 PT**	**2021 PT+TDM**
Population	10,27,264	14,65,600	14,65,600	14,65,600
City Wide Person Trips	9,99,000	15,53,000	15,53,000	15,53,000
IE/EI Trips By Rail	97,852	1,19,980	1,19,980	1,19,980
IE/EI Person Trips By Road	1,62,009	1,90,709	1,90,709	1,90,709
TOTAL	22,88,136	33,29,289	33,29,289	33,29,289

Business As Usual (BAU) Scenario for 2021

As discussed, this scenario expects the trend from the past 4 years to continue through till 2021.

- Data from the transport department indicates a 13% increase annually over this period. At such pace, Raipur city will experience a situation of having more vehicles than the number of people in the city, which seems unlikely. Hence, for future, the average annual growth in the number of vehicles registered, which stands at 90,807 has been used.
- Given that there is no significant push for public transportation in this scenario, it is assumed that the number of trips made by private vehicles will grow in direct proportion to the forecasted number of private registered vehicles in the Raipur area. With the proposed increase in the number of city buses and also the expected increase in auto-rickshaws, it is assumed that the overall share of public transport increases by 30% over the 2011's mode share of 12.45%. Hence, in this scenario, the switch to private vehicular travel is almost entirely from NMT.
- In case of IE/EI trips by rail, it was assumed that 80% of the work and school trips and 50% of the other trips will use public transport (including para-transit) for the "last

mile" connectivity. Similarly, in case for IE and EI trips by road, only 30% of people coming in buses and auto-rickshaws are assumed to need a local public transport to reach their final destinations. This corresponds to the observations on the RITES survey.

- Another critical factor in demand estimation is the average trip length. The RITES survey indicates that it is 3.6 km in the year 2009. Given the rapid expansion on the city in the past few years and also accounting for the increasing number of trips to Naya Raipur for work related to government, this is assumed to increase by 8% annually, in line with what has been seen in similar cities like Indore, Rajkot, etc. Thus the average trip length for year 2021 BAU scenario is taken as 9.07 km.
- Based on the travel parameters discussed above, the total daily demand for PT in this scenario is 3,54,194 trips, that will further be catered to by a combination of auto-rickshaw (33.16%), chartered buses (41.45% - for schools and offices) and the city bus (25.39%) as per the RITES survey.
- With this mode distribution, it is calculated that Raipur city with require a total of 235 buses (which includes 173 mini buses and 62 standard buses) operating at least 160 km each day at a 70% occupancy rate, to cater to the travel within the city. This includes 10% buses set-aside as spare for regular maintenance as is standard practice.
- However, in this scenario, the total number of private vehicular trips in Raipur will be more than 9.73 lakh each day, which is 50% more than what is seen today. This can lead to severe traffic congestion all across the city and leading to excessive emissions, which is also reflected in the fewer kilometres operated (160 km/day/bus) by buses in a day than what is typically observed on the roads today.

Public Transport (PT) Focussed Scenario for 2021

In the Public Transportation scenario (2021 PT), a more comprehensive public bus system is envisioned; leading to an increased PT mode share which when combined with the NMT mode share of 27.92% as in the BAU scenario will cater to at least 60% of the trips.

This scenario uses the same basic travel parameters as in the BAU scenario. However, provision of a reliable bus based public transport system results in better PT occupancy ratio (80%). Apart from a shift in trips from private vehicles, a good number of people (20%) currently using auto-rickshaws and other shared transport are expected to shift to the bus. Since the private vehicle mode share is reduced to less than 40%, the overall traffic congestion in the city in 2021 will be almost representative of the traffic conditions experienced today. Thus, each bus in the fleet is also expected to operate 210 km a day, as is done by the buses today. However, in the absence of any deterrent to private vehicular use, the city is still expected to expand. Thus, the average trip length used for this scenario will more or less remain the same as in BAU.

Hence, the total demand for public transport in this scenario is estimated to be 6,27,421 daily trips of which city buses, auto-rickshaw and other shared transport will cater to 61.5%, 17.1% and 21.4% respectively.

To cater to this demand, a total fleet of 674 buses (496 mini-buses and 178 standard buses) will be required by 2021, considering 10% of the fleet as spare to facilitate maintenance and handle breakdowns.

Public Transportation + Transportation Demand Management Scenario for 2021

This scenario is an upgrade over the 2021 PT scenario where the improvement in public transport is complemented by disincentives for use of private vehicles for travel to achieve sustainable city status. One of the immediate impacts of this is a compact city development which is reflected by average trip length to 7.23 km (rate of increase in trip length between the years 2015 to 2021 is reduced to 4% instead of 8% used in BAU/PT scenario).

PT and NMT mode shares need to increase by 25% to 40.5% and 34.9% respectively to achieve a total of 75% together. All other input parameters are considered same as in the 2021 PT scenario.

The total demand for PT in this scenario stands at 7.57 lakh trips per day., about 20% over the PT scenario. However, this demand can be fully served by just 568 buses (418 mini-buses + 150 standard buses) with considering 10% fleet as spare. This reduced need of buses in this scenario is due to two reasons:

a) Reduced trip length, thus reducing the passenger kilometres of travel
b) Since the actual travel demand in 2021 will be lesser than experienced today, buses will be able to effectively operate at slightly faster speeds thus covering 240 km in a day as against 210 km in the PT Scenario.

This in itself explains the effectiveness of this strategy.

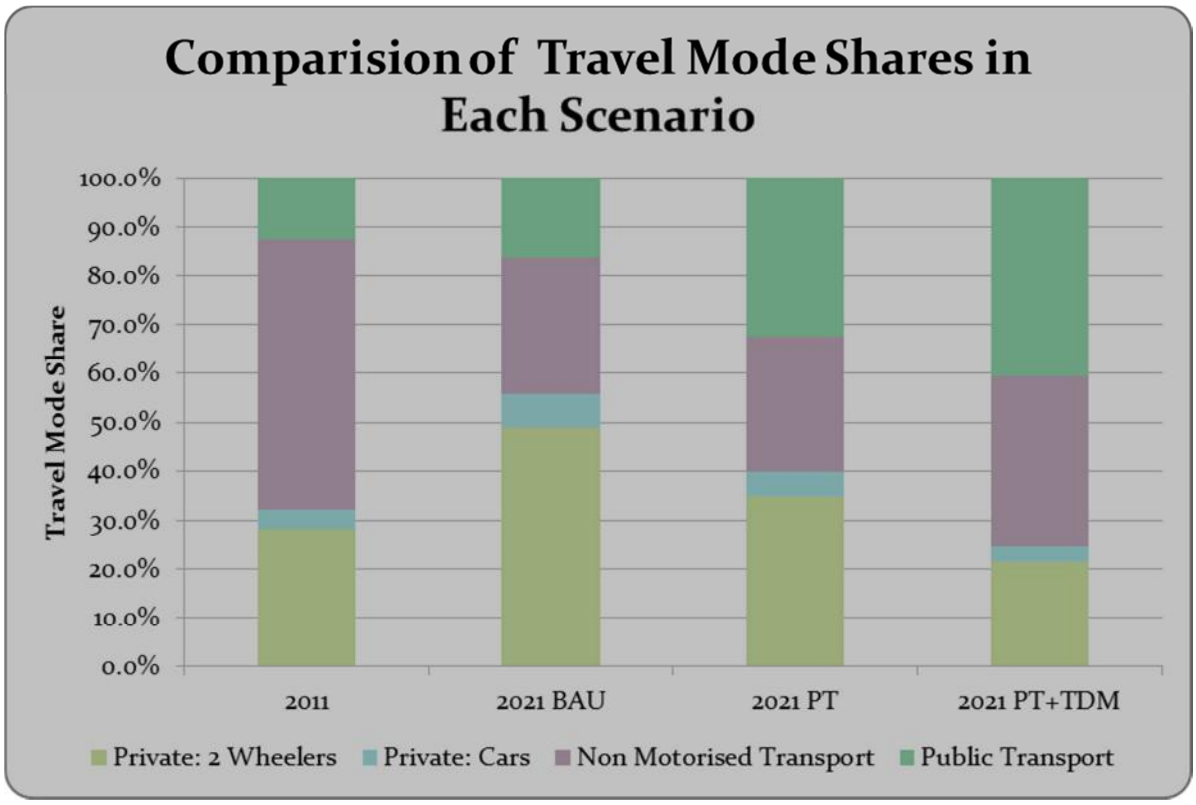
Scenarios Snapshot: Demand Estimation

A full comparison of the three scenarios is presented in Table 3.

Table 3 – Scenario Comparison

	2011	2021 BAU	2021 PT	2021 PT+TDM
Total Demand for PT	2,09,118	3,54,194	6,27,421	7,56,934
PKT By PT	8,78,093	32,10,917	56,87,835	54,71,459
PT Seat Km @ 70% - 80% OR	12,54,419	45,87,024	71,09,793	68,39,324
Auto Rickshaw	33.2%	33.2%	17.1%	17.1%
School/Charter Bus	41.5%	41.5%	21.4%	21.4%
City Bus	25.4%	25.4%	61.5%	61.5%
Seat Km Serviced By Auto Rick	4,15,965	15,21,057	12,16,846	11,70,555
Seat Km Serviced By Chartered	5,19,957	19,01,322	15,21,057	14,63,193
Seat Km Serviced By City Bus	3,18,497	11,64,645	43,71,890	42,05,576
PKT Serviced By Mini-Bus (65%)	3,18,497	7,57,020	28,41,729	27,33,624
PKT Serviced By Standard Bus (35%)	-	4,07,626	15,30,162	14,71,951
No. Mini Buses Reqd. @10% Spare	73	173	496	418
No. Std. Buses Reqd. @10% Spare	-	62	178	150
TOTAL FLEET SIZE	73	235	674	568

The following graphic clearly shows the progressive decrease in usage of private vehicles and the corresponding increase in NMT and PT between the 2021 BAU scenario and the 2021 PT and 2021 PT+TDM scenarios.



Some of the key observations from the analysis are as follows:

- The 235 bus requirement of 2021 BAU scenario is equivalent of 205 buses in the year 2016, which is very close to the number of buses in operation in the city. This validates the assumptions made in the process
- It is typically estimated that 60 standard buses will be needed for every 1 lakh population to provide a good public transport system. At that rate, the fleet requirement should be nearly 840 for the 2021 PT scenario. However, the reduced need in case of Raipur is due to shorter trip lengths and significantly higher NMT mode share
- The fleet size recommendation for the PT and PT+TDM scenarios in real terms is equivalent of:
    - 100 km of major road network served by standard size buses at less than 5 minute headway
    - Another 100 km of secondary road network operated by mini buses at less than 3 minute headway
- As can be seen from the bar-chart, in percentage terms, the mode share of private vehicular traffic (cars + 2 wheelers) in 2021 PT+TDM scenario is in fact lower than that in 2011.

Impact of 2021 Scenarios

The genesis of developing the PT and PT+TDM scenarios was to quantify the magnitude of benefits offered by public transportation and TDM in reducing overall travel; particularly by private modes. The first step in doing so was to estimate the total demand for travel and the total demand for public transportation (as discussed in the previous section). The next step is to translate this demand into tangible terms to be able to compute the emission reductions. To this end 2 metrics have been calculated for each of the scenarios: vehicle kilometres travelled (VKT) and passenger kilometres travelled (PKT) by each mode. While VKT serves as a good measure of the number of vehicles on the road, PKT shows us the number of people that are being moved by these vehicles.

PKT is calculated by multiplying the number of passenger trips forecasted by mode with the average trip length for that scenario. The VKT is calculated by dividing the PKT in each mode by the average occupancy ratio for that mode. For the private vehicles, occupancy ratios as indicated in the RITES survey have been used: 2.2 persons per car, 1.3 persons per motor bike. For the public transport modes, it was calculated as 80% of the passenger capacity which has been taken as 30 for mini and chartered buses, and as 45 for a standard bus.

VKT serves as a good proxy for the pressure vehicular traffic puts on the environment; hence the savings in VKT over the BAU scenario is used as a metric to do comparative analysis and calculate reductions in GHG emissions. Table 4 shows the reductions in VKT and PKT of 2021 PT and 2021 PT+TDM scenario over the 2021 BAU scenario. It should be noted here that in case of the 2021 PT+TDM scenario, the reduction in VKT is a combination of mode shift and also due the vehicle miles avoided due to reduced travel distance.

Table 4 – VKT and PKT Calculations

	2021 BAU	**2021 PT**	**2021 PT+TDM**
Mini Bus VKT	25,234	94,724	91,121
Standard Bus VKT	9,058	34,004	32,710
TOTAL Bus Trips VKT	34,292	1,28,728	1,23,831
Bus VKT Increased Over BAU		**94,436**	**89,538**
PKT Avoided Over BAU Scenario	-	26,82,260	44,88,263
PKT Shited From Auto Rickshaw		91,263	2,81,405
PKT Shited From Chartered Bus		1,14,079	3,51,756
PKT Shited From Cars		3,06,890	4,77,647
PKT Shited From Two Wheelers		21,70,028	33,77,455
Auto Rickshaw VKT ↓ Over BAU		21,729	67,001
Chartered Bus VKT ↓ Over BAU		5,432	16,750
Car VKT ↓ Over BAU		1,39,495	2,17,112
Two Wheeler VKT ↓ Over BAU		16,69,252	25,98,043
TOTAL VKT Avoided Over BAU		**18,35,909**	**28,98,906**

From Table 4, it can be inferred that in the public transport focussed scenario, 94,436 km operated by bus is displacing about 18.36 lakh km of vehicular travel across all modes. However, in the TDM scenario, just 89,538 km of bus operations is able to displace almost 29 lakh km across all modes.

Section 5: Financial projections

The earlier section establishes the public transport fleet size and the policy environment required in each of the scenarios, this section looks into the financial implications of implementing these scenarios. The broad financial categories involved in implementing a public transport system are:

- Cost Components
  a) Bus Operations
  b) Fixed Infrastructure – Bus Depots (for Parking & Maintenance)
  c) Fixed Infrastructure – Transit Terminals (to Facilitate Passenger Transfers)
  d) Technology – Intelligent Transportation System (ITS)
  e) Planning and Management
- Revenue Components
  f) Passenger Fares
  g) Advertising
  h) Rental Income from Terminals
  i) Revenue from TDM Strategies

The following sections discuss each of these in detail to understand the financial implications of each of the scenarios.

Bus Operations

Procurement and operation of bus fleet is the biggest cost component which runs into hundreds of crores annually and hence requires a detailed assessment. Fundamental to this is the decision making on the operations model, which has an implication of the organisation set-up and management.

Operating Models

There are different operating models for bus operations world-wide, each of them with varied involvement of the Urban Local Body (ULB) and other government agencies. Each model has it pros and cons; while some are more suited for small operations, others are more suited for bigger bus systems. The most common bus operating models are:

Self-owned, Self-operated

Provision of public transport is a state subject and most states have established Road Transport Corporations (RTC) that have monopoly on passenger transport across the state, which also provide bus services within urban areas. The self-owned, self-operated model is a complete public sector undertaking with minimal or no involvement from private players. State run transportation units like KSRTC and APSRTC are examples of such models. Operations, maintenance, ticketing, route optimization, staffing etc. are all internal to the organization. Although there is a significant risk involved in such a set-up, it ensures sufficient geographic and diurnal coverage thus making city a bus a reliable and “real” option for commuting. One of the main challenges in this model is with personnel cost management as typically the staff is paid on-par with other government employees. This system takes a long time to set-up and typically suited for a large scale operation having thousands of buses in fleet.

Net Cost Model

The Net cost model is completely opposite of the RTC model and is the quickest and easiest to implement. It has been adopted in many North-Indian cities with mixed results. In this model of public-private partnership (PPP), private operator is allotted the contract of operations on the payment of a fixed licensing fee or "route authorization" fee to the ULB. The operator is allowed the right to collect the notified fares. Hence, the revenue and operations risks are entirely with the private operator. This is the current model that is adopted and operational in Raipur since 2011. Since there is constant revenue flowing into the ULB, there is a tendency to believe that this model results in profitable operations. However, there are various levels of subsidies offered to the private operator by way of the ULB making the capital investment for procuring and owning the fleet, provision of depot and maintenance infrastructure, office space, etc. The main disadvantage in this model is that it limits the city bus facilities to limited high-demand routes with buses being operated only in peak hours to minimize losses. This makes it an unreliable and incomplete public transportation system thus leading to a high dependency on private vehicles and unorganised para-transit as is being observed in Raipur city.

Gross Cost Model

Gross cost model is a middle-ground that has the advantages of both the models and minimises the negative aspects of the other two models. It is also a PPP model, however, limiting the private operator's role to bus operations by way of making a fixed payment based on the distance operated as specified by the ULB. This entity operates the buses as per the routes, schedules and other norms specified by the ULB. The responsibility of fare collection and the revenue risk is with the ULB. This model is widely in use in across India where the RTC's have a monopoly in bus operations and resort to this model to augment fleet at times when they do not have budget to procure additional buses.

Recommended Bus Operations Model

Based on observations from Raipur and other cities across India, it is clear that a net cost based approach cannot ever fulfil the public transport needs of the entire city. The bus funding scheme under JnNURM propelled many cities to procure buses though they have not had any competence for running bus operations. This has given rise to a large-scale adoption of the net cost model.

In the PT focussed scenarios, about 600 buses are recommended for Raipur area by the year 2021, which doesn't make it a big enough system for a self-operated self-owned model. Hence, a true gross cost model, with full ownership of buses vested with the private operator is best suited for Raipur. However, by 2021 policies and actions should be in place to set-up a RTC for the state of Chhattisgarh that could first start operations on long-distance routes which typically are more profitable and then augment city bus services as well in the future.

Costs of Operations

In the Gross Cost model of operations, the private operator is paid at a fixed rate per unit distance of travel. Depending on various conditions of the contract, type of bus and the operating variables, the typical cost of operations in different cities varies from Rs. 28 – 38 per kilometre in case of a non-AC mini-bus and from Rs.40 – 52 in case of a non-AC standard

bus. Given the wide variation in the prices and their implications for financial projections, detailed calculations were made with the following assumptions:

- Bus (compliant with Urban Bus Specifications – II) fully owned & operated privately
- Seven year contract period
- Use of diesel fuel
- 320 days of operation in a year
- 10% fleet set aside as spare
- Daily assured operating distance between 160 – 240 km depending on scenario
- Revenue from advertising on the bus is shared with the operator

Under these conditions, the operating costs arrived are as follows:

- Operating cost of Standard bus (Non AC) for 160 km/day is 49.5 Rs/Km
- Operating cost of Standard bus (Non AC) for 210 km/day is 47.0 Rs/Km
- Operating cost of Standard bus (Non AC) for 240 km/day is 44.0 Rs/Km
- Operating cost of Mini bus (Non AC) for 160 km/day is 37.0 Rs/Km
- Operating cost of Mini bus (Non AC) for 210 km/day is 35.0 Rs/Km
- Operating cost of Mini bus (Non AC) for 240 km/day is 32.5 Rs/Km

The above costs include the salaries that have to be paid to the ticket collectors in the bus who will be hired by the ULB or its Special Purpose Vehicle (SPV).

Bus Depot and Parking

A good and reliable public transport is critically dependent on availability of good maintenance infrastructure to ensure fitness and cleanliness of the bus. Typically a 5 acre land parcel is necessary for every 100 buses. Since the current fleet recommended is a mix of mini-buses and standard buses, a 4 acre plot with 50% developed area should be sufficient. Recent estimates of depot construction costs from Surat, Hyderabad and Indore suggest a cost of Rs. 2.5 crores/acre. Hence the cost of establishing a 4 acre depot is estimated at Rs. 10 crores with an estimated maintenance cost at 12% of the investment. However, this cost does not include the cost of acquiring land.

Transit Terminals

These are facilities required for passengers to conveniently and safely change from bus on one route to another. Typically a half-acre size terminal can accommodate movement of 6 to 8 buses and costs Rs. 2.5 crores and can also house a few retail establishments for passenger convenience. Maintenance of this infrastructure is again counted as 12% of the investment.

Technology – ITS

Bus operations have become very complex and it gets very difficult to monitor the services. Further, since the private operator is paid based on the distance operated, it is important to ensure that the operations are in line with the schedules planned. Use of GPS based vehicle tracking system is also useful to provide estimated arrival times, that will attract more passengers. On the other hand, fare collection can also be made cashless through the use of electronic ticketing machines and smart-card.

The cost of ITS varies quite drastically depending on the technical specifications, operations model, complexity of features, and other tender conditions. There have not been any technology implementations in the country that have managed to deliver complete solutions and these end up as typical hardware procurement which are difficult to handle by non-technical persons. However, with the recent advancements, a services contract model seems to be a win-win situation where the technology providers are free to decide on the hardware but are purely engaged to deliver certain services. Further, use of some standard protocols and open-data standards allows third-party technology companies to offer analytical solutions by exploring alternate revenue sources.

Considering all these factors, the capital cost for a control centre is estimated between Rs. 1 – 3 crores for different scenarios and the service cost for the BAU and PT scenarios is estimated at Rs. 12,000 and Rs. 25,000 per bus per annum respectively.

Since the buses are already UBS-II compliant, they are capable of tracking and transmitting various location and performance parameters to the control centre. In the BAU scenario, the operating cost includes a basic Electronic Ticketing Machine (ETM) and simple data analytics on ticketing and operations.

In the PT and PT+TDM scenarios, a slightly advanced systems are deployed including smart-card based cashless ticketing, passenger information systems and advanced monitoring.

Planning and Management

As per the current model of administering the public transit service, the SPV is housed within the ULB. However, with expanded operations, the SPV will need to be staffed with technical experts who shall look into the functions of legal, procurement, accounting, planning, engineering, public relations and human resources functions. Further, a significant number of non-technical staff and supervisors will be required for various on-ground functions including monitoring and security. The capital cost for establishing an office space is estimated as Rs. 1 crore and Rs. 1.5 crores in the BAU and PT focussed scenarios respectively. Similarly, the recurring costs are estimated as Rs. 10 lakhs/month and Rs. 20 lakhs/month respectively.

Bus Stops and Shelters

The other component of infrastructure that is necessary to provide a complete solution is the bus stops. However, as in Raipur and many other cities, bus stops have been developed by way of contracting out the advertising rights on top of the structure. There is also small revenue that is being generated from these advertisements. It is possible to enhance the aesthetics and maintenance of the bus stops with this revenue.

Bus Fare Revenue

From the demand estimation process, the exact quantum of demand served by each bus is known. Using the fares specified in the Chhattisgarh Bus Fare Notification[8] as applicable to the average trip lengths for each scenario, the total fare revenue is calculated as shown in Table 5.

Table 5 – Bus Fare Revenue Calculations

	2021 BAU	2021 PT	2021 PT+TDM
Avg. Daily VKT/Bus	145	191	218
Avg. Daily PKT Served/Mini-Bus	3,055	4,582	5,236
Avg. Daily PKT Served/Std. Bus	4,582	6,873	7,855
Revenue/Mini-Bus/Year	**10,86,061**	**16,29,091**	**21,54,390**
Revenue/Std. Bus/Year	**16,29,091**	**24,43,636**	**32,31,584**

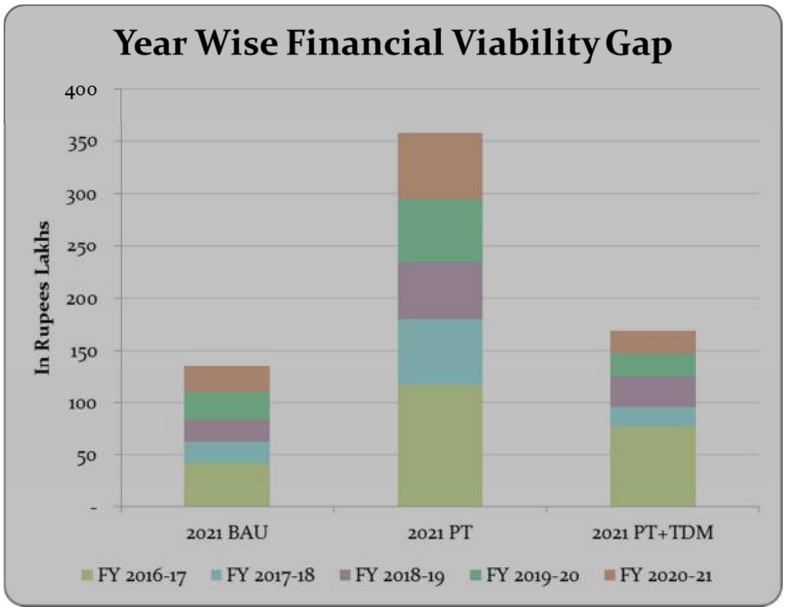
Lease Revenue from Transit Terminals

Another aspect of revenue that is applicable across scenarios is the revenue from renting/leasing of commercial space within the transit terminals. Since the terminals attract buses from various parts of the city, it once again helps promote shopping and recreational trips to shift to public transport. Similar such work has been very successful in Bangalore and currently the city of Vijayawada is planning a cinema multiplex within their regional bus terminus.

Since each transit terminal extends over an area of half an acre, the commercially exploitable area is estimated as 20,000 sq.ft. on ground level and two floors above combined. Adjusting for the cost of construction and maintenance, the net revenue is assumed to be Rs. 20/sq.ft. Thus, each transit terminal can generate lease revenue of Rs.48 lakhs as per 2016 costs.

Viability Gap

Based on the costs and revenues discussed above, the net viability gap has been calculated in the current year. From 2016 to 2021, the costs and revenues have been assumed to increase at 5% per annum. The detailed calculation for all three scenarios has been presented in Table 6. The bar-graph shown here presents the cumulative viability gap over the five year period for the three scenarios.



[8] Notification # F-5-13/viii-Trans/2015 issued by the Government of Chhattisgarh on August 25, 2015

Year		FY 2016-17					FY 2017-18					FY 2018-19				
* All costs in Rs. Lakhs * Each Depot is 4 acre size - For 100 buses * Depot Life 30 Years @ 12% AMC * Interchange Terminals 0.5 acre size * Terminal Life 30 Years @ 12% AMC		Total Infrastructure	Capital Cost	Operations Cost	Direct Revenue	Viability Gap (Lakhs)	Total Infrastructure	Capital Cost	Operations Cost	Direct Revenue	Viability Gap (Rs. Lakhs)	Total Infrastructure	Capital Cost	Operations Cost	Direct Revenue	Viability Gap (Rs. Lakhs)
2021 BAU	Standard Bus Ops. (Buses)	54	-	1,368.58	923.69		56	-	1,490.23	1,005.80		58	-	1,620.62	1,093.81	
	Mini-Bus Ops. (Buses)	151	-	2,860.54	1,721.95		156	-	3,103.03	1,867.92		161	-	3,362.61	2,024.17	
	Bus Depot Infra. (4 Acre Size Each)	2	2,000.00	240.00	-	4,290.08	2	0.00	252.00	-	1,988.58	2	0.00	264.60	-	2,147.31
	ITS - AVLS+Ticketing (Total Fleet)	205	100.00	24.60	-		212	-	25.44	-		219	-	26.28	-	
	Transit Interchange Terminals	1	250.00	30.00	48.00		1	0.00	31.50	50.40		1	0.00	33.08	52.92	
	Planning & Mgmt.		100.00	10.00	-		-		10.50	-		-		11.03	-	
2021 PT	Standard Bus Ops. (Buses)	155	-	4,895.52	3,977.02		160	-	5,306.11	4,310.57		166	-	5,780.35	4,695.83	
	Mini-Bus Ops. (Buses)	432	-	10,160.64	7,389.56		446	-	11,014.42	8,010.48		461	-	11,954.10	8,693.89	
	Bus Depot Infra. (4 Acre Size Each)	6	6,000.00	720.00	-	11,722.34	7	1,050.00	888.30	-	6,298.74	7	0.00	932.72	-	5,378.51
	ITS - AVLS+Ticketing (Total Fleet)	587	300.00	146.75	-		606	-	151.50	-		627	-	156.75	-	
	Transit Interchange Terminals	3	750.00	90.00	144.00		4	262.50	127.58	201.60		4	0.00	133.95	211.68	
	Planning & Mgmt.		150.00	20.00	-		-		21.00	-		-		22.05	-	
2021 PT+TDM	Standard Bus Ops. (Buses)	131	-	4,426.75	4,445.04		135	-	4,790.02	4,809.81		140	-	5,215.80	5,237.35	
	Mini-Bus Ops. (Buses)	364	-	9,085.44	8,234.08		376	-	9,854.21	8,930.81		389	-	10,704.66	9,701.56	
	Bus Depot Infra. (4 Acre Size Each)	5	5,000.00	600.00	-	7,722.82	5	0.00	630.00	-	1,870.83	6	1,102.50	807.36	-	2,967.98
	ITS - AVLS+Ticketing (Total Fleet)	495	300.00	123.75	-		511	-	127.75	-		529	-	132.25	-	
	Transit Interchange Terminals	3	750.00	90.00	144.00		4	262.50	127.58	201.60		4	0.00	133.95	211.68	
	Planning & Mgmt.		150.00	20.00	-		-		21.00	-		-		22.05	-	

Year		FY 2019-20					FY 2020-21				
* All costs in Rs. Lakhs * Each Depot is 4 acre size - For 100 buses * Depot Life 30 Years @ 12% AMC * Interchange Terminals 0.5 acre size * Terminal Life 30 Years @ 12% AMC		Total Infrastructure	Capital Cost	Operations Cost	Direct Revenue	Viability Gap (Rs. Lakhs)	Total Infrastructure	Capital Cost	Operations Cost	Direct Revenue	Viability Gap (Rs. Lakhs)
2021 BAU	Standard Bus Ops. (Buses)	60		1,760.33	1,188.10		62		1,909.96	1,289.09	
	Mini-Bus Ops. (Buses)	168		3,684.25	2,217.79		173		3,983.59	2,397.99	
	Bus Depot Infra. (4 Acre Size Each)	2	0.00	277.83		2,608.66	2	0.00	291.72		2,500.54
	ITS - AVLS+Ticketing (Total Fleet)	228	-	27.36			235	-	28.20		
	Transit Interchange Terminals	2	289.41	74.93	111.13		2	0.00	78.68	116.69	
	Planning & Mgmt.	-		11.58			-		12.16		
2021 PT	Standard Bus Ops. (Buses)	173		6,325.30	5,138.54		178		6,833.52	5,551.41	
	Mini-Bus Ops. (Buses)	481		13,096.35	9,524.62		496		14,180.00	10,312.73	
	Bus Depot Infra. (4 Acre Size Each)	7	0.00	979.35		6,116.92	7	0.00	1,028.32		6,268.69
	ITS - AVLS+Ticketing (Total Fleet)	654	-	163.50			674	-	168.50		
	Transit Interchange Terminals	5	289.41	180.85	277.83		5	0.00	189.90	291.72	
	Planning & Mgmt.	-		23.15			-		24.31		
2021 PT+TDM	Standard Bus Ops. (Buses)	146		5,711.30	5,734.90		150		6,161.16	6,186.62	
	Mini-Bus Ops. (Buses)	405		11,702.20	10,605.63		418		12,681.72	11,493.36	
	Bus Depot Infra. (4 Acre Size Each)	6	0.00	847.73		2,274.03	6	0.00	890.12		2,117.50
	ITS - AVLS+Ticketing (Total Fleet)	551	-	137.75			568	-	142.00		
	Transit Interchange Terminals	5	289.41	180.85	277.83		5	0.00	189.90	291.72	
	Planning & Mgmt.	-		23.15			-		24.31		

Table 6 – Financial Analysis by Year

Key Observations

The financial assessment for the scenarios presents some interesting observations, some of which are as follows:

- The first and the foremost thing that presents itself prominently is that there is not much difference in the viability gap between the 2021 BAU and PT+TDM scenarios, though the fleet size is more than doubled.
- Except for Rs.35 crores additional viability gap in the first year, the fund requirement is almost exactly the same in both BAU and PT+TDM scenarios.
- The TDM scenario further results in additional sources of revenue to the ULB as discussed in Section – 7. When this additional revenue is linked to public transport, it can potentially cover the entire viability gap from the PT+TDM scenario.
- Both PT and PT+TDM scenarios potentially qualify for additional funding from climate finance as discussed in Section – 6, thus bridging the viability gap to some extent.

Thus, these scenarios clearly bring about the advantages of adopting a comprehensive approach to tackling traffic congestion, rather than adopting piece-meal approach of disconnected strategies.

Section 6: Cost & Benefits of Mitigating Climate Change

This section explores the trade-offs between the costs and benefits (emission reduction and travel time reduction) by performing an investment analysis for providing a PT focussed solution to the city of Raipur. PT has emerged as a viable option to enhance transportation capacity and provide increased levels of mobility and accessibility in Raipur. The PT system is particularly effective and reliable when the buses operate in conditions that are free from delays caused by other vehicles.

The benefits and cost of adding new PT buses to the existing fleet in Raipur will depend heavily on how such a project affects traffic speed, time delay, and vehicle miles travelled. The benefit will depend on the extent to which the addition of new infrastructure results in mode shift to PT. Thus, a critical part of this section is the description of the analytical methods and assumptions used for these calculations.

This analysis involves identifying and quantifying benefits and costs that will accrue if this project is undertaken. Therefore, it will help to determine economically efficient investment alternatives, i.e., one that maximizes the net benefit to society from allocation of resources. For transportation projects, this involves estimating a financial value of benefits to users (a value for social benefits) and comparing these benefits to project capital, operations and maintenance costs. Such an analysis compares project alternatives with the 'no build' or 'baseline' case, to determine a locally preferred alternative. To enable comparison of alternatives, it is necessary to standardize the categories of benefits and costs that are considered and the methodology that is used to calculate them.

Direct benefits to users of the upgraded bus system include travel time savings, fewer vehicle operating expenses such as fuel purchases and out-of-pocket vehicle ownership expenses, and reduced costs associated with vehicle accidents. Other direct benefits can accrue to users and non-users, such as reductions in emissions and noise. For the purpose of this evaluation, only the benefits arising from emission reduction and travel time savings have been considered. This is because these two benefits have significant direct benefits that can be quantified. While these impacts can be relatively simple to estimate, much variation exists in how benefits are monetized. The construction, operation, and maintenance costs of the project are used for this analysis. The two benefits considered in this evaluation are sufficient to develop a business case.

Indirect benefits from the improvement of Public Transport system in Raipur can also arise from increased economic development and land development. Ease of commuting travel enables employment opportunities from farther distances. Other co-benefits include health benefits, less air pollution, job creation for the operations & maintenance, and in introducing new technology. These co-benefits are however omitted in this analysis as these are difficult to estimate owing to limited data availability. The costs against which these benefits are weighed are also very varied.

Indicators for Investment Analysis

There are several measures or indicators to compare benefits to costs in this investment analysis. Internal Rate of Return (IRR) and Economic Internal rate of Return (EIRR) are the indicators used here.

The IRR calculates the discount rate at which discounted benefits equal discounted costs. The IRR is therefore useful for comparing programs of different size and has the attraction of being equal to the rate of interest that the programme could afford to pay, if the social value of all costs and benefits was equal to the market price.

The EIRR provides a similar decision factor to the financial IRR. The EIRR indicates the rate of return at which the present value of the economic costs and benefits of the project are equal. In other words, it is the discount rate for which the net present value is zero. The EIRR is compared with the socially required rate of return. Projects that are found to have an EIRR that is higher than the socially required rate of return are considered to be potentially financially viable.

Emission Reduction Calculation

Emission Reductions (ER) for the baseline scenario (BAU) and the two possible PT focussed scenarios were calculated on the basis of the VKT estimates presented in table – 4 under Section – 4.

BAU SCENARIO	Mode share of NMT and public transport in 2021 is 44%
PT SCENARIO	Mode share of NMT and public transport in 2021 is expected to increase to 60%
PT+TDM SCENARIO	Mode share of NMT and public transport in 2021 is expected to increase to 75%

To calculate the emission reductions per year in each of the scenarios, the vehicle kilometres for each mode were multiplied by the emission factor for that mode of transport.

As the VKT of private vehicles like car and motorbike would decrease, the VKT of mini and standard buses would increase as compared to the baseline case. To calculate the total emission reductions in a year, the emission reductions from private vehicles was subtracted from the emission additions due to increase in buses.

The emission factors used in the calculations are taken from the factors defined by Automotive Research Association of India (ARAI). The factors for each of the category of vehicles are as given in table – 7.

Table 7 – Emission Factors for Different Vehicle Classes in Equivalent CO_2 (in g/km)

Two Wheeler	28.81
Auto Rickshaws	67.70
Cars	129.54
Mini Bus	353.95
Bus	806.50

Using the above emission factors, the ER expected over the project duration from 2016 to 2021 is calculated and presented in table – 8. It can be seen that the reduction in emissions in the PT+TDM scenario is almost 3 times higher than just the PT scenario. This clearly shows the effectiveness of coupling TDM strategies into urban transport planning process.

Table 8 – Annual Emission Reductions over the BAU Scenario

	Units	2016	2017	2018	2019	2020	2021
Emission reduction in PT scenario over baseline scenario	tCO2	3,975	4,770	5,565	6,360	7,155	7,950
Emission reduction in PT+TDM scenario over baseline scenario	tCO2	11,368	13,641	15,915	18,189	20,462	22,736

Travel Time Reduction Calculation

The assumed monthly wage rate and percentage of wage loss were calculated for each mode of transport. These values were used to estimate the value of travel time in monetary terms. The passenger km/year by mode and modelled vehicle speed were used to estimate the time person hours lost in travel. While the results shown here are limited to year 2021, travel time savings have been estimated till 2045 (30 years from 2016) for the purpose of calculating financial returns.

The travel time reduction calculation was conducted for the BAU and two project case scenarios. The travel time savings of each scenario was calculated as a difference of time taken in the baseline case and the scenario. Travel time savings was also calculated in monetary terms from the monetary value of travel time calculated using the average wage rate for each mode of transport.

The assumptions in the calculations are as listed below:

- The wage rate per year is taken as Rs. 46,743.
- It was assumed that when a person is travelling by car, motor cycle or non-motorised transport modes, 100% of the wage is lost during the travel time. For an auto rickshaw, the percentage of wage loss reduces to 70% and it is least when the travel is through a charted, Mini or standard bus at 40%.
- The vehicle speeds for the different transport modes are shown in table – 9.

Table 9 – Average Vehicular Travel Speeds for Year 2021 for Various Scenarios

	Vehicle Speed (km/hr)		
Modes	**Baseline**	**PT**	**PT+TDM**
Car	19.2	21	24
Motor Bike	25	25	25
NMT	5	5	5
Charter Bus	17.6	19.25	22
Auto Rickshaw	12	12	12
Mini Bus	16	17.5	20
Standard Bus	16	17.5	20

The calculated time saving for the PT focussed scenarios are presented in table – 10.

Table 10 – Total Travel Time Value Gain relative to Baseline Scenario (in Rupees Lakhs)

	2016	**2017**	**2018**	**2019**	**2020**	**2021**
PT Scenario	855.95	1,092.07	1,364.99	1,676.52	2,028.01	2,420.22
PT+TDM Scenario	9,641.10	9,349.90	9,150.76	9,045.27	9,034.26	9,117.42

A quick comparison with the viability gap calculations from table – 6 shows that the value of travel time savings along compensates for the investments required for the PT+TDM scenario.

Detailed IRR and EIRR calculation

As part of the cost and benefit analysis, cash flows have been determined for 30 years for each scenario including the project implementation stage. 2016-17 has been considered to be the base year and the project construction and bus deployment activities are expected to be complete by 2020-21.

The expenses and revenue are extrapolated over the years from 2021 to 2045 as per the assumptions given below:

1. The public transport system is assumed to run on the Gross Cost Model wherein the private operator is paid a fixed charge to operate the buses. This fixed charge consists of the capital cost, operations cost and staff salary component.
2. The term of Gross Cost Contract is taken as 7 years.
3. The capital cost component is assumed to increase by 5% every 7 years
4. The operating cost of the buses and staff salary component is assumed to increase by 1% each year. This component includes the increase in fuel price.
5. The maintenance cost of bus depots, transit interchange terminals and ITS + ticketing system is assumed to increase by 5% every year.
6. The planning and management cost is again assumed to increase by 5% every year.
7. The revenue from fare collection in buses is assumed to increase by 3.1% each year in proportion to the increase in population and by 10% every five years to account for the increase in fare proposed by the State Government.
8. Tax on O&M services is taken as 14.5% of the O&M expenses.

The total estimated capital expenditure (infrastructure cost of bus depots, transit interchange terminals and ITS system) on this project is estimated as given below for the three scenarios. Assuming 70% financing is available on the total cost of the project at an interest rate of 12.5% per annum, the total interest to be paid is calculated over 30 years.

Table 11 – Loan Amount in Different Scenarios

	Baseline	**PT**	**PT+TDM**
Total capital cost (in INR Lakhs)*	2,639.4	8,651.9	7,704.4
Total loan amount (in INR Lakhs)	1,847.6	6,056.3	5,393.1

*The total capital cost varies in different scenarios due to different quantities of buses and civil infrastructure proposed to be constructed.

Year-on-year depreciation on assets is calculated for 30 years (or sooner if the salvage value become zero) at the rate of 5% per year for the infrastructure components. As the buses will be owned by private operators, depreciation on the cost of buses is not included in these calculations but has been accounted for while arriving at the gross cost contract value.

For each of the project scenarios considered, the IRR and EIRR has been calculated from the cash flow statement for each scenario and presented in table – 12. The revenue is taken to be the cash inflow for the 30 years. Total expenses incurred include O&M expenses, tax on OMS, yearly loan instalments payable and interest on debt apart from the total capital expenditure.

The EIRR for the three project scenarios has been calculated by adding the benefit of time value savings to the cash flow statement.

Table 12 – IRR & EIRR on Investment

	Baseline	PT	PT+TDM
IRR	-6.54%	0.79%	8.96%
EIRR	-6.54%	4.89%	411.96%

The EIRR for project scenario PT+TDM is the highest among the three at 411.96% making it the most favourable project scenario. This no. is so high because the mode shift from private vehicles to public transport is the highest in this scenario. The EIRR for project scenario PT is 4.89% and for baseline project scenario, EIRR is -6.54% which is same as IRR as there are no travel time savings in the business as usual case.

The above calculations show that introducing public transport in Raipur can result in very high positive net benefits under certain conditions. Though the net benefits of this project are highly sensitive to the input assumptions, there are trade-offs between the variables that affect the estimated net emission reduction benefits. For instance, a higher trip length may be favourable even with relatively lower passenger throughput, but if transit mode share is low, even a high speed bus may not result in a favourable project case.

Project Scenario PT+TDM presents the best possible project case scenario having the highest emission reductions with an IRR of approximately 9%. At this IRR, the project case is suitable

for funding through international grants as this scenario provides the most favourable returns for the investor.

Potential Funding from Climate Finance

The present IRR and EIRR calculation is done using a commercial interest rate of 12.5%. If international grants or loans are available then the interest rate is reduced to 2-4%. In such a case, the project IRR further improves as indicated in table – 13. A higher value of IRR can increase the chances of getting concessional loans and also attract more investors.

Table 13 – IRR Variation with Lower Interest Rates on Loan

	Loan Interest Rate	Baseline Scenario	PT Scenario	PT+TDM Scenario
IRR	12.5%	-6.54%	0.79%	8.96%
	2-4%	-6,23% to -6.15%	1.13% to 1.21%	9.51% to 9.64%

It should be noted that some benefits of a public transport project were not incorporated into this analysis because they are difficult to quantify. These include indirect positive impacts on land and economic development and savings associated with use and supply of parking for auto drivers and accident rate reduction. If these types of benefits were included, more scenarios analysed in this study would produce a more favourable project case. For example, if parking charges and cordon tax are added (as presented in the next section) to the IRR calculation for PT+TDM scenario, the revenue generated from this project case would increase leading to a higher IRR and EIRR.

To summarise, PT+TDM is the best scenario followed by PT scenario for applying for finance from various sources like national and international climate funds, international banks and private investors.

Section 7: Other Revenue Sources

As is clear from the previous sections, a comprehensive approach of providing extensive public transport facilities along with disincentives for private transport gives better results than just the improving public transport. It is also seen that the social benefit incurred in terms of travel time saving far over weighs the viability gap in the PT+TDM scenario. Further, some of the TDM measures have a potential to generate additional revenues to the ULB. Since this is a consequence of the public transport infrastructure, the National Urban Transport Policy recommends that the funds be routed to an Urban Transportation Fund (UTF) which will be used to finance public transport and NMT facilities exclusively. UTF will however also have other dedicated revenue streams other that TDM as discussed later in this section.

Some of the key TDM strategies adopted in India and across the world are:

1. Restrictive Parking Policies – restricting parking spaces along transit corridors
2. Road Space Rationing – allowing only a selected sub-set of vehicles access roads on certain days; such as vehicles with odd or even registration numbers only.
3. Repurposing of Road Space – providing exclusive place on roads for PT and NMT
4. No-Motor Zones – notifying some streets and market areas as NMT only
5. Car-Free Days – restricting use of cars in an entire neighbourhood/city on some days
6. Parking Tax – considering parking space as part of built-up area for property tax
7. Parking Pricing – eliminate free parking along roads and public spaces
8. Congestion Pricing – imposing a fee for use of certain busy roads which varies by time-of-day
9. Cordon Tax – imposing toll on private vehicles entering into the city

Case studies of application of these practices are listed in the Annexure. Of all the above, items #6, #7, and #8 will generate significant revenue towards development of public transport facilities. Sample calculations are presented in this section.

Parking Pricing

Cities worldwide and across the nation are now realizing the high-cost associated with free parking. Parking pricing could also be used as a proxy for congestion pricing for Indian conditions as it is much easier to implement than the later. Parking is currently free in Raipur. Even modest parking fees can have significant impact on travel patterns. National Urban Transportation Policy has advocated levy of high parking fee that represents the value of land occupied. Union Ministry of Urban Development has also recommended variable pricing based on the demand for parking in the area; on-street parking be priced higher than off-street parking; off-street parking pricing be representative of the total costs in providing such a facility; and long-term parking not be subsidised.

The scope of this study doesn't entail developing a parking policy for Raipur. The analysis is limited to estimating revenue from introducing on-street paid parking across the city. No new parking structures are recommended as a part of this study. However better parking management with the aid of parking pricing and regulation is necessary to achieve the sustainable transport objectives stated for the 2021 PT+TDM scenario.

Data from the RITES parking survey was used to estimate the average daily demand for cars and 2-wheelers along the busy corridors such as M.G. Road, and Banjari Road for 2009. It is assumed that the total parking demand in the city of Raipur is 1.5 times that of the busy market areas surveyed as part of the study. The study also finds that the average parking duration is about 1 hour.

Parking demand increases proportionally to the number of vehicular trips. The demand estimation section of 2021 PT+TDM scenario has factored in a 56% reduction in vehicular trips over the BAU scenario as a result of improved PT and introduction of TDM strategies.

A parking fee of Rs. 10/hr for two-wheelers and Rs.20/hr for cars is proposed in the current year. For future years, it is proposed to be incremented at a rate of 5% as has been done with the other financial projections. However, for ease of fee collection, such increments should be rounded to the nearest multiple of Rs. 5. Further, as in case of bus operations and financial projections, the parking demand is also calculated at 320 days per year.

However, collection of parking charges entails certain costs. It is assumed that such costs shall account for up to 25% of the fee collected. Hence, the revenue estimates in Table 14 account for this cost.

Table 14 – Parking Revenue for 2021 PT+TDM Scenario by Year

	2009	**2011**	**FY 2016-17**	**FY 2017-18**	**FY 2018-19**	**FY 2019-20**	**FY 2020-21**
Total Private Vehicular Trips	2,57,720	3,21,378	3,56,829	3,63,107	3,69,495	3,75,995	3,82,610
Parking Demand: 2W (veh-hrs)	42,237	52,670	58,480	59,509	60,555	61,621	62,705
Parking Demand: 4W (veh-hrs)	4,370	5,449	6,050	6,156	6,265	6,375	6,487
Parking Fee: 2W (Rs./Hour)			10	10	10	10	10
Parking Fee: 4W (Rs./Hour)			20	20	20	25	25
Parking Management Cost			25%	25%	25%	25%	25%
Yearly Net Parking Rev. (Rs. Lakhs)			**1,693.90**	**1,723.71**	**1,754.03**	**1,861.39**	**1,894.13**

From the above table, it can be seen that even with conservative estimates, the net revenue potential from parking is Rs. 89.27 crores over the five year period, which can substantially reduce the viability gap in public transport operations.

Cordon Tax

Cordon tax is a toll that is charged to private vehicles entering a designated area, usually a city centre. This congestion pricing measure has been very successful in reducing congestion in London and Singapore. This tax is much different from the highway toll, which typically is applied to heavy vehicles including public transport vehicles as the later is meant for recovery of investments into construction and maintenance of such facility. This travel demand management measure is in line with those put-forward by Government of India, Planning Commission's report[9] on Urban Transport that suggests the use of road pricing as

[9] Table 5.14, http://planningcommission.nic.in/sectors/NTDPC/voulme3_p2/urban_v3_p2.pdf

an effective tool to discourage private vehicle use and encourage switch to NMT or PT. Hence, in the case of Raipur, this cordon tax should be applied along the main roads entering the city and applicable only on private passenger motor vehicles (cars, two-wheelers, scooters, taxis, etc.). Public transportation vehicles and emergency vehicles are usually exempt from this tax. Apart from reducing congestion, this tax shall:

- Discourage the use of private vehicles for travel to and from Naya Raipur and Durg/Bhilai
- Promote the use of public transport, making the planned BRT and commuter rail services more attractive choice for commuters
- Reduce average trip length, decrease carbon emissions, improve health and promote an active life style
- Encourage families of government employees to move to Naya Raipur
- Generate additional revenue for the improvement of public transport in the area

Cordon station survey data on Durg/Bhilai Road (NH 6) from RITES survey and the number of forecasted private vehicle trips between Raipur and Naya Raipur from Naya Raipur Development Plan were the basis of estimating the vehicular demand between Raipur- Naya Raipur and Raipur – Durg/Bhilai. The base year traffic is increased in proportion to the population forecasts of the corresponding urban areas to arrive at the horizon year private vehicle demand. Cars and 2-wheelers are both proposed to be taxed at Rs. 1.00/km and Rs. 0.50/km respectively in the first year and increased at 5% annually. Here again, the same rule of rounding the fee to the nearest multiple of Rs.5, toll management cost of 25% and demand for 320 days/year are applied. For purposes of the cordon tax, the distance between Raipur – Naya Raipur and Raipur – Durg/Bhilai is taken as 20 and 30 km respectively. Revenue calculations are shown in Table 15 and indicate net revenue of Rs. 81.26 over the next five year period.

Table 15 – Cordon Tax Revenue for 2021 PT+TDM Scenario by Year

	FY 2016-17	**FY 2017-18**	**FY 2018-19**	**FY 2019-20**	**FY 2020-21**
Raipur - Naya Raipur (20km)					
Number of 2W/day	12,921	13,554	14,217	14,913	15,643
Number of 4W/day	5,337	5,598	5,872	6,160	6,461
Cordon Tax: 2W (Rs.)	10.00	10.00	10.00	10.00	10.00
Cordon Tax: 4W (Rs.)	20.00	20.00	20.00	25.00	25.00
Raipur - Durg/Bhilai (30km)					
Number of 2W/day	11,443	11,898	12,370	12,862	13,372
Number of 4W/day	5,722	5,949	6,185	6,431	6,686
Cordon Tax: 2W (Rs.)	15.00	15.00	15.00	15.00	20.00
Cordon Tax: 4W (Rs.)	30.00	30.00	35.00	35.00	35.00
Toll Management Cost	25%	25%	25%	25%	25%
Yearly Net Toll Revenue (Rs. Lakhs)	**1,390.22**	**1,450.65**	**1,587.97**	**1,730.70**	**1,966.61**

Urban Transport Fund (UTF)

Apart from the TDM measures, the state of Chhattisgarh has already promulgated the creation of an UTF that is a repository of revenues from various transactions within the municipal area that have implications on mobility.

A State Level UTF was set-up for Chhattisgarh in April 2015 to support city level public transportation services. Up to 2% of the estimated annual budget of municipal authorities will be contributed towards this fund. The exact value of that this translates to at the city level for Raipur is not known by the time of this report. However, the notification limits the use of such budget for research, planning, capacity building, public awareness, and outreach.

A City Level Urban Transport Fund was set-up in June 2014 for the 9 urban areas in Chhattisgarh to run the corresponding Urban Public Transport Societies. An initial funding of 15 to 25 lakh rupees has been awarded to each of them. These funds are to be used towards day-to-day operation and maintenance costs but not for salaries or execution of projects.

Taxes

Taxes can be an effective economic instrument that can be used to promoted transit usage and control the use of private vehicles. DPR for Phase 2 funding of JnNURM scheme recommends levying cess on various taxes collected in the city to generate additional funds for the UTF, such as:

- 0.25 paise per liter on petrol sales
- 0.10 paise per liter on diesel sales
- 5% of motor vehicle tax
- 5% of stamp duty

Advertising

It has been a common practice and a recommendation of the NUTP to transfer the advertising rights along major transit corridors to the public transport agencies as a way to offset their operational costs. While this is desirable and recommended, this is not a new revenue source but just a transfer of revenue stream from one department to another.

Key Observations

It is envisioned that when additional streams of revenue are identified, Raipur Urban Public Transport Society can use Raipur's city level UTF as a special purpose vehicle to provide better public transportation services to the city dwellers. The set-up of UTF is a commendable first step and the scope of revenue streams and spending have to be expanded to make it fully functional and a tangible budget source.

The total revenues from all the recommendations made in this section will far surpass the viability gap estimated in the 2021 PT+TDM scenario. The surplus funds could then be used for creation of better NMT infrastructure and other dedicated bus infrastructure.

Section 8: Way Forward

The analysis undertaken here specifically for the city of Raipur and the experiences from other cities in India and across the world clearly suggest that the transportation challenges in cities are best dealt by an integrated approach. This section recommends a strategy to enable the Government of Chhattisgarh / Raipur Municipal Administration to achieve the objective of sustainable transport.

Short-Term Actions (0 – 6 months)

This section deals with strategies that can be implemented immediately, without much cost or any significant infrastructure changes. Further, each action can be initiated within a small neighbourhood and then incrementally scaled-up to other areas. The primary aim of these strategies would be to bring awareness and understanding among the citizens about the challenges of use of private transport and also build consensus in favour of sustainable transport.

1. *Car (motor-vehicle) Free Days (CFD)*

   CFD is a method adopted by cities across the world to designate a particular day/time as 'no motor-vehicle zone' (popularly called NoMoZo) in a set of streets or a neighbourhood. There is typically apprehension among people when a new idea that is contrary to common understanding is presented to people. Hence, implementing such measures gradually, starting with one or two days a week in a small area and gradually scaling up both spatially and temporally allows people to understand the benefits. Further, this also allows the administration to understand the implementation issues, get citizen feedback, and make improvements.

   Market areas and other places having heavy pedestrian movement are best suited for such experiment. Typically, such measures are also combined with conducting various people engaging activities and events that promote local culture and folklore. This will improve the footfall and also promote tourism, which is good for promoting local businesses. This effort should finally lead to creation of permanent NoMoZo's spread across the cities.

Implementing Agency:	Urban Local Body (typically Municipal Corporation) in association with Department of Tourism and Culture, and various local NGO's, Educational Institutions, Civil Society and Elected Representatives
Budget:	Rs. 2 – 5 lakhs per neighbourhood per month

2. *Parking Pricing*

   As discussed in earlier sections, this discourages use of private vehicles and creates demand for shared transport which is space efficient. Creation of NoMoZo's typically results in people parking their vehicles in its periphery. Thus, parking pricing should be applied in conjunction with CFD in the surrounding areas. However, managing parking

requires man-power and systems, and hence recommended that parking charges are collected through-out the week and not just on car-free days. Raipur Municipal Corporation should target to implement parking pricing across the city over the next two years.

Implementing Agency:	Urban Local Body by way of engaging private contractor
Budget:	None; Generates revenue of Rs. 3 – 5 lakhs per neighbourhood per month. Same can be used in organizing activities during CFD.

3. *Promoting Cycling*

The key to promoting cycling within a city is to create an eco-system for convenient bicycling and make cycling as a fashion statement. Some of the key strategies to achieve this are as follows:

(a) Make it mandatory for all commercial and office complexes to provide secure, convenient and free parking for bicycles, very close to the entrance of the buildings.
(b) Allocate space near the bicycle parking stands at discounted rates to set-up maintenance workshops for cycles. This will allow people to get their bicycles repaired/serviced while they are at work or shopping.
(c) Facilitate creation of cycling clubs, in association with manufacturers and vendors of bicycles, which will help people in learning and use of bicycles.
(d) Conduct cycle rallies and brevets on regular basis, at least one every month, that are flagged-off by prominent personalities and announce gifts for participants.
(e) Enlist prominent personalities to provide leadership by cycling to work regularly.
(f) Monitor bicycle sales as a key performance indicator (KPI) to ascertain the success of the transport strategies.

These actions should essentially pave way for building public opinion for improved, connected and dedicated infrastructure for bicycles and walking.

Implementing Agency:	Urban Local Body in association with Cycle Stores and Manufacturers
Budget:	None; Raise sponsorships to organise events

4. *Transit Route Planning*

As part of this current exercise, the overall scale of bus transport services required to realise the mode-share targets has been determined. This will be sufficient to provide public transport coverage for 200 km of route network. However, determination of the exact routes and frequency will be a separate exercise, which is quite extensive in itself. This is the essential first step in deploying transit facilities.

Implementing Agency:	Bus Operations SPV – either internally or through Consultant
Budget:	Rs. 30 – 75 lakhs

5. *Tendering for Bus Operators*
   Deploying buses for route operations is a time consuming process as it requires the successful operators to procure and customise the bus fleet. Since the model suggested for Raipur is to go for gross-cost operations, tendering for bus operations can be independent of the route planning exercise.

   Implementing Agency: Bus Operations SPV

6. *Policy Action: Expanding Revenue Sources and Utilisation of UTF*
   Chhattisgarh currently already has constituted an Urban Transport Fund. However, this legislation is to be amended to enhance revenue receipts from parking, cordon tolls, fuel taxes, and others. Similarly, the scope of utilisation of funds has to be expanded to be used for public transport operations and related infrastructure.

   Implementing Agency: Government of Chhattisgarh

7. *Continuous Measurement of Ambient Air Quality and Sources of Air Pollution*
   Chhattisgarh currently already has constituted an Urban Transport Fund. However, this legislation is to be amended to enhance revenue receipts from parking, cordon tolls, fuel taxes, and others. Similarly, the scope of utilisation of funds has to be expanded to be used for public transport operations and related infrastructure. This information and the consequences of it should be actively communicated to the citizens.

   Implementing Agency: Ministry of Environment / Pollution Control Board

8. *Formal Association and Engagement with Centres of Excellence in Urban Transport*
   Urban transport is a complex subject, having implications on health and safety of the citizens. Hence, it is important to have subject matter experts and centres of excellence represented within UMTA and other decision making bodies.

   Implementing Agency: Government of Chhattisgarh / Raipur Municipal Corporation

9. *Knowledge Dissemination and Public Relations*
   Currently there are many misconceptions both among people and also among elected representatives about ways to solve traffic congestion. Most people still believe that traffic congestion can be solved by widening roads and building flyovers, though that only worsens the situation over time. Case studies of solutions adopted by cities across the world and the results, like those provided in the Annex – 1, have to be widely disseminated to create public opinion in favour of sustainable transport. Failure in doing so has been the prime reason for failure of many good initiatives that have been taken up earlier in the country.

   Implementing Agency: Government of Chhattisgarh / Raipur Municipal Corporation

Medium Term Strategies (0 – 2 Years)

Though described as medium term, these actions are recommended to be initiated immediately. However, completion of these actions may require some time and budget, especially for completion of infrastructure.

10. *Transit Facilities*

    In a developing city, open lands become a scarce commodity. Hence, as a first step, it is important to clearly earmark spaces that are spread across the city for bus depots and also transit terminals at prominent route interchanges

    Implementing Agency: Urban Local Body in coordination with the SPV for Bus Operations
    Budget: Rs. 60 – 75 crore

11. *Technology Deployment*

    Another critical decision point would be the nature of the technology deployment. While the AVLS technology is reasonably standard, Raipur city should opt for cashless payment fare media that operates across transport modes. The smart card deployed should be a uniform mode of payment for bus tickets, payment of parking charges, toll charges, etc. Once the decision is made, it may be necessary to engage a technology consultant in order to define the scope of services and process.

    Implementing Agency: UMTA or the SPV for Bus Operations
    Budget: Rs. 3 crore for Control Center + On-going cost

12. *Toll Collection at Cordon Points*

    Once a consistent bus service is in place, the next action item is to establish an agency for collecting toll charges at cordon locations from private motor vehicles.

    Implementing Agency: UMTA or Raipur Municipal Corporation
    Budget: None; Expected to generate revenue of Rs. 14-19 Crore/year

These are some of the critical next steps for the city of Raipur over the next few months in-order to step into a sustainable transport trajectory.

Section 9: Conclusions

No single practice can turn a city around; a sustained effort towards well-defined committed goals is required. By creating an equitable transportation system, we not only improve the ride for a public transit user, but also non transit users benefit from shorter queues, fewer accidents, more green space, better air quality, improved mobility and health benefits from living an active lifestyle.

Roads are public spaces and it is not possible to provide for the ever increasing private motor vehicle demand. The modern approach for an equitable distribution of road space has been to tax the use of private motor vehicles and in turn use the revenue to improve public transport, walk and bicycle facilities and also subsidize their operations. This is typically enabled through the creation of a dedicated fund, such as an UTF, which receives all the proceeds from the TDM interventions and other taxes.

While the focus of this study was on financial analysis, the non-revenue generating TDM options will be the key to arrive at such scenario. Further, Raipur city could benefit by way of introduction of programs such as Raahgiri Day and Car-Free Days that have become extremely popular and help in engaging community and in building consensus on sustainable mobility practices.

Raipur can become a 'trend-setter' among million+ cities in India by leveraging the PT framework that it already has and by laying the foundation for a self-sustaining, financially viable public transport system so as to jump start its journey to achieve transport-sustainable status. Raipur can set a good example of how local governments can successfully integrate climate change into existing planning policies and leverage such initiatives to balance the worksheet and thereby also serve as a model for other sectors.

With the focus on Naya Raipur continuing into the near future, Raipur has to be proactive not to be left behind. It is not possible for Naya Raipur to serve as an effective seat of administration without proper support from Raipur. Even when Naya Raipur becomes fully functional, Raipur will continue to serve as the regional business centre for all of Chhattisgarh.

Raipur Public Transport Scoping Study resulted in a set of recommendations based on current and forecasted need for public transport in the city. Taken together, these recommendations strive to provide congestion relief in the city, improve the economy, improve operating speeds of buses in the city, improve the conditions for pedestrians and bicyclists, manage parking demand and provide more travel options for all commuters in Raipur.

The recommendations do not include building any new parking lots. Vehicular demand is insatiable and research shows that the more you build the more they will come. So adding more parking spaces will further subsidise use of private vehicles thus paving way for creating more vehicular demand. Instead it is recommended that paid parking be

introduced and parking management be made more stringent. Other related recommendations include:

- Transit-oriented development should be promoted in the city, especially along major transit corridors and around transit terminals
- A detailed TDM plan needs to be developed for the city; 'low-cost' and 'high-impact' measures such as Car-Free Days and Raahgiri Day need to be implemented immediately so that the benefits can begin to accrue prior to 2021
- FAR regulations must be modified for bus terminal buildings and transit interchange terminals to be able to develop more commercial space and hence generate additional revenue towards UTF
- Advertisement revenue from buses, bus shelters and major transit corridors should be rerouted to the UTF
- Necessary policy amendments must be made so that Raipur's city-level UTF can receive the funds generated through TDM interventions. Also, the role and responsibilities of the Raipur Urban Public Transport Society should be modified so that they can undertake implementation of PT related projects
- Policies and actions should be in place to set-up a RTC for the state of Chhattisgarh by 2021
- Public outreach programs should be initiated to go hand-in-hand with the PT system enhancements to make citizens aware of their new travel options
- Increasing minimum legal age of driving will encourage younger travellers to use public transport. For example, if minimum age of driving is increased from 18 years to 21 years, the citizens within this age bracket may avail public transport more.

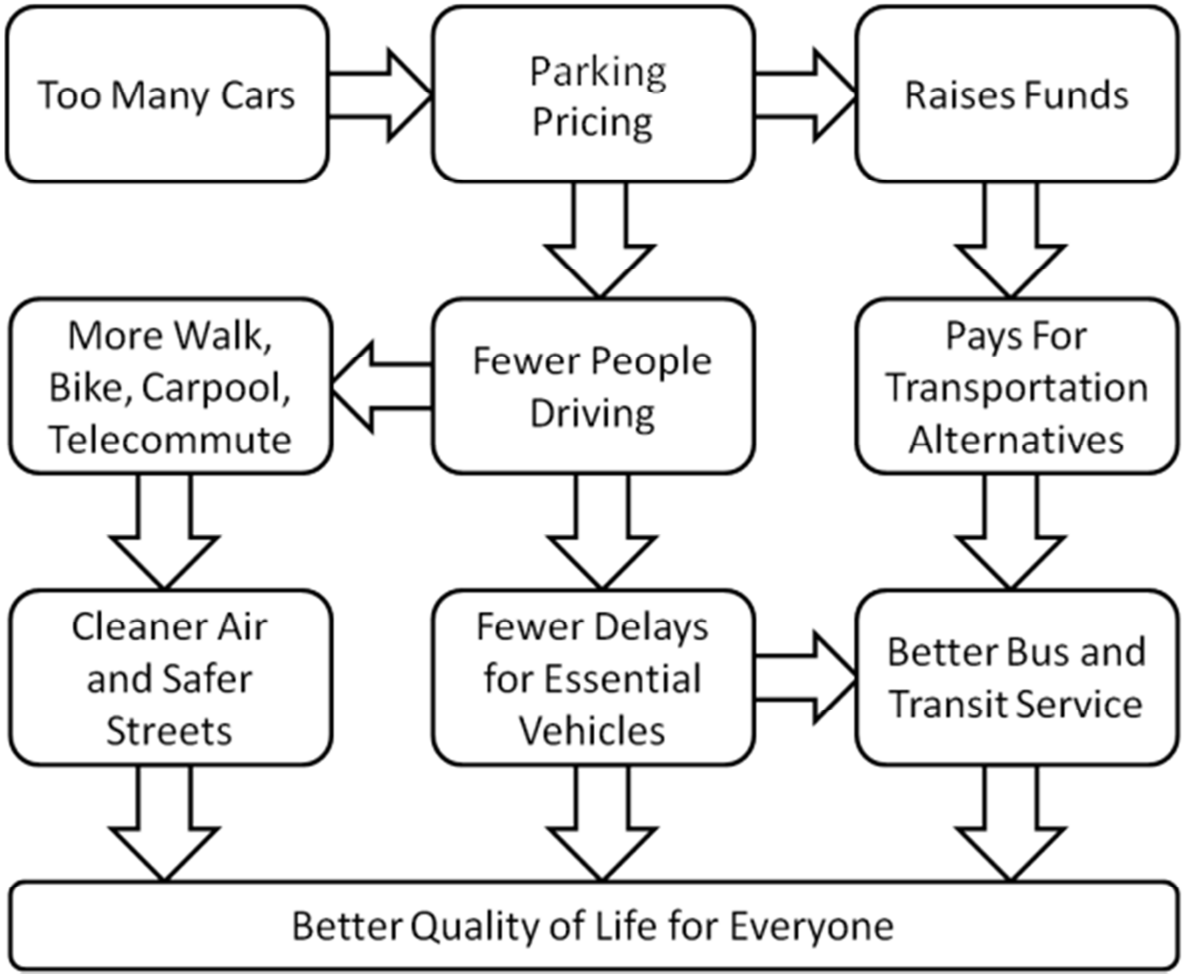
Also, as seen from the financial calculations, arranging funding for public transport if TDM initiatives are undertaken, may not be a challenge as it forms a good business case with an IRR of close to 9%. However, funding for the expanded bus system for the PT and the baseline scenario might be a challenge. Although this scoping exercise explored general potential funding sources, it will still be up to the planners and policy makers to program funds for the recommended enhancements and realize the potential of a 'full-scale' city bus system.

In summary, a fully viable proposition exists for ushering sustainable transport in the city of Raipur by way of adopting a comprehensive approach and leveraging climate finance.

Annex 1: Travel Demand Measures – Case Studies

The problem of traffic congestion is not unique to Raipur or just India. In the later part of the 20th century, cities attempted addressing this by widening roads and building flyovers. However, they soon realized the effect of "induced demand", and the fact that "if you build it, they will come". Researchers have found a one-to-one relationship between road capacity and amount of traffic, which means that a 20% addition to roads results in a corresponding increase of 20% or more in traffic.

The key to "fixing" this congestion is to increase overall transportation system efficiency by either reducing the amount of travel and/or make alternate modes of transportation such as public transit, walking and bicycling more attractive. A shift from single-occupied private vehicle to public transit can be achieved by increasing travel options, providing information and incentives to encourage individuals to alter their travel behaviour. These set of strategies, now widely adopted by all developed and smart cities are known by the term Travel Demand Management (TDM). The cascading impact of such strategies is presented in the flowchart below[10].



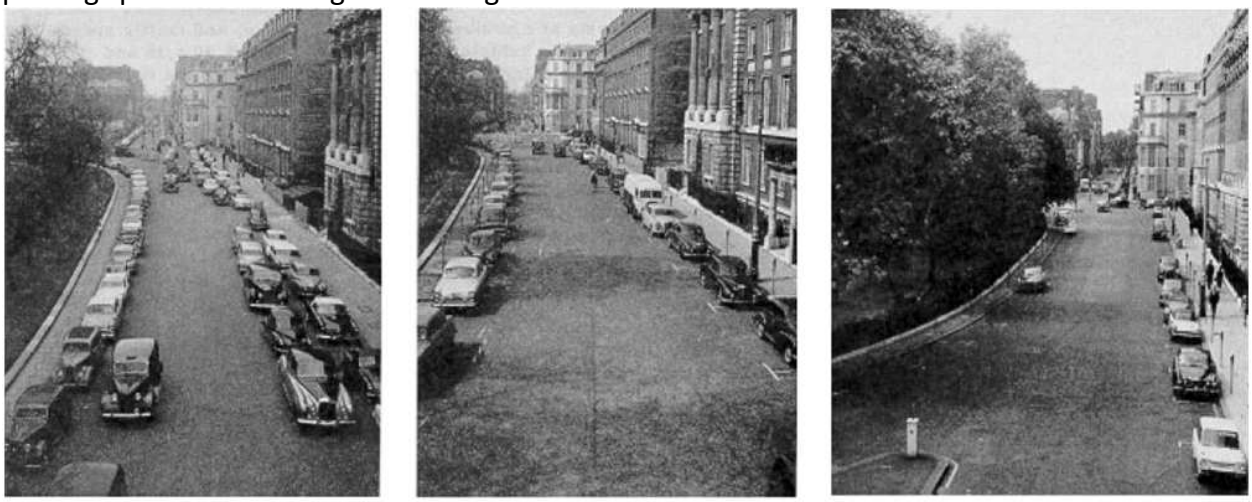
[10] http://www.wallyhood.org/2015/06/congestion-pricing-vs-property-taxes-vote/#gsc.tab=0

Parking Pricing

Many cities worldwide are now realizing the high-cost associated with free parking. Even modest parking fees can have significant impact on travel patterns. Research indicates that if the price of parking is doubled, solo driving can be expected to decrease by 30%[11]. A U.K. based study showed that cutting the parking supply in half led to a 30% decrease in car use. Variable pricing can be used to reflect peak and off-peak demand. Long-term parking can be made more expensive than short-term parking to improve the utilization ratio of the parking lots and discourage employees from driving to work.

Case Study: London

The pictures below from Grosvenor Square in London clearly show the impact of pricing of parking spaces in reducing traffic congestion.



No meters | Meters | Prices quadrupled

Case Study: Mumbai

The Brihanmumbai Municipal Corporation has started a pilot program for the city of Mumbai, where in the entire city is divided into 3 categories and hourly charges ranging from 60 rupees to 15 rupees. Along with this aggressive pricing for commercial areas, it is testing a residential parking policy that allows only one parking spot per residence.

Cordon Tax

Cordon tax, also known as road pricing are direct charges levied on motorists for the use of roads within a cordon or a specific road. The user has to pay a special "fee" or toll for entering the urban area. Cordon area tolls have been successfully implemented in London, Stockholm and Singapore. Distance based tolls are very common in Europe. These charges can be designed to discourage the use of a certain segment of traffic like private vehicles and/or serve as travel demand management measure in reducing congestion. Public transportation vehicles and emergency response vehicles are usually exempt from such a tax. They also serve as an additional source of revenue for the Urban Transportation Fund.

[11] Report 95, Transit Cooperative Research Program

Case Study: London
In 2003, London introduced a cordon charge for all vehicles entering or exiting central London in an attempt to ease congestion and simultaneously promote public transport. The initial fee was £5, which was last increased in 2014 to £11.50. Motorists have to pay this fee by midnight on the day of travel fee for driving on weekdays in or out of the clearly marked congestion zone between 7 a.m. and 6 p.m. (initially 6:30 p.m.). Cameras record traffic footage and automatic license plate recognition software is used to collect payments. Public transit vehicles, emergency vehicles, 2-wheelers, and 'green' cars running on alternate fuel sources are exempt from this fee. By 2006, the congestion charge reduced the number of chargeable vehicles entering central London during charging hours by 70,000. Accidents per mile driven in the congestion zone have dropped by 40% and bicycle traffic has increased by about 70%. Despite the presence of a venerable metro system, bus system has grown at exceptional rates and even taxi fares are down because the traffic moves more swiftly. In 2008, congestion charging raised £435 million revenue that was used to improve public transport and pedestrian/bicycle facilities.

Case Study: Singapore
In 1975, Singapore introduced congestion pricing as a mechanism to manage the road traffic entering Singapore's central business district. Singapore uses 'Electronic Road Pricing' - an open road tolling system in which vehicles do not have to slow down to pay toll. Since the introduction of this scheme, public transit usage has been increasing and the mode share has reached an outstanding 65%.

Parking Space Reduction

Parking demand is insatiable. In an environment of rapid increase in private vehicles, conventional policies that encourage parking supply are moot. Over the last few decades, many cities worldwide have capped the total number of parking spots available or reduced the amount of parking allowed per square foot of commercial space (mostly central business areas).

If developers were allowed to choose how many parking spaces to provide, the number of spaces would be a result of a careful economic calculation rather than a matter of satisfying a legal requirement.

Case Study: Portland
- Capped off-street parking spaces at 40,000 (excludes hospitals and residences)
- Increased public transit usage from 20 to 25%

Case Study: Brooklyn
In a major effort to reign in traffic congestion and improve the quality of living for the residents, many parking lots in New York state have been converted into public spaces.

Case Study: Tokyo
Tokyo provides less than 0.5 spaces for every 100 sq. meters of commercial/office space.

Case Study: Vancouver
Vancouver, Canada capped downtown parking and banned the construction of new roads in the city centre, after which the number of car trips and parking spaces subsequently reduced, but the total number of jobs in the city centre and trips to the downtown increased.

Case Study: London
U.K. Department for Communities and Local Government **"(does) not require developers to provide more spaces than they themselves wish…there should be no minimum (parking) standards for development, other than parking for disabled people"**. Greater London Authority set a maximum number of parking spaces allowed, no minimum requirements for each of its 33 boroughs. Further, London replaced existing car parking spaces into secured bicycle parking areas in a bid to promote cycling.

Case Study: Bordeaux
Realising the impact of parking on traffic congestion, many European cities have converted on-street parking into public spaces.

Before:

After:

Road Space Rationing

Another easy way for reducing traffic congestion is to restrict use of vehicles on the roads based on the vehicle registration number. Many cities have implemented schemes to allow even and odd numbered vehicles on alternate days. In the short-term, this measure can cut the traffic into half immediately and promote people to carpool or use public transport. However, the impact in the long term may not be as expected as people may own multiple private vehicles with registration numbers in different categories, thus enabling them to use a different vehicle on alternate days. This form of Road Space Rationing is practiced in Beijing, Sao Paulo, etc.

Repurposing Road Space

This is based on the principle of democratic utilisation of road space. The 2011 household travel survey indicates that only 12% of the trips happen by car. However, cars occupy more than 70% of the road space. Cities across the world have realised this problem and have re-purposed the existing road width for various modes of traffic. This also helps in improving the safety and speed for all modes of transport. Repurposing of street space can take various forms such as dedicated bicycle lanes, Bus Rapid Transit (BRT), or simply creating public spaces.

Case Study: New York

In an attempt to solve the traffic congestion, New York City has implemented multiple road repurposing solutions including converting an 8 lane road into just 3 lanes for cars. The following images speak volumes about the city's effort to become a people friendly smart city.

Case Study: Paris

Europe has been in the fore-front of realising the importance of active commuting and has hence repurposed streets entirely for bus lanes and walk/bicycle paths. Many downtown streets have been closed for motor vehicles. The city has created a good public transport system.

Case Study: Seoul

In a revolutionary step, the city has decided to pull down its urban flyovers as a means to resolve the issues of traffic congestion, air pollution and need for public spaces. Over the past decade, more than 40 such flyovers have been demolished to replace them with spaces for alternate commute options and public amenities.

Case Study: Indore BRT (iBus)

1. 26% increase in journey speed, 3,250 man-hours of travel time saving each day even with just a 11 km BRT corridor
2. 47% of passengers own a private two or four wheeler vehicle
3. 24% of passengers shifted from private transportation

Case Study: Bogota

In the year 1974, in an attempt to contain the menace of traffic congestion, Bagota started with Ciclovia, a weekly event that closed a 4 km stretch of road for motor vehicles. This small change has now led to creation of 357 km permanent bicycle paths and establishment of no-motor zones across the city. The image beside is of the Inner Ring Expressway (IRE) which was originally planned 17.6 km elevated toll road.

Car Free Days

The aspects discussed earlier all relate purely as transportation interventions. However, it is also key for the healthy development of a city to engage its citizens to bring awareness and consensus on the subjects. One such initiative that is a TDM measure and also helps in community building is the 'car free day'. Most of these take their inspiration from Ciclovia which started in Bagota in the year 1974. Over the years, it has taken many forms.

Here in India, the movement started under the name 'Raahgiri Day', motivating people to reclaim their streets by closing portions of streets to motorised traffic on Sundays and spread awareness among people on the subjects of road safety, air pollution, need for physical activity (for health), and social inclusion. Starting in Gurgaon in November 2013, this has spread to more than 30 locations across the country.

This has further led to the initiation of 'Car Free Thursday' in Hyderabad in August 2015, which has seen people voluntarily coming forward to let switch to sustainable transport modes and car-pooling on Thursdays. The success of the initiative can be gauged from the comments posted by the people on their experiences on that day (see graphic above). This campaign resulted in saving more than 400 tons of emissions and 300,000 man hours in travel time in just 12 Thursdays. The outcomes of this campaign have led to the launch on similar program in 3 other cities (Gurgaon, Delhi, Karnal) and four more cities making similar plans.

Congestion Mitigation Measures Worldwide

Scores of such examples exist that have arised out of the understanding that the roads are public spaces and it is not possible to provide for the private motor vehicle demand. The matrix below gives a sample of how cities have adopted a combination of these measures to systematically contain the use of private vehicles.

Policy Approach (↓)	London	New York	Singapore	Bogota	Paris
Pedestrianizing Streets (NMT)		✓	✓	✓	✓
PT Improvement + Dedicated RoW	✓	✓		✓	✓
Parking Regulation & Pricing	✓	✓	✓		✓
Congestion Pricing	✓		✓		
Rationing Pvt. Vehicle Ownership			✓		
Public Bicycle Sharing	✓	✓		✓	✓

Annex 2: Stakeholder Comments & Responses

This section has been annexed post the first round of review with the stakeholders. The comments received have further motivated the addition of Section-8 of the report that discusses the actions necessary by the city and government in order to put the city on a sustainable transport trajectory. Below are some comments received and responses.

1. Is there any data on transport related CO2 emissions in the city and the raise in pollution due to emissions especially from diesel vehicles?

This scope of this work has been limited to collecting secondary source of data. The pollution control board is the relevant authority to collect such information. However it is very difficult to arrive at a correct estimate. Earlier research suggest transport sector to contribute between 13.3% - 56.8% of the total Greenhouse Gas Emissions, but that includes emissions from freight as well. Below is a reference of the same. However, this study does not have values for Raipur city.

> GHG footprint of major cities in India (2015) - T.V. Ramachandra, Bharath H. Aithal, K. Sreejith;
> https://www.researchgate.net/publication/271078880_GHG_footprint_of_Major_cities_in_India

2. Bring out clearly data source for present vehicle movement in Raipur and future projections.

The 'Demand Estimation' under Section - 4 on page 13 and 14 lists the two key data sources from where population projections and base year trip rates have been collated. Tables 1 through 4 put together explain the calculations. However, the computations are presented together here for ease of understanding.

Parmeter	2011	2021 - BAU	2021 - PT	2021 - PT+TDM
CITY BASED TRIPS				
Population [(a)]	10,27,264	14,65,600	14,65,600	14,65,600
City Wide Person Trips [(a)]	9,99,000	15,53,000	15,53,000	15,53,000
Pop. Growth Rate	3.91%	3.62%	3.62%	3.62%
Trip Rate	0.97	1.06	1.06	1.06
Avg. Trip Length [(b)]	4.20	9.07	9.07	7.23
No. Registered Pvt. Vehicles [(c)]	5,33,848	14,41,921	13,05,710	11,69,499
Mode Share – Private [(b)]	32.17%	55.89%	39.71%	24.64%
Mode Share – NMT [(b)]	55.38%	27.92%	27.92%	34.90%
Mode Share - PT+IPT [(b)]	12.45%	16.19%	32.37%	40.46%
Trips By Pvt. Vehicles	3,21,378	8,68,041	6,16,688	3,82,610
Trips By NMT	5,53,246	4,33,606	4,33,606	5,42,007
City Based Trips By PT	1,24,376	2,51,353	5,02,706	6,28,383

Parmeter	2011	2021 - BAU	2021 - PT	2021 - PT+TDM
INTER-CITY TRIPS				
IE/EI Trips By Rail [b]	97,852	1,19,980	1,19,980	1,19,980
IE/EI Rail: Last Mile PT Trips	63,017	77,267	96,584	96,584
IE/EI Person Trips By Road [b]	1,62,009	1,90,709	1,90,709	1,90,709
IE/EI Road Trips By PT [b]	72,418	85,247	93,772	1,06,559
IE/EI Road: Last Mile PT Trips	21,725	25,574	28,131	31,968
Total Demand for PT	2,09,118	3,54,194	6,27,421	7,56,934
PKT By PT	8,78,093	32,10,917	56,87,835	54,71,459
PT Seat Km @ 70% - 80% OR	12,54,419	45,87,024	71,09,793	68,39,324
PT Mode Split:				
Auto Rickshaw [b]	33.16%	33.16%	17.12%	17.12%
School/Charter Bus	41.45%	41.45%	21.39%	21.39%
City Bus	25.39%	25.39%	61.49%	61.49%
Seat Km Serviced By Auto Rick	4,15,965	15,21,057	12,16,846	11,70,555
Seat Km Serviced By Chartered	5,19,957	19,01,322	15,21,057	14,63,193
Seat Km Serviced By City Bus	3,18,497	11,64,645	43,71,890	42,05,576
PKT Split: Mini Bus [d]	1	0.65	0.65	0.65
PKT Split: Std. Bus		0.35	0.35	0.35
PKT Serviced By Mini-Bus	3,18,497	7,57,020	28,41,729	27,33,624
PKT Serviced By Standard Bus	-	4,07,626	15,30,162	14,71,951
No. Mini Buses Reqd. @10% Spare	73	173	496	418
No. Std. Buses Reqd. @10% Spare	-	62	178	150
TOTAL FLEET SIZE	73	236	674	568
VKT Calculations				
Mini Bus VKT	10,617	25,234	94,724	91,121
Standard Bus VKT	-	9,058	34,004	32,710
TOTAL Bus Trips VKT	10,617	34,292	1,28,728	1,23,831
Bus VKT Increased Over BAU			94,436	89,538
PKT Avoided Over BAU Scenario	-	-	26,82,260	44,88,263
PKT Shited From Auto Rickshaw			91,263	2,81,405
PKT Shited From Chartered Bus			1,14,079	3,51,756
PKT Shited From Cars			3,06,890	4,77,647
PKT Shited From Two Wheelers			21,70,028	33,77,455

Parmeter	2011	2021 - BAU	2021 - PT	2021 - PT+TDM
Auto Rickshaw VKT ↓ Over BAU			21,729	67,001
Chartered Bus VKT ↓ Over BAU			5,432	16,750
Car VKT ↓ Over BAU			1,39,495	2,17,112
Two Wheeler VKT ↓ Over BAU			16,69,252	25,98,043
TOTAL VKT Avoided Over BAU			18,35,909	28,98,906
Revenue Calculations				
Avg. Daily VKT/Bus		145	191	218
Avg. Daily PKT Served/Mini-Bus		3,055	4,582	5,236
Avg. Daily PKT Served/Std. Bus		4,582	6,873	7,855
Revenue/Mini-Bus/Year		10,86,061	16,29,091	21,54,390
Revenue/Std. Bus/Year		16,29,091	24,43,636	32,31,584

Notes:

(a) Population and travel projections from *Traffic and Transportation Policies and Strategies in Urban Areas in India, May 2008; MoUD*.

(b) Base year data from *Traffic and Transportation Plan for Raipur Urban Agglomeration, April 2010; by RITES.* Projections based on reasonable assumptions to achieve targeted mode shares of scenarios.

(c) Vehicle registration information from Transport Department. Projections based on past trend.

(d) Current ratio of standard vs. mini buses in Raipur City. The same mix is considered ideal from the near future.

3. A small section summarising the limitations of the previous studies.

Section – 2 of the report describes the studies relevant to transport for Raipur area in the past. The earlier works have a quite different scope ranging from funding assistance from JnNURM, to specific studies for the BRT, etc. The only comprehensive work on transport in Raipur city is the *Traffic and Transportation Plan for Raipur Urban Agglomeration,* submitted by RITES in the year 2010. A critique of the same is already presented on page-8. The current work specifically related to provisioning of public transport in the city, its long-term financial viability and the social benefits that accrue, in order to achieve emission reductions and sustainable development of the city.

4. Bring out clearly the challenges in present public transport systems

The sub-section on 'Existing Transport System' in Section – 1 talks about the extent of public transport services in Raipur city. The bus services in Raipur are provided by way of a public-private partnership under the net-cost model. Hence, the system suffers with all the generic problems associated with this method as discussed in under 'Net Cost Model' on page 21. Further, operation of just 100 odd buses (of which a significant portion are actually operated out-side of the city) when about 600 of them are needed clearly speaks of the lack of coverage and the dependence on para-transit modes for travel needs.

5. Need to substantiate all calculations on projected PT demand and financial models
The computations on public transport needs is already provided earlier in this annexure. It needs to be understood here is that this study approaches the problem by reverse engineering. We first established the ideal PT+NMT mode shares for the sustainable growth of the city and then calculated the quantum of PT facilities needed to serve such ridership. The computations on financial projections over the first 5 year period are provided in table-6. Calculation of IRR and EIRR are more detailed and the spread sheets shall be shared as soft-copies along with this report.

6. In the revenue sources section, we need to bring out clearly how it will work and who is the authority to do that.
Below are the list of revenue streams discussed in this document and the jurisdiction under which it falls. However, it should be noted that all revenue sources other than that directly collected by the SPV for bus operations should be routed to the Urban Transport Fund.

Revenue Source	***Agency***
- Fare revenue from bus operations	Bus Operations SPV
- Lease Revenue from Terminals	Bus Operations SPV
- Advertising Revenue from Bus Stops	Bus Operations SPV
- Motor Vehicle Parking Charge	ULB (Municipal Corporation)
- Cordon Toll Tax	ULB (Municipal Corporation)
- Green Tax on Fuel Sale	Excise Department (?)
- Cess on Motor Vehicle Tax	Transport Department
- Surcharge on Stamp Duty	Revenue Department (?)

7. Bring out location specific interventions separately; Areas (city area names like market area, railway station etc) where PT is required, areas where Car free zones should be promoted, areas where parking lots and pricing systems can be implemented etc.
Section – 8 of this report talks about the way-forward for Raipur administration to steer the transport scenario in the city. However, identifying the specific areas to start these initiatives can be part of the stakeholder workshop.

8. In the financial models and analysis we need to bring out clearly why BRT systems are success in some cities like Ahmedabad while failure if any in some cities like Delhi . Also on the profit and loss making stories of these BRTs and recommend a best model that would work for Raipur
Specific discussion on the BRT falls outside the scope of this work. It is important to state here that 'success' and 'failure' have been very loosely used in each context and have never been qualified with data. However, here are a few thumb-rules for a developing a successful BRT.

- Bus lanes in a BRT system should be median lanes. Using the left side lanes for buses is not suitable for Indian cities due to our pattern of development.
- BRT has to be network and not just a single line.
- For a successful intra-city BRT, the minimum network length has to be four to five times of the average trip length. Hence, a city like Delhi requires a network of about 45 km to even assess the success or failure of the BRT. However, Delhi built only a 5 km route, which was also not fully enforced.

- Operating a high frequency network Is key to the success of the BRT (minimum 30 buses/hour/direction)
- Having a good public relations strategy as discussed in Section-8 is very essential. This is because, a BRT lane will appear empty, even when it carries more people that that served by the motor-vehicle lane. As a result, there is some criticism by motorists, without realising the real throughput of the BRT lane. A data driven communications approach is very important to counter peoples perceptions.

9. The case studies of Singapore and other major cities are known widely however, its not implementable in India, can we recommend specific strategies for Raipur particularly. Cycling lanes are good only in naya Raipur not in old Raipur. Congestion pricing- how to make it work in India, who will collect tolls etc?

Section – 8 of this report which has been added as a result of the stakeholder feedback exactly addresses this question. On the specific issue of congestion-pricing, it has to be understood that it is near impossible and very expensive to implement this in India. Parking pricing is a good proxy for congestion pricing, which is very easily implementable. Parking prices can be varied by time-of-the-day, thus exactly simulating congestion pricing that is done in Singapore.

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