Service and Business Plan for City Bus Operations - Chandigarh

Project Consultancy-7 (PC-7)

Service and Business Plan for City Bus Operations for two ESCBS Cities Chandigarh and Mira-Bhayandar under the World Bank – GEF assisted Efficient and Sustainable City Bus Services (ESCBS) Project

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CoE-UT Team

Project Team

Project Team Leaders	Prof. H. M. Shivanand Swamy Dr. Shalini Sinha
Technical Advisor	Mr. A. S. Lakra
Socio-economic Specialist	Dr. Nitika Bhakuni
Core Team	Mr. Khelan Modi Ms. Maitry Shah Mr. Suraj Sunil
Support Team	Ms. Hemangi Dalwadi Mr. Jignesh Panchal Ms. Yaksha Chakravarti Ms. Anushree Jain Mr. Preet Amin Mr. Ritesh Suthar Ms. Nisha Pramanik Ms. Grishma Mehta Ms. Diti Upadhyay Mr. Jaydeep Kalaria

List of Abbreviations

AMTS	Ahmedabad Municipal Transport System
BA	Boarding-Alighting
BEST	Brihanmumbai Electricity Supply and Transport
CAGR	Compound Annual Growth Rate
CAM	Chief Account Manager
CAMC	Comprehensive Annual Maintenance Contract
CCBSS	Chandigarh City Bus Service Society
CEO	Chief Executive Officer
CMP	Comprehensive Mobility Plan
COM	Chief Operation Manager
CPKM	Cost per Passenger Km
CTU	Chandigarh Transport Undertaking
CVC	Classified Volume Count
DTC	Delhi Transport Corporation
EPKM	Earning per Passenger Km
ESCBS	Efficient and Sustainable City Bus Services
ETM	Electronic Ticketing Machine
ETVM	Electronic Ticketing Vending Machine
EV	Electric Vehicle
F & A	Finance and Account
FU	Fleet Utilisation
FY	Future Year
GCC	Gross Cost Contract
GR	Growth Rate
HDW	Headway
HH	House Hold
HRD	Human Resource Department
IPK	Index Passenger Km
IPT	Intermediate Public Transport
ITMS	Intelligent Transport Management System
JnNURM	Jawaharlal Nehru Urban Renewal Mission
KCR	Kilometre Charge Rate
km	Kilometre
KPI	Key Performance Indicators
LF	Load Factor

LOS	Level of Service
MACT	Motor Accidents Claims Tribunal
MC	Municipal Corporation
MIS	Management Information System
MoHUA	Ministry of Housing and Urban Affairs
MVT	Motor Vehicle Tax
NCC	Net Cost Contract
OD	Origin-Destination
OEM	Original Equipment Manufacture
OR	Operating Ratio
PO	Private Operator
PPHPD	Passengers Per Hour Per Direction
PPP	Public Private Participation
PSO	Public Service Obligation
PT	Public Transport
R & M	Repair and Maintenance
RfP	Request for Proposal
RTO	Regional Transport Office
SLA	Service Level Agreement
SMF	System Management Fees
SQ	Service Quality
STU	State Transport Undertaking
TCO	Total Cost of Ownership
TCRP	Transit Cooperative Research Program
UT	Union Territory
VGF	Viability Gap Funding
VU	Vehicle Utilisation
WFPR	Work Force Participation Rate
WPI	Wholesale Price Index

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EXECUTIVE SUMMARY

Project background

Ministry of Housing and Urban Affairs, Government of India under Efficient & Sustainable City Bus Services has awarded the study to prepare Service and Operations Plans for bus services in the cities of Chandigarh and Mira-Bhayandar to the Centre of Excellence in Urban Transport, CRDF. The main objective of the Service and Business Plan is "To optimise the effectiveness and viability of the public transport network and services in Chandigarh city".

City context

Chandigarh, a Union Territory of India, has a population of 10.5 lakhs as per 2011 and has an area of approximately 114 sq. km. To its south-west is the Mohali city in the state of Punjab and towards south-east is the Panchkula city in Haryana. It is surrounded by smaller cities namely Mohali on its west and Zirakpur on its south in the state of Punjab and Panchkula towards south east in Haryana. All of these towns have a very strong interaction (in terms of travel) with Chandigarh, thus making it practically a larger urban area. Based on the growth rate in the last decade, current estimated population is about 19.5 lakhs for Chandigarh and surrounding areas including Mohali, Panchkula and Zirakpur.

The Chandigarh Transport Undertaking (CTU) initiated bus operations in 1966 under the Union Territory Administration of the Central Government. It functions under the supervision of Secretary, Transport, Chandigarh Administration and operates bus services in Chandigarh as well as adjoining areas of Punjab and Haryana along with the inter-state routes. CTU received financial assistance under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) to strengthen city bus services in the year 2014 and a new Special Purpose Vehicle 'Chandigarh City Bus Service Society' (CCBSS) was formed as an extended arm of Chandigarh Transport Undertaking. CCBSS is entrusted with the city bus operations which carries about 1,44,000 passengers per day (CTU, September 2019).

Chandigarh city is experiencing a rapid increase in personal motorised vehicles and decrease in city bus ridership. Thus, to attract passengers, a comprehensive improvement and modernization strategy is needed.

Study Approach

The study was undertaken in four stages- a) baseline analysis which involved assessment of existing bus service levels, operational areas of intermediate public transport (IPT) services, demand patterns of bus, IPT and private mode users and concurrence of demand and supply levels; b) Stakeholder analysis which included inputs from CTU/CCBSS regarding future vision and strategies as well as user perception survey to capture their priority service attributes; c) Developing the route rationalization and service plan which was based on a detailed analysis of route wise ridership and demand structure and evaluated using a PT model; and d) Business Plan which included fleet type and infrastructure requirements, bus operations, performance monitoring framework, financial analysis and investment requirements over the next ten year period.

Key observations

The baseline analysis of the bus system showed that the bus services cover 38% and 43% of road network in Chandigarh & Mohali and the tri-city area respectively. IPT caters to significant demand in the areas having poor bus service levels. The coverage improvement is required in areas like Vikas Nagar, Maloya Colony, Industrial Area Mohali, Rehri Market and Sector 78 in Chandigarh and Mohali.

Bus services are centralised with majority of routes originating/ending at either ISBT 43, ISBT 17 and PGI. This one-many route structure is useful in providing direct connectivity to various places in the city. However, concentration of routes on some corridors in the city leads uneven distribution of bus supply with some areas having skeletal services. This results in people relying on personal modes or IPT modes for travel. The routes have moderate service headways of around 15 mins. The composition of AC and Non AC buses for city service is in the ratio of 60:40 and about 38% of the total passengers uses AC buses for their travel.

About 3.1 lakhs daily trips in the city are performed either by IPT or PT mode. The share of IPT in this is about 66% where about 45% of total IPT users are having more than 6km of average trip length, therefore there is significant market opportunity for PT system if it can be designed appropriately.

In terms of fleet size, Chandigarh would require about a total of 420-1000 buses depending on the Level of Service targeted. As per MoHUA Service Level Benchmarks, cities should have a minimum of 0.1 buses as per LOS3, 0.25 for LOS2 and 0.4 as per LOS1. Currently, 330 buses i.e. 0.17 buses per 1000 population, are operated by CCBSS. Fleet utilization is around 88% and the average vehicle utilization for weekdays is 187 km which is less than the desired range of 200 kms per bus per day for urban services. About 80% of routes have load factor <0.3, indicating low bus patronage. The operating ratio is around 0.53.

Mission, Vision and Objectives

Taking into consideration commuter perceptions on bus service attributes as well as inputs from CTU/CCBSS, the Mission for CCBSS has been defined as “Providing high quality, safe and dependable bus services for residents of Chandigarh”.

The Vision Statement is “**Chandigarh city services as an attractive and everyday mobility choice for residents”.** In line with this vision statement, strategic objectives have been defined as:

- Reliable and efficient bus operations for all
- Commuter friendly services
- Revenue enhancement by optimal utilisation of resources
- Services targeting specific market segments

Proposed Service Plan

The existing routes were analysed for the passenger demand and load factor at different route segments. This along with demand patterns were used for modifying existing routes and proposing new routes. Some key principles adopted for proposing new routes are:

- Retaining existing high demand PT routes to ensure no disturbance to passengers on these routes.
- Connecting neighbouring towns or sub urban areas with major city terminals/ nodes and providing frequent services to ensure good connectivity for the commuting population.
- Consolidating routes along major corridors to reduce the number of overlapping of routes and simplify route structures
- Based on the IPT and private vehicle demand pattern, provide routes in the major demand interaction zones.
- New routes to improve the coverage and provide complementary movement within city.

Following types of routes have been proposed:

1. *Sub urban routes:* These routes connect Chandigarh city with the surrounding towns. A total of 25 routes are proposed of which 3 are existing routes, 2 are new routes and 20 routes are modified existing routes.
2. *City routes:* A total of 12 routes are proposed within Chandigarh city, of which 2 are existing routes, 1 is a new route and the rest are modified existing routes.
3. *Terminal / Express Routes:* All the terminals such as ISBT43, ISBT17, PGI, Mani Majra, ISBT Mohali and ISBT Panchkula are connected with terminal routes with high frequency to facilitate easy transfers and express service to save the travel time for direct passengers.
4. *Linear grid routes:* Seven new straight routes on city grids to increase area coverage.

Business Plan

Trajectory of vision realisation and the timeline is a function of agency's intent and drive along with constraints like financial resources and land availability for infrastructure facilities. Hence, alternative scenarios are hence presented as part of the business plan, which the cities could choose from for deciding on an appropriate business strategy for bus services in the city.

The existing mode share is 10% and for the year 2032, three mode share scenarios 15%, 20% and 25% have been outlined.

Mode share realisation is a function of the service levels (fare levels, bus quality, frequencies and last mile connectivity) delivered to the commuters along with the proactive communication on the bus service improvements being undertaken. In the plan period of 12 years, moderate scenario (mode share 20%) has been considered for developing the service and business plan. However, in case a proactive approach is taken by CCBSS in the short to medium term in terms of fleet addition, infrastructure development and roll out of the service plan, a higher trajectory for achieving 25% mode share could also be considered.

Fleet size and mix: Chandigarh is in the process of procuring 80 electric buses. The future strategy for 2032 has been worked out considering all new fleet to be air-conditioned buses and electric. Three possible fleet-mix scenarios for fleet mix and type has been proposed:

a) Standard and midi buses (40:60 ratio fleet mix as in the current situation): 750 buses (295 standard & 455 midi)
b) All midi-buses with a fleet size of 750
c) Midi and mini-buses with a fleet size of 950 (292 Midi + 659 Mini)

Guiding principles for selection: From the existing 10% PT share to targeted PT share of 20% - 25% by 2032 would require significant quantitative as well as qualitative improvements in the bus services.

The fleet mix concept is not new for the city as CTU/ CCBSS operating standard and midi buses, however city may consider transitioning of standard-midi mix to all midi or midi-mini mix to offer frequent services to the citizens which would induce IPT and private vehicle users to shift to PT. Also, availability of information through apps and websites apart from at-stop information would help passengers plan their journeys better.

The requirement of number of smaller buses would be more compared to requirement of standard buses because of lesser capacity; however it is estimated that the operating ratios would improve due to the potential of higher passenger ridership levels with better service headways and connectivity. Preferably lower demand routes should be operated with smaller buses which aid improving the load factor by providing frequent services to citizens. Switching to a different bus type should not pose a big challenge as the average age of a bus is 8-10 years and hence the transition could happen gradually as old buses get phased out. With congestion levels continuously increasing in the city, operating smaller vehicles may also be easier in the city.

Like other Indian cities in Chandigarh also, auto-rickshaws operating as shuttle service compete with the buses despite high fare levels. Facilitating a shift from them would require buses which are affordable, frequent and have good coverage and accessibility. With smaller bus sizes (Midi / Mini), it may be possible to offer a high frequency service with better load factor levels.

Depot requirements: There are 3 existing depots – Depot 2, 3 and 4 from where urban bus services operate. A new depot is planned at Raipur Kalan. In addition to these four depots, two additional depots would be required to accommodate these buses. The tentative location proposed for these two depots are near Mani Majara and near PGI in Chandigarh.

Scenario	**Scenario 1- Standard & Midi**	**Scenario 2 – All midi**	**Scenario 5A – Midi & mini**
Total Depot Area required - 2032	32.96 acre	30.01 acre	33.62 acre
Existing Depot Area available *(includes Raipur Kalan & 50% capacity of Depot 3)*	20.50 acre	20.50 acre	20.5 acre
Additional area required for depots	12.5 acre	9.5 acre	13.1 acre
Additional number of depots	2.00 (~6 acre of land near Mani Majra and ~6.5 acre of land near PGI)	2.00 (~4 acre of land near Mani Majra and ~4.5 acre of land near PGI)	2.00 (~6.5 acre of land near Mani Majra and ~6.5 acre of land near PGI)

Capital costs: Cost estimates have been worked out for the entire plan period 2023-2032 for the 3 alternative scenarios at constant prices.

Item	**Scenario 1- Standard & Midi**	**Scenario 2 – All midi**	**Scenario 5A – Midi & mini**

Capital infrastructure cost (incl.bus stops, terminals, depots, ETVMs etc) in Cr	178	147	186
Fleet cost in Cr	1109	922	854
Total infrastructure investment cost in Cr	1287	1070	1040

Overall investment for all three scenarios by 2032 would be around Rs.1040 to Rs.1290 crore. However, if the CCBSS opts for a Gross Cost Model for electric bus operations, fleet cost could also be built as part of the GCC rate reducing the capital budget requirements for CCBSS.

Operating Costs: The total operating costs varies from 2600-3000Cr over the plan period depending on the opted fleet mix scenario.

Cost details	**Cost in Cr**		
	Scenario 1- Standard & Midi	**Scenario 2 – All midi**	**Scenario 5A – Midi & mini**
Fuel Cost	215.06	198.88	229.73
Lubricant Cost	0.65	0.65	0.65
R & M Cost	548.43	502.84	510.58
Insurance + MVT + MACT + RR Tax	157.24	129.84	131.34
Staff Cost	883.87	869.70	1155.06
ITMS Operating Costs	30.35	30.31	31.13
Cost of Depreciation - Total	608.21	506.20	518.48
Cost of Fund - (Expected returns & Interests)	239.76	239.76	239.76
Miscellaneous Cost	140.73	128.91	144.25
Total Operational Cost	**2824**	**2607**	**2961**

Operating Model: Adoption of GCC model for both existing as well as proposed depot operations and management is suggested. This model would be most suitable in case of electric fleet operations. As per this option, CCBSS shall be responsible for the revenue risk, planning of overall services and managing the contract services & quality. All the operations and management work shall be outsourced or contracted out to OEMs who would manufacture, operate and maintain the buses. The OEMs would also be responsible for all necessary equipment along with maintenance of workshop and depot infrastructure.

Proposed fare structure: The proposed fare structure is:

Distance Range (km)	**Fare in Rs**
Upto 2 km	5
2-4 km	10
4-6 km	15
6-10 km	20
More than 10 km	25

It is suggested to revise the fare structure every two years based on a fare revision formula.

Sources of Funding: With the above fare structure and demand estimates, the operating ratio in the three scenarios is in the range of 0.9 to 1.0. However, building up ridership would require proactive branding

and marketing strategies for buses and restraining measures for private modes. The fare box revenues in public transport hence may not be entirely sufficient to recover the operations cost. Identification and earmarking of alternative funding sources is important. Innovating funding sources like green tax, parking charges and developing depots and terminals on a PPP basis can be explored. With such measures, non-fare box revenue could be increased and could be used for covering operating deficits and improving service levels. Further, any operating deficits would have to be covered through Viability Gap Funding by the Government of Chandigarh.

One of the major capital expenses is the cost of the fleet which would be around INR 800-1100 crores over the next 12 years. Various operating models could be tested – for example in GCC the operator could bring in buses as per CCBSS's specifications.

Management Structure: The overall management of the CCBSS operations would be by the Corporate Office under which has four divisions have been proposed: administration and personnel, operations, technical, finance and accounts. In the proposed operating model of GCC for E-bus operations, responsibilities on finance department and operations department are going to increase because of auditing and monitoring private operators' bills and their maintenance and operations.

Increase in fleet size would also add to the depot requirement from 3 to 5. To ensure that a quality bus system is delivered, apart from monitoring of the outcome, setting up of a process monitoring system is essential. Depot level technical staff could undertake this task of checking of service schedule preparation as per SLAs, regular maintenance of buses, etc, and also help in ensuring coordination with operator, ITMS agency and revenue collection agency. A process monitoring system along with outcome monitoring may prove to have a better effectiveness in achieving delivery of quality services.

Other Measures: In order to attract passengers to the bus system, apart from putting in place a good quality bus system, marketing and branding is crucial to improve the overall image of the bus system. Some of the possible measures could be targeted marketing campaigns, color branding of routes, awareness and sensitization towards sustainable transport modes. In addition, provision of accurate and reliable real-time information to existing and potential users is also important in improving the visibility of the system and building trust in the CCBSS. Apart from the route, service and fare information at bus stops and terminals, websites and apps should also be developed. Prioritising buses on road such that the delays during travel could be minimized, would help in making the services reliable. Discussions with local authorities could be undertaken for prioritizing of bus services at junctions along with control on private vehicle usage on highly congested routes. Regulation on private traffic in terms of high parking charges or control on availability of parking spaces could also influence shift from private to PT modes.

A phased implementation of new bus routes would be required. New buses should be gradually inducted on new routes to allow for development of demand. At the same time, modification and removal of the old routes should be done with prior information and supported with alternative route details, so that existing users are not inconvenienced.

Performance Indicators: Performance indicators are useful tools for ensuring monitoring the quality of the delivered transit services. It is important to identify indicators of relevance as "what gets measured, gets attention". A performance measurement system should take into consideration the vision and

objectives set by the transit agency. Hence, apart from the existing CCBSS indicators, additional indicators have been identified for monitoring of services. These 21 indicators relate to both user and agency set of measures and can be categorised as: service availability, service delivery, service effectiveness, safety, efficient operations and cost efficiency. The proposed service plan shows an improvement in terms of various indicators – service availability in terms of buses per 1000 population improves to LOS 2 with 750 buses, transit access area in Chandigarh increases to 88% from 67% currently and 94% of the transit access area has access to high frequency stops. Also, with improved bus supply and area coverage, the average passenger wait time for bus journeys reduces to 5 mins from more than 10 mins in the current situation.

1 Introduction

1.1 Study Background

With increased dependence on personalised modes for travel and declining ridership on public transport, cities are now struggling with traffic congestion, delays, air pollution and road accidents. As outlined by the National Urban Transport Policy 2006, cities need to focus on sustainable modes of transport like public transport and non-motorised modes to move towards a sustainable future. Several cities are now concentrating on improving service levels of existing public transport systems. It is in this context that the Ministry of Housing and Urban Affairs, Government of India under Efficient & Sustainable City Bus Services has commissioned the study to prepare Service and Operations Plans for bus services in the cities of Chandigarh and Mira-Bhayandar to the Centre of Excellence in Urban Transport, CRDF.

1.2 City Background

Chandigarh is a city, district and union territory in India that serves as the capital of the two neighboring states of Punjab and Haryana. It is bordered by the state of Punjab to the north, the west and the south, and by the state of Haryana to the east. The metropolitan area of Chandigarh, Mohali and Panchkula collectively forms Tri-City. It is one of the early planned cities in post-independence India and is internationally known for its architecture and urban design. Chandigarh is located near the foothills of the Shivalik range of the Himalayas in northwest India.

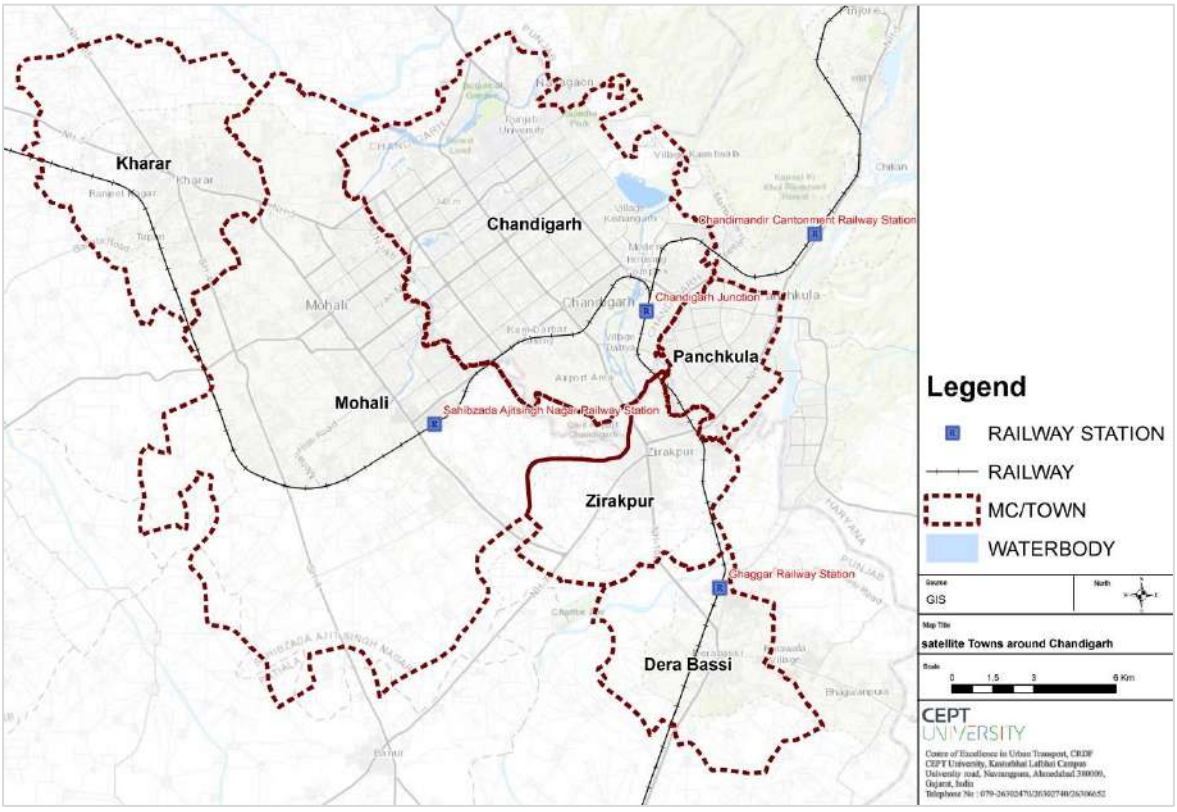


Figure 1: Chandigarh Surrounding Towns and Municipalities

The urban areas of Mohali (SAS Nagar) and Zirakpur in Punjab and Panchkula in Haryana share their boundaries with the city. The Chandigarh-Mohali-Panchkula metropolitan region collectively forms a tri-city, with a combined population of nearly 2.0 million. The industrial areas of Kharar and Dera Bassi also have strong linkages with the city. Figure 1 above shows the regional setting of Chandigarh city.

Chandigarh is well connected with the cities in northern India like Delhi (NH44), Patiala (NH7 and SH12A), Ludhiana (NH5 and NH44), Shimla (NH5, SH16), Manali (NH105). Two railways stations, Chandigarh and Sahibzada Ajit Singh Nagar also provide connectivity to major cities like Delhi, Kalka, Ludhiana, Amritsar to name a few.

The population density in the city has increased over the last two decades from 56 pph to 92 pph. The central sectors with commercial zones have moderate density in the range of 50 -100 pph. The density increases towards the western parts where it is around 200 pph and the highest density is seen in sector 23 where the numbers cross 400 pph. Apart from this, high densities are also seen in Mani Majra 300 pph. The population density map is presented in Figure 2 below.

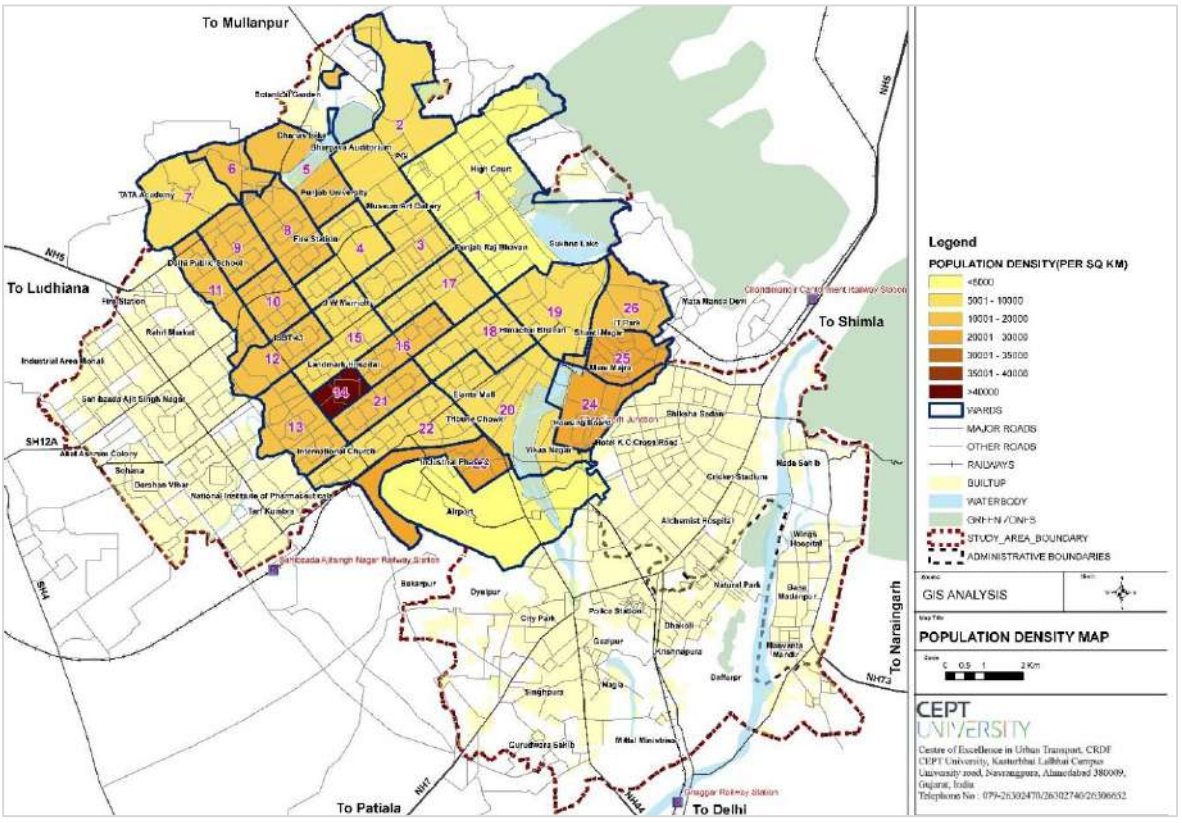


Figure 2: Population Density in Chandigarh

Based on the growth rate in the last decade, current estimated population is about 19.5 lakhs for Chandigarh and surrounding area including Mohali. Panchkula and Zirakpur. The average household size in the city has remained stable at 4.3 in the last three decades. Though the sex ratio has improved to 818 as compared to the previous decades, it is still lower than the national average of 940. Literacy rate in the city is high with almost 86% of the population reported literate in 2011.

Table 1: Demographics Chandigarh

Chandigarh	Population		
	1991	2001	2011
Area	114	114	114
Number of households	1,46,521	2,06,465	2,41,173
Population	6,42,015	9,00,635	10,55,450
Average HH Size	4.38	4.36	4.38
Density (population per hectare)	56.32	79.00	92.58
CAGR	-	3.44%	1.60%
Sex Ratio	790	777	818
Literacy rate	78	82	86
WFPR	35	38	38

Source: Census India (1991, 2001 and 2011)

As per Census 2011, the population of Chandigarh has crossed the one million mark (Table 1 above). The Union Territory recorded a population of 10,55,450 in 2011 with much lower decadal rate of 17.18% as compared to the growth rate in 2001 of 40.28% (Table 2 below). This is perhaps due to the rapid pace of urbanization taking place in the neighboring towns of Mohali, Panchkula, Zirakpur, Mullanpur, Kalka, and Kharar etc.

Table 2: Population growth in Chandigarh and surrounding municipalities

City	Population[1]				GR 91-01	CAGR 91-01	GR 91-01	CAGR 01-11
	1991	2001	2011	2020[2]	(%)			
Chandigarh	6,42,015	9,00,635	10,55,450	12,48,885	40.28	3.44	17.18	1.6
Mohali	78,457	1,23,484	1,66,864	2,07,300	57.39	4.64	35.13	3.06
Panchkula	70,735	1,40,925	2,11,355	2,73,901	99.23	7.14	49.97	4.14
Zirakpur	-	25,022	95,553	2,16,103	-	-	281.87	14.34
Total	**-**	**11,90,066**	**15,29,222**	**19,46,189**				

Source: 1. Population (Census Tables), Growth Rate (GR), Compound Annual Growth Rate (CAGR)
2. CoE-UT estimates based on 2001-2011 growth.

The projected population of Chandigarh and neighboring towns is around 24.83 lakh in 2030; breakup of the population is presented in Table 3.

Table 3: Population projections for Chandigarh and surrounding municipalities

Year	2020	2025	2030	2032**
Chandigarh	12,48,885	13,49,264	14,51,826	15,01,382
Mohali	2,07,300	2,33,859	2,59,467	2,71,809
Panchkula	2,73,901	3,16,329	3,56,155	3,76,266
Zirakpur	2,16,104	3,26,115	4,16,215	4,85,947
Total Population	**19,46,190**	**22,25,567**	**24,83,662**	**26,13,745**
Chandigarh + Mohali	**14,56,185**	**15,83,123**	**17,11,293**	**17,73,190**

Based on Chandigarh Master Plan and Census Projection
***Extrapolated based on Chandigarh Master Plan*

1.3 Private Vehicular Composition

The city has the one of the highest car ownerships per capita in the country, i.e. about 251 cars per 1000 people in the Tri-City as per current estimates (2019). There were more than 45000 motor vehicles registered in Chandigarh in 2018 alone *(RTO Data, Chandigarh).* Two wheelers account for around 60% and cars/jeeps around 36% of the total vehicles registered. Details of vehicles registered from 2005 to 2019 are mentioned in Figure 3 and Table 4 below;

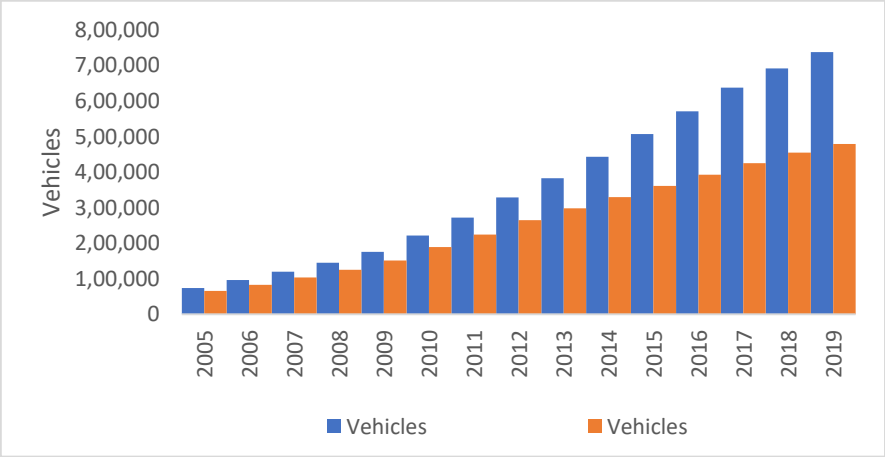


Figure 3: 2-wheeler & 4-wheeler vehicle growth trend in Tricity (2011- 2019)
Source: Licensing & Registering Authority, U.T. Chandigarh

Table 4: Private Vehicles Registered in Tri-City area (2011 and 2019)

Vehicles Registered	2011				2019			
	Chandigarh	Mohali	Panchkula	Total	Chandigarh	Mohali	Panchkula	Total
Motor cycle/ Moped/ Scooter	1,40,879	96,676	34,463	2,72,018	3,25,579	2,56,384	97,290	6,79,253
Car	1,52,870	39,346	29,376	2,21,592	2,62,617	99,900	55,678	4,18,195
Taxi/ Maxi Cab	872	1,805	1,292	3,969	2,365	2,466	5,339	10,170
Auto Rickshaw	3,070	5,005	2,978	11,053	6,760	17,500	16,057	40,317
Buses	1,761	2,061	887	4,709	3,228	3,333	3,113	9,674
Total Passenger Vehicles	**2,99,452**	**1,44,893**	**68,996**	**5,13,341**	**6,00,549**	**3,79,583**	**1,77,477**	**11,57,609**
Population	10,55,450	1,66,864	2,11,355	14,33,669	12,25,750	2,02,361.8	2,66,124.3	16,94,236
Total Pass. Veh/ 1000 Pop	284	868	326	358	490	1876	667	683
Cars/ 1000 Pop	146	247	145	157	216	506	229	253

Source: Licensing & Registering Authority, U.T. Chandigarh

1.4 Existing Transport Characteristics and Overview

1.4.1 Existing Road Network and Hierarchy

The city of Chandigarh has a well-defined grid iron road network pattern with roads intersecting at right angles. The roads are classified in accordance with their functions; an integrated system of seven roads (referred as 7V's) was designed to ensure efficient traffic circulation as mentioned in Table 5 below.

The city's vertical roads run northeast/ southwest are called 'path' and the horizontal roads run northwest/southeast are called 'marg'.

Table 5: The hierarchical network of 7Vs

Sr. No.	Type	Function
1	V1	Roads connecting Chandigarh with other cities in the region. The Madhya Marg and Dakshin Marg merge with the V1s leading to Kalka and Ambala respectively.
2	V2	The major avenues of Chandigarh, with important institutional and commercial buildings located on them. Madhya Marg, Dakshin Marg, Jan Marg, Himalaya Marg, Uttar Marg and Purv Marg are important examples of these.
3	V3	Roads between sectors for fast moving vehicular traffic. Each sector is surrounded either by a V2 or V3.
4	V4	Shopping streets cutting through sectors with shops on their southern side.
5	V5	Circulation roads within sectors.
6	V6	Roads providing access to houses.
7	V7	Footpaths through green belts enabling pedestrians to cross sectors without having to cross vehicular traffic and cycle tracks.
8	V8	Cycle tracks through green spaces. Buses to ply only along V2, V3 and V4 roads. Each sector to have only four entry points from V3s no direct entry to houses was permitted from these roads.

Source: Chandigarh Master Plan 2031, 2013

Table 6 below presents the distribution of roads by road lengths.

Table 6: Road lengths by type (2019)

Sr. No.	Road Type	Length (km)	Share (%)
1	NH	45.09	5.76
2	SH	6.10	0.78
3	Arterial	91.70	11.71
4	Sub arterial	330.16	42.16
5	Collector	310.13	39.60
	Total	**783.19**	**100.00**

Source: Computed based on Google imagery 2019 and site survey

Road widths in Chandigarh for the major network are detailed in Figure 4 and Table 1Table 7 below. 47% of the roads have carriageways between 10-18 meters, 10% roads have carriageways above 24 meters and 11% have widths greater than 24m (Figure 5). Majority of roads in Chandigarh have a carriageway width of 10m or higher accounting to two lanes each way, which can easily accommodate bus services for efficient operations.

Table 7: Road width distribution

Sr. No.	Carriageway widths in (m)	Length (km)	Share (%)
1	<6	15.07	1.92
2	6-9	118.35	15.11
3	9-18	399.19	50.97
4	18-24	164.03	20.94
5	24-36	39.41	5.03

Sr. No.	Carriageway widths in (m)	Length (km)	Share (%)
6	36-40	20.86	2.66
7	>40	26.29	3.36
	Total	**783.19**	100.00

Source: Computed based on Google imagery and site survey (2019)

Figure 4: Road Network (2019)
Source: Google Imagery 2019

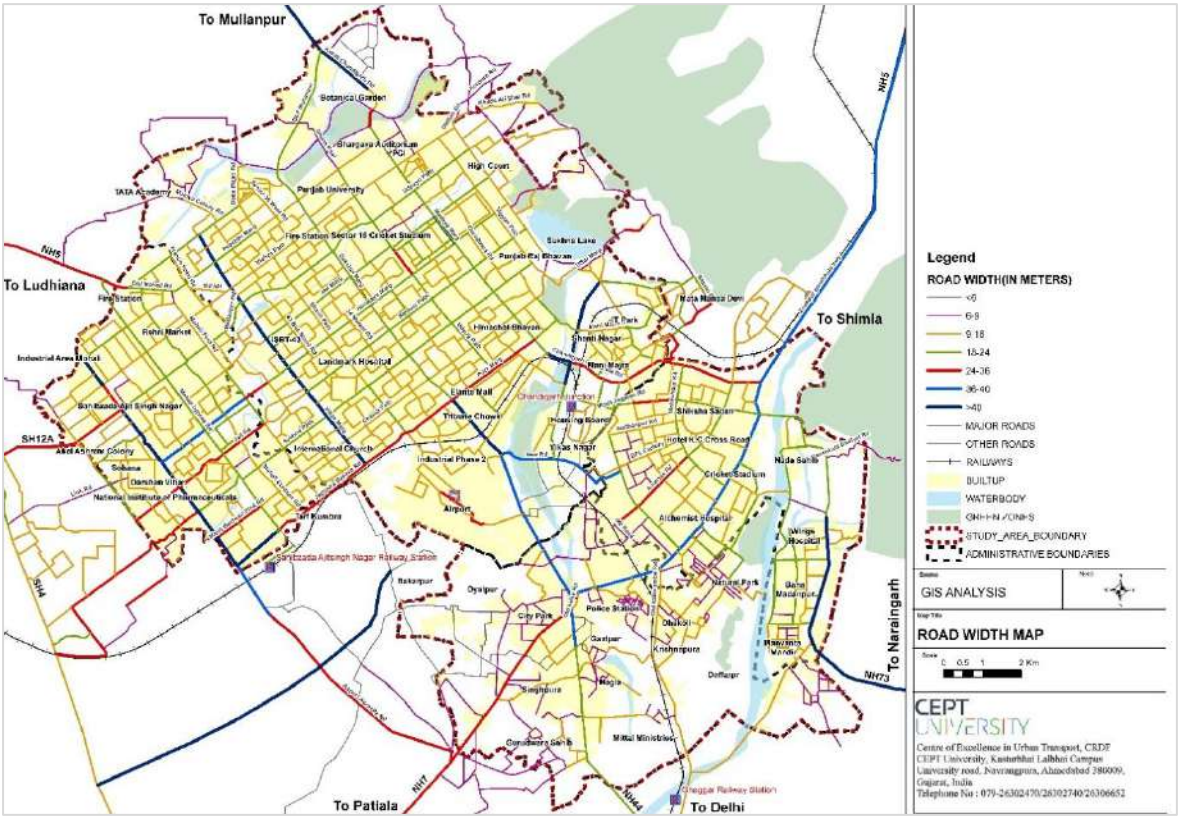


Figure 5: Road width distribution (2019)
Source: Google Imagery 2019

1.4.2 Travel Speed

The travel speed of road network in Chandigarh (Figure 6) is quite good with the morning peak travel speed of 23 kmph and the evening peak travel speed of 20 kmph (*Google Maps 2019*). The worst affected is the Himalaya Marg since it is the main corridor that connects Mohali and Chandigarh as well as ISBT43 and ISBT17. Due to heavy traffic movement, Himalaya Marg has an average speed of 14.66 kmph during the peak hours. It is also observed that the average travel speed is reduced in the vertical connecters Madhya Marg and Udyog path compared to around 25 kmph speed along the horizontal road network (Jan Marg, Sarovar Path, Purv Marg). Moreover, travel speeds of road network in Panchkula and Zirakpur are also quite comfortable, with an average travel speed of 25.20 kmph providing easy movement of traffic during peak hours.

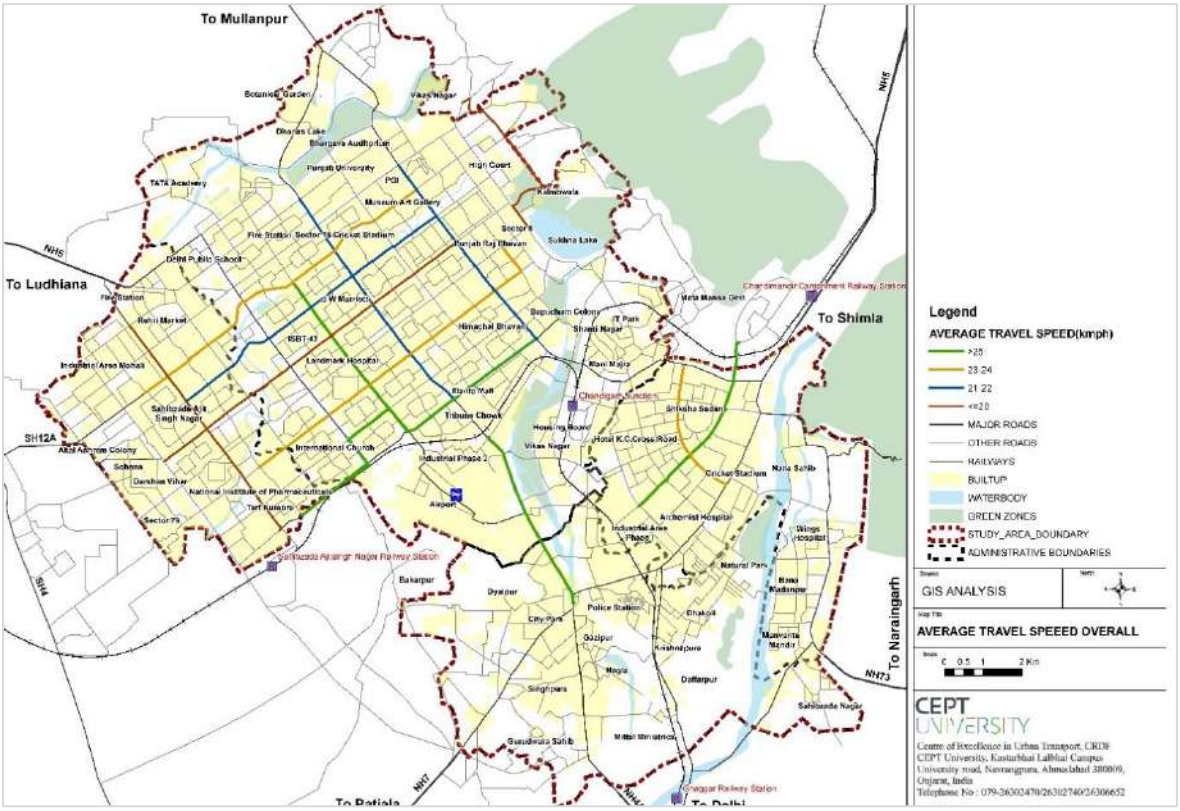


Figure 6: Network Speeds (2019)
Source: Google Imagery (2019)

1.5 Overview of City bus Services

Chandigarh Transport Undertaking (CTU) came into existence with a fleet strength of 30 buses only, as a result of trifurcation of Punjab Roadways at the time of re-organization of Punjab State in 1966. CTU is a government undertaking under the Union Territory Administration of the Central Government which initiated its operations in 1966.

It is the sole public bus operator in the city and surroundings (World Bank Report, 2014). CTU operates buses not only within Chandigarh but also to adjoining tri-city areas such as Mohali and Panchkula (*World Bank Report, 2014*) as well as the neighboring states.

A special society, Chandigarh City Bus Services Society (CCBSS) was set up on 29th April, 2014 by the Chandigarh Administration as an extended arm of the CTU. It was laid under JnNURM Scheme-II as an SPV. The SPV was set up for the operation of the city bus services and the operational losses were to be borne by the Union Territory (UT) Administration.

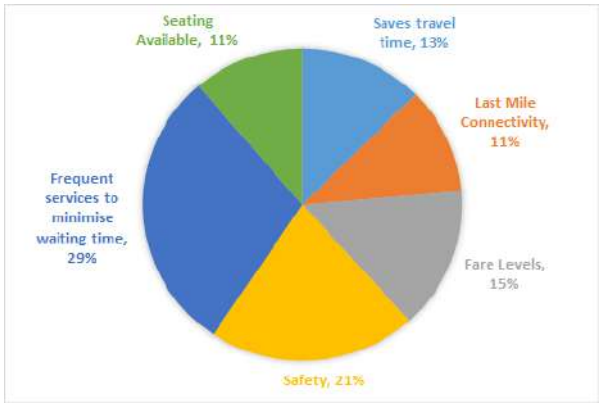
Presently, there are total of 68 operational urban and sub-urban routes (Annexure 1) with 330 buses on road, attracting around 1.2 lakh daily passengers and Rs.16.50 lakh daily revenue on the system. (Sept 2019)

1.6 Vision and Objectives

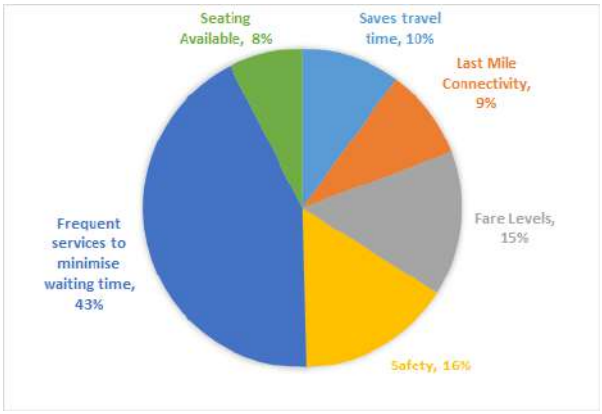
Setting up of vision and objectives for the bus operations is critical for the success of the business plan. For Chandigarh, CCBSS formulated the vision and the strategies based on the inputs received from the city residents as well as the past studies.

1.6.1 User and Non-user perceptions (Primary survey)

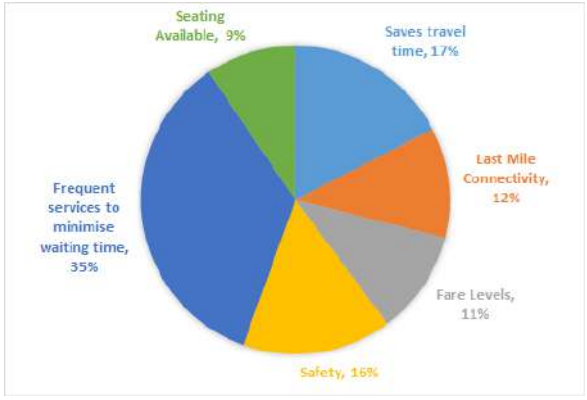
The city of Chandigarh has the highest per capita vehicle ownership in the country. As per the CMP, the mode share of buses is around 11% and of shared autos is 6%. The existing bus structure is more oriented towards regional and suburban commuters, providing connectivity between major nodes like bus terminals, PGI hospital and university area in the city. In order to develop a bus system which can attract other users, high quality reliable and efficient services would be required.



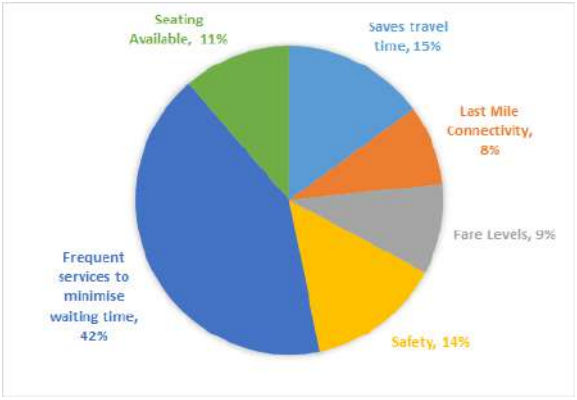
Bus users' priorities



3-Wheeler users' priorities



2-Wheeler users' priorities



4-Wheeler users' priorities

Figure 7: Commuter preferences for bus service improvement areas (2020)
Source: Primary Survey, CoE-UT CEPT

The commuter preference from the field study in Chandigarh showed frequent services and safety as two important attributes across all mode users (Figure 7). In addition, bus users indicated affordable fares as another important service attribute. In comparison, private mode users were majorly concerned about travel time by buses.

1.6.2 Past Studies

As per a User Satisfaction Survey (Mott Macdonald, 2017-18) in Chandigarh, service attributes related to "punctuality & reliability", "safety", "maintenance" and "crew behaviour" were found to be important for the users. Measures related to women safety like installation of CCTV cameras, lighting inside the buses as well as at bus shelters, women crew, etc. were also recommended in the study. Further, fleet quality and cleanliness along with improved service coverage were also highlighted as being important. Non users desire good quality buses with AC and adequate seating available.

The objective as set out by the Comprehensive Mobility Plan 2040 is "To offer viable and reliable transportation options that aim at reducing dependence on cars, with widespread use of non-motorised modes and mass rapid transit system". The plan suggests rationalisation of local bus system and its augmentation apart from proposing BRT and metro for an efficient PT system.

The Vision as presented by the Bus Modernisation Plan is "To make CTU Buses the primary mode of choice for travel in the Tri-city region by offering better operations, friendlier service, enhanced safety and greater affordability". The objectives and strategies as per the plan are shown in Figure 8 below:

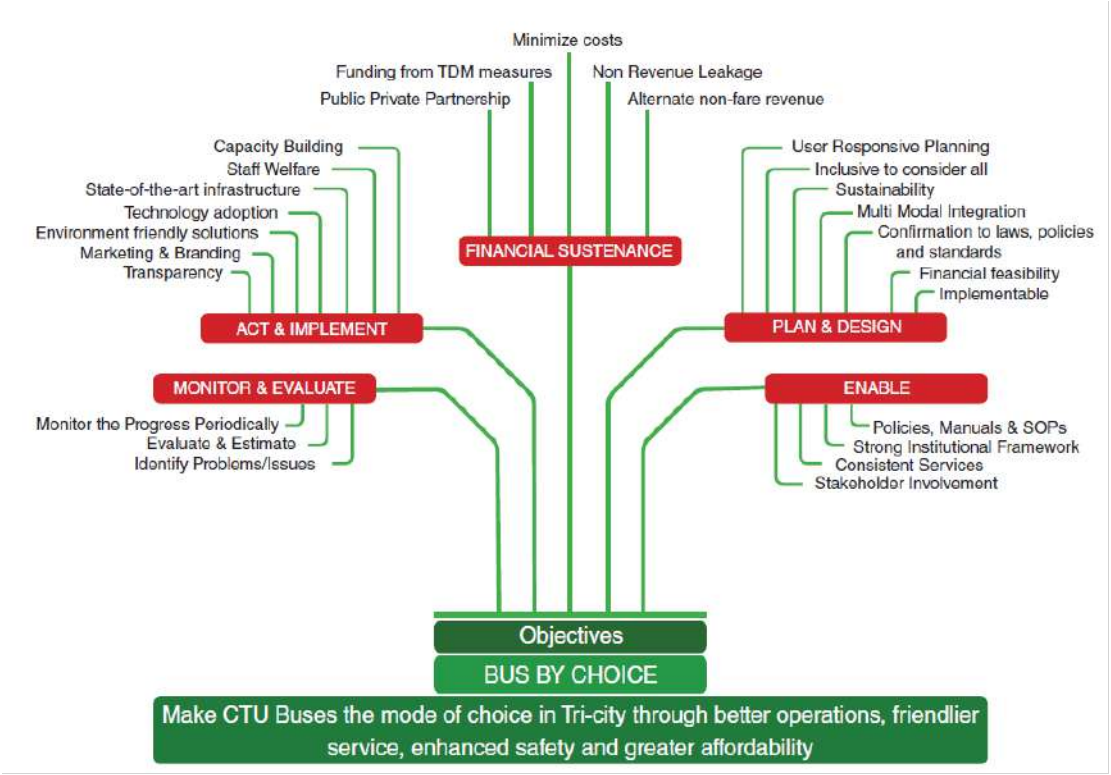


Figure 8 City Bus Modernization Sustenance Tree for CTU
Source: City Bus Modernization Plan for Chandigarh Transport Undertaking, 2015

1.6.3 Mission, Vision and Strategies

In absence of an efficient bus system within the city, the passengers have to depend on auto services or taxi services which are not as affordable as the public transport systems. Going by the growth trends in the city, the travel demand is expected to grow very rapidly. It thus becomes important to plan for a quality bus service in the city, in order to attract people on a sustainable mode of transport.

Given the context set out by previous studies, taking into consideration user perceptions and inputs from previous studies, vision, mission and strategic objectives have been formulated for the city bus services by CCBSS.

The Mission has been defined as "Providing high quality, safe and dependable bus services for residents of Chandigarh".

The Vision Statement is:

Chandigarh city services as an attractive and everyday mobility choice for residents

In line with this vision statement, strategic objectives have been defined as shown in Figure 9 below:

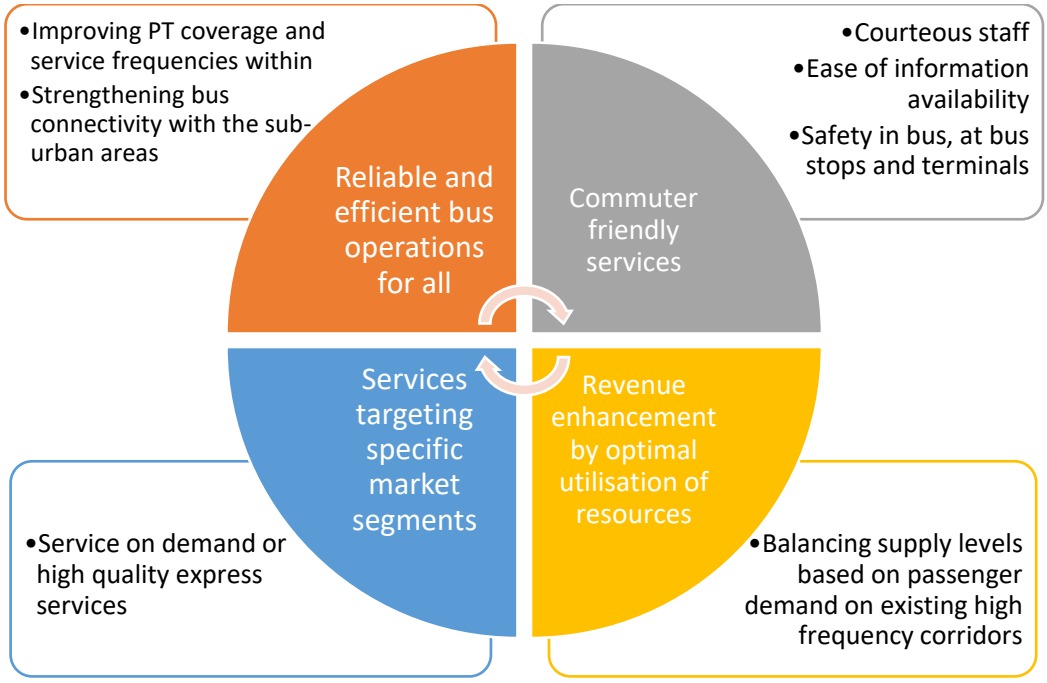


Figure 9: CCBSS Objectives and Strategies

2 Service plan for city bus services

Preparation of a service and business plan requires a thorough assessment of the existing situation in terms of transport service supply, demand patterns, operational and financial performance of the bus services along with demand and service levels of competitive modes. Table 8 below presents the data collection summary from secondary sources as well as primary surveys used for the existing situation assessment.

Table 8: Details of data collected

Category		Data collected	Source	Primary/ Secondary
Route Rationalisation and Service Plan Inputs	Operational performance assessment	Bus service expenditure details - System wide	CTU/CCBSS	Secondary
		Route wise ridership and vehicle km		
		Fleet size, Fleet utilisation, vehicle utilisation		
		Schedule adherence and trip cancellation		
		Capacity utilisation (Load factor)		
		Indexed passenger km		
		Bus staff ratio		
		Bus operational expenditure and its breakup		
		Existing fare structure, ticketing and concession details and revenue		
	Assessment of existing transport service supply	Types of Bus services	CTU/CCBSS	Secondary
		Operational routes alignment, routes frequency and fleet details		
		Stops locations and stop sequence by route		
		IPT routes structure and alignment	Field survey	Primary
		IPT stops and major demand nodes		
	Existing demand assessment	Bus demand - ETM data	CTU/CCBSS	Secondary
		Bus Boarding - Alighting details	Field survey	Primary
		IPT demand and its BA details by stops	Field survey	Primary
		Passengers access egress pattern at terminals	Field survey	Primary
		Private vehicular demand patterns	Field survey	Primary

2.1 Model Development

A public transport demand model was developed using EMME 4.4.3 software to analyse the existing bus demand and understand travel pattern of bus users as well as IPT. Figure 10 below shows the study approach.

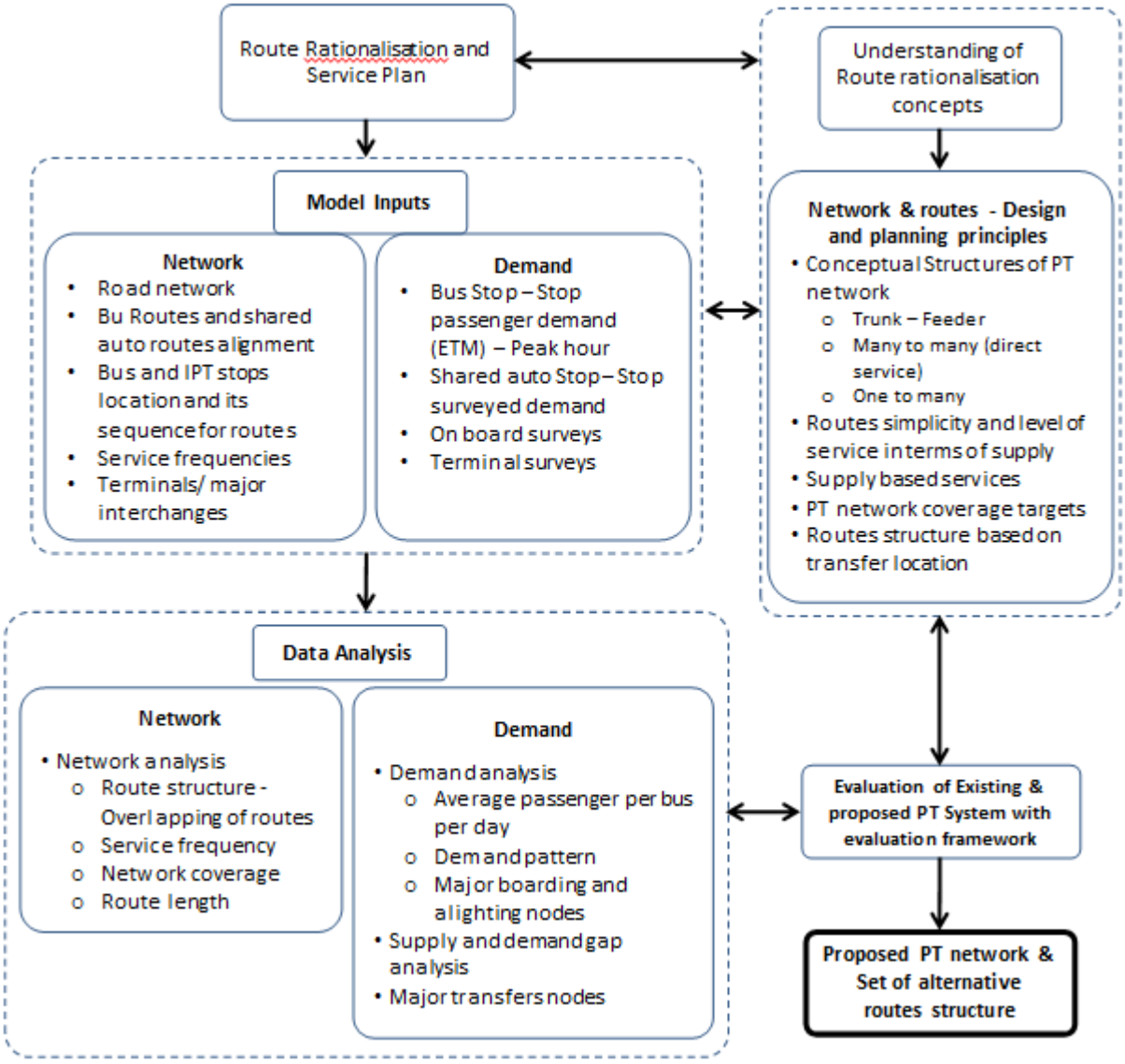


Figure 10: Study approach

The modelling area consists of Chandigarh and surrounding areas including Mohali, Panchkula and Zirakpur. The first step was to delineate the modelling area and finalise the zoning framework. In terms of the existing development within modelling area, it was observed that around 60% of the area is currently developed. Since, the current development area is well within the operational limit of CTU, it was decided to consider modelling area as Chandigarh, Mohali, Panchkula and Zirakpur. Along with these, few suburban areas such as Kharar, Mullanpur, Derrabasi and Khizrabad are also connected with the city.

Table 9 and Figure 11 below presents data inputs used for the development of public transport model:

Table 9: Data inputs for model

Type of data	Base Year Details
Demand Data	Existing Bus demand – ETM data, IPT demand – OD surveys at major IPT stops Pvt. Demand – OD surveys at major work centers/parking locations

Type of data	Base Year Details
Network Data	Road network from Google earth
	Public Transport network – stops, corridors, routes, service details (headway, speed etc.) 179 km bus network within Chandigarh and 337 km total bus network (Chandigarh and surrounding area), 68 routes, 280 stops, 3 depots and 4 major terminals
	IPT network - stops, corridors, routes, service details (headway, speed etc.) 280 km of shared auto rickshaw network, 24 routes, 25 major IPT stops
Model calibration data	Travel speeds and travel time on major network (2019) Classified Volume Counts (2020)

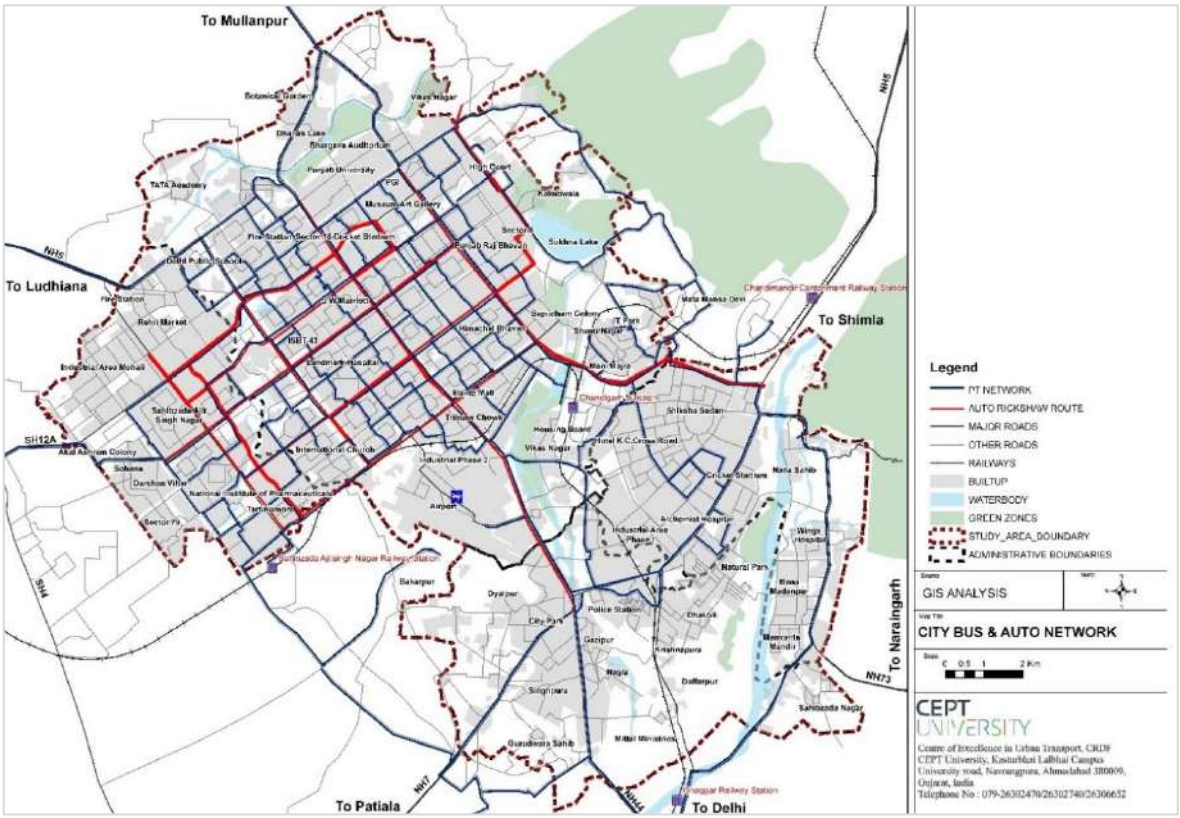


Figure 11: Public transport network (2020)

2.2 Existing Bus services

2.2.1 Fleet Size

Chandigarh has a total fleet of 435 buses, of which around 330 buses run on local routes in the city including 200 midi buses mostly operating from Depot 2 and a few from Depot 3. As per MoHUA Service Level Benchmarks, cities should have a minimum of 0.1 buses per 1000 population as per LOS3, 0.25 for LOS2 and 0.4 as per LOS1. As against this, the city has 0.17 buses per 1000 population considering total population of Chandigarh and surrounding areas including Mohali, Panchkula and Zirakpur, which translates to LOS 3.

2.2.2 Bus Routes

There are a total of 68 city bus routes, of which 36 routes operate within Chandigarh and the rest operate in its suburbs (Table 10 below). Also, of these 68 routes, 53 routes run within tri-city and the

other 15 routes are connected to sub-urban towns in the periphery namely Zirakpur, Kharar, Derabassi, Mulanpur.

Table 10: Distribution of routes within city and towards suburbs

Sr. No.	Service Area	No. of Routes	% of routes
1	Within Chandigarh	36	53%
2	Chandigarh to Mohali	10	15%
3	Chandigarh to Panchkula	7	10%
4	Chandigarh to Zirakpur	6	9%
5	Chandigarh to Other surrounding areas	9	13%
Total		**68**	**100%**

Source: Based on CTU/CCBSS Data, August, 2019

2.2.3 Bus Depots and Terminals

Depot facilities are important considering maintenance and parking requirement for buses. The regular maintenance of fleet at depot facility is important to ensure longer life of urban buses. As seen in Figure 12 below, there are four depots in Chandigarh city, Depot 1 and Depot-2 on Purv-Dakshin Marg, Depot-3 near Punjab University and Depot-4 near ISBT-43. Routes from Depot 1 were not considered for the analysis as they are regional routes (more than 30km length).

About 50% of the routes from Depot 2 ply within the city with headways ranging from 15 - 90 mins, and the rest are suburban routes connecting mainly Panchkula and Zirakpur. Depot 2 city routes originate from ISBT 43 (44%) and PGI (31%).

Around 78% of the routes from Depot 4 operate within Chandigarh city having headways ranging from 15 - 25 mins. Routes under Depot 3 have headways ranging from 20 - 60 mins (Table 11 below). Majority of these routes originate from ISBT 17 (55%) and PGI (25%) towards Kharar, Khizrabad, Mullanpur, New Airport and Zirakpur.

Table 11: Local routes from depot 2, depot 3 and depot 4

Sr No	Depot	Within city	Suburban	Total Routes	(%) Total routes
1	Depot 2	18	17	36	59%
2	Depot 3	7	12	20	24%
3	Depot 4	11	3	14	17%
Total		**36**	**32**	**68**	**100%**

Source:CTU, August 2019

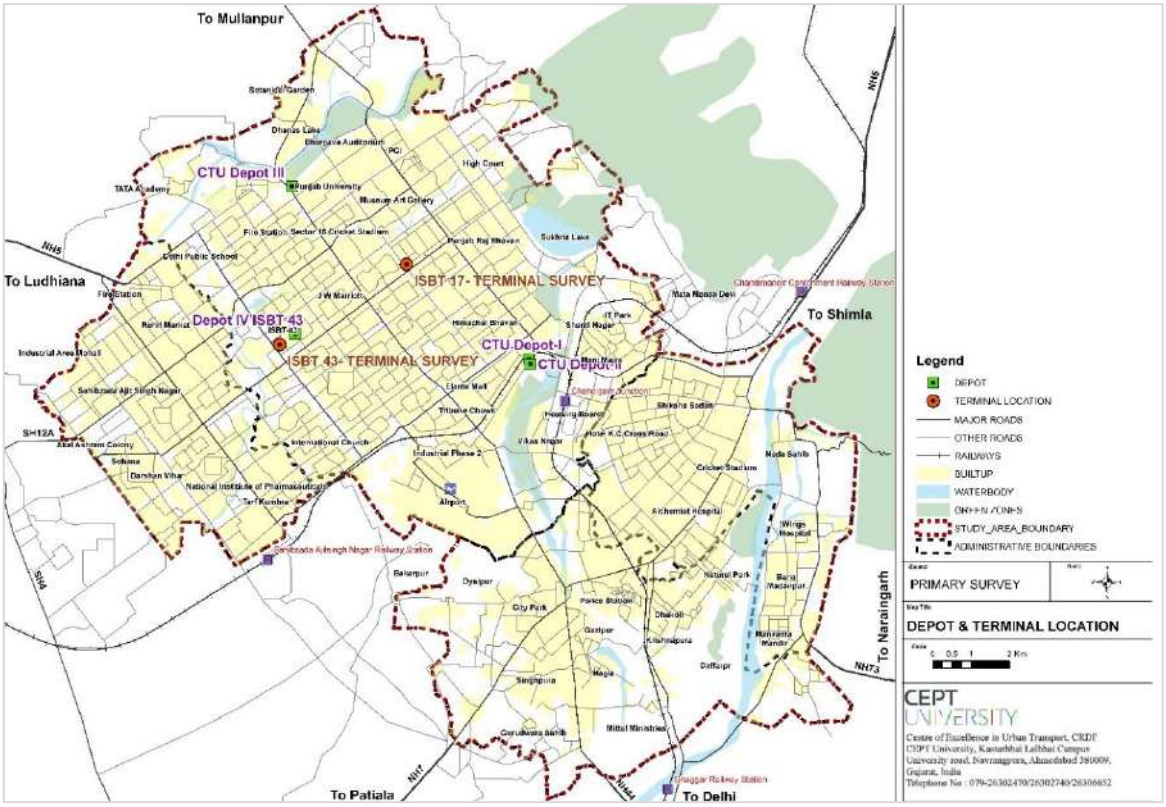


Figure 12: Depots and Major Terminal in the city

The city and the surrounding sub urban towns have sufficient infrastructure facilities in terms of terminals. The locations of these are also very strategic providing connectivity to the entire city.

ISBT 43	Biggest regional terminal in Chandigarh city in sector-43 near the Judicial academy. Both ordinary and AC for Intercity and Sub-urban services ply from this location. Interstate services for Punjab, Haryana, Uttarakhand, Himachal and J&K also ply from this location.
ISBT 17	Located at sector-17 adjacent to Parade ground/ District Courts in Chandigarh city and is another major terminal in Chandigarh. Buses services for Delhi, Haryana, UP and Rajasthan also operate from this terminal along with intercity and suburban bus services.
ISBT Mohali	Routes from ISBT Mohali are operated by Punjab Roadways and are regional routes, currently, city bus services are not operational in Mohali.
ISBT Panchkula	Major terminal for Haryana roadways operating both city and regional routes in Panchkula.

2.2.4 Fare Structure, Ticketing and Concession

Fare system of CTU for Chandigarh public transport service is a mix of distance based and fixed fare system up to 60km of travel (Table 12 below).

- The fare for travel within Chandigarh are in three distance slabs Rs.10, Rs.15 and Rs.20 for distance range of upto 5 km, 5-10km and more than 10km respectively

- Passengers travelling to any suburban area adjacent to Chandigarh but within Punjab, must pay a fixed fare of Rs.10 plus Rs.1.2 and Rs.1.4 per km for Non-AC and AC services

- Passengers travelling to any suburban area adjacent to Chandigarh but within Haryana, must pay fixed fare of Rs.5 plus Rs.0.9 and Rs.1.3 per km for Non-AC and AC services

Table 12: Bus Fare details for City and Sub urban routes (2019)

Sr. No	Nature of Buses	Location	Fare of Kms.	Fare
1	Non-AC Bus	Chandigarh Passengers	(i) Upto 05 Kms	Rs.10/-
			(ii) 05 Kms to 10 Kms	Rs.15/-
			(iii) Above 10 Kms	Rs.20/-
		Punjab Passengers	Fixed Fare Rs.10/- + Rs.1.2 per km	
		Haryana Passengers	Fixed Fare Rs.5/- + Rs.0.9 per km	
2	AC Bus	Chandigarh Passengers	(i) Upto 05 Kms	Rs.15/-
			(ii) 05 Kms to 10 Kms	Rs.20/-
			(iii) Above 10 Kms	Rs.25/-
		Punjab Passengers	Fixed Fare Rs.10/- + Rs.1.4 per km	
		Haryana Passengers	Fixed Fare Rs.10/- + Rs.1.3 per km	

Source: CTU Data, 2019

CTU provides concessions on bus fares to various categories of citizens including children, physical handicapped, senior citizens, army officials, jail wardens etc. the details of the fare charged, and discount is mentioned in Table 13 below.

Table 13: Pass and concession details (2019)

Category of Passengers	Nature of Buses	Area	Rate (Exclusive of Smart Card Fee)
Daily Passes	Non-AC	Tri-city (M.C.Limit)	Rs.50/- per day per person
Daily Passes	All buses (AC/Non-AC)	Tri-city (M.C.Limit)	Rs.60/- per day per person
Additional Daily Pass for Non-AC bus pass holders	All buses (AC/Non-AC)	Tri-city (M.C.Limit)	Rs.10/- in addition to the daily or monthly pass of ordinary pass (Non-AC bus)
General public monthly pass	Non-AC	Tri-city (M.C.Limit)	Rs.600/-per person per month Note:- *There will be a discount of 33% for BPL public on production of BPL card issued by chandigarh administration
General public monthly pass	All buses (AC/Non-AC)	Tri-city (M.C.Limit)	Rs.800/- per person per month
All states/Central Govt./Govt. banks, including outsourced/Contractual employees monthly passes	(i) Non-AC bus (ii) All buses (AC/Non-AC)	Tri-city (M.C.Limit)	(i) Rs.300/- per person per month (ii) Rs.800/- per person per month
Bonafide students of Recognized Schools/Colleges monthly passes	(i) Non-AC bus (ii) All buses (AC/Non-AC)	Tri-city (M.C.Limit)	1) (i) Rs.100/- per month per student within a specific route for school/college (ii) Rs.300/- per month per student for all general routes

Category of Passengers	Nature of Buses	Area	Rate (Exclusive of Smart Card Fee)
			2) for AC buses 50% discount on monthly pass (All buses)
Children above 06 years & below 12 years, monthly pass	All buses (AC/Non-AC)	Local/Long Route	50% discount on Ticket fare/monthly pass
Personnel up to the rank of inspector U.T Chandigarh Police, Home guard, Jail Warden & CBI, Chandigarh Office	Non-AC	Local/Long Route	Rs.200/- per person per month (as a group)
Senior Citizen above 60 years of age, having an identity card,issued by the Director social welfare, Chandigarh Administration	All buses (AC/Non-AC)	Local/Long Route	50% discount on ticket fare/monthly passes
(i) Children below 06 years (ii) Freedom fighters and war widows (iii) Deaf & Dumb, HIV-Aids & Disabled persons (iv) Mentally retarded children, blind persons, Thalassaemic children (along with one attendant)	(i) All buses (AC/Non-AC) (ii) Non-AC bus (iii) All buses (AC/Non-AC) (iV) All buses (AC/Non-AC)	Local/Long Route Tri-city (M.C.Limit) Tri-city (M.C.Limit) Tri-city (M.C.Limit)	(i) Free Facility (ii) Free Facility (having an ID card issued by the competent authority of Chandigarh U.T) (iii) Free Facility (having an ID card issued by the competent authority of Chandigarh U.T) (iv) Free Facility (having an ID card issued by the competent authority of Chandigarh U.T)

Source: CTU Data, 2019

2.2.5 Bus Network Analysis

PT network and bus routes were analysed based on various network assessment criteria like network coverage, routes structure, routes frequency and the length of routes.

Majority of the routes originate from the two terminals - ISBT17 and ISBT43. Routes from ISBT 43 serve mainly areas near the city center and south-west areas of the city Kharar, Mohali, railway station, airport, Zirakpur, Dera Bassi. ISBT 17 serves near the city center and the north-east section of the city namely Mani Majra, PGI, Panchkula, Mulanpur. The bus network in the tri-city currently has a total of 280 stops of which 165 stops lie within Chandigarh.

2.2.5.1 Network Accessibility

Public transport network coverage is the geographical catchment of the PT network spread. The total PT network length is 211 km in Chandigarh plus Mohali covering 38% road network and 337 km in Chandigarh and surrounding area, covering about 43% of road network. Taking a 500-meter buffer, the PT covers 102 (74%) sq.km of developed area in Chandigarh and surrounding areas and around 59 sq.km (87%) developed area in Chandigarh city.

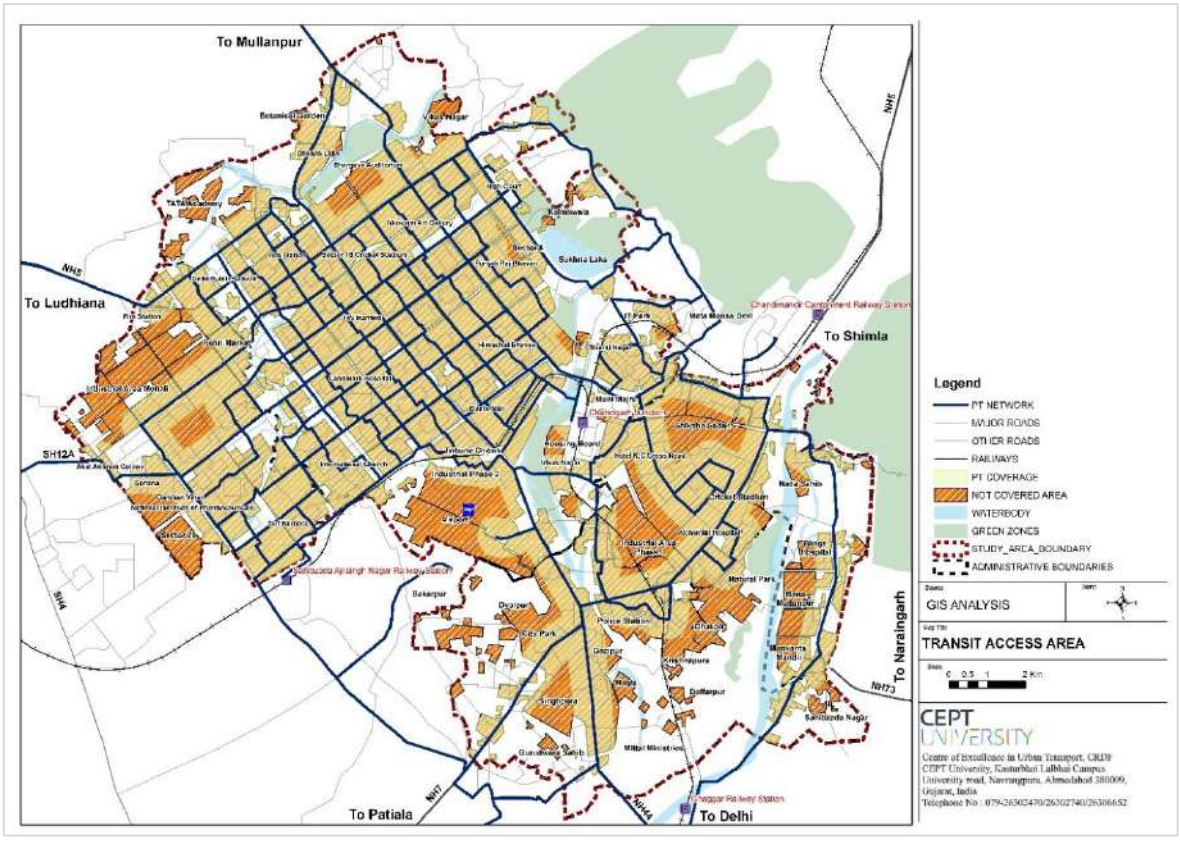


Figure 13: PT network coverage (2020)

Figure 13 above shows the coverage of PT in the Chandigarh and surrounding areas. In Chandigarh, most of the developed area is covered by public transport network while in Mohali, Zirakpur and Panchkula few pockets have poor PT network connectivity. Table 14 below represents percentage of developed area covered by PT system in Chandigarh and surrounding areas.

Table 14: Developed area coverage in Chandigarh and surrounding areas (2019)

	Chandigarh	**Mohali**	**Panchkula**	**Zirkpur**	**Total**
Developed Area (sq.km)	67.5	27.3	23.0	19.8	137.6
Developed Area Coverage (sq.km)	58.8	16.7	15.2	11.7	102.4
Coverage (%)	**87%**	**61%**	**66%**	**59%**	**74%**

The areas for which PT coverage needs to be improved are:

Chandigarh	**Mohali**	**Panchkula**	**Zirakpur**
• Vikas Nagar • Maloya Colony	• Industrial Area Mohali • Rehri Market • Sector 78	• Industrial Area Panchkula • Siksha Sadan • Wings Hospital • Bana Madanpur	• Dhakoli • Singhpura

2.2.5.2 Bus Route Structure

The bus route structure seems to be centralized with majority of routes originating from the three terminals. About 40% of routes originate from ISBT 43 and caters majorly to the Panchkula and Zirakpur suburbs, while 28% originates from ISBT 17 and operates within the city and suburbs namely

Kharar, Mullanpur, Mohali etc. (Table 15 below). The routes originating from PGI operates majorly within the city.

Table 15: Distribution of routes from major terminals

Sr No	Terminal Name	No of Routes	Route Nos	Percentage (%)
1	PGI	16	3, 32, 34, 36, 39, 79, 80, 211, 212, 242, 123A, 1A, 1C, 2B, 2D, 2F	24%
2	ISBT17	19	11, 28, 7C, 7A, 5C, 5A, 38, 214, 32A, 38A, 26, 213, 20, 25, 35, 40, 20A, 25A, 35B	28%
3	ISBT43	27	10, 17, 18, 22, 37, 71, 203, 206, 240, 241, 254, 239A, 239C, 205, 202, 4C, 18B, 23A, 28C, 24A, 24C, 4A, 28A, 30, 30A, 30B, 216	40%
4	Others	6	143, 2C, 2A, 8, 9C, 9A	9%
Total		**68**		**100%**

2.2.5.3 Overlapping of routes on major corridors

Figure 14 below shows the bus network and number of routes as red bandwidths. It can be seen that the routes are concentrated on the major corridors like Janmarg, Himalaya Marg, Madhya Marg etc, while the other network is sparsely covered.

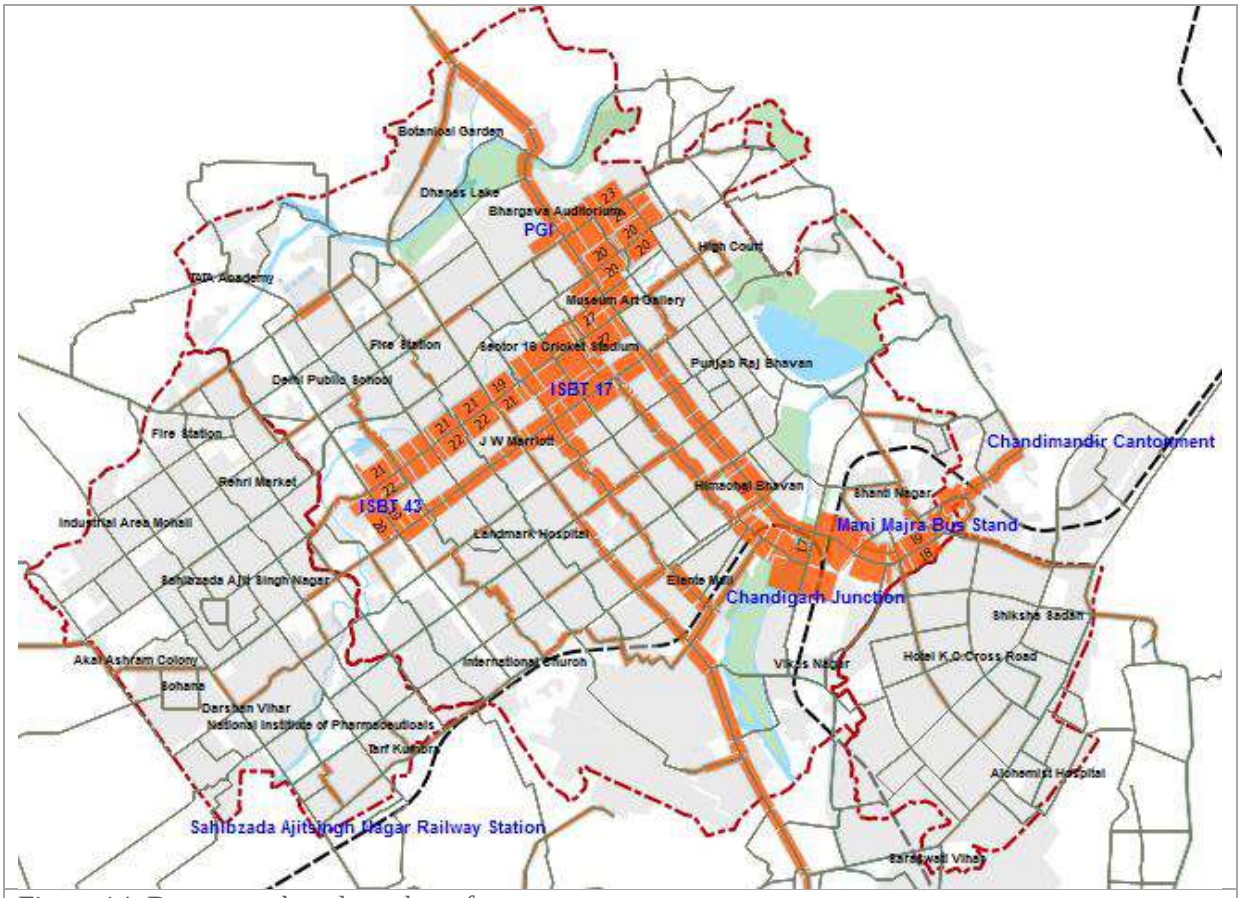


Figure 14: Bus network and number of routes

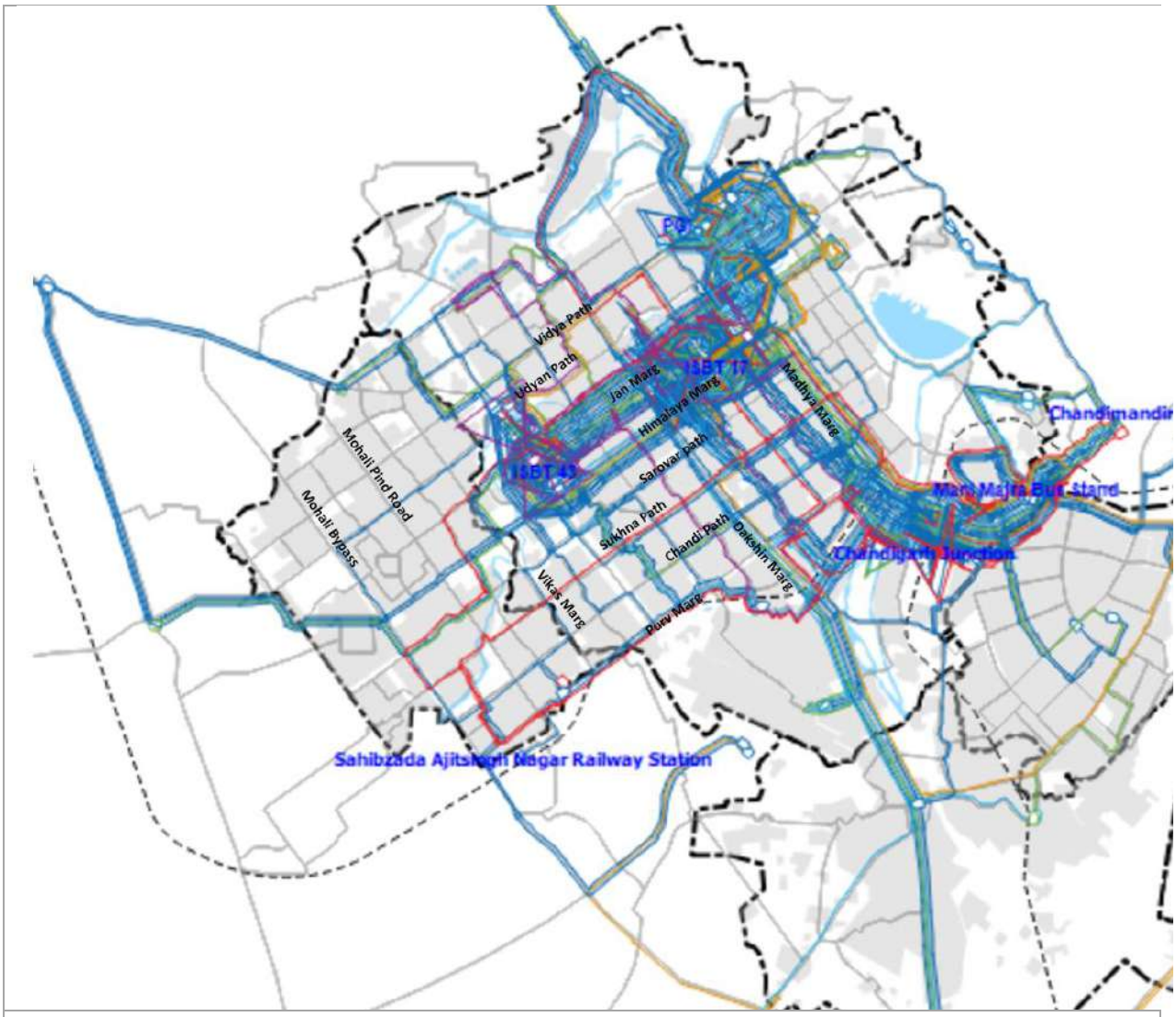


Figure 15: Existing Bus Routes Structure

The routes follow 'one-many' route structure where each route connects the final destinations, providing direct connectivity to passengers involving no transfers. While doing so there is concentration of routes on the trunk corridor but service frequencies of each individual route is low, impacting passenger waiting time.

2.2.5.4 Frequency of Bus Routes

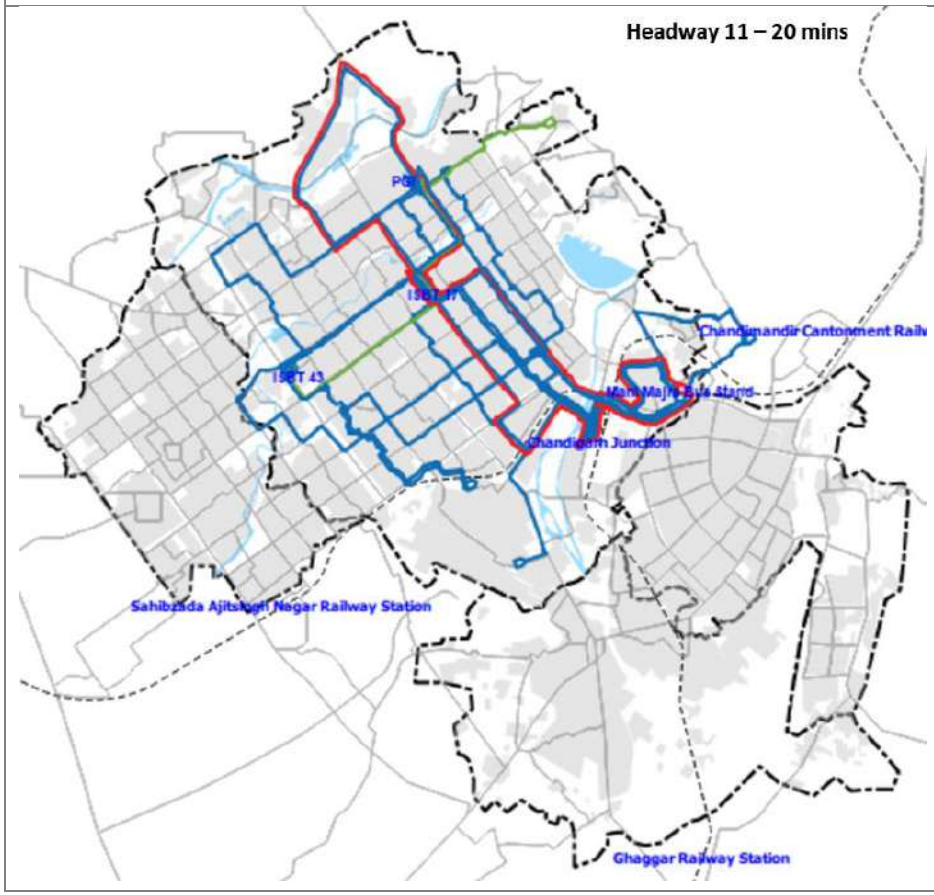
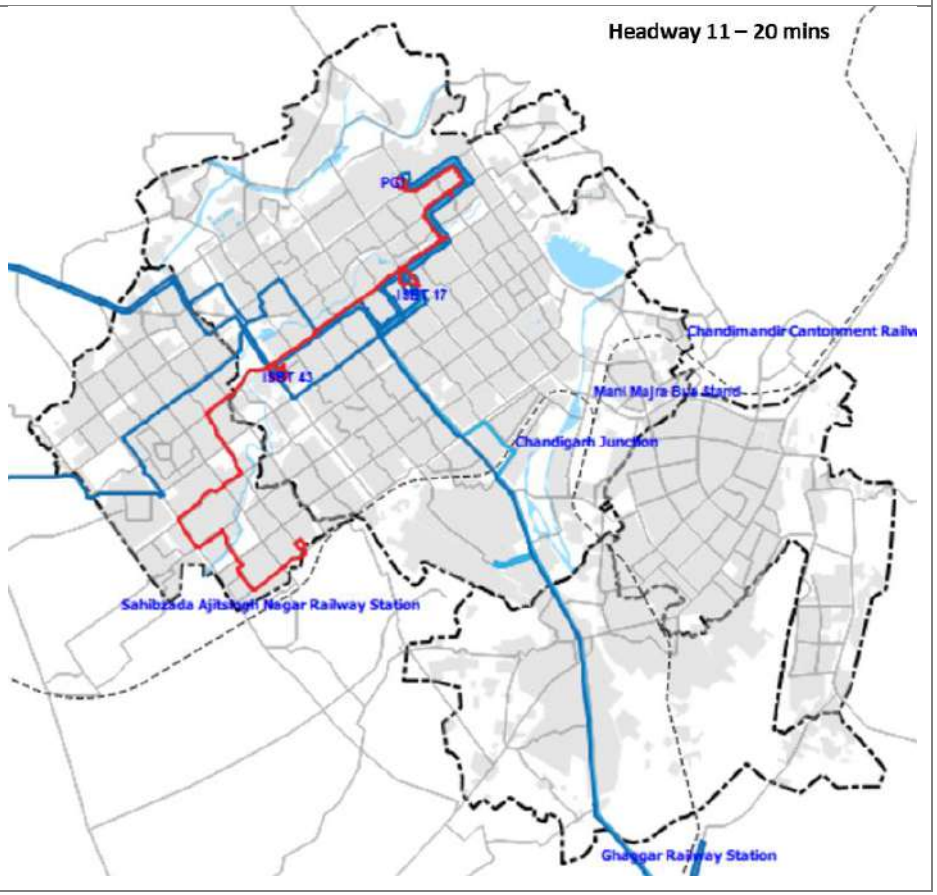
The frequency of bus services has an impact on passenger waiting time which is very crucial factor for passenger to select PT as travel mode. Because of the limited fleet size, city bus routes do not have adequate frequencies. Table 16 below shows the routes and its service headways along with route length and speed. City lacks high frequency services and there are no routes with headway less than 10 mins. About 29% of total routes have headway between 10 to 20 min and can be considered moderate frequency routes. Headways beyond 20 min may not be very desirable for urban bus services. And the below distribution of routes are based on schedule services, based on actual operations of service trips considering cancelation of trips, the effective headways could be even lower.

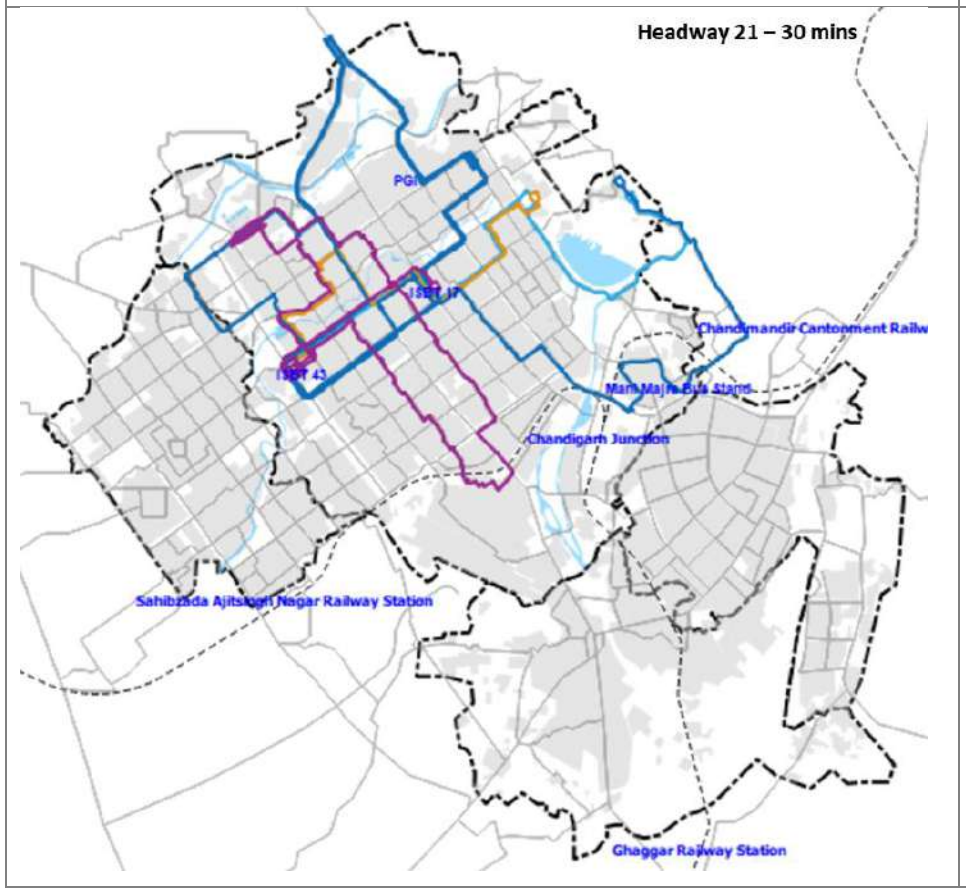
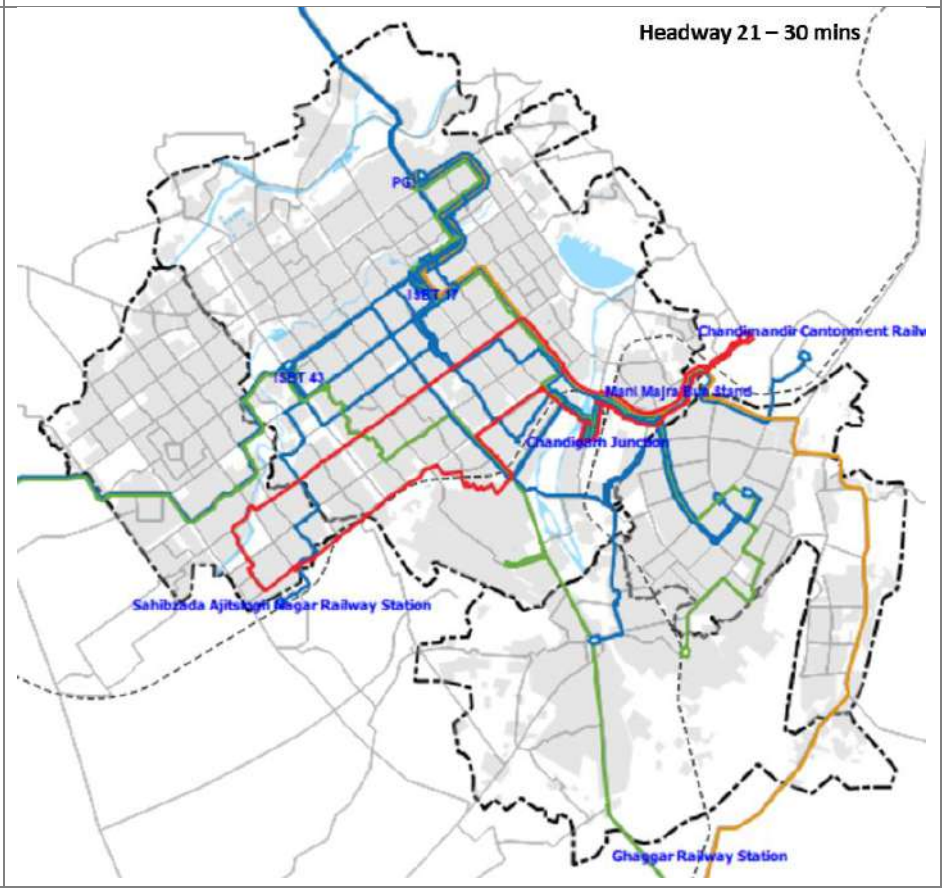
Apart from number of routes, it is also important to see network length covered by high and moderate frequency routes. It can be seen from Table 16 below that about 58% (197 km) of PT network is with moderate frequency (11 to 20 min) routes which covers about 69% of developed area.

Table 16: Distribution of routes based on headways category

Sr. No.	Headway (min)	No. of Routes			% of Total Routes	Network Length (km)	% of Network	Developed area covered	% Developed Area
		City	Suburban	Total					
1	< = 10	-	-	0	0%	0	0	0	0
2	11 – 20	11	7	18	26%	197	58%	71	69%
3	21 - 30	14	14	28	41%	103	30%	27	26%
4	>30	11	11	22	32%	38	12%	4	4%
Total		**36**	**32**	**68**	**100%**	**338**	**100%**	**102**	**100%**

Figure 16 presents the routes by different headway ranges.

City Routes	**Suburban Routes**
	

City Routes	**Suburban Routes**
	

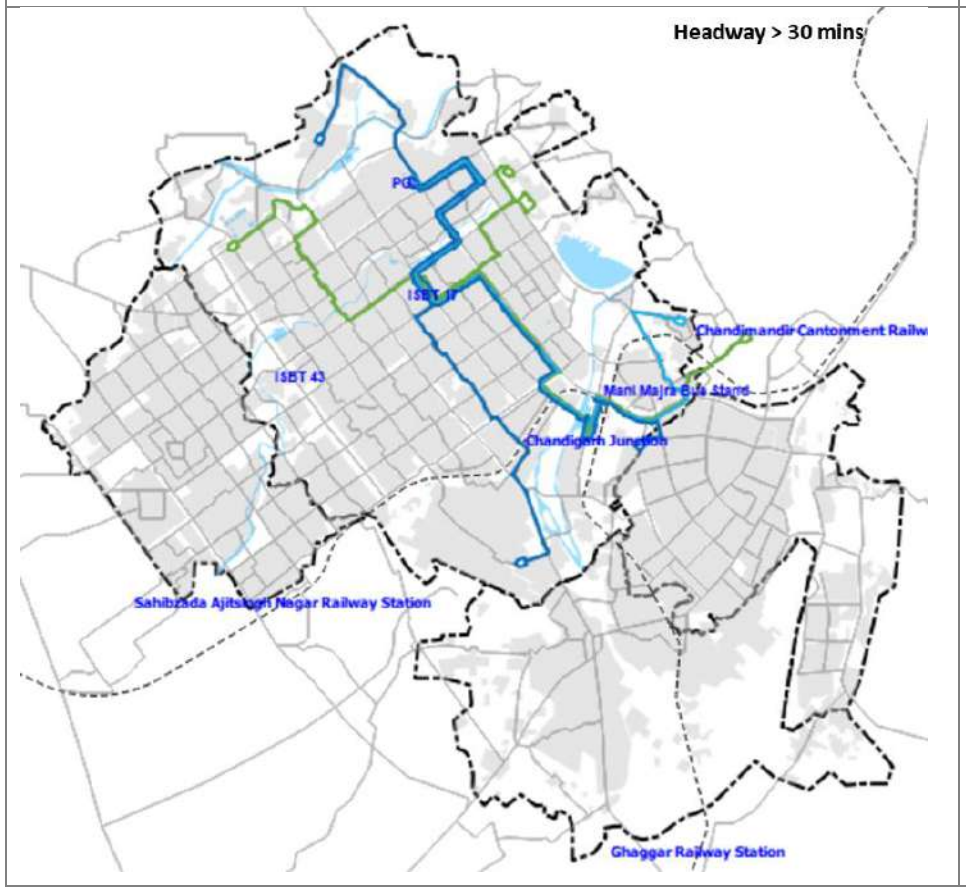
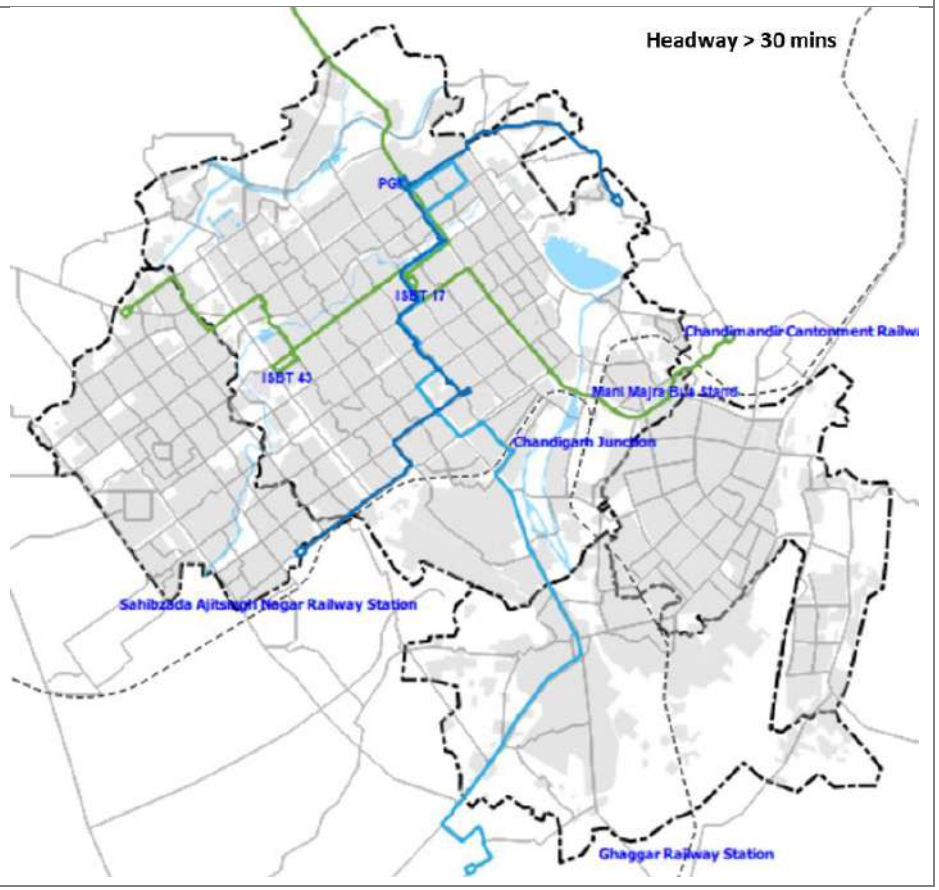
City Routes	**Suburban Routes**
	

Figure 16: Route frequency distribution of City and Suburban Routes

2.2.5.5 Passenger Ridership

As per August 2019 data, the total passenger ridership is around 1.28 lakh per day. Table 17 below presents the ridership break up by service type. Around 48% of the ridership is on city routes and rest is on sub urban routes which connect Mohali, Panchkula, Zirakpur, Kharar, Dera basi and Khizrabad. The suburban routes also cater to the urban demand as the city stoppages do not vary for these services. In terms of demand by depot, both depot II and IV have roughly equal share of 38% each and Depot III contributes to 23% of the demand.

Table 17: Passenger ridership by depot and route types

Depots	City routes	Sub urban routes				Total	%
	Within Chandigarh	Chandigarh -Mohali	Chandigarh -Panchkula	Chandigarh -Zirakpur	Chandigarh -Other		
II	21695	7641	11311	7341	2135	50123	39%
III	7879	5582			15743	29204	23%
IV	32193	6426		5158	4526	48303	38%
Total	**61767**	**19649**	**11311**	**12499**	**22404**	**127630**	**100%**
%	**48%**	**15%**	**9%**	**10%**	**18%**	**100%**	

Source: CTU, 5th August 2019

2.2.6 Operations Performance Assessment

This section discusses about the operational performance measures for system as well as for routes.

2.2.6.1 Fleet Utilisation

Fleet utilization is 88% for urban and suburban services of CTU which is below the observed average 92% in other Indian cities. The lower level of FU is attributed to high number of breakdown of buses and age of the fleet.

2.2.6.2 Vehicle Utilisation

The average vehicle utilization of the system is 187 km daily which is below the benchmarked range of 200±10 kms per bus on road daily for urban bus services (Table 18 below).

Table 18: Depot wise vehicle utilisation

Depot	Vehicle Kms	On road buses	Vehicle Utilisation
2	25723	149	173
3*	28242	138	205
4	17634	95	186
System VU	**71599**	**382**	**187**

Source: Depot 2: Route wise data compilation from ETM and schedule; Depot 3 and Depot 4: Dashboard data from CTU for 5th August 2019
**Depot-3 also operates few buses on regional routes.*

2.2.6.3 System Capacity Utilisation

Load factor of the CTU for urban and sub-urban bus service is around 0.22 considered for a day (Table 19 below).

Table 19: Depot wise Load factors

Depot	Passenger km	On road buses	Vehicle Utilisation	Load Factor
2	423,560.7	149	173	0.23
3*	270,938.1	138	205	0.14
4	384,657.2	95	186	0.31
System LF	**1,079,156**	**382**	**187**	**0.22**

Source: Depot 2: Route wise compilation from ETM and schedule; Depot 3 and Depot 4: Dashboard data from CTU for 5th August 2019
**Depot-3 also operates few buses on regional routes.*

2.2.6.4 Indexed Passenger Km

Indexed Passenger Kilometer (IPK) is a performance indicator commonly used to evaluate the operational productivity of a route. It is computed by dividing the total number of passengers served by actual bus-kilometers run. Generally, an IPK greater than 4 passengers per bus km is considered as a good level of performance *(Source: Embarq, Big-10 Performance Analysis for Bangalore, May 2011)*.

Majority of the routes have IPK in the range of 0.9 – 2.4, and average is about 0.9 which is considerably low compared to the standards. In comparison to the bus fleet of depot-4, depot-3 is consistently showing a lower IPK i.e. 1.0, which in the case of depot 4 is 2.3. Route wise IPK as calculated for 5th August 2019 is presented in Table 20 below.

Table 20: Service wise indexed passenger km (August 2019)

	Daily Ridership	Total Bus km	IPK
City Routes	61,767	66,714	0.93
Suburban Routes	65,863	76,623	0.86

Source: Analysed from ETM Data, 5th August 2019

2.2.6.5 Vehicle Km Supply Distribution and Load Factor

Table 21 below shows the total vehicle km distribution across peak and non-peak hours. It is observed that load factor ranges from 0.24 to 0.36 indicating low ridership levels against the supply levels.

Table 21: Distribution of total vehicle km between peak and non-peak hours

Peak Hour Category	Ridership	Pass Km	Actual Veh Km	Load Factor
Night Services (00:00 to 6:00AM)	847	5,855	734	0.11
Morning Off Peak (6:00AM to 7:45AM)	14,681	1,45,153	8,050	0.26
Morning Peak (7:45AM to 10:45AM)	32,478	2,86,238	12,963	0.32
Intermediate + Afternoon Peak (10:45AM to 3:15PM)	46,566	3,77,372	22,137	0.24
Evening (3:15PM to 7:45PM)	29,753	2,41,243	14,343	0.24
Late Evening (7:45PM to 00:00)	3,305	23,295	912	0.36
Total/ Average	**1,27,630**	**10,79,156**	**59,139**	**0.26**

Source: Analysed from ETM Data, 5th August 2019

Similarly, vehicle km distribution as computed for headways range from the service schedule / timetable is presented in Table 22 below. It is observed that more than 60% of vehicle km is operated by the services with more than 20 min headway and is not recommended for urban bus services. About

35% vehicle km is operated by moderate frequency (11-20 min headway) services and more than 25% vehicle km is operated by routes having more than 30 min headway.

Table 22: Distribution of total vehicle km by service headways

Sr. No.	Headway (min)	No of Trips		Vehicle kms		Total no of Trips	Total Schedule Vehicle kms
		Within Chandigarh Routes	Suburban Routes	City Routes	Suburban Routes		
1	<=10	0	0	0	0	0	0
2	11-20	667	390	14032	9700	1057 (38%)	23733 (36%)
3	21-30	406	607	9414	14559	1013 (36%)	23973 (37%)
4	>30	251	459	5176	12154	710 (26%)	17329 (27%)
Total		**1324**	**1456**	**28622**	**36413**	**2780**	**65035 (100%)**

Source: Schedule of Time Table

2.2.7 Financial Performance

2.2.7.1 Recent Years' Financial and Physical Performance Parameters

As per the details provided by CTU, system is performing unsatisfactorily in terms of operational ratio since past 2-3 few years. Table 23 below presents operating revenue and operating cost for last two years, which shows that the operating ratio remains close to 0.5 i.e. fare revenue is only about 50% of the total operating cost.

Table 23: Operating Revenue and Expenses

FY	Depot	**Operating Revenue in Lakh** (Traffic Receipts including tickets pass, police vouchers etc.)	**Operating Costs in lakh** (Maintenance and Repairing expenses)	Operating Ratio (OR)
2017-18	Depot-I	4,669	7,052	0.66
	Depot-II	2,441	6,960	0.35
	Depot-III	2,559	5,501	0.47
	Depot-IV	1,891	4,338	0.44
	CTU Over All	**11,562**	**23,852**	**0.48**
2018-19	Depot-I	5,975	8,609	0.69
	Depot-II	3,229	7,695	0.42
	Depot-III	2,786	5,666	0.49
	Depot-IV	2,189	5,011	0.44
	CTU Over All	**14,179**	**26,982**	**0.53**

Note: Depot I operate only regional services, while Depot III operates both regional as well as city/suburban operations
Source: CTU, August 2019

2.2.7.2 Route Level Financial Performance

Apart from the Operating Ratio, it is also important to assess the financial performance at route level. The depot level expenditure per km provided by CTU for year 2018-19 is used to compute the route level daily expenditure. Similarly, route level revenue is taken from February 2020 ETM data and pass revenue at trip level is computed using logical assumptions.

Table 24 below presents the distribution of routes w.r.t. Operating Ratio by route type. Average OR of city and sub urban routes is 0.6 where about 66% of routes have OR below 0.6. Only about 15% routes have >0.8 OR. Route level financial details are presented in Annexure 3.

Table 24: Operating Ratio at route level analysis

Route Type\ Operating Ratio	**<=0.4**	**>0.4 & <=0.6**	**>0.6 & <=0.8**	**>0.8 & <=1**	**>1**	**Total**
Within Chandigarh	4 (6%)	21 (31%)	6 (9%)	4 (6%)	1 (1%)	36 (53%)
Chandigarh to Mohali	3 (4%)	7 (10%)				10 (15%)
Chandigarh to Panchkula		5 (7%)	2 (3%)			7 (10%)
Chandigarh to Zirakpur		2 (3%)	3 (4%)	1 (1%)		6 (9%)
Chandigarh to Outside		3 (4%)	2 (4%)	3 (4%)	1 (1%)	9 (13%)
Total	**7 (10%)**	**38 (56%)**	**13 (19%)**	**8 (12%)**	**2 (3%)**	**68 (100%)**

Source: Financial details 2018-19, Feb 2020 ETM data. Compiled and analysed by CoE-UT, CRDF

2.2.8 Observations – Operations and financial performance

Observations made from the operational performance analysis of the system are mentioned below:

- It is observed that average 8% of trips are cancelled daily. Cancellations of trips without any prior information may lead in losing the trust on reliability of system.
- Average vehicle utilization for weekdays is 187 km which is below benchmarked range of 200±10 kms per bus on road daily for urban bus service. A closer look at city and sub urban routes shows a utilization of level of 180 km/bus/day which is below the desired level.
- Load factor of the service is around 0.22 which appears to be much lower than the desired range of 0.65-0.75. At a route level also, about 80% of routes have load factor <0.3.
- The operating ratio has increased from 0.48 to 0.53 over the last year. More than 65% of routes have <0.6 Operating Ratio.

2.2.9 City Bus Demand

The city bus demand has been assessed using ETM data provided for month of August, 2019.

2.2.9.1 Temporal City Bus Demand

Temporal variation of ridership on bus routes can be seen in Figure 17 below. The morning peak is observed from 7:45 AM to 10:45 AM and 7:15AM to 10:15AM for city and sub urban services. The city does not have typical evening peak as shown in the graph below; the peak actually starts from 12:15 PM and ends around 3:15PM for both city and sub urban. The morning peak hour demand is about 10% of the total demand.

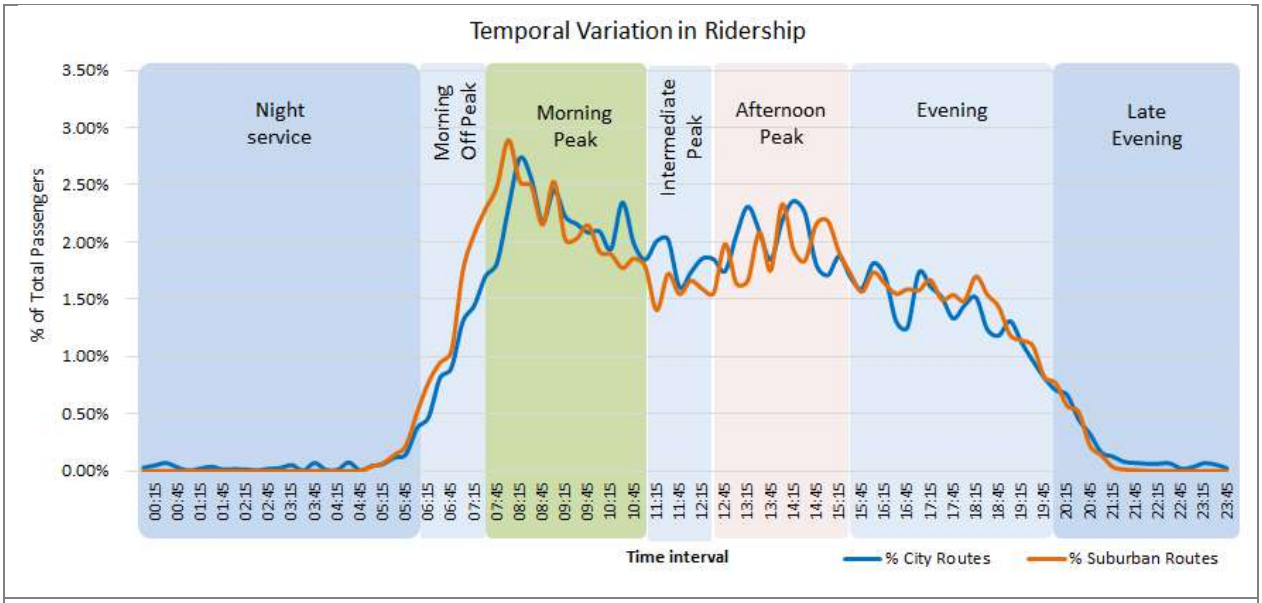


Figure 17: Temporal Variation of bus system demand

2.2.9.2 Route wise Ridership

ETM data is analysed for 68 operational routes having a total ridership of around 1.28 lakh (Table 25 below). The passenger flow for each route is presented in Annexure 3. One sample trip for each route has been analysed in terms of ridership, boarding alighting, average trip length, maximum line loading and the load factor and the same has been presented in Annexure 2.

Table 25: Details of route wise average trip length, maximum load and load factor

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
3	U	MOULIJAGRAN - PGI	17	8.5	60	86	Morning	76	Standard	1.1
	D	PGI - MOULIJAGRAN	17	8.2	60	75	Morning	54	Standard	0.8
8	U	PH 11 - KAIMBWALA	25.6	6	35	50	Afternoon	47	Standard	0.7
	D	KAIMBWALA - PH 11	25.6	6.1	35	48	Morning	26	Standard	0.4
11	U	PBCIVIL SEC - ISBT17	7.1	4.8	60	30	Morning	30	Standard	0.4
	D	ISBT17 - PBCIVIL SEC	7.1	5.2	60	48	Morning	48	Standard	0.7
17	U	APORTBEHLAN - ISBT43	15.3	7.6	20	82	Afternoon	60	Standard	0.9
	D	ISBT43 - APORTBEHLAN	15.3	6.9	20	59	Afternoon	42	Standard	0.6
18	U	KAIMBWALA - ISBT43	15.5	7.6	30	54	Morning	50	Standard	0.7
	D	ISBT43 - KAIMBWALA	15.5	6.8	30	24	Morning	23	Standard	0.3
22	U	IT PARK - ISBT 43	19.6	8.5	15	128	Afternoon	98	Standard	1.4
	D	ISBT 43 - IT PARK	19.6	8.1	15	115	Afternoon	77	Standard	1.1
25	U	KHIZARABAD - ISBT17	27.2	14.2	30	108	Morning	94	Standard	1.3
	D	ISBT17 - KHIZARABAD	27.2	13.1	30	58	Evening	40	Standard	0.6
28	U	MANSADEVI - JUJHARNAGAR	25.9	8.9	45	47	Afternoon	25	Standard	0.4
	D	JUJHARNAGAR - MANSADEVI	25.9	10.2	45	64	Morning	50	Standard	0.7
30	U	NADA SAHIB - ISBT43	21.5	8.7	40	55	Afternoon	37	Standard	0.5
	D	ISBT43 - NADA SAHIB	21.5	9.2	40	95	Morning	49	Standard	0.7
32	U	DERABASSI - PGI	36.2	12.5	30	133	Afternoon	53	Standard	0.8
	D	PGI - DERABASSI	36.2	12.9	30	110	Afternoon	66	Standard	0.9
34	U	DERABASSI - PGI	28	14.1	20	61	Afternoon	52	Standard	0.7
	D	PGI - DERABASSI	28	12.7	20	67	Afternoon	46	Standard	0.7
35	U	KHARAR - ISBT17	18.3	11.5	20	67	Afternoon	63	Standard	0.9
	D	ISBT17 - KHARAR	18.3	11.8	20	61	Afternoon	54	Standard	0.8
39	U	SEC65PH11 - PGI	24.4	9.5	15	108	Afternoon	75	Standard	1.1
	D	PGI - SEC65PH11	24.4	9.3	15	112	Afternoon	88	Standard	1.3
40	U	KHDERABAD - ISBT17	31	14.2	60	94	Afternoon	78	Standard	1.1

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
	D	ISBT17 - KHDERABAD	31	13.4	60	71	Afternoon	55	Standard	0.8
71	U	KAMBWALA - ISBT43	24	7.7	30	70	Afternoon	39	Standard	0.6
	D	ISBT43 - KAMBWALA	24	8.2	30	73	Afternoon	57	Standard	0.8
79	U	CHATTBIR - PGI	27.9	12.5	45	90	Morning	68	Standard	1
	D	PGI - CHATTBIR	27.9	10.3	45	64	Morning	42	Standard	0.6
80	U	ZIRAKPUR - PGI	20	9.8	30	92	Afternoon	69	Standard	1
	D	PGI - ZIRAKPUR	20	9.4	30	48	Morning	35	Standard	0.5
143	U	AIRP.BEHLAN - DHANAS	21.3	7.4	75	42	Morning	26	Standard	0.4
	D	DHANAS - AIRP.BEHLAN	21.3	6.8	75	40	Morning	25	Standard	0.4
212	U	DERA BASSI - PGI	20.4	15	20	148	Afternoon	104	Standard	1.5
	D	PGI - DERA BASSI	20.4	12.1	20	118	Afternoon	79	Standard	1.1
213	U	DERABASSI - LANDRAN	34	12.4	30	67	Morning	40	Standard	0.6
	D	LANDRAN - DERABASSI	34	10.9	30	58	Afternoon	45	Standard	0.6
241	U	MANSA DEVI - ISBT43	22	9.4	20	104	Afternoon	61	Standard	0.9
	D	ISBT43 - MANSA DEVI	22	9.6	20	78	Afternoon	65	Standard	0.9
242	U	SANETA - PGI	30.3	10.4	20	141	Afternoon	76	Standard	1.1
	D	PGI - SANETA	30.3	9.8	20	79	Afternoon	63	Standard	0.9
10AC	U	MANSA DEVI - ISBT43	19.4	9.4	25	66	Morning	53	AC Standard	0.8
	D	ISBT43 - MANSA DEVI	19.4	9.3	25	53	Afternoon	32	AC Standard	0.5
123A	U	MOHALI RS - PGI	19.8	7.7	30	81	Afternoon	52	Standard	0.7
	D	PGI - MOHALI RS	19.8	8.1	30	80	Afternoon	62	Standard	0.9
123AAC	U	MOHALI RS - PGI	19.8	9.3	95	82	Afternoon	52	AC Standard	0.7
	D	PGI - MOHALI RS	19.8	8.9	95	46	Afternoon	36	AC Standard	0.5
143AC	U	APORTBEHLAN - DHANAS	21.3	11.3	150	92	Morning	79	AC Standard	1.1
	D	DHANAS - APORTBEHLAN	21.3	7.9	150	44	Morning	32	AC Standard	0.5
17AC	U	APORTBEHLAN - ISBT43	15.3	8.8	50	55	Afternoon	47	AC Standard	0.7
	D	ISBT43 - APORTBEHLAN	15.3	8.2	50	40	Afternoon	29	AC Standard	0.4
18AC	U	KAIMBWALA - ISBT43	15.5	7.5	40	34	Afternoon	30	AC Standard	0.4

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
	D	ISBT43 - KAIMBWALA	15.5	8.1	40	30	Afternoon	28	AC Standard	0.4
18B	U	HIGH COURT - ISBT43	14	8.6	30	29	Morning	21	Standard	0.3
	D	ISBT43 - HIGH COURT	14	7.7	30	52	Morning	41	Standard	0.6
1	AC	PGI - PGI	27.4	7.5	20	146	Afternoon	65	Standard	0.9
	C	PGI - PGI	27.4	7.4	20	96	Afternoon	54	Standard	0.8
202AC	U	PBCIVILSECT - ISBT 43	13	6.9	15	46	Afternoon	42	AC Standard	0.6
	D	ISBT 43 - PBCIVILSECT	13	8.2	15	89	Afternoon	76	AC Standard	1.1
203AC	U	MANSA DEVI - ISBT43	18	9.3	35	64	Morning	54	AC Standard	0.8
	D	ISBT43 - MANSA DEVI	18	8.5	35	50	Morning	31	AC Standard	0.4
205AC	U	PGI - ISBT 43	11.1	7.6	15	57	Morning	47	AC Standard	0.7
	D	ISBT 43 - PGI	11.1	8.2	15	113	Afternoon	112	AC Standard	1.6
206AC	U	IT PARK - ISBT 43	18.01	9.6	20	103	Afternoon	64	AC Standard	0.9
	D	ISBT 43 - IT PARK	18.01	10	20	85	Afternoon	71	AC Standard	1
20A	U	KHARAR - ISBT17	25.6	10.3	30	103	Afternoon	78	Standard	1.1
	D	ISBT17 - KHARAR	25.6	11.4	30	64	Afternoon	49	Standard	0.7
20AC	U	KHARAR - ISBT17	25.6	12.4	30	106	Afternoon	90	AC Standard	1.3
	D	ISBT17 - KHARAR	25.6	13.3	30	143	Afternoon	98	AC Standard	1.4
211AC	U	CANTONMENT - PGI	22.3	10.8	40	71	Afternoon	59	AC Standard	0.8
	D	PGI - CANTONMENT	22.3	9.6	40	73	Morning	42	AC Standard	0.6
212AC	U	DERA BASSI - PGI	20.4	13.5	75	90	Afternoon	74	AC Standard	1.1
	D	PGI - DERA BASSI	20.4	13.4	75	88	Morning	68	AC Standard	1
214AC	U	NADA SAHIB - SARANGPUR B	22	9.4	40	73	Afternoon	45	AC Standard	0.6
	D	SARANGPUR B - NADA SAHIB	22	9.2	40	52	Afternoon	37	AC Standard	0.5
216AC	U	DERABASSI - ISBT 43	25	14.5	20	155	Afternoon	118	AC Standard	1.7
	D	ISBT 43 - DERABASSI	25	14	20	172	Afternoon	122	AC Standard	1.7
239AAC	D	ISBT 43 - ISBT 43	24	7.5	25	78	Morning	62	AC Standard	0.9
	U	ISBT 43 - ISBT 43	24	9.8	25	107	Morning	54	AC Standard	0.8

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
23A	U	KUDALISHER - ISBT43	13.8	6.3	15	51	Afternoon	44	Standard	0.6
	D	ISBT43 - KUDALISHER	13.8	7.3	15	51	Afternoon	45	Standard	0.6
240AC	U	MATA M DEVI - ISBT43	20.4	10.8	30	37	Afternoon	28	AC Standard	0.4
	D	ISBT43 - MATA M DEVI	20.4	9.7	30	46	Afternoon	24	AC Standard	0.3
242AC	U	SANETA - PGI	30.3	10.5	50	133	Afternoon	85	AC Standard	1.2
	D	PGI - SANETA	30.3	11.1	50	144	Afternoon	116	AC Standard	1.7
24AAC	U	PGI - ISBT43	9.8	5.2	80	20	Evening	19	AC Standard	0.3
	D	ISBT43 - PGI	9.8	6.7	80	36	Evening	36	AC Standard	0.5
24CAC	U	ISBT17 - ISBT43	5.7	5.6	25	22	Evening	22	AC Standard	0.3
	D	ISBT43 - ISBT17	5.7	5.5	25	43	Evening	43	AC Standard	0.6
254AC	U	IT PARK - ISBT43	19.6	9.9	70	41	Afternoon	32	AC Standard	0.5
	D	ISBT43 - IT PARK	19.6	8.4	70	40	Afternoon	25	AC Standard	0.4
25A	U	KHIZERABAD - ISBT17	27	13.8	30	101	Afternoon	79	Standard	1.1
	D	ISBT17 - KHIZERABAD	27	13.7	30	85	Afternoon	63	Standard	0.9
26AC	U	DHAKOLI - DHANAS	29	17	45	74	Afternoon	71	AC Standard	1
	D	DHANAS - DHAKOLI	29	13.2	45	84	Afternoon	64	AC Standard	0.9
28A	D	ISBT43 - ISBT43	25.7	7.4	30	68	Afternoon	30	Standard	0.4
	U	ISBT43 - ISBT43	25.7	7.7	30	84	Afternoon	63	Standard	0.9
2A	D	MANI MAJRA - MANIMAJRA	38.3	9.1	20	142	Afternoon	61	Standard	0.9
	U	PKLBSTAND - PGI	22.4	10.2	30	67	Morning	48	Standard	0.7
2B	D	PGI - PKLBSTAND	22.4	9.2	30	83	Morning	64	Standard	0.9
2BAC	U	PKLBSTAND - PGI	22.4	11	110	58	Morning	48	AC Standard	0.7
	D	PGI - PKLBSTAND	22.4	8.8	110	52	Morning	38	AC Standard	0.5
2C	U	MANIMAJRA - MANI MAJRA	38.3	8.9	20	119	Afternoon	47	Standard	0.7
2CAC	U	MANIMAJRA - MANI MAJRA	38.3	10.9	60	67	Afternoon	29	AC Standard	0.4
2D	U	IT PARK - PGI	21	9	35	74	Morning	65	Standard	0.9
	D	PGI - IT PARK	21	8.4	35	41	Morning	22	Standard	0.3
2F	U	DHAKOLIBORD - PGI	27.6	11.2	30	116	Morning	78	Standard	1.1

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
	D	PGI - DHAKOLIBORD	27.6	10.2	30	75	Afternoon	55	Standard	0.8
2FAC	U	DHAKOLIBORD - PGI	27.6	12.8	120	83	Afternoon	74	AC Standard	1.1
	D	PGI - DHAKOLIBORD	27.6	12.2	120	55	Afternoon	40	AC Standard	0.6
30A	U	CANTONMENT - ISBT43	21.1	9	30	137	Afternoon	67	Standard	1
	D	ISBT43 - CANTONMENT	21.1	8.4	30	71	Afternoon	36	Standard	0.5
30AAC	U	CANTONMENT - ISBT43	21.1	10.7	85	70	Afternoon	43	AC Standard	0.6
	D	ISBT43 - CANTONMENT	21.1	9.2	85	57	Afternoon	43	AC Standard	0.6
30AC	U	NADA SAHIB - ISBT43	21.5	9.9	95	72	Morning	41	AC Standard	0.6
	D	ISBT43 - NADA SAHIB	21.5	10.2	95	70	Afternoon	44	AC Standard	0.6
30B	U	SEC4PKL - ISBT43	20.7	9.3	25	90	Afternoon	61	Standard	0.9
	D	ISBT43 - SEC4PKL	20.7	10.6	25	48	Afternoon	32	Standard	0.5
30BAC	U	SEC4PKL - ISBT43	20.7	11.6	45	51	Afternoon	32	AC Standard	0.5
	D	ISBT43 - SEC4PKL	20.7	10.8	45	59	Afternoon	42	AC Standard	0.6
32A	U	MANSA DEVI - ISBT MOHALI	23.1	7.6	45	51	Afternoon	27	Standard	0.4
	D	ISBT MOHALI - MANSA DEVI	23.1	7.9	45	31	Afternoon	25	Standard	0.4
34AC	U	DERABASSI - PGI	28	16.7	105	96	Afternoon	85	AC Standard	1.2
	D	PGI - DERABASSI	28	14	105	61	Afternoon	47	AC Standard	0.7
35AC	U	KHARAR - ISBT17	18.3	12	65	88	Afternoon	76	AC Standard	1.1
	D	ISBT17 - KHARAR	18.3	12.3	65	116	Evening	114	AC Standard	1.6
35B	U	KHARAR - ISBT17	19.2	11.2	20	86	Afternoon	75	Standard	1.1
	D	ISBT17 - KHARAR	19.2	10.9	20	71	Afternoon	58	Standard	0.8
35BAC	U	KHARAR - ISBT17	19.2	11.5	20	131	Afternoon	117	AC Standard	1.7
	D	ISBT17 - KHARAR	19.2	11.8	20	125	Afternoon	106	AC Standard	1.5
36AC	U	NEWAIRPORT - PGI	30.9	13.9	45	94	Afternoon	83	AC Standard	1.2
	D	PGI - NEWAIRPORT	30.9	14.1	45	66	Afternoon	56	AC Standard	0.8
37AC	U	R STATION - ISBT43	12	7.8	90	35	Evening	34	AC Standard	0.5
	D	ISBT43 - R STATION	12	8.1	90	25	Evening	23	AC Standard	0.3
38AAC	U	NEWAIRPORT - ISBT17	21.1	10	45	25	Afternoon	16	AC Standard	0.2

Route no.	Dir	Description	Route Length (km)	Avg. trip Length (km)	Headway (min)	Ridership	Peak Time	Max_section load	Type of bus	Load factor
	D	ISBT17 - NEWAIRPORT	21.1	8.9	45	52	Afternoon	32	AC Standard	0.5
38AC	U	NEWAIRPORT - ISBT17	21.3	10.8	45	25	Afternoon	18	AC Standard	0.3
	D	ISBT17 - NEWAIRPORT	21.3	8.5	45	37	Afternoon	27	AC Standard	0.4
4	AC	ISBT 43 - ISBT 43	31	8.2	25	161	Afternoon	84	Standard	1.2
	C	ISBT43 - ISBT43	31	8.1	25	147	Afternoon	62	Standard	0.9
5	AC	RAM DARBAR - RAM DARBAR	33.9	7.5	15	354	Afternoon	91	Standard	1.3
	C	RAM DARBAR - RAM DARBAR	33.9	7.3	15	318	Afternoon	87	Standard	1.2
71AC	U	KAMBWALA - ISBT43	24	8.7	30	35	Morning	26	AC Standard	0.4
	D	ISBT43 - KAMBWALA	24	9	30	52	Morning	25	AC Standard	0.4
79AC	U	CHHATBIR - PGI	27.9	12.7	45	109	Morning	78	AC Standard	1.1
	D	PGI - CHHATBIR	27.9	12.7	45	61	Morning	45	AC Standard	0.6
7	AC	ISBT17 - ISBT17	36	7.3	25	114	Afternoon	31	Standard	0.4
	C	ISBT17 - ISBT17	36	6.8	25	89	Morning	42	Standard	0.6
80AC	U	ZIRAKPUR - PGI	20	11.7	70	84	Morning	70	AC Standard	1
	D	PGI - ZIRAKPUR	20	9.9	70	78	Afternoon	58	AC Standard	0.8
8AC	U	PH 11 - KAIMBALA	25.6	7.4	140	19	Morning	13	AC Standard	0.2
	D	KAIMBALA - PH 11	25.6	9.1	140	14	Morning	10	AC Standard	0.1
9	AC	MANSA DEVI - MANSA DEVI	37	8.9	30	105	Afternoon	44	Standard	0.6
	C	MANSA DEVI - MANSA DEVI	37	9.6	30	219	Afternoon	73	Standard	1

Source: ETM data from CTU/CCBSS, August 2019

2.2.9.3 Public Transport Demand vs. Supply

The passenger flows on the network was compared against the bus flows to see how well the demand matches the supply. Apart from load factor, it is also important to assess the demand supply gaps. From Figure 18 below it can be observed that the PT is over supplied on certain corridors because of overlapping/ concentrated route structure while there is insufficient supply on rest of the network. At some major corridors like Jan Marg, Himalaya Marg and Madhyam Marg bus supply seems to be twice the demand. There can be couple of reasons such as overlapping of routes for longer network, competing IPT routes with PT and inappropriate bus service planning.

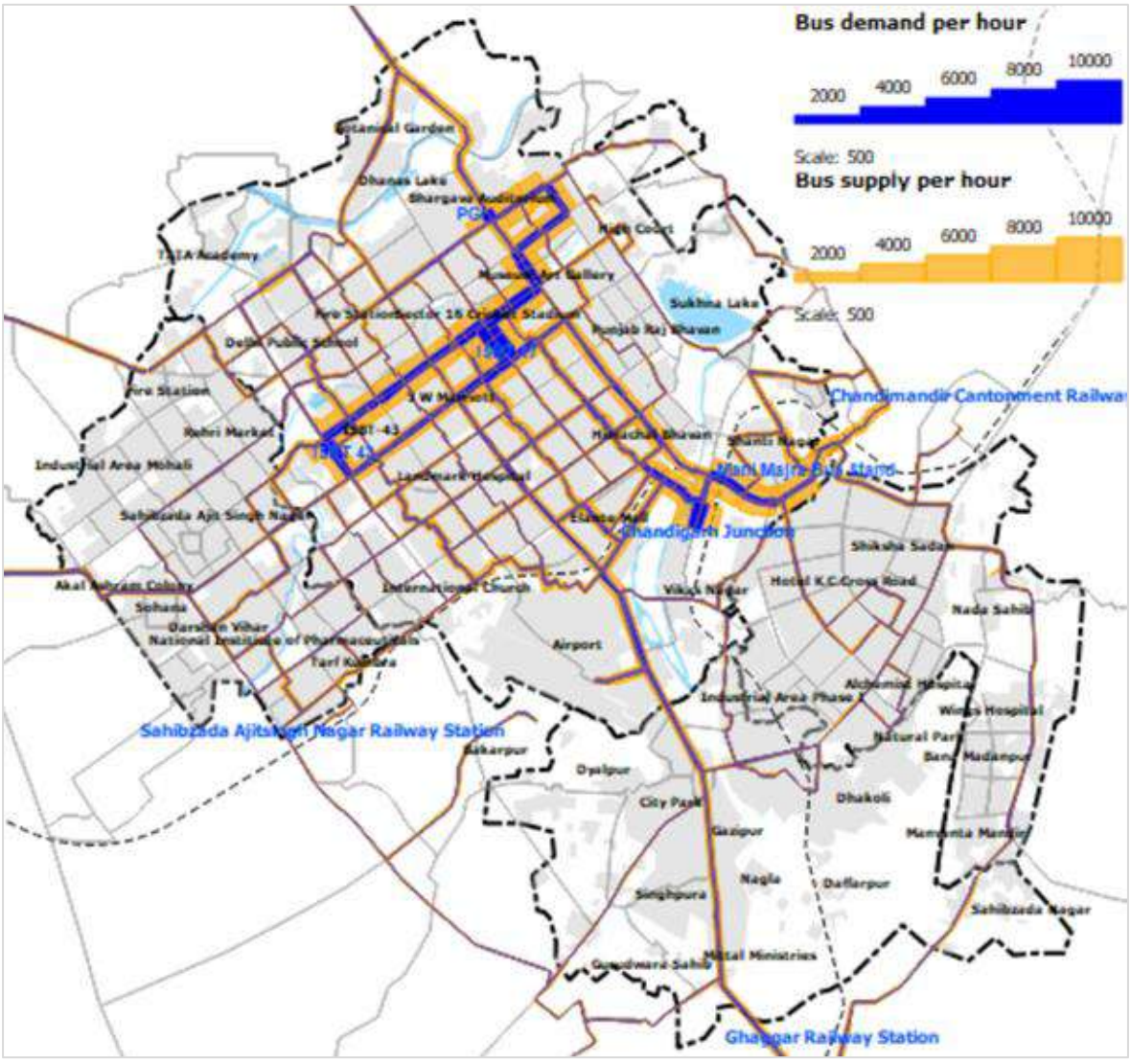


Figure 18: Bus supply vs demand analysis (2019)

2.2.10 Existing Intermediate Public Transport System

To understand the entire operational network of shared auto rickshaw in the city, a reconnaissance survey was carried out to identify major nodes where these are parked and to identify how these routes operate. It can be seen from the map below that routes of shared auto routes are sparsely spread across the city. An on-board (Boarding Alighting) survey was carried out on autos from different nodes to identify the major corridors and stops covered by them. The identified network length of shared auto is

about 280 km and major 25 shared auto parking nodes. The major nodes/stands of auto rickshaws identified and the network is presented in Figure 19 and Table 26 below.

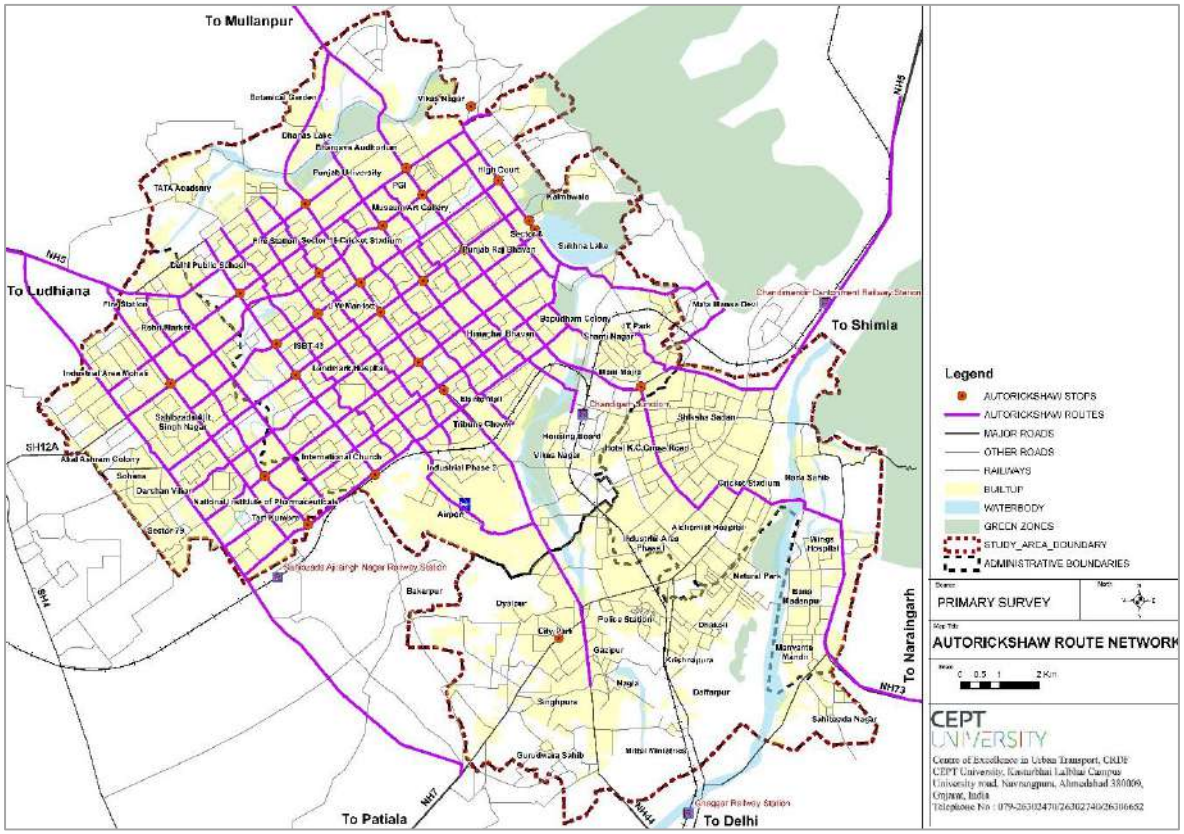


Figure 19: Shared Auto Rickshaw Nodes and Network (2019)

In terms of concentration of auto-rickshaws during the peak hours, the ten locations can be categorized under two groups:

Table 26: Major Auto-Rickshaw nodes within Tri-city

Survey Location	**High Demand**	**Moderate Demand**
Chandigarh	ISBT 43 PGI	Sector-17 Jan Marg Sector-22 Chandigarh Purv Marg
Mohali	Mohali Bypass Sohana Gurudwara	
Panchkula		Mani Majra Majri Chowk

For demand assessment on IPT, a sample survey of passengers at major nodes was carried out. During the survey, auto passengers were asked their entire trip information such as origin point, auto boarding stop, auto alighting stop, access and egress modes, cost of travel and time taken for each leg etc. A total of 1000 passengers' OD samples were collected and expanded using CVC counts at various location. Total expanded IPT demand comes out to be around 1.9 lakh in a day which can be considered potential PT demand as fare for IPT (Table 27 below) is highly comparable to PT.

Table 27: Shared Auto Fares Chandigarh (2019)

Sr No	Shared Auto Rickshaw Route	Fare (in INR.)
1	up to 3.5 km	10
2	3.5 - 7 km	20
3	> 7 km (within city of Chandigarh)	30

As per discussions with officials, a permit from RTO is required to ply auto services within Chandigarh and cap of 6000 auto rickshaws has been set up to control the growth and dominance of auto rickshaws in the city.

2.2.11 PT and IPT Demand in 2020

Bus demand analysis is done using stop-stop demand from ETM database. Therefore, each of the stops was taken up as a separate zone. Daily average PT demand is about 1,28,000 on 68 operational routes as obtained from ETM data of August 2019. ETM data was cleaned and OD matrix was prepared with each stop ID to be processed in the model. The share of suburban ridership is about 42% ridership.

Similarly, expanded IPT OD samples was also prepared in OD matrix format with stop ID and processed in EMME model. Estimated IPT demand is about 1.83 lakhs daily, out of which about 38% demand is suburban demand. Table 28 below shows the PT and IPT demand break up by Chandigarh and Suburban interaction.

Table 28: PT and IPT demand estimation

	Chandigarh	Suburban Areas	Total Trips
City Bus Demand			
Chandigarh	74,468 (58%)	22,520 (18%)	**96,988 (76%)**
Suburban Areas	20,632 (16%)	10,010 (8%)	**30,642 (24%)**
Total Trips	**95,100 (75%)**	**32,530 (25%)**	**1,27,630**
IPT Demand			
Chandigarh	1,14,116 (62%)	9,316 (5%)	**1,23,432 (67%)**
Suburban Areas	30,082 (16%)	30,334 (16%)	**60,416 (33%)**
Total Trips	**1,44,198 (78%)**	**39,650 (22%)**	**1,83,848**

Source: 5th August ETM data, CTU, Primary survey on IPT, 2019

It can be observed that Chandigarh and surrounding area has a total of 3.1 lakhs daily trips on PT and IPT of which PT share is to about 34%. Therefore, there seems to be a significant market opportunity for PT system if it can be designed appropriately.

Table 29 , Table 30 and Table 3150 below shows the demand interaction among the cities and external areas. About 58-62% demand is only within Chandigarh and about 15-20% of demand is between Chandigarh to Mohali, Panchkula, Zirakpur and rest of the external area. Almost 80% demand is associated with Chandigarh, therefore it becomes essential to provide frequent high-quality service within Chandigarh as well as from Chandigarh to neighbouring cities.

Table 29: Demand interaction based on PT demand from ETM data (2019)

Demand Matrix		Chandigarh and surrounding areas				Kharar, Khizrabad, Derabassi	Total
		Chandigarh	**Mohali**	**Panchkula**	**Zirakpur**		
Chandigarh and surrounding areas	Chandigarh	74,468 (58%)	3,529 (3%)	4,955 (4%)	3,237 (3%)	10,799 (8%)	**96,988 (76%)**
	Mohali	2,824 (2%)	1,069 (1%)	55 (0%)	3 (0%)	1,002 (1%)	**4,953 (4%)**
	Panchkula	4,910 (4%)	60 (0%)	1,271 (1%)	78 (0%)	447 (0%)	**6,766 (5%)**
	Zirakpur	2,760 (2%)	7 (0%)	41 (0%)	189 (0%)	868 (1%)	**3,865 (3%)**
Kharar, Khizrabad, Derabassi		10,138 (8%)	1,215 (1%)	626 (0%)	779 (1%)	2,300 (2%)	**15,058 (12%)**
Total		**95,100 (75%)**	**5,880 (5%)**	**6,948 (5%)**	**4,286 (3%)**	**15,416 (12%)**	**1,27,630 (100%)**

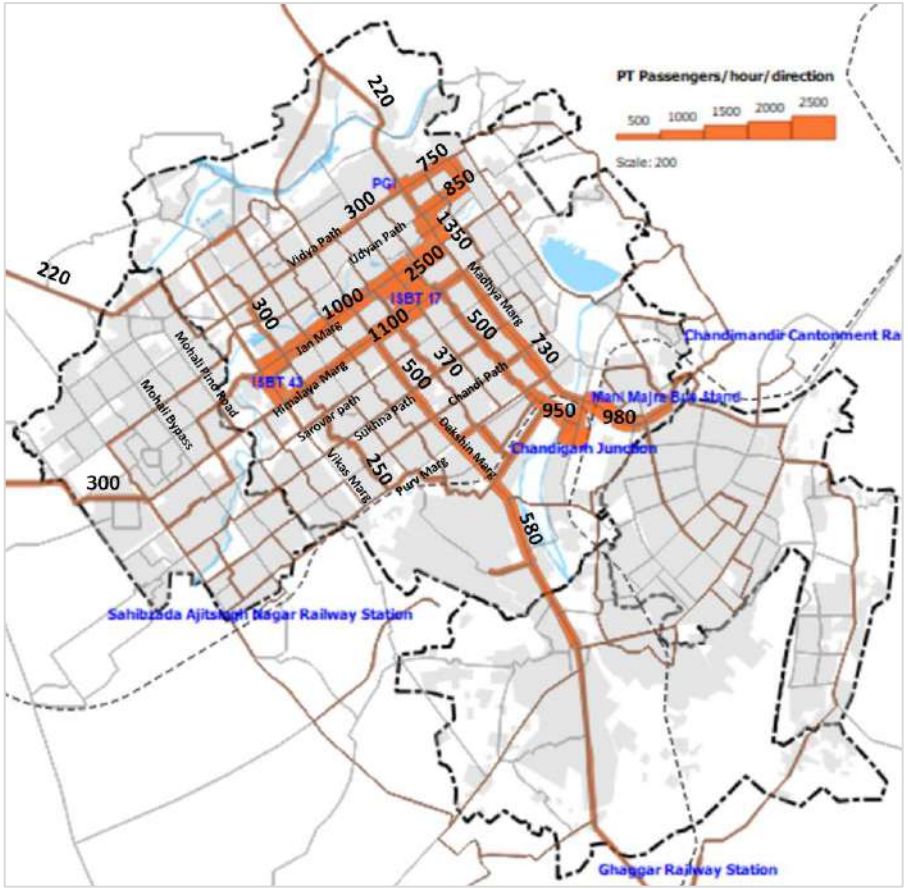
Table 30: Demand interaction based on IPT demand from OD survey data (2019)

Demand Matrix		Chandigarh and surrounding areas				Kharar, Khizrabad, Derabassi	Total
		Chandigarh	**Mohali**	**Panchkula**	**Zirakpur**		
Chandigarh and surrounding areas	Chandigarh	1,14,116 (62%)	4,824 (3%)	430 (0%)	20 (0%)	4,042 (2%)	**1,23,432 (67%)**
	Mohali	12,972 (7%)	9,466 (5%)	262 (0%)	0 (0%)	2,331 (1%)	**25,031 (14%)**
	Panchkula	3,874 (2%)	195 (0%)	4,515 (2%)	0 (0%)	1,531 (1%)	**10,115 (6%)**
	Zirakpur	4,057 (2%)	485 (0%)	0 (0%)	131 (0%)	206 (0%)	**4,879 (3%)**
Kharar, Khizrabad, Derabassi		9,179 (5%)	4,659 (3%)	4,673 (3%)	206 (0%)	1,674 (1%)	**20,391 (11%)**
Total		**1,44,198 (78%)**	**19,629 (11%)**	**9,880 (5%)**	**357 (0%)**	**9,784 (5%)**	**1,83,848 (100%)**

Table 31: Demand interaction based on both PT and IPT demand data (2019)

Demand Matrix		Chandigarh and surrounding areas				Kharar, Khizrabad, Derabassi	Total
		Chandigarh	**Mohali**	**Panchkula**	**Zirakpur**		
Chandigarh and surrounding areas	Chandigarh	1, 90,635 (61%)	12,596 (4%)	6,917 (2%)	5,361 (2%)	16,056 (5%)	**2,31,565 (74%)**
	Mohali	11,891 (4%)	11,060 (4%)	375 (0%)	348 (0%)	4,374 (1%)	**28,047 (9%)**
	Panchkula	6,872 (2%)	380 (0%)	4,354 (1%)	192 (0%)	3,471 (1%)	**15,269 (5%)**
	Zirakpur	4,884 (2%)	352 (0%)	155 (0%)	682 (0%)	1,074 (0%)	**7,147 (2%)**
Kharar, Khizrabad, Derabassi		15,395 (5%)	4,587 (1%)	3,650 (1%)	985 (0%)	4,835 (2%)	**29,452 (9%)**
Total		**2, 29,677 (79%)**	**28,974 (9%)**	**15,451 (5%)**	**7,568 (2%)**	**29,810 (10%)**	**3, 11,478 (100%)**

Figure 20 below show the passenger flow on PT and IPT transit networks. The auto passenger flow is well distributed within the city than that of city bus flow. The bus passenger flow is maximum along Himalaya Marg and Jan Marg with around 1100 PPHPD and 1000 PPHPD respectively. The IPT passenger flow on Himalaya Marg and Jan Marg shows similar trend as PT passengers with 570 PPHPD and 480 PPHPD respectively. The other major corridors for IPT modes are Madhya Marg, Dakshin Marg and Vidya Path. IPT movement is also considerably higher from Chandigarh towards Panchkula and Zirakpur.



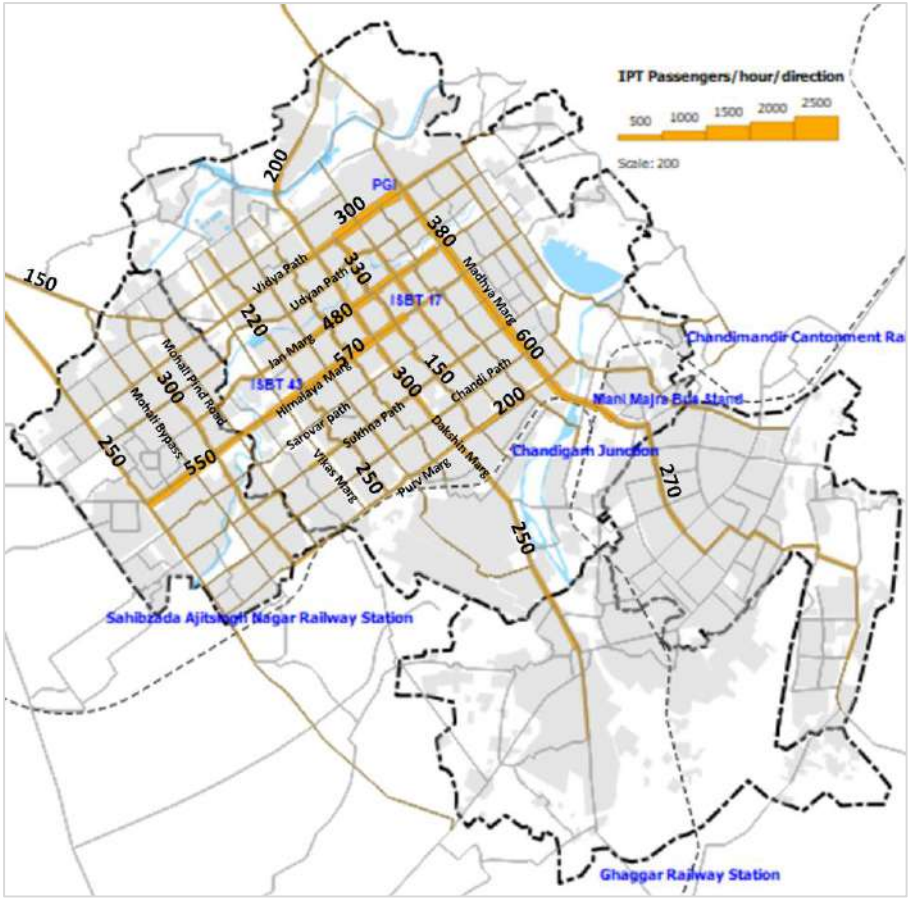


Figure 20: Base year PT and IPT demand on Transit Networks (2019)

2.2.11.1 Major Activity nodes in city

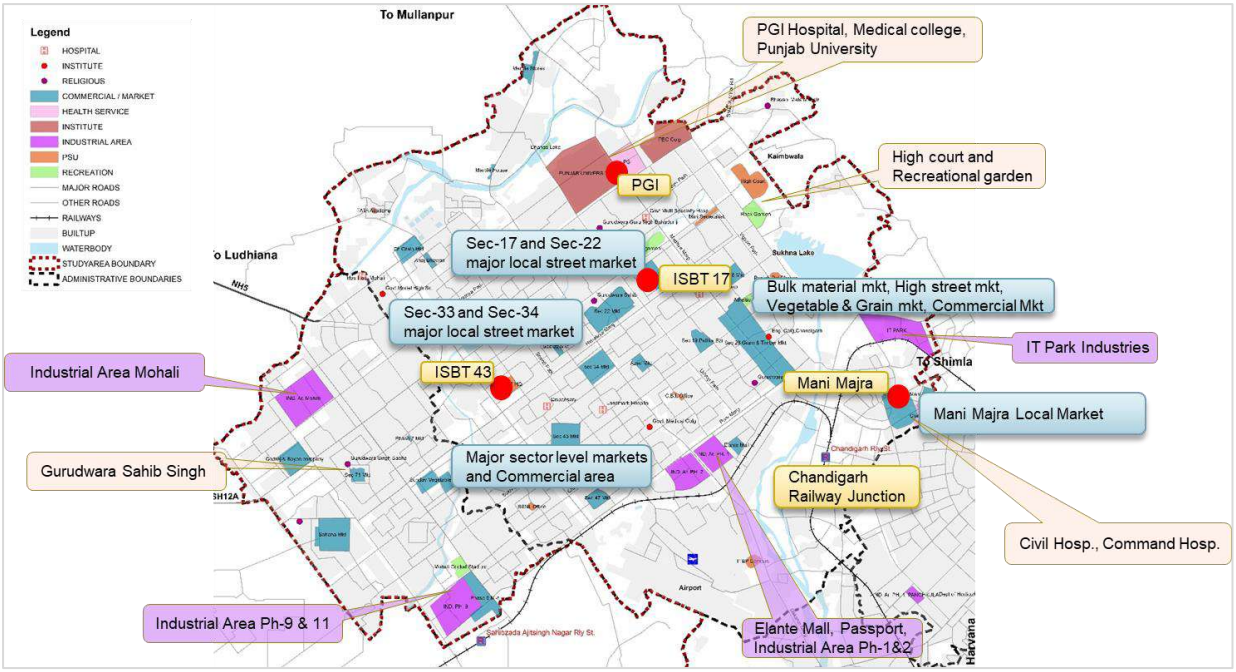


Figure 21: Major activity nodes in Chandigarh and Mohali

Figure 21 above presents the major activity nodes in Chandigarh and Mohali. Most of the centers are connected by existing PT system. However, apart from the connectivity, supply levels are also checked with respect to the demand pattern of both PT and IPT.

2.2.11.2 Major Boarding Locations – PT and IPT

The following Figure 22 shows the major passenger boarding nodes for both PT and IPT. It can be seen that around 2000 people board from ISBT-43, about 1600 board from ISBT 17 and around 800 board form PGI in peak hour daily. The major boarding nodes for bus users in the city are:

- ISBT 43
- ISBT 17
- PGI
- Chandigarh Railway Station
- Mani Majra Bus stand and
- Housing Board Chowk

The major boarding nodes for IPT users are ISBT 43, ISBT 17, PGI, Transport Chowk and Tribune Chowk in Chandigarh. IPT stop near Gurdwara Singh Shaheed Sahib in Mohali is also a major boarding node.

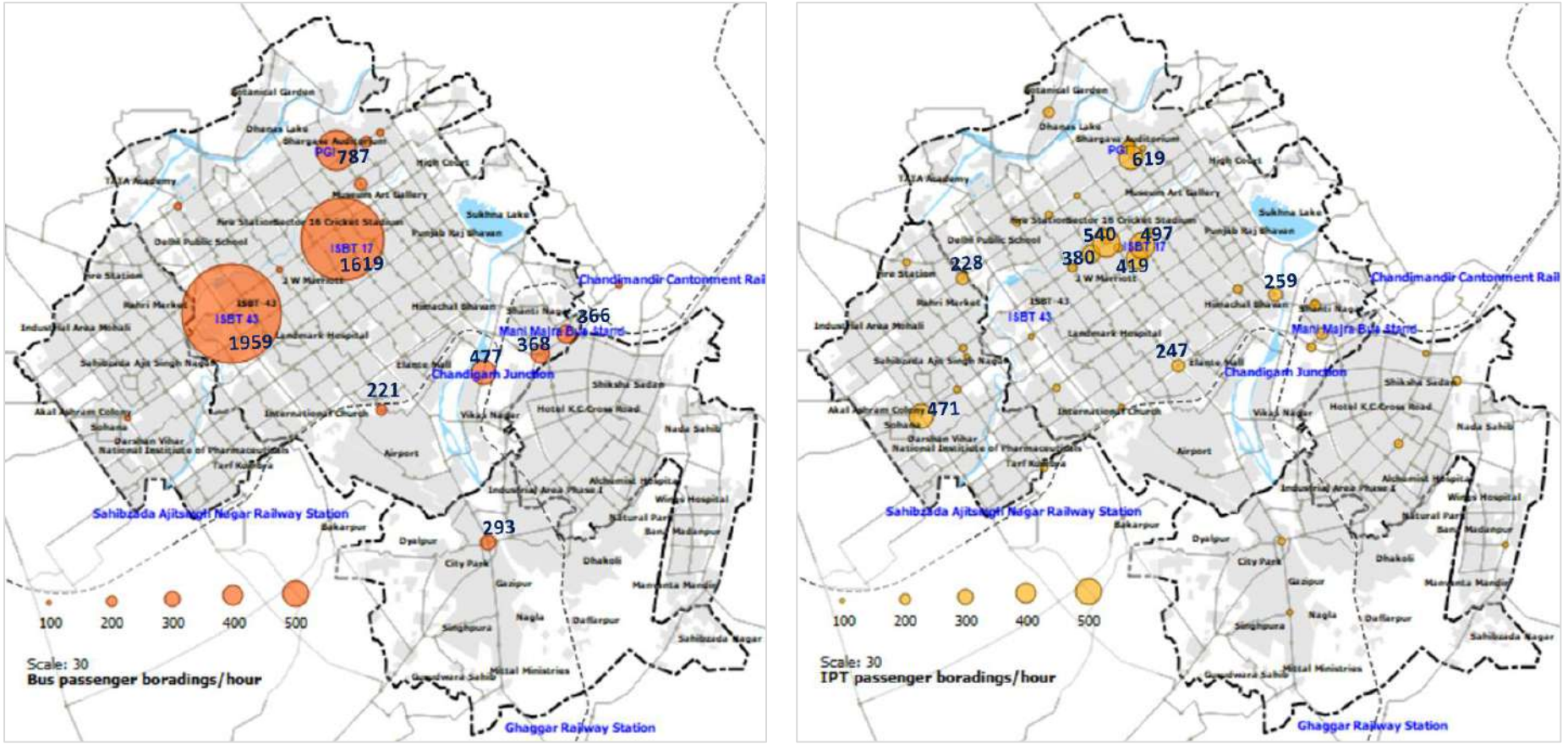
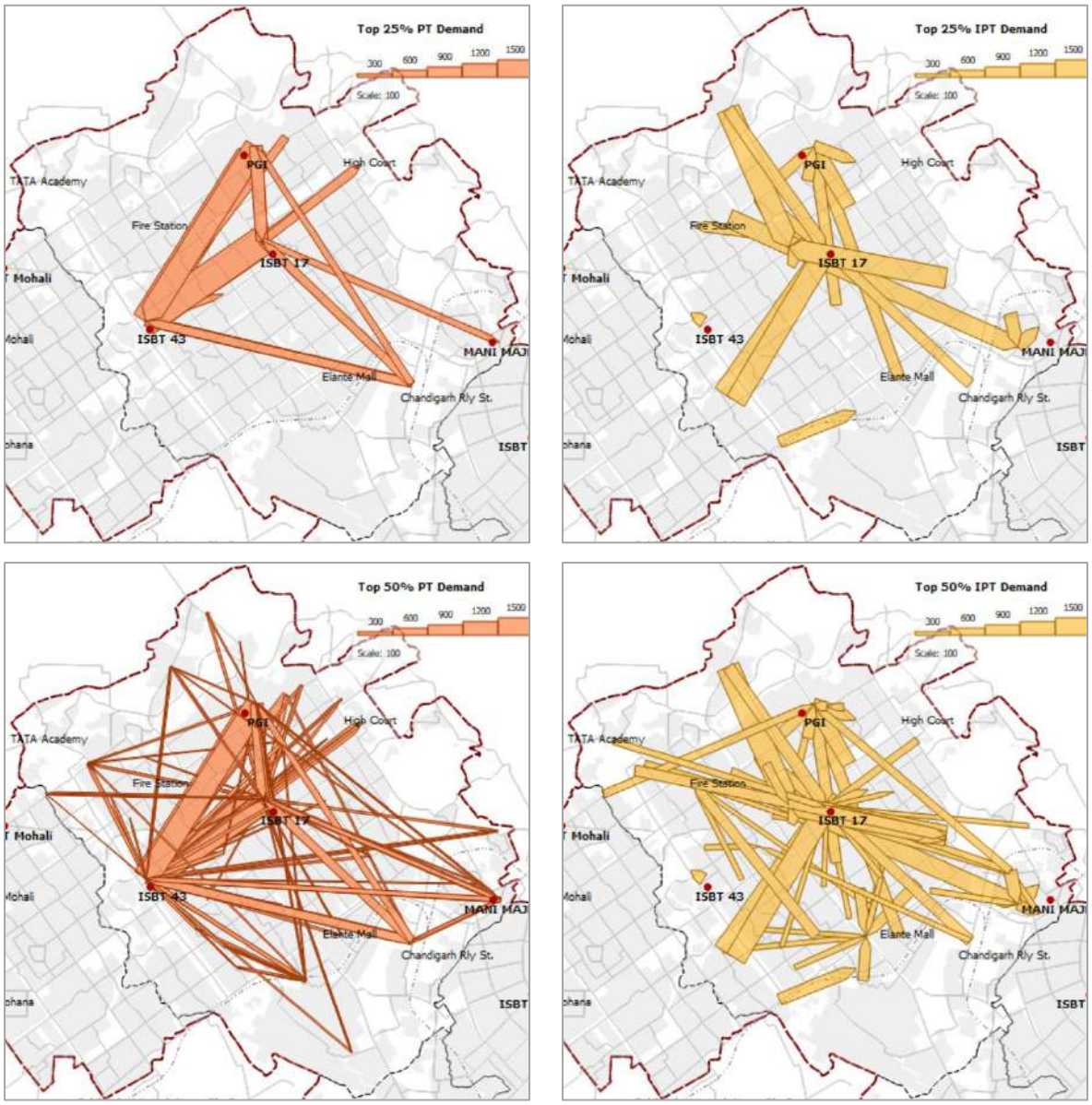


Figure 22: Major boarding locations of PT & IPT users

2.2.11.3 Existing Demand Pattern

Figure 23 below shows travel pattern of both city bus users and IPT users within city. It is observed that major trip interaction for PT users is between ISBT43, ISBT 17, PGI, Chandigarh Railway station, High Court and Mani Majra while new areas are emerging for IPT users. Major trip interactions of IPT users are from ISBT 17 to Sector 45, 46 and 47 Markets, Dadu Majra, Mani Majra and Grain Market. About 58% of total PT demand as well as 68% of total IPT demand is within Chandigarh, and out of combined total demand, about 60% demand (intra city) is within Chandigarh (Table 32 below).

Further, looking at the top 50% and 75% demand pattern, PT users' interaction is observed towards Airport IT park, Dadumajra, Ramdarbar and major terminals ISBT 17 and ISBT 43. Instead, IPT user's interaction is observed near Elante mall at Tribune chowk, ISBT 17 to High Court and from PGI to nearby areas.



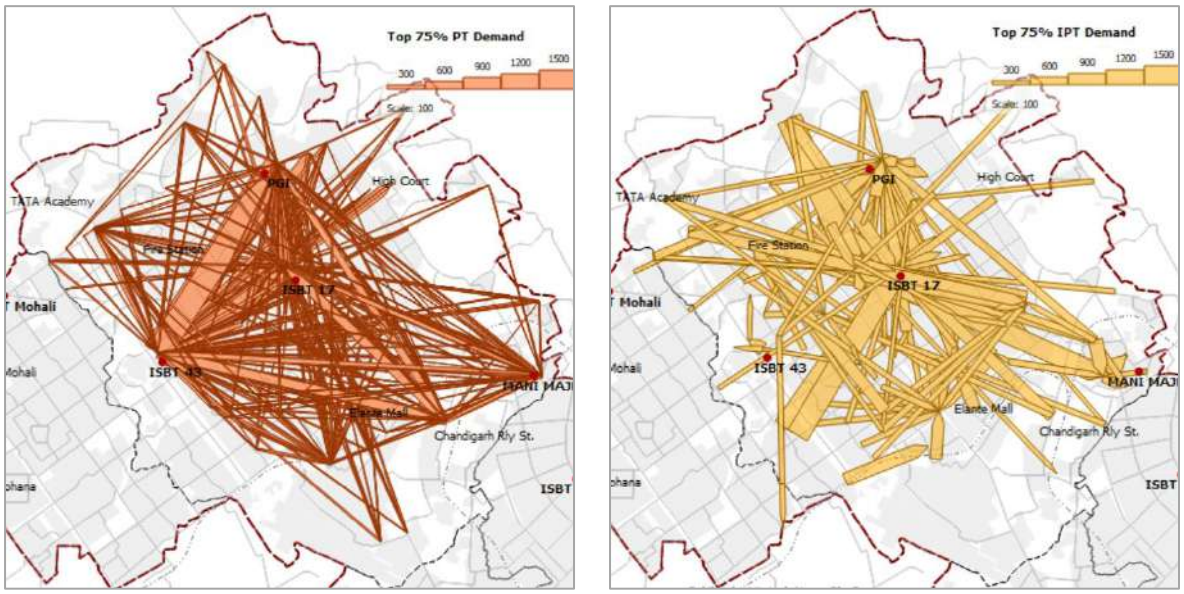


Figure 23: Travel pattern of PT and IPT users within Chandigarh City

Table 32: PT and IPT Demand interaction within Chandigarh

Demand Pairs	PT demand			IPT Demand		
	OD Pairs	Demand	% out of Total demand (1.27 L)	OD Pairs	Demand	% out of Total demand (1.83 L)
Full day City Demand	3456	74,468	58% (within Chandigarh)	416	1,14,116	62% (within Chandigarh)
Top 25% Demand	17	18,647	15%	22	28,194	15%
Top 50% Demand	115	37,263	29%	29	56,445	31%
Top 75% Demand	470	55,886	44%	146	84,565	46%

Figure 24 presents the demand pattern of IPT and PT users for suburban areas. For PT users, major interaction is observed from Kharar to ISBT 17, ISBT 43, ISBT Mohali and Sohna Gurudwara. The interaction is also high between Derabassi and Zirakpur towards ISBT 43, ISBT 17 and PGI. In case of IPT users, high demand is observed between Zirakpur and ISBT 17.

Further, looking at 50% and 75% demand patterns (Table 33 below), PT users interaction intensifies towards major terminals ISBT 17, ISBT 43 and PGI. The demand pattern of IPT users is very different with high concentrations of demand towards Mohali and near Mani Majra.

Table 33: PT and IPT Demand interaction in Chandigarh and surrounding suburban areas

Demand Pairs	PT demand			IPT Demand		
	OD Pairs	Demand	% out of Total demand (1.27 L)	OD Pairs	Demand	% out of Total demand (1.83 L)
Full day City Demand	2612	53,162	42%	434	69,732	38%
Top 25% Demand	26	13,502	11%	19	17,743	10%
Top 50% Demand	116	26,557	21%	70	34,954	19%
Top 75% Demand	425	39,874	31%	180	52,331	28%

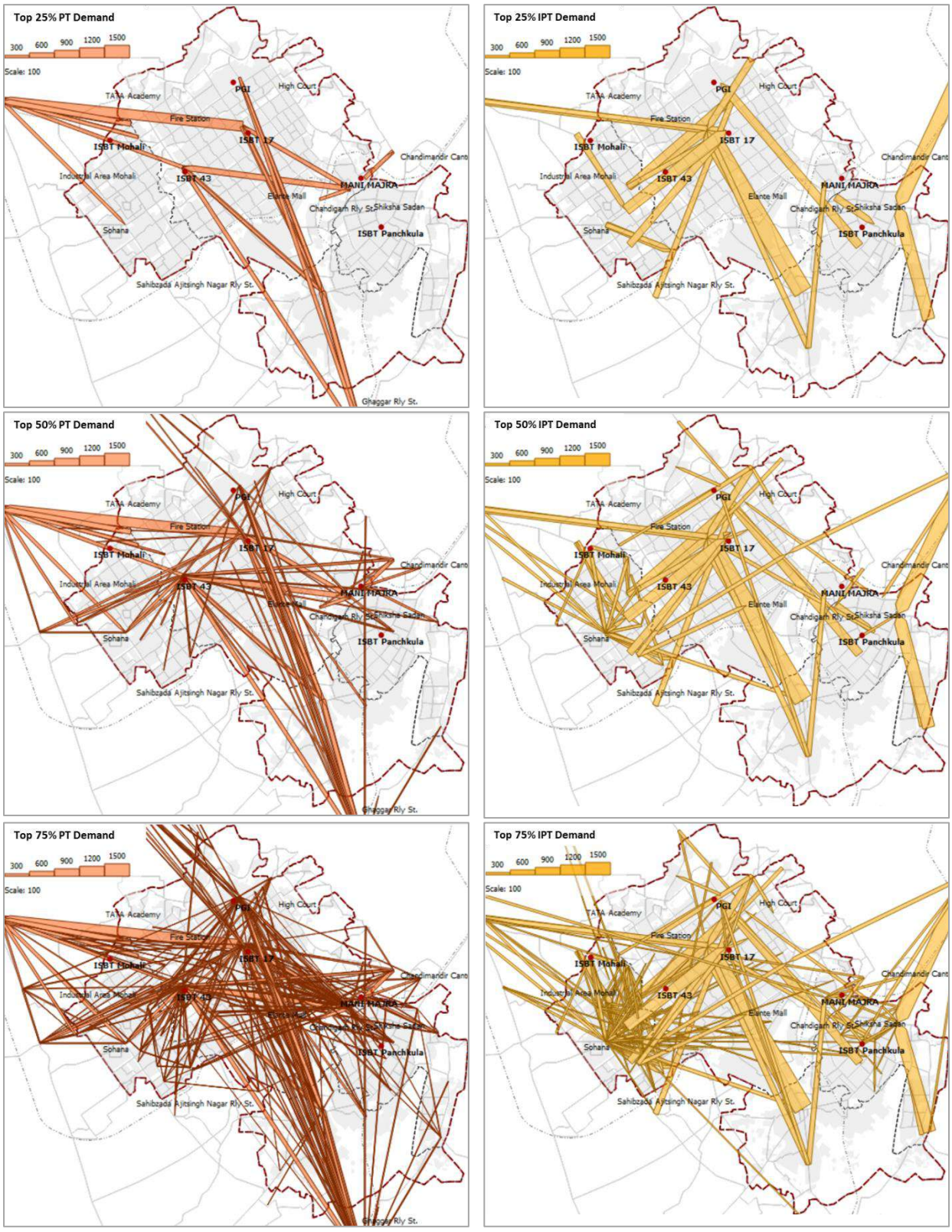
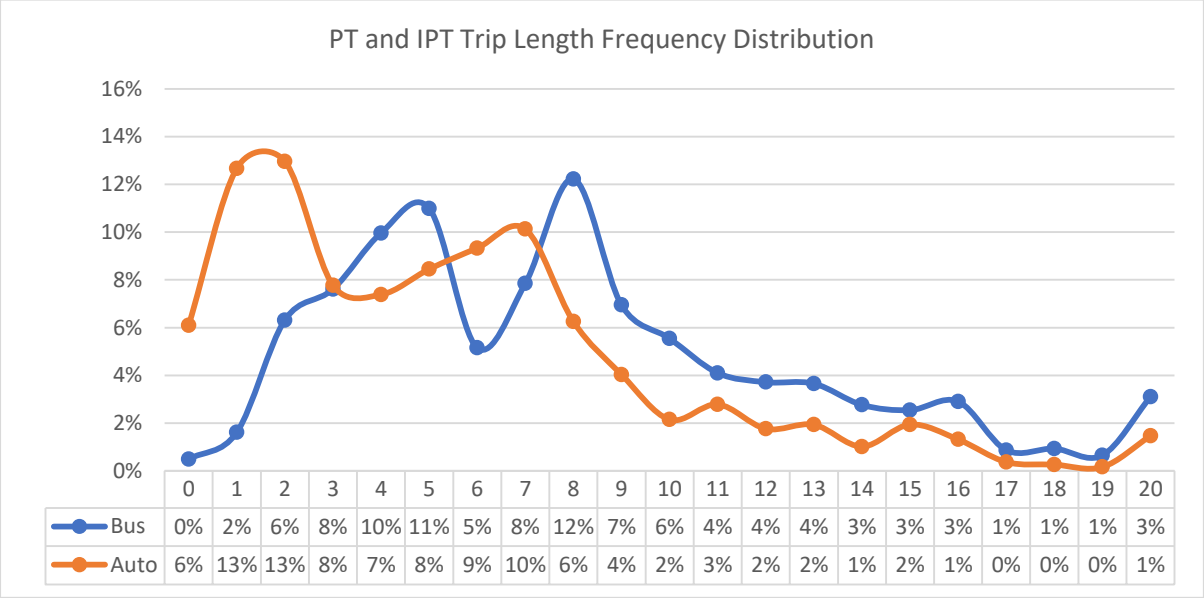


Figure 24: Travel pattern of PT and IPT users in suburban areas

The trip length frequency distribution for PT and IPT is presented in Figure 25 below. The average trip length of IPT users is about 5.8 km while for bus users is 8.5 km as obtained from the O-D survey for IPT (2019-20) and ETM data for PT (2019).

About 45% of IPT users have trip length less than 6km whereas about 40% of PT users have their average trip length greater than 9km. Analysis of trip lengths and the desire line diagram of IPT demand interactions presents high demand interactions between ISBT 43, ISBT 27 and PGI which are also covered by bus services along with significant service in the areas having poor bus service levels.



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Bus	0%	2%	6%	8%	10%	11%	5%	8%	12%	7%	6%	4%	4%	4%	3%	3%	3%	1%	1%	1%	3%
Auto	6%	13%	13%	8%	7%	8%	9%	10%	6%	4%	2%	3%	2%	2%	1%	2%	1%	0%	0%	0%	1%

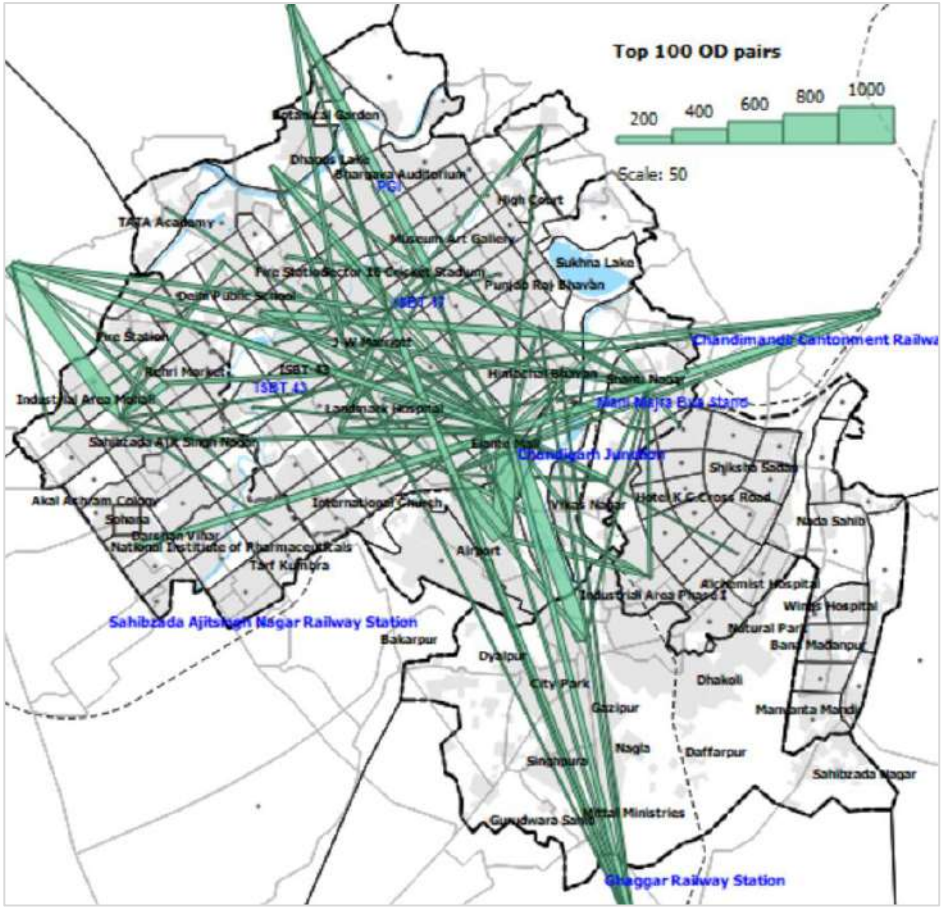
Figure 25: Trip Length Frequency Distribution for PT and IPT mode

The fare levels upto 3km is same for PT and IPT services, after which there is a fare differential by 50%. Further, it should be noted that the shared IPT services are operating along some of the major corridors. Unlike such informal services which are well established in other cities, shared IPT operations in Chandigarh are still not very prevalent. The availability is limited to certain parts of the city and headways are also quite low at around 10mins. Also, the fare levels are much higher for trip lengths greater than 3km. There is also a cap on number of auto-rickshaws to be registered in the city (6000 nos.), as a result of which it is unlikely that the share of IPT will increase significantly over the years. With a high frequency and better coverage of bus services being planned, a significant shift from IPT can be expected, especially in trip lengths greater than 3km.

2.2.12 Private Demand Pattern

As it was discussed in Chapter 2, private vehicle survey was conducted at parking locations to understand their origin-destination patterns. The OD patterns of private vehicles has also been considered while designing new PT routes.

The travel patterns of 2W and 4W users are presented in Figure 26 and Figure 27 below. The major nodes for 2W users are Industrial Phase 2, Industrial Phase 1, Ram Darbar/Tribune Colony in Chandigarh along with Industrial area and Phase 8 in Mohali. The 4 W users also perform longer trips and majority of external trips are performed by 4W users.



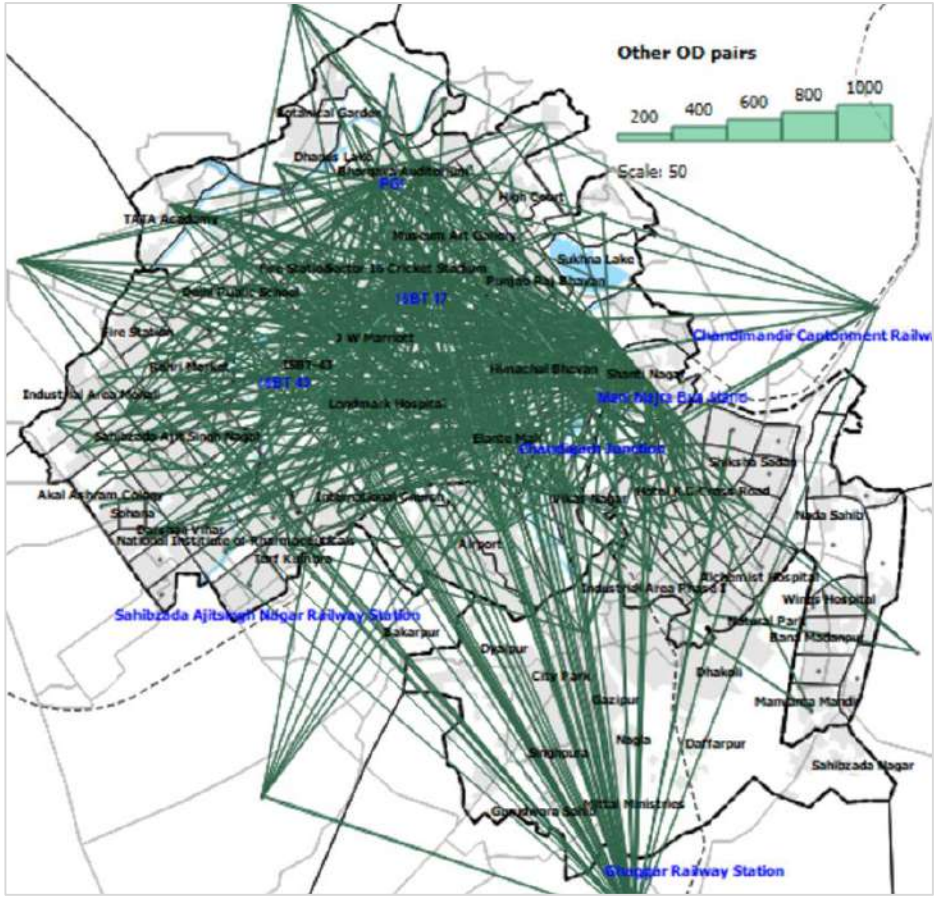
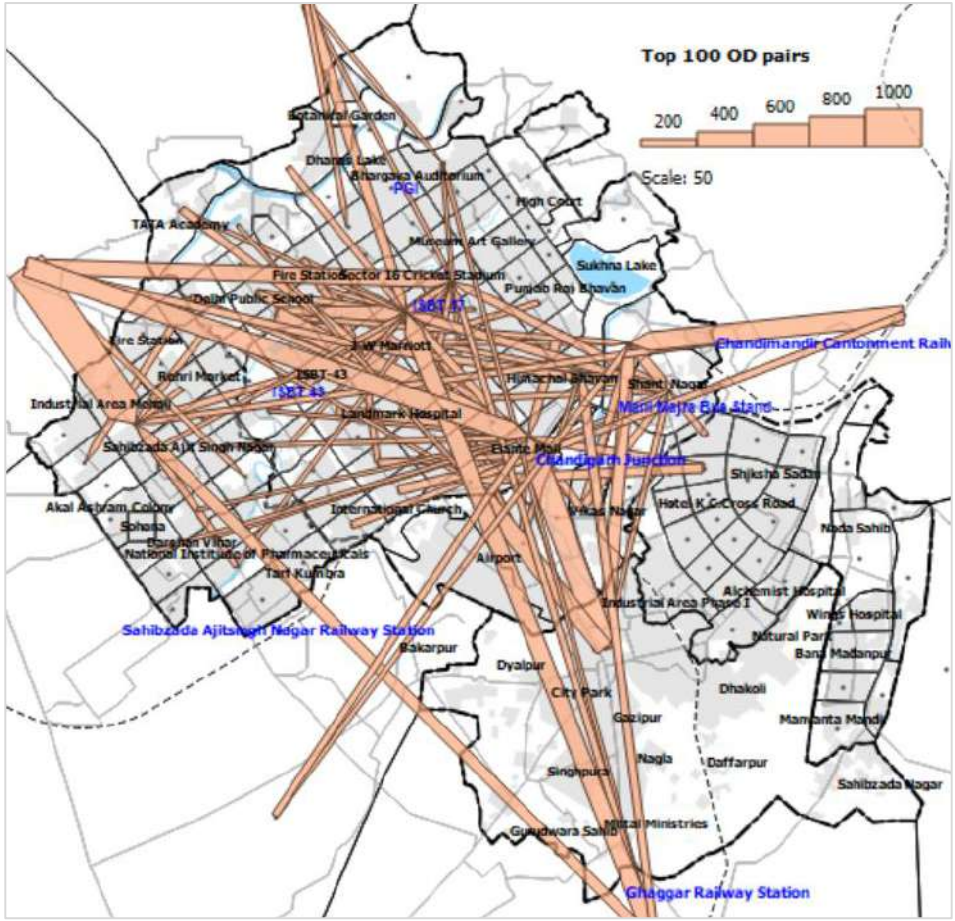


Figure 26: Travel pattern of Two-Wheeler users



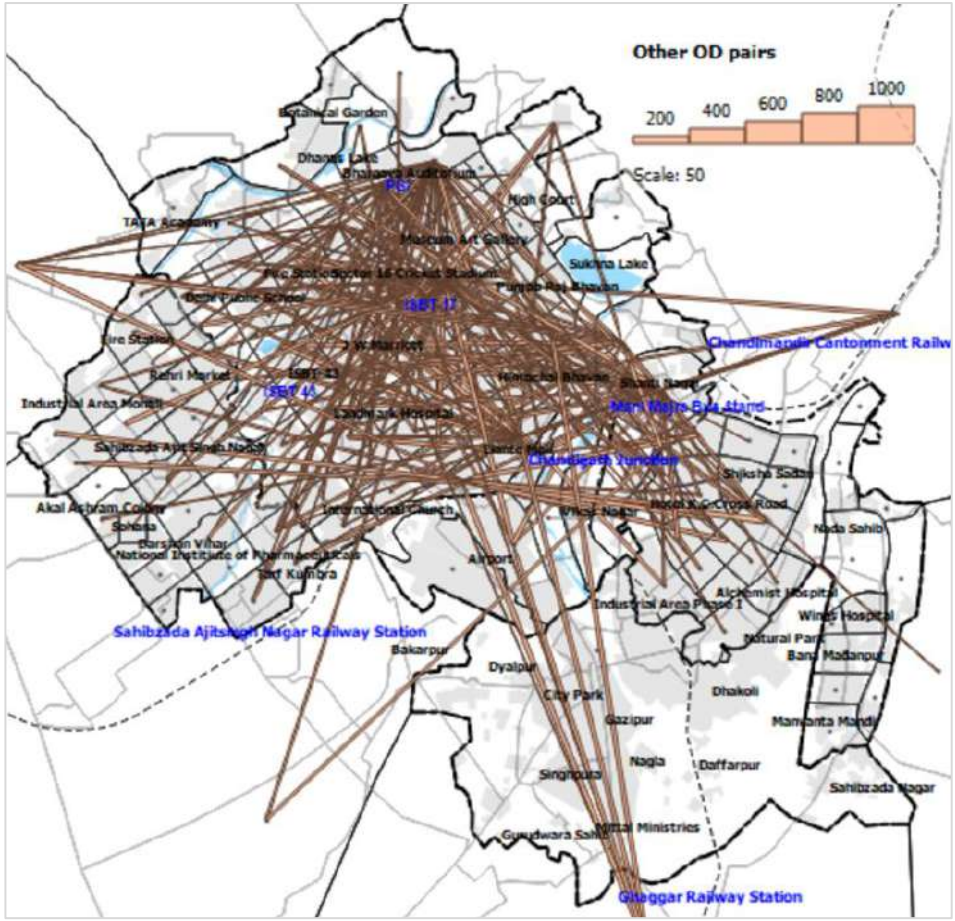


Figure 27: Travel pattern of Car users

2.3 Observations

Following observations were made based on the analysis of existing city bus services, IPT demand and private modes demand pattern within Chandigarh.

- PT is highly centralised with majority of routes originating/ending at either ISBT 43, ISBT 17 and PGI. This one-many route structure is useful in providing direct connectivity to various places in the city. Concentration of routes on some corridors in the city leads to oversupply and also creates confusion for occasional passengers. Also, the other areas in the city are not well covered, resulting in people relying on personal modes or IPT modes for travel. Instead, if the bus supply can be distributed to other part of the city, it can help attract more people on board.
- IPT desire lines show high demand interactions between ISBT 43, ISBT 27 and PGI which are also covered by bus services, however IPT caters to significant demand in the areas having poor bus service levels.
- Shared IPT routes are operating along some of the major corridors, their availability is limited to certain parts of the city and frequency is also quite low around 10mins and fare levels are around 33%-55% higher for trip lengths greater than 3km. There is also a cap on number of auto-rickshaws to be registered in the city (6000 nos.), as a result of which it is unlikely that the share of IPT will increase significantly over the years. With a high frequency and better coverage of bus services being planned, a significant shift from IPT can be expected, especially in trip lengths greater than 3km.
- About 3.1 lakhs daily trips in the city are performed either by IPT or PT mode. The share of IPT is about 66% where about 45% of total IPT users are having more than 6km of average trip length, therefore there is significant market opportunity for PT system if it can be designed appropriately. The bus routes have service headways of around 15 mins on city routes, which for urban services is not adequate. Looking at the potential demand with neighbouring cities, there is large room for modification in terms of frequent high quality service connectivity.
- Currently Bus-Bus transfers are very minimum from the survey, considering about 8.5km of trip length, PT service can be planned in such a way that most of the passengers can travel with minimum one transfer at major terminals, taking advantage of already developed terminal infrastructure. City's grid iron network also influence to make it "One Transfer City" provided with high frequency services.
- In terms of fleet size, Chandigarh would require about a total of 420-1000 buses depending on the Level of Service targeted. As per MoHUA Service Level Benchmarks, cities should have a minimum of 0.1 buses per 1000 population as per LOS3, 0.25 for LOS2 and 0.4 as per LOS1. Currently, 330 buses i.e. 0.17 buses per 1000 population, are operated by CCBSS.

2.4 Proposed Bus Network

This section presents the proposed route rationalisation scenario(s) based on certain principles and comparison of the same with respect to the existing set of routes and services.

2.4.1 Network Scenario Development

The main objective of bus route rationalisation is to improve the ridership on the public transit system by providing good spatial network overage, frequency levels and efficient services planning. The objective is not only to cater to the existing demand but also to attract more people from other modes to the bus services.

For this, two different sets of proposals are considered and compared through an evaluation framework. The following scenarios are being considered:

Business As Usual	This refers to the existing route structures and the same has been taken for the future years.
Alternative scenario 1 (Radial Routes and Loop)	In year 2015, a route rationalisation study was conducted by EMBARQ for CTU, the same has been take as alternative scenario 1. Proposal consists of a combination of radial routes and city loops.
Alternative scenario 2 A (Route Rationalisation with loops)	Based on the existing demand and network analysis, this study proposes changes in existing routes structure to cater existing demand pattern. Few routes are kept as they are or modified slightly based on existing demand analysis. In addition, few new routes have been proposed as complementary routes to cater to the city's internal demand.
Alternative scenario 2B (Route Rationalisation with grids)	This is similar to Alternative scenario 2A. In this scenario, for the uncovered areas, routes on all the grid roads in the uncovered areas are proposed (based on the Neilsen's 'Squareville' concept)

2.4.2 Business As Usual

This refers to the existing route structures and the same is considered for the future years. The alignment of each existing route is presented in Annexure 4.

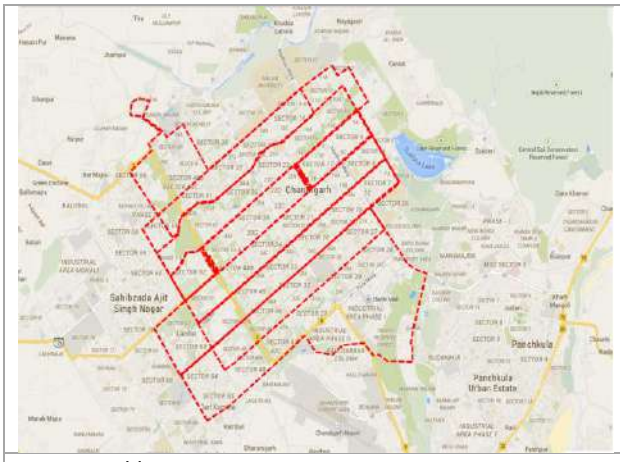
2.4.3 Alternative Scenario 1

CTU with support from EMBARQ India has prepared the city bus route rationalisation proposal for city and sub urban services. The bus routes were planned in such a way that it provides extensive network coverage connecting major origin and destinations along with a reliable and frequent bus service in shortest possible time from anywhere in the city. The basic principle adopted for route rationalisation were[1]:

- Loops (circular routes) - clock and anticlockwise
- Route length not to exceed 18 km in most cases
- Travel time not to exceed 1 hour
- 1 transfer to travel to any point in the city
- Major nodes to be connected via frequent services
- Retained the existing well performing routes

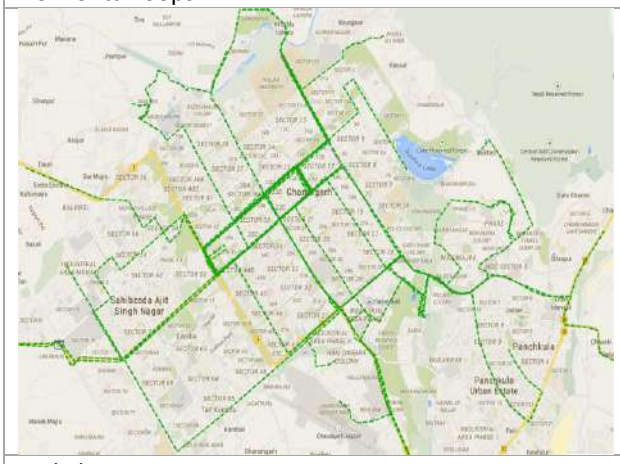
[1] EMBARQ, India

This was a completely new structure of routes which was the combination of loops and radial routes. Radials were mostly proposed to connect sub urban area to city centre. Loops were proposed for city area.

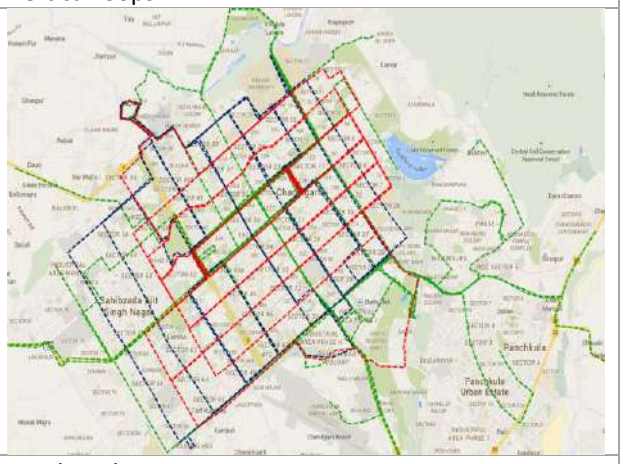


Horizontal loops

Vertical loops



Radial routes



Combined route structure

Figure 28: Proposed routes/ network (Scenario 1)
Source: Embarq, India

Total 35 routes were proposed as presented in Figure 28 above with 7 horizontal loops, 7 vertical loops and 21 radial routes. About 80% of the routes have moderate frequency (10 - 20 mins) which is quite similar to the existing services.

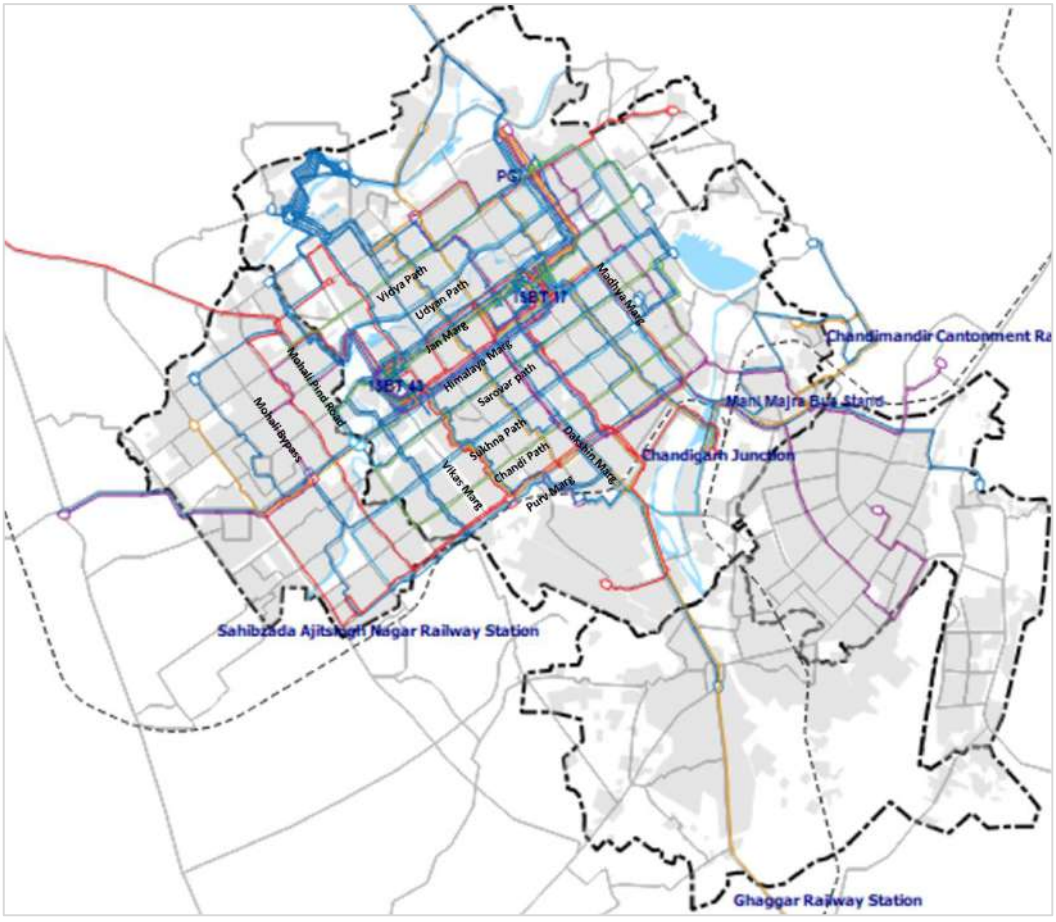


Figure 29: Route Structure for Scenario 1
Source: Model coding by CoE-UT, CRDF

This route structure was coded in model (shown in Figure 29 above) and presented overlapping of routes on Jan Marg and Himalaya Marg between ISBT 17 and ISBT 43. The study was conducted in 2015, therefore speed is also modified in line with current level of bus speed to compute the fleet size. The estimated fleet size is 373 by retaining the same proposed headway.

2.4.4 Alternative Scenarios Proposed

Two sets of scenarios are proposed for which following principles are taken into consideration.

2.4.4.1 Route Design and Planning Principles

The existing route structure in the city can be characterised as numerous lines on a few corridors leading to over bus supply on a few routes, focus on provision of direct services which are routed through the city centre, lesser travel opportunities in other parts of the city. In comparison the rationalised routes would focus on provision of direction based services with opportunity to travel directly with one/ max two transfers, decongesting the city center/ existing terminals and adding travel opportunities in the uncovered areas of the city.

Key principles for the route design are outlined below:

A. Network Structure: This depends on city structure, in the ring radial city, arterial rings and radial becomes trunk corridors and rest becomes feeder. Looking at Chandigarh network structure, land

use and travel demand, there is no clear trunk and feeder corridors. Chandigarh is a planned urban city with average trip length of around 8.5 km on PT and has strong interaction with the suburbs like Mohali, Panchkula, Zirakpur and Kharar. The major terminals ISBT 43, ISBT 17 and PGI are connected to major demand nodes in the city and the suburban areas. While these would be retained, connectivity in other areas would also be supplemented.

B. Coverage: The city bus network would attempt to cover more than 90% of the developed area, so that bus services are available to the residents within easy reach (5-7 minutes of walking distance). Such a supply based approach is suggested to attract more people towards public transport.

C. Frequency of services: Apart from area coverage, a certain minimum level of bus services would be provided, so that people have travel opportunities even in areas which have low level of demand. A minimum frequency of 3-4 buses/hour would be considered for any urban service. Apart from this, consolidation of routes along major demand corridors would be done so that passengers get frequent and "simple to understand" bus services. By looking at the demand, it may not be worth for few routes to operate buses at high frequency but as an urban bus service, it is preferable to have not more than 20 minute headways.

D. Network simplicity: Too many bus routes increase confusion for passengers and makes it difficult for new passengers / occasional users to understand. The network structure would therefore be simple with direct connections between important areas of travel demand. The routes would follow direct and short connections rather than trying to cover all market segments on the way with detours, making journeys slow and uncomfortable.

E. Transfers: Providing easy transfer opportunities for passengers wanting to use multiple services in a single journey is important. A quick and convenient transfer supports fast journeys to dispersed destinations within a public transport network. Provision of high frequency bus services requires minimal coordination with other routes.

2.4.4.2 Proposed Route Scenarios (Scenario 2A&B)

The following Table 34 presents the approach for the formulation of the two route rationalisation scenarios. The route rationalisation was undertaken in four stages. It can be seen that largely the two options are similar except for the minor difference in stage 4. The route rationalisation approach is presented below;

Table 34 Proposed route scenarios

Stages	Alternative scenario 2 A (Route Rationalisation with loops)	Alternative scenario 2B (Route Rationalisation with grids)
Stage 1: Existing routes and demand profile on the routes	Improvements to the existing routes based on the line load profile.	
Stage 2: Existing network structure and overlap analysis	Consolidation of routes where there is duplication of services which would help in creating high frequency networks and easy to identify services from user perspective.	

Stages	Alternative scenario 2 A (Route Rationalisation with loops)	Alternative scenario 2B (Route Rationalisation with grids)
Stage 3: Major demand centres based on IPT and Private demand interactions	Providing for major demand interactions not covered by bus services currently	
Stage 4: Supply based approach for the uncovered areas to attract passenger demand	Identification of complementary loop routes	Routes are proposed based on Neilsen's Squareville concept for grid-iron network structures. High frequency services on all major horizontal and vertical grids are proposed providing interchange opportunities at all junctions.

Figure 30 below shows the 'Squareville' concept, which appears to be a good fit for the city of Chandigarh given the grid-iron city structure. Each red and green lines represent one single route, and each node represents transfer point between routes.

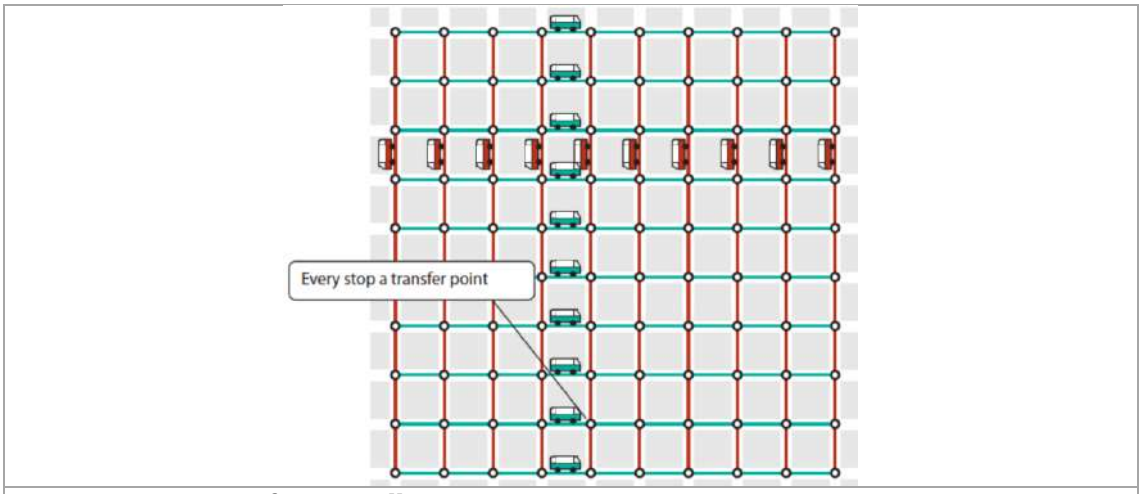


Figure 30: Concept of Squareville

2.4.4.3 Route types

The above points can be summarised as a set of following route types adopted as part of route rationalisation:

Route types	Description
Sub urban routes	The sub urban routes have been proposed first, most of these routes are unchanged with minor modifications if required. Few existing suburban routes are consolidated, extended and truncated to make the structure more clear. However the main objective of connecting sub urban/ neighbouring towns with major city nodes/ terminals along with high/ moderate frequency services have been addressed.
High demand city routes (Figure 31)	Demand routes are high demand city routes which are more or less same as existing with minor modifications, if required.
Terminal / Express Routes	All the terminals such as ISBT43, ISBT17, PGI, Mani Majra, ISBT Mohali and ISBT Panchkula are connected with terminal routes with high frequency to facilitate easy transfers.
Loops	For Alternative Scenario 2A, new loops are proposed as complementary routes covering city areas with less demand and/or no existing services. These loops are short covering small area and providing services within the neighbourhood, i.e. connecting 4-5 sectors in a single loop to serve shorter trip length passengers.
Grid routes (Squareville)	For Alternative Scenario 2B, Squareville concept is used to cover remaining area with the services. Loops may create confusion to passengers therefore a few straight routes have been

	proposed on city grids increasing area coverage. Such straight routes may also be simple and clear to understand by passengers.

2.4.4.4 Key Steps for Route Rationalisation

Based on the principles and approach outlined in section above, about 45 to 50 routes have been proposed. The key steps adopted are as below:

1. Retaining existing high demand PT routes without any major modification to ensure not to disturb major passenger flow. Most of these PT routes are connecting major terminals such as ISBT43, ISBT17, PGI and Mani Majra. Few neighboring town connecting routes have also been identified such as Panchkula, Zirakpur, and Kharar. To avoid disturbing the existing passengers, these high demand routes have been retained with slight modification in alignment, curtailing or extending same route in some cases.
2. Connecting neighbouring towns or sub urban areas with major city terminals/ nodes and providing frequent services to ensure good connectivity for the commuting population.
3. Consolidating routes along major corridors to reduce the number of overlapping of routes and simplify route structures
4. Based on the IPT demand pattern, provide routes in the major demand interaction zones.
5. Based on the private vehicle demand pattern, identified OD pairs with major interactions and propose new routes.
6. New loops and Squareville routes have been proposed to improve the coverage and provide complementary movement within city.
7. Because of the grip iron pattern and longer trip length, transfers would be inevitable in the city. However, route structure has been proposed in a way to have seamless transfers.

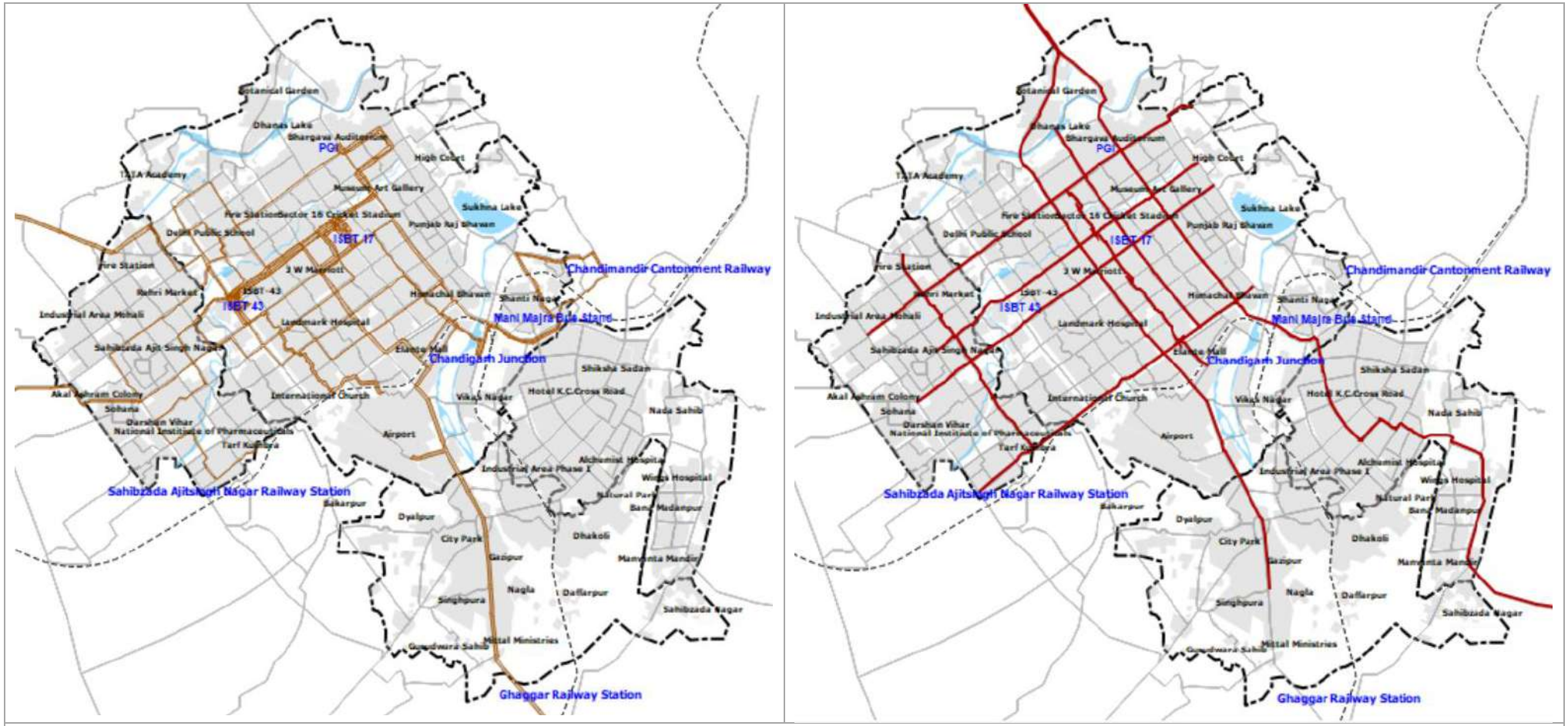
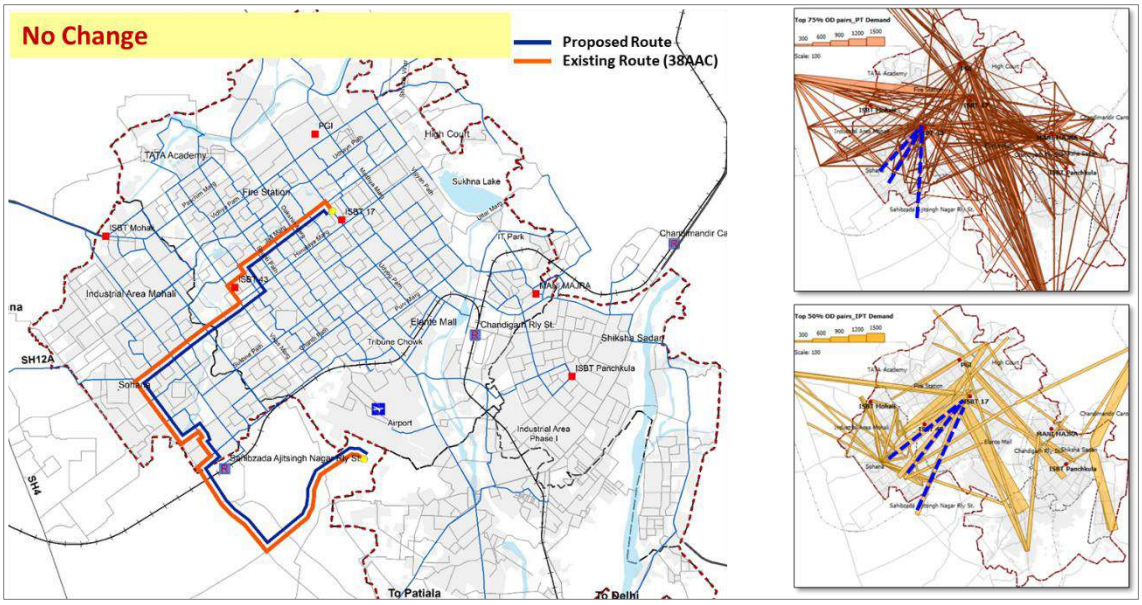
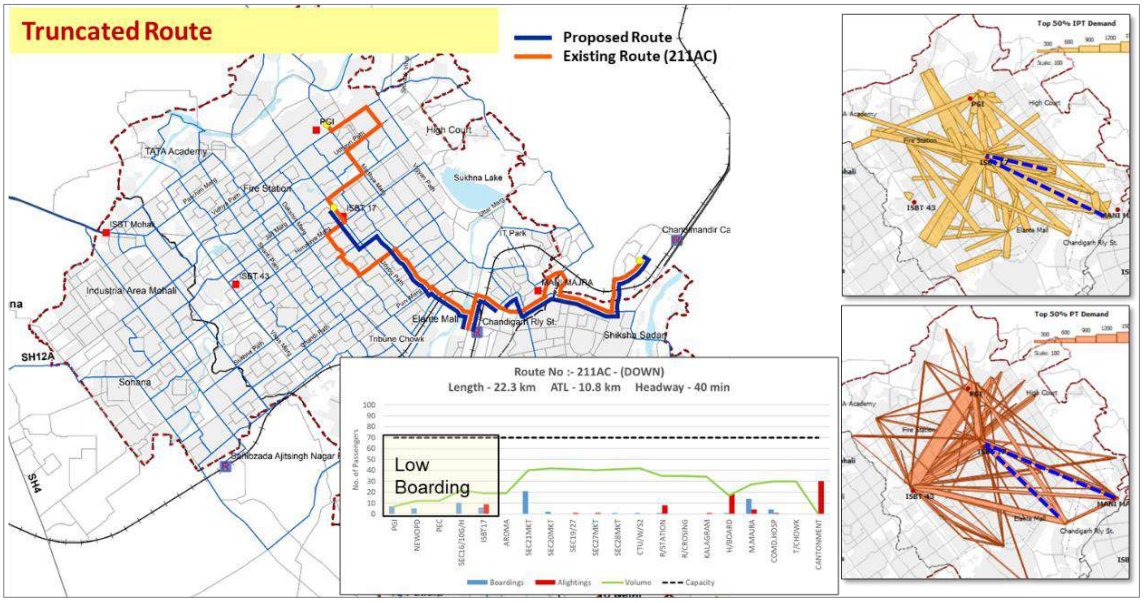
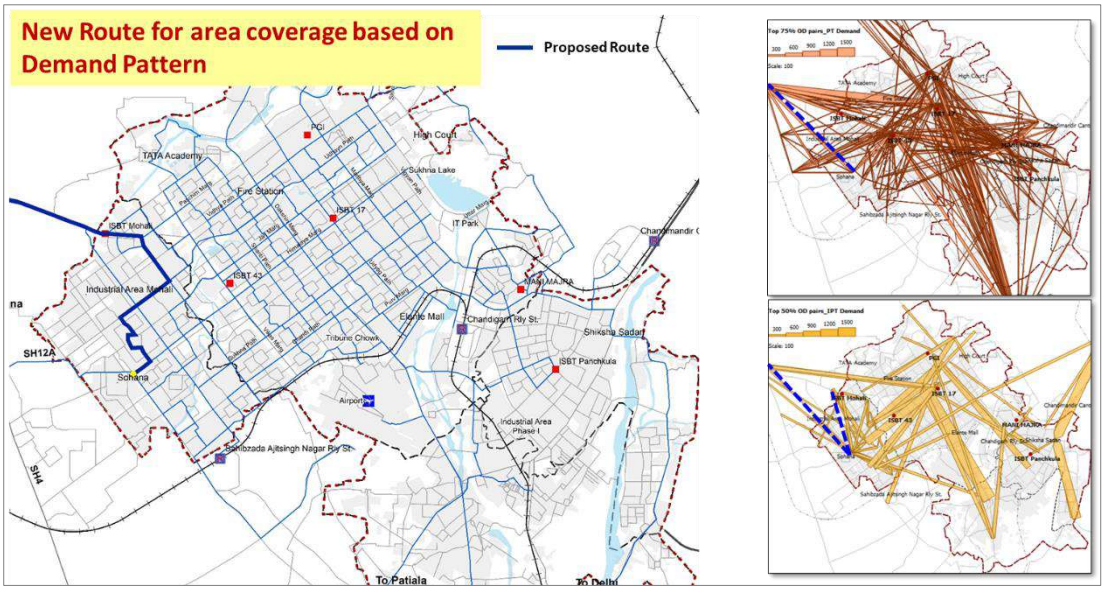


Figure 31: Existing high demand PT routes and IPT network

Few examples of route modifications based on above principals are presented in Figure 32 below.







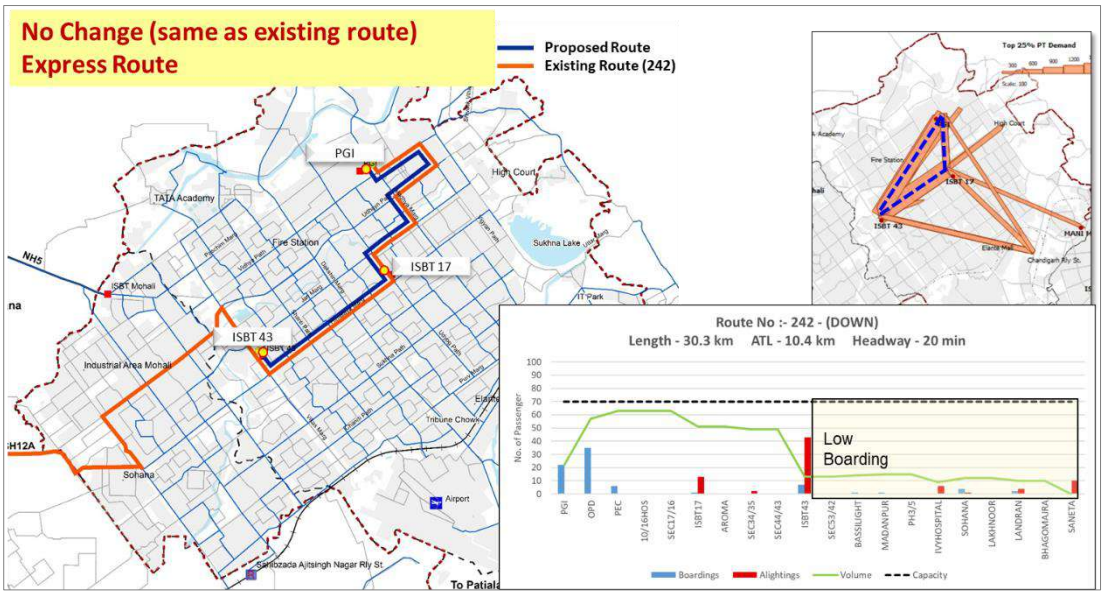
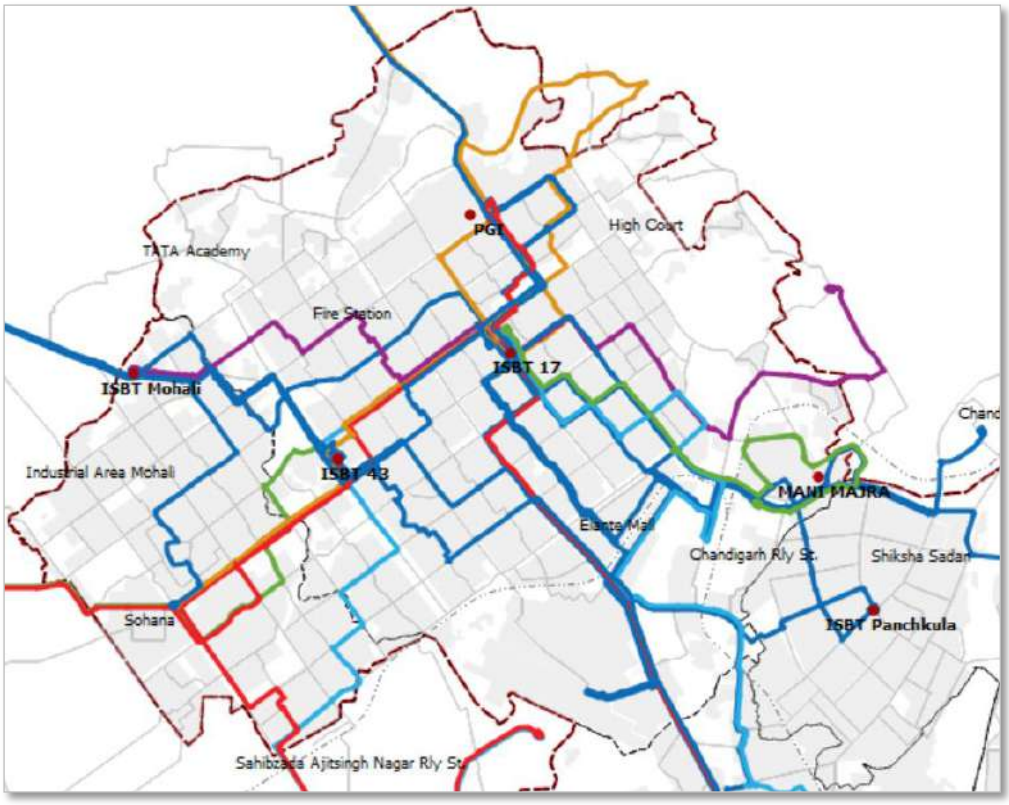
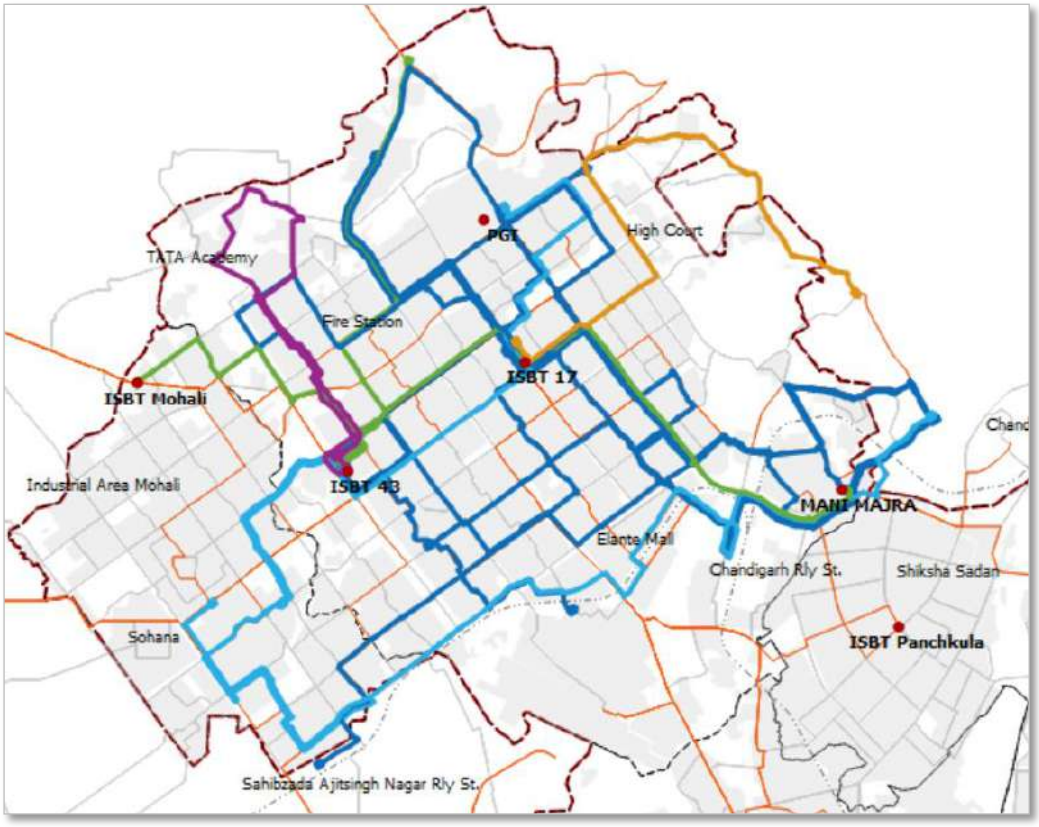


Figure 32: Examples of route modifications

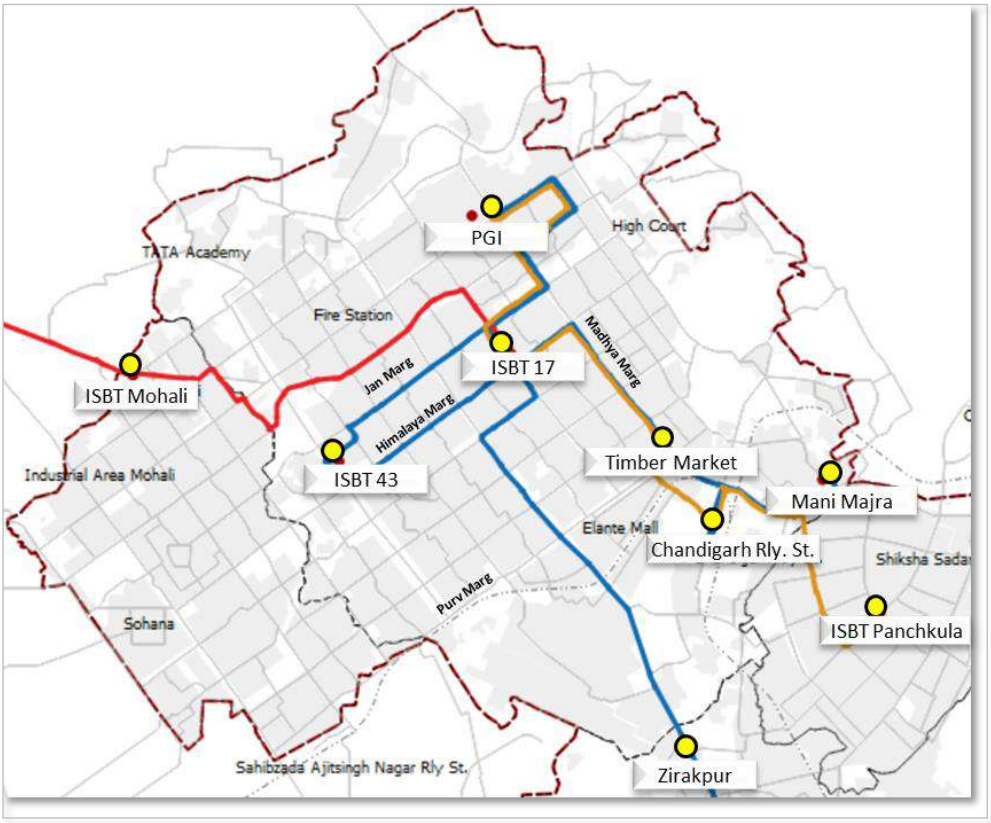
Figure 33 below presents the proposed routes by its category;



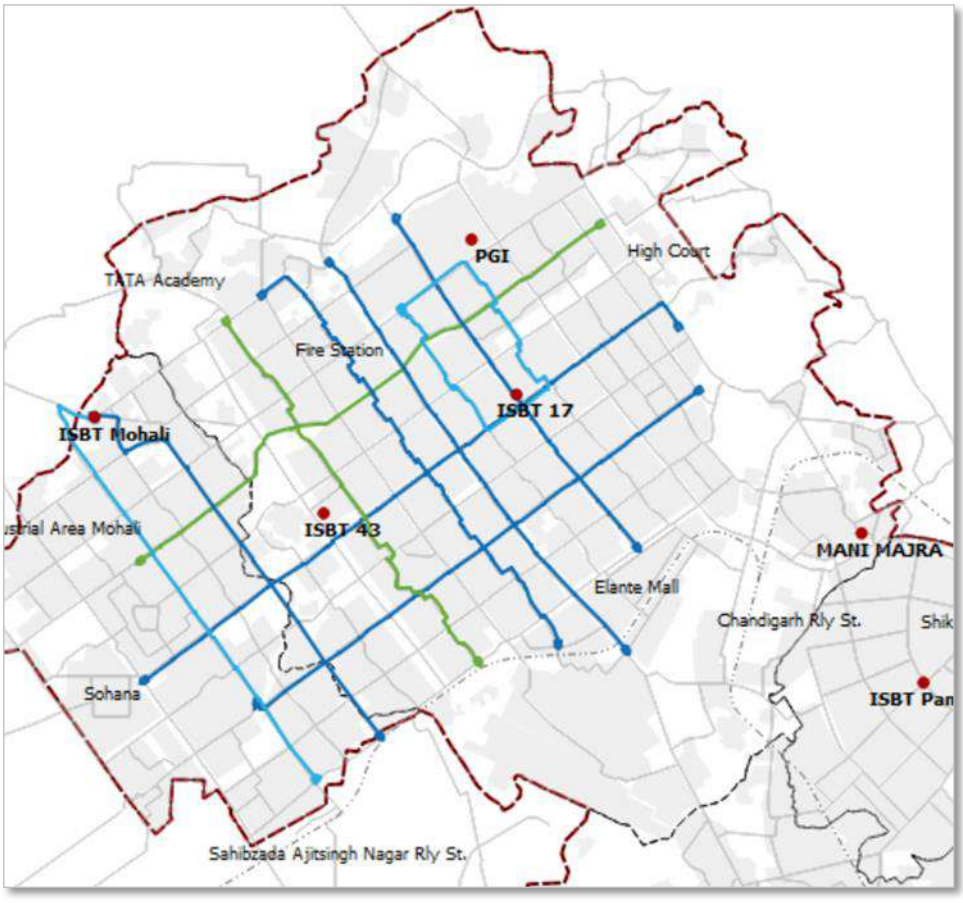
Sub urban routes – 25 routes



City routes – 14 routes



Terminal/Express Routes – 5 routes



Linear routes – 10 routes

Figure 33: Proposed routes by category

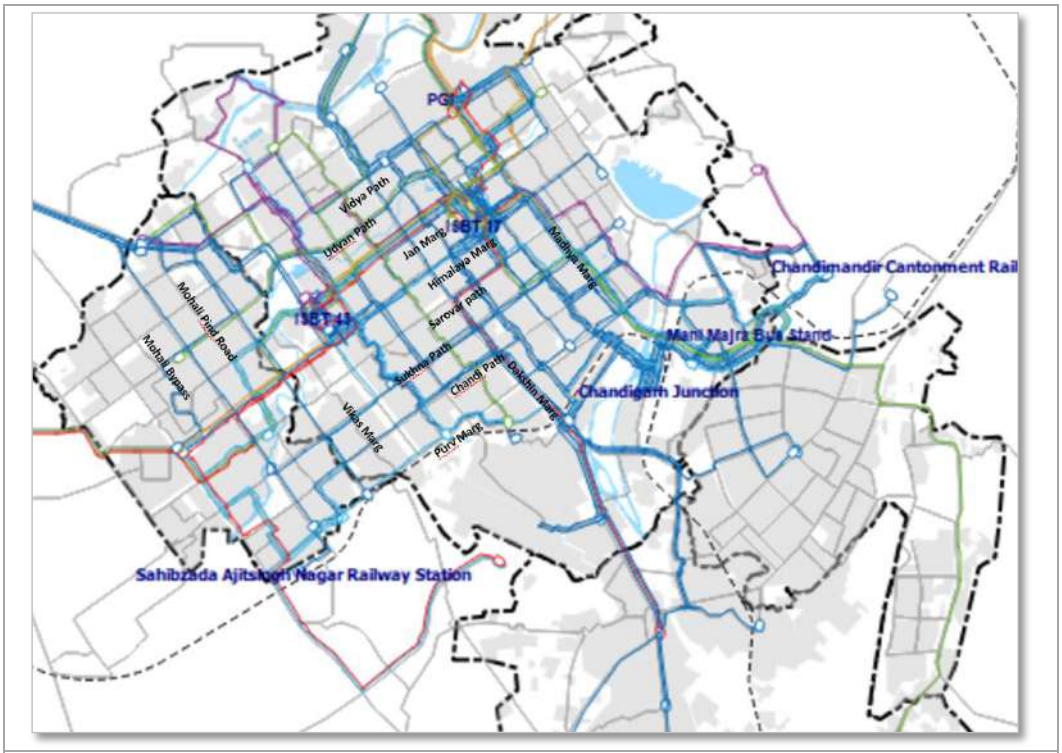


Figure 34: Proposed routes structure

Figure 34 above shows the proposed routes structure and detailed route list is presented in Table 35 below.

Based on the future potential demand, required number of buses i.e. standard and midi buses has been estimated for FY2023, FY2025 and FY2030. FY2023 is considered as the year when all the proposed routes would be implemented with the given service headways. Alignment of each proposed route is given in Annexure 5.

Table 35: Details of proposed bus routes

EMME Code	Route No.	Service type	Description	Length (km)	Remarks
Suburban Routes					
SU13	1	Suburban	ISBT Mohali - ISBT 17 - Sukteri	25.7	Extended (C35)
SU12	2	Suburban	Sohna Gurudwara - ISBT 43 - ISBT 17 - PGI - Khizrabad	34.6	Extended (C40)
SU11	3	Suburban	ISBT 17 - ISBT 43 - Airport	21.9	Same Route (C38AAC)
SU10	4	Suburban	ISBT 17 - Railway Station - Cantonment	14.8	Curtailed (C211AC)
SU9	5	Suburban	ISBT 43 - Tribune Chowk - Derabassi	24.4	Curtailed (C213)
SU8	6	Suburban	ISBT 17 - PGI - Khizrabad	24.6	Same Route (C25A)
SU7	7	Suburban	ISBT 17 - Mani Majra	13.7	Curtailed (C2A/C2C)
SU6	9	Suburban	ISBT17 -Railway Station -Dhakoli	19.2	Modified Alignment (C26AC)
SU3	11	Suburban	ISBT 17 - Mani Majra - Derabassi	29.4	Curtailed (C32)
SU2	12	Suburban	PGI - ISBT 17 - Derabassi	26.2	Curtailed and Extended (C216AC)
SU15	13	Suburban	Kharar - ISBT 43 - ISBT 17 - Airport	29.8	Same Route (C35B, C17)
SU16	14	Suburban	ISBT 43 - Landran - Kharar	20.9	Curtailed (C20A)
SU17	15	Suburban	ISBT 17 - PGI - Nayagao - ISBT 17	17.7	New Route
SU19	17	Suburban	Sohna Gurudwara - ISBT Mohali - Kharar	13.4	New Route
SU20	18	Suburban	PGI - ISBT 17 - Zirakpur	15.2	Modified Alignment (C26AC)
C38AC	20	Suburban	ISBT 17 - ISBT43 - New Airport	21.1	Modified Alignment (C38AC)
C213	21	Suburban	ISBT43 - Landran	12.1	Curtailed (C213)
SU2E	12E	Suburban - Express	PGI - ISBT 17 –Zirakpur - Derabassi	26.2	Curtailed and Extended (C216AC)
I1	31	Suburban - Terminal	PGI - ISBT Mohali - Kharar	20.8	Modified Alignment (C35)
I4	30	Suburban - Terminal	ISBT Mohali-ISBT 43	5.2	Curtailed (C35B)
SU4	35	Suburban - Terminal	ISBT 17 - CTU Workshop - Panchkula	14.2	Curtailed (C2F)

EMME Code	Route No.	Service type	Description	Length (km)	Remarks
I1E	31E	Suburban - Terminal - Express	ISBT17 - ISBT Mohali – Kharar	15.5	Modified Alignment (C35)
SU4E	34E	Suburban - Terminal - Express	PGI - ISBT 17 – Grain Market – Chandigarh Railway Station – ISBT Panchkula	13.1	Curtailed (C2F)
City Routes					
SU14	8	City	ISBT 17 - PGI - Mullanpur Barrier - ISBT 17	18.9	Curtailed (C2A/C2C)
SU18	16	City	ISBT 43 - Maloya Colony	11.5	New Route
SU21	19	City	ISBT 17 - High Court - Kaimbwala	12.5	Curtailed (C8)
C9C	22	City	Sohna Gurudwara - White House - Mata Mansa Devi	22.8	Curtailed (C9A/C9C)
C5A	24	City	Ramdarbar - ISBT43 -PGI - ISBT43	34.4	No change (C5A/C5C)
C241	25	City	ISBT 43 - CTU Workshop - Mata Mansa Devi	23.0	No change (C241)
C2D	26	City	Mata Mansa Devi - ISBT17 - Dhanas	14.6	Modified Alignment (C2D)
C8	27	City	ISBT17 - SAS Railway Station	11.8	Curtailed (C8)
C12	28	City	ISBT43- Mohali Municipal Corporation - Phase11	16.7	Curtailed (C12)
C551E	29E	City - Express	ISBT43 – ISBT 17 - PGI	10.5	Curtailed (C242)
I2	33	City - Terminal	PGI - ISBT17 - ISBT 43 - Fortis Hospital	15.7	Curtailed and Extended (C28C)
C22	36	City - Terminal	ISBT 17 - Railway Station - Mata Mansa Devi	16.4	Curtailed (C22)
Grids for Scenario 2B					
V3	53	Grids	V3_Sector40 Market Rd	8.2	New Route
V4	54	Grids	V4_Daddu Majra Rd	9.9	New Route
V5	55	Grids	V5_Dakshini Marg	8.6	New Route
V7	57	Grids	V7_ISBT17 - Sector25	9.4	New Route
H1	58	Grids	H1_Udyan Path	11.4	New Route
H2	59	Grids	H2_Himalaya Path	11.2	New Route
H3	60	Grids	H3_Sukhna Path	10.9	New Route

2.5 Service Plan Output

An evaluation framework has been prepared which considers few indicators - supply indicators, demand-supply gap, transfer rate, and Service Level Benchmark (SLB) criteria by MoUHA. The detailed evaluation description and results are presented in the Annexure 6. The detailed service plan output and process was also discussed with CTU/ CCBSS and was decided to take that up for further Business Plan study. The list of proposed routes is presented in Annexure 7. The key outcomes of the evaluation of the three scenarios are presented below. Scenario 2B performed better in comparison to the other scenarios.

- Similar network lengths; however more than 95% of bus stops have high frequency routes (<=10min headways) compared to 48% in Scenario 1.
- 85% and 91% PT network with high frequency of 10 min in the study area compared to only 6% and 7% in Scenario 1. 77% and 91% population served with high frequency routes compared to only 11% and 14% in Scenario 1.
- Reduced bus overlaps, routes having wider coverage and better distribution of bus supply in different parts of the city network
- With high trip length of about 8 km compared to city size, Scenario 2 offers more direct services resulting in optimum transfer rate.
- There are loops proposed in Scenario 2A, which may not be easy to understand from passenger perspective; however all the supply indicators are nearly same between Scenario 2A and 2B. Because of the loops, route length is longer, may result in larger fleet requirements in comparison to Scenario 2B.

3 Bus Service Infrastructure Plan

3.1 Existing infrastructure facilities

The Chandigarh City Bus Services (CCBSS) serves a total of 179 km in the city limit of Chandigarh which covers about 43% of road network with 198 bus stops. (Refer Figure 35 below)

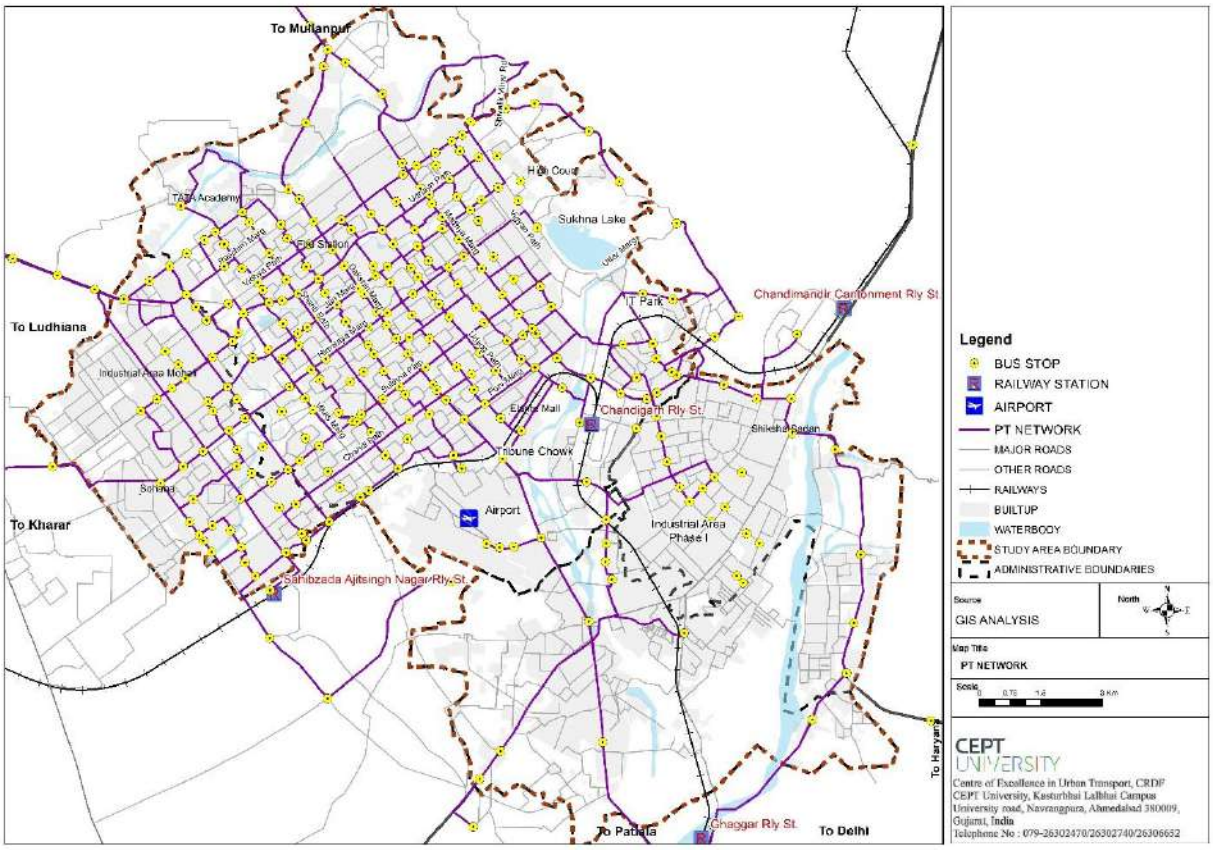


Figure 35: PT network and bus stops (2020)

Chandigarh has a total fleet of 435 buses, of which an average of 330 buses run on local routes in the city out of which about 200 buses are midi mostly operating from Depot 2 and few from Depot 3. As per the MoHUA's Service Level Benchmarks in Urban Transport, Chandigarh would require about a total of 440-1000 buses depending on the Level of Service targeted (refer section 2.2). Currently, 330 buses i.e. 0.17 buses per 1000 population, are operated by CCBSS.

3.2 Bus Stops

There are a total of 198 existing bus stops in Chandigarh city. Figure 36 below shows a one bay bus stop in Chandigarh.

Figure 36: An illustration of proposed bus stop design

To improve the accessibility in the city, an average stop-stop distance is taken 350 – 400m within developed area. 84 new bus stops are proposed in the city to improve the service coverage. The bus stop locations as shown in Figure 37 below are tentative locations. Final locations shall be decided based on following criteria after site feasibility.

1. **Availability of RoW:** All locations on roads with 18m and above ROW were considered for development of a bus stop.
2. **Adjacent Land use:** Activities around each location was taken into consideration for potential local demand and rationale of space availability.
3. **Distance between stations:** the distance between stations were planned to be between 300m to 500m on proposed PT network length over built up area.
4. **Stop accessibility**: A complete development of bus stop area is recommended along with bus stop including access to bus stop

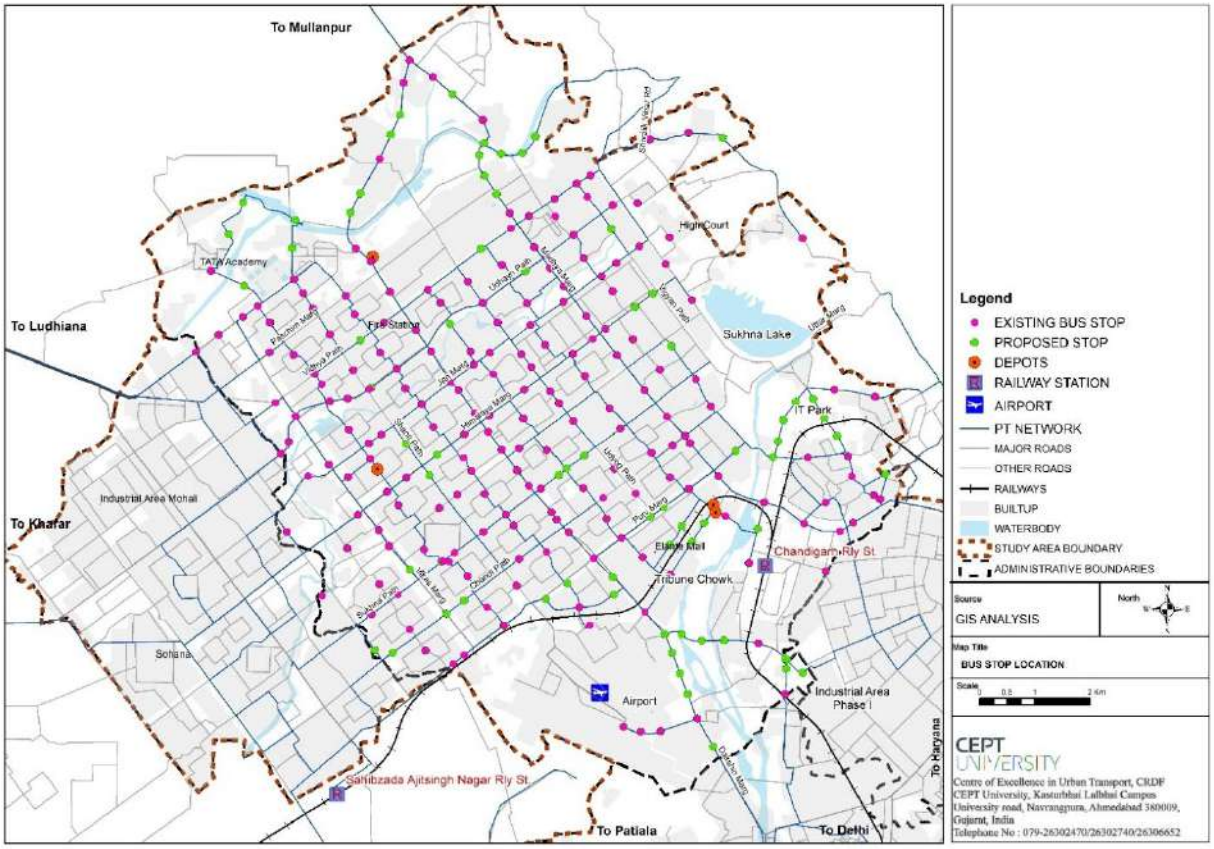


Figure 37: Existing and proposed bus stops in Chandigarh

The bus stops have been further classified as mentioned (Figure 38 below). Year wise stops with no. of bays is presented in Table 36 below.

- **One bay bus stop:** One bay bus stop has been proposed within Chandigarh at places are passing and the bus frequency is less than 30 buses per hour.
- **Two bay bus stops:** Two bay bus stop has been proposed at places where in the bus frequency is less than 60 buses per hour.
- **Three bay bus stops:** Three bay bus stops have been proposed at places where in the bus frequency is more than 60 buses per hour.

Table 36: Number of bus stops by type within city for year 2023

No of Bays	2023	2025	2030
1	252	242	231
2	3	12	22
3	3	4	5

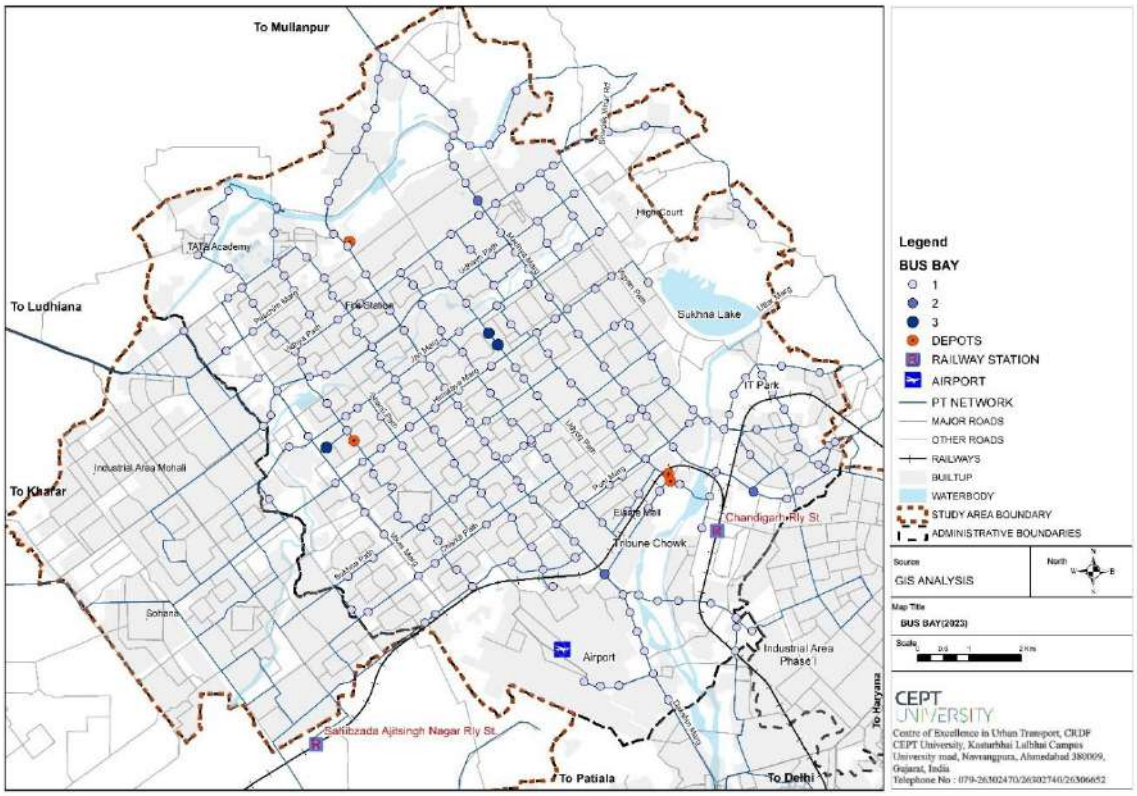


Figure 38: Stop locations by number of bays (Proposed)

3.3 Terminals

The city and the surrounding sub urban towns have four major terminals. The locations of these are also very strategic providing connectivity to the entire city as shown in Table 37 below.

Table 37: Existing Terminal

ISBT 43	This is biggest regional terminal in Chandigarh city situated at sector-43 near the judicial academy. Both ordinary and AC services for Intercity and Sub-Urban are plying from this location. Also interstate services for Punjab, Haryana, Uttarakhand by Paonta Sahib, Himachal and J&K. State HVAC Volvo and Integral Coach Buses of Private, Punjab Roadways P.R.T.C are also plying from this location to various cities of Punjab and Himachal.
ISBT 17	It is located at sector-17 adjacent to Parade ground/ District Courts in Chandigarh city and is another major terminal in Chandigarh. Buses Services for Delhi, Haryana, UP and Rajasthan also operates from this terminal along with intercity and suburban bus services.
ISBT Mohali	Routes from ISBT Mohali are operated by Punjab Roadways and are regional routes, currently, city bus services are not operational in Mohali.
ISBT Panchkula	This is major terminal for Haryana roadways operating both city and regional routes in Panchkula.

Figure 39 below shows the terminal locations.

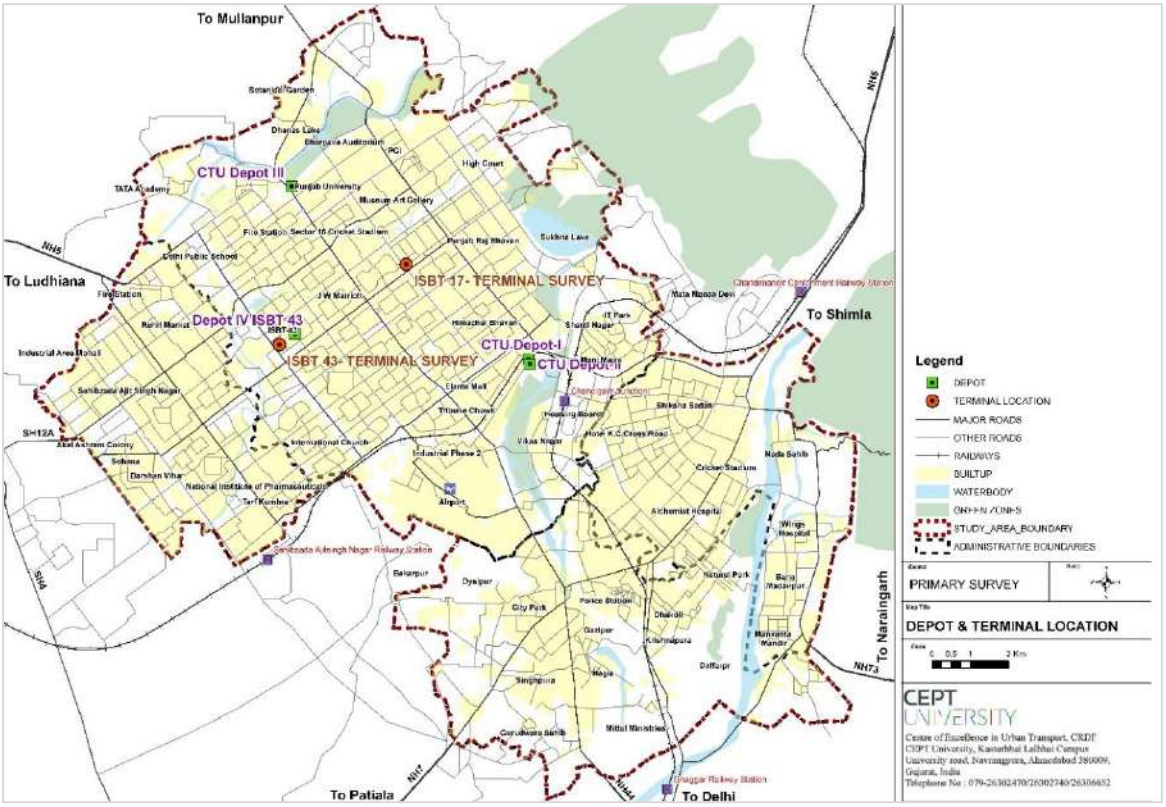
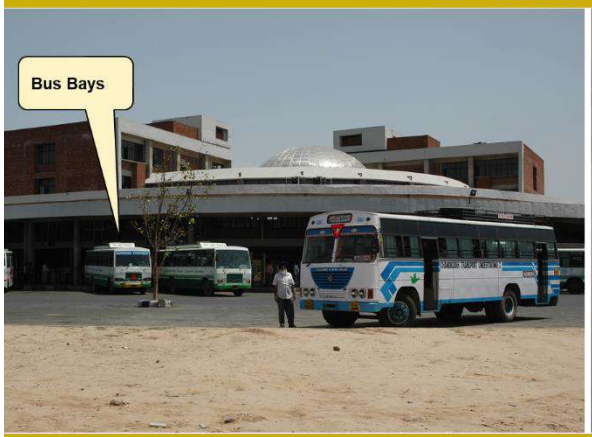
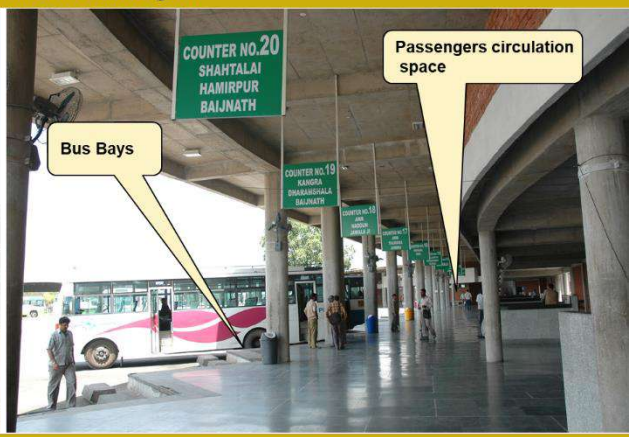


Figure 39: Depots and Major Terminal in the city

Figure 40 below presents visual images of existing city bus service infrastructure facilities. The infrastructure conditioned good at ISBT 43 bus lacks adequate signages for passenger circulation. It also lacks PIS and way finding facilities. The infrastructure condition at ISBT 17 is unattractive and lacks user friendly facilities like way finding and other information system. Also the bus stops have little bus related information and at some stops there is no information at all.

ISBT 43 bus terminal in Chandigarh





Good condition of infrastructure facility;
Large circulation space with lack of passenger information and way finding system

Figure 40: Existing infrastructure facilities in Chandigarh

3.4 Interchanges

The formal transit nodes in and around Chandigarh are: airport, rail station, regional bus terminals and city bus stops. Following 51 interchanges (Figure 41 & Table 38) are identified in the city based on the proposed route structuring:

Table 38: Interchanges in Chandigarh

Interchange types	
Airport + City Bus	
1. New Airport 2. Old Airport	
Railway + City Bus	
3. Chandigarh Railway Station 4. SAS Nagar Railway Station (Mohali)	
Regional Bus +City Bus	
5. ISBT 43 6. ISBT 17	
City Bus + City Bus	
7. Airport Chowk 8. Sector 48/49	29. Furniture Market Chowk 30. Sector 26 Market

Interchange types	
9. Vikas Nagar 10. Sector 47 11. Hallo Majra 12. Industrial Area Phase 2 13. Tribune Chowk 14. Industrial Area Phase 1 15. Housing Board 16. Sector 32 Hospital 17. CTU Workshop 18. Sector 52/51 19. Phase 7/3 20. Sector 33/32 21. Railway Crossing 22. Mani Majra FR 23. Sector 28 Petrol Pump 24. Sector 43 Market 25. Shivalik Park 26. Sector 21/20 27. Sector 26 28. Mata Mansa Devi	31. Sector 35/36 32. Phase 1 33. Aroma 22/21 34. Kisan Bhawan 35. Sector 40/41 36. Sector 36/37 37. Sector 23/22 38. Sector 18/17 39. Sector 16/17 40. Sector 9/17 41. Maloya 42. Sector 15/24 43. Sector 24/25 44. Sector 39/38 West 45. Sector 11 46. Daddu Majra Colony 47. Sector 11/10 48. PGI 49. Nayagaon 50. Khudda Lahora 51. Mullanpur Barrier

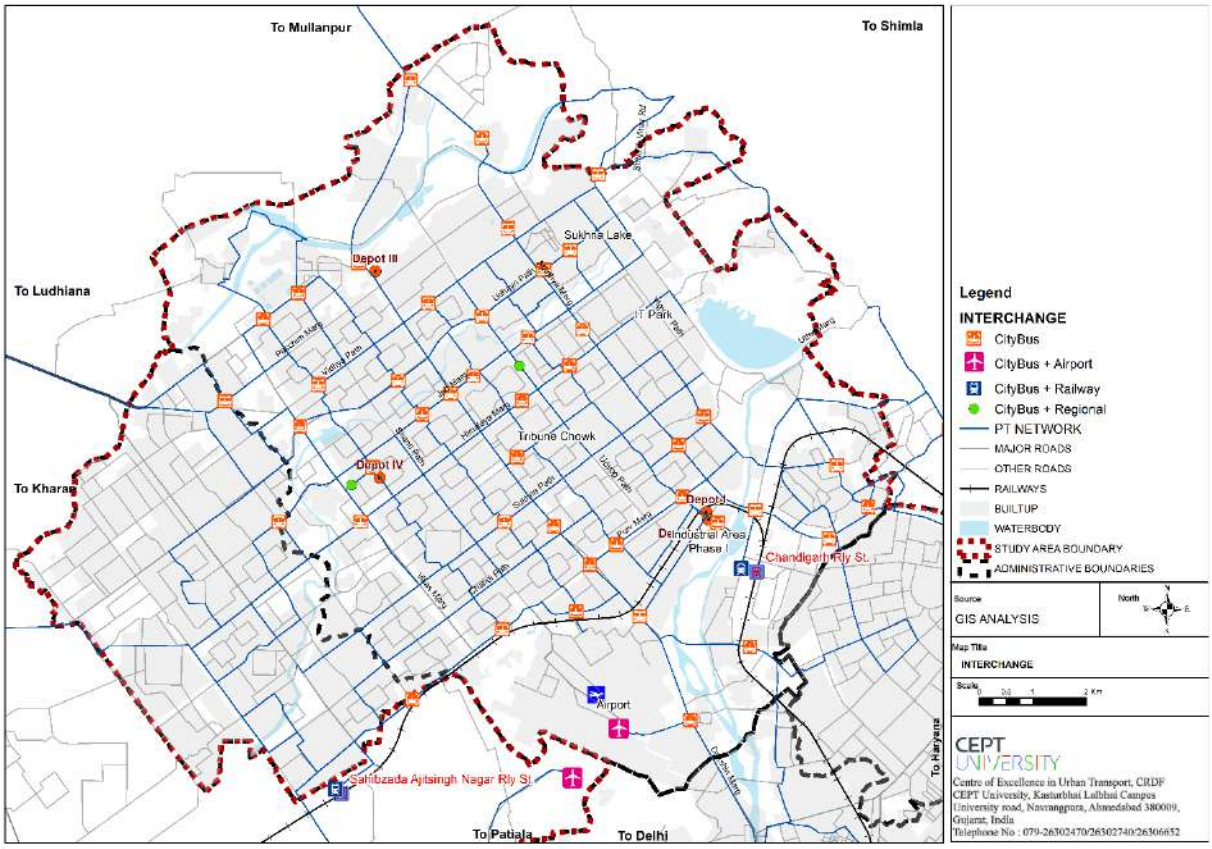


Figure 41: Interchange facilities within Chandigarh

3.5 Depot requirements

Bus depots are among the primary infrastructural requirements for any bus system. Special attention shall be paid to the location, size and capacity of a depot. The regular maintenance of fleet at depot facility is important to ensure longer life of urban buses. The design components of depot would include fuelling station, minor inspection pits, major inspection pits, washing area, and painting and denting areas, spare parts storage, engineers' cabin and administration unit as well as bus parking. It also includes amenities like changing rooms, resting rooms, and other necessary facilities for the depot crew (drivers, conductors, and office and workshop staff).

As analyzed in the sections above, fleet requirement depends on what PT share targeted which also influences depot requirement. Depot area requirement and costs have been estimated for all the different scenarios as part of financial analysis. Since the city has not defined any additional location for depot apart from Raipur Kalan, as per the inputs from CTU/CCBSS, this section identifies the tentative location for additional depots space requirement geographically with an objective to minimize the dead km.

The major attributes considered in selecting the site of a depot are:

1. Depot accessibility (for buses from the nearest terminal, and the staff),
2. Efficient utilization of space/land, equipment and manpower

Currently, CCBSS/ CTU have four depots for their city, sub urban and regional services and manages total of about 435 Standard and Midi buses. Depot 1 is only assigned for regional buses where as Depot 3 operates both City/ Suburban and regional buses. All these three depots of city and sub urban buses are located in different parts of the city as shown in the map below with facilities developed for repair and basic maintenance, washing etc. The infrastructure includes bus repairing PITS, Washing Bus Bay, PITS for Under Washing Bus Bay, Water Collection Tanks, Solar Panels, Starter & Alternator Testing Machine, Wheel Alignment Machine, Fuel Injector Testing Machine, Floor Scrubbing Machine, Lathe Machine etc. A new depot is also under construction near Panchkula and is expected to be operational in a year's time. Table 39 below presents the existing and committed depots capacities of bus accommodation.

Table 39: Existing depot capacities

Depot	Midi	Standard	Approx. Land Area (in acre)	Remarks
Depot 2	150		6.00	Capacity of this depot is only 150 midi buses however currently 170 midi buses accommodated
Depot 3	49	101	7.00	Depot 3 operates about 60 standard buses on regional services
Depot 4		100	5.00	Capacity of 100 standard buses
Raipur Kalan		120	6.00	The new depot under construction has the designed capacity of 120 standard buses.

4 Future Demand Assessment and Fleet Requirement

This section elaborates the business plan which includes operational strategy, financial strategy and institutional strategy. The operational strategy outlines the service characteristics for operations, fare structure, fleet type and size requirements. It also includes the bus operating model options. The financial strategy presents the capital expenses, budgeting for revenue and expenditure and also suggests alternative sources for funding the bus operations. Organisational Strategy proposes changes that may help in better management of the bus operations.

For the operational strategy, the key decision areas are:

- Fleet requirements
- Depot and workshop requirements
- Operating Model

Demand assessment is the first step for service design and operations strategy formulation which is presented below:

4.1 Demand Assessment

4.1.1 User and non-users' preferences

As outlined in Section 1.3.1, primary surveys of commuters in the city helped identify their preferences for various bus service quality factors. The bus users indicate preference for improved service frequencies and safety followed by fare levels. In case of 3-W users, frequent services along with safety, travel time and affordable fares are identified as important. Private mode users indicate frequent services, low waiting times along with comfort and last mile connectivity as important.

wait time, travel time and fare levels were identified as highly weighted quantifiable variables based on user and non-users' preference surveys, and were used to develop a logistic model for existing travelers on bus and IPT mode. The utility equations derived for bus and IPT users were used to determine the future demand for the improved bus services. As per this, wait time was estimated to be weighted 1.8 times the travel time.

4.1.2 Previous Studies

A Comprehensive Mobility Plan (CMP) for Chandigarh was prepared in 2010 for the horizon year 2040. In 2015, a Bus Modernisation Plan was prepared for the year 2024 focusing on bus service improvements. Both these studies propose future mode share scenarios. Table 40 below shows the mode share for the year 2040 as per the CMP study:

Table 40: Mode Shares 2040 as per CMP

Years	**2014**	**2021**	**2031**	**2041**
Population in lakh	24.5	31.28	39.42	46.93
Per Capital Trip Rate (motorized)	1	1.1	1.2	1.3
Total Trips in lakh	29.34	40.56	56.31	73.4

Years	**2014**	**2021**	**2031**	**2041**
Modal split (Share by Public Transport for total Intra city trips)	54%	60%	65%	70%

It can be seen that the proposed PT share is around 60% and 65% for the years 2021 and 2031 respectively. However, the existing mode share of bus trips is only 10% in comparison to projected 60% for the year 2021. Therefore, achieving the mode share of 70% by 2031 does not seem plausible in such a short duration of time.

The Bus Modernization Plan prepared in 2015 also presented the mode shares for different years up to 2024 as represented in Table 41 below.

Table 41: Passenger ridership at target mode shares

Year	**@583 buses**	**Ridership at Target Mode Shares**						
		18%	20%	22%	24%	26%	28%	30%
2015	3,95,750							
2016	3,95,750							
2017	3,95,750							
2018	3,95,750							
2019	3,95,750							
2020	3,95,750							
2021		4,28,868	4,76,520	5,24,172	5,71,824	6,19,476	6,67,128	7,14,780
2022		4,43,540	4,92,822	5,42,104	5,91,386	6,40,669	6,89,951	7,39,233
2023		4,58,212	5,09,124	5,60,036	6,10,949	6,61,861	7,12,774	7,63,686
2024		4,72,883	5,25,426	5,77,969	6,30,511	6,83,054	7,35,596	7,88,139

Source: Bus Modernisation Plan 2015

Table 42: Fleet size at target mode shares

Year	**Fleet at Target Mode Shares**						
	18%	20%	22%	24%	26%	28%	30%
2021	734	743	752	770	778	796	814
2022	759	779	797	833	851	888	924
2023	784	815	843	899	927	984	1040
2024	809	852	890	**968**	1007	1084	**1161**

Source: Bus Modernisation Plan 2015

Table 42 above shows that different mode share scenarios from 18% to 30% have been presented in the plan. For each of these target mode shares, fleet requirements and ridership estimates was also given.

4.1.3 Future Demand Scenarios

Trajectory of vision realization and the timeline is a function of agency's intent and drive along with constraints like financial resources and land availability for infrastructure facilities. Scenario based approach is hence adopted in this report, which can aid cities in deciding on an appropriate strategy for instituting a quality bus service in the city.

Considering the existing bus service levels and bus ridership, CMP estimates of 60% mode share in the year 2031 seems ambitious. The Bus Modernization Plan considers scenarios ranging from 18% to 30% in the year 2024.

For this study, to assess the mode shift, a mode split model using revealed preference data of commuters was developed. The attributes used for this consisted of waiting time, in-vehicle time and cost. Waiting time was considered as commuters indicates strong preference for high frequencies/low waiting times. Based on this, 3 scenarios were developed:

1) Scenario 1: Improvement in service coverage in the city with new proposed routes and average headways similar to existing levels (10-15 minutes). Mode split model used to assess shift from IPT.

2) Scenario 2: Improvement in service coverage with lowering of service frequencies to an average of 5 minutes. Mode split model used to assess shift from IPT.

3) Scenario 3: Conditions in scenario 2 plus considering shift from private vehicles. Mode split model used to assess shift from IPT. For shift from private vehicles, empirical data from other Indian cities have shown around 5-7% shift from private mode users with improvement in bus service levels; thus 6% shift has been assumed for this study.

Thus, the scenarios and mode shares are presented in Table 43 below:

Table 43: Demand Scenarios and Bus Mode Shares (2020-2030)

	2020	**2023**	**2025**	**2030**	**2032**
Population (Chandigarh + Surroundings)	19,46,190	20,89,706	21,91,215	24,67,089	25,86,930
Internal motorised trips (75%)*	13,13,678	14,10,551	14,79,070	16,65,285	17,46,178
Scenario-1	1,27,630	1,66,652	1,95,447	2,43,341	2,61,927
PT share - Gradual	10%	12%	13%	15%	15%
IPT Shift %		15%	25%	35%	35%
Pvt. Shift %				0%	0%
Scenario-2	1,27,630	1,86,393	2,47,196	3,38,786	3,49,236
PT share - Moderate	10%	13%	17%	20%	20%
IPT Shift %		25%	50%	76%	76%
Pvt. Shift %				0%	0%
Scenario-3	1,27,630	1,86,393	2,68,790	4,09,294	4,36,544
PT share - High Growth	10%	13%	18%	25%	25%
IPT Shift %		25%	50%	76%	76%
Pvt. Shift %			2%	6%	6%

**Trip rates of 0.9 and internal mode share @ 75% as per CMP*

For this analysis on the fleet requirements, moderate scenario (Scenario 2) has been considered and has been used to derive the ridership for FY2032 on each route. However, in case CCBSS undertakes a proactive approach for the short to medium time frame in terms of fleet addition, infrastructure development and roll out of the service plan, a higher trajectory for achieving 25% mode share could also be considered. The fleet requirement, procurement plan, cost estimates and revenue estimates for the 25% PT share scenario in similar approach, has been provided in Annexure 10.

4.2 Fleet requirements

4.2.1 Vehicle types and capacities

Details of different types of buses i.e. Standard, Midi and Mini are mentioned in Table 44 below. Bus type for a city should be selected based on the passenger demand and the desired service levels.

Table 44: Fleet type

Fleet Type	Floor Ht.	Length	Total Capacity
Standard	650mm	12m	70
Midi	400/650mm	9m	42
Mini	900mm	7m	22

Different bus types would have different carrying capacities which would influence service levels. As shown in Table 45 below, a standard bus can offer 280 PPHPD at 15min headway, while a similar demand served by midi and mini buses would require 10min and 5min headway operations respectively.

Table 45: Capacities offered by fleet type and headways

Type of vehicle	Headways (min) -->				
	5 min	**10 min**	**12 min**	**15 min**	**20 min**
Standard Bus – 12mt. (Capacity – 70 passenger)	840	420	350	280	210
Midi Bus – 9mt. (Capacity – 42 passenger)	504	252	210	168	126
Minibus – 7mt. (Capacity – 22 passenger)	264	132	110	88	66

In other words, if the service standard is to provide 5 min headways along a route to offer a good service level and the passenger demand on about 50% of routes are ranging between 250-300 PPHPD, Midi and midi-mini buses may ensure a much better capacity utilisation than standard buses.

4.2.2 Fleet Size and Mix Selection Criteria

The route services proposed as per the service plan is further analysed in terms of the potential demand to decide of the service headways as well as the fleet requirements. Following criteria were considered:

1. **Service Headway Distribution:** Service headway distribution is related to the average waiting time at a stop for a passenger. Higher headways of routes imply more waiting time and thus makes the system unattractive for passengers. The recommended headways for urban bus

services should be <=10 min i.e. average waiting time on the major routes should not be higher than 5min.

2. **System Capacity Utilisation:** The capacity of a system can be measured by calculating Load factor (dividing passenger km by seat km) of the system. The higher the load factor, the more profitable the operation. Ideal system utilisation is considered around 60% - 65%.

3. **Buses per 1000 population:** As per MOHUA's Service Level Benchmarks in urban transport, buses per 1000 population is one of the indicators to measure extent of service supply in the city. Bus requirement is related to trip length and city size. Large size cities have large trip lengths; hence the need of bus fleet is higher to serve the same number of passengers in comparison with smaller cities. Table 46 shows the benchmarking level for cities with <0.2 million population.

Table 46: Buses per 1000 population by cities categories

Mega Cities (4 Million+ Population)		Metro Cities (1-4 Million population)		Other cities I (<1- 0.2 million population) Other cities II (<0.2 Million population)	
Buses/1000 population	LoS	Buses/1000 population	LoS	Buses/1000 population	LoS
>0.6	1	>0.4	1	>0.3	1
0.4 – 0.6	2	0.25 – 0.4	2	0.2-0.3	2
0.2 – 0.4	3	0.1 – 0.25	3	0.1-0.2	3
<0.2	4	<0.1	4	<0.1	4

Source: Service Level Benchmarking, MoHUA

4. **Capital and Operations Cost**: Fleet mix also has an impact on capital and operations cost including driver, fuel, maintenance.

4.2.3 Fleet Size and Mix Scenarios

Fleet size estimation was done based frequency approach and based on the load factor method which considers passenger-km and ridership. Alternative fleet mix and size options were developed using these two methods. Scenario 2 with 20% mode share was considered for the demand.

Table 47: Fleet type scenarios

Approach	Approach Description	Existing fleet + Fleet Mix Scenarios for New Fleet	
Frequency approach	Irrespective of the demand, all the proposed routes are assigned with 10min headway to achieve 5min average waiting time	1	Standard + Midi buses with improved frequency at 10min
		2	All Midi buses at 10min headway
Load Factor (LF) Approach • FY2023 – 45%LF • FY2025 – 45%LF • FY2030 – 60%LF	Ridership and passenger km are used to compute fleet requirement (Bus supply) based on 45%LF in FY2023 and FY2025 and 60% LF in FY2030 and FY2032.	3	All Midi, hdw cap at 15min
		4	Standard + Midi, hdw cap at 15min
		5	Midi + Mini, hdw cap at 15min
		5A	Midi+Mini, hdw cap at 10min

Approach	Approach Description	Existing fleet + Fleet Mix Scenarios for New Fleet	
• FY2032 – 60%LF		6	Standard + Midi + Mini, hdw cap at 15min

Based on these two approaches –Frequency and load factor, different fleet requirements for different scenarios were estimated. The demand based on Moderate demand scenario was assigned on the proposed routes and the ridership on the proposed routes was used to estimate the fleet requirements.

As shown in Table 47 above, different types of vehicles and vehicle-mixes were considered in scenarios 1 to 6. The bus asset requirements over next 5 and 12 years was estimated. CTU is currently operating total of about 435 buses on three depots, Depot 2, 3 and 4. Based on the fleet procurement information received from CCBSS, about 219 diesel Midi buses were procured in the year of 2015-16 for city and sub urban services, which will serve till 2025. Rest of the existing buses is already about 9-10 years old and will not serve beyond 2023 (Table 48 below). Government of India has sanctioned 80 Electric Midi buses to CTU/CCBSS which are expected to be in operations by 2023 on the city and sub urban routes.

Table 48: Existing fleet procurement and scrapping plan

Years	Buses Purchased		Bus Scrapping	
	Standard	Midi	Standard	Midi
2015		219		
2016		-		
2017		-		
2018		-		
2019		-		
2020		-		
2021		-		
2022		-		
2023		80 Electric (Recently sanctioned)		
2024		-		
2025			0	219
2031			0	0
2032			0	0

Since the city is aiming for transition to electric buses gradually, the analysis considers electric buses for new fleet (additional buses as well as replacement fleet). For financial analysis, 10 years period from inclusion of e buses in 2023 i.e., 2032 is considered, as the average life of an electric bus is 10 years. Thus, taking into consideration the fleet to be replaced, and the demand estimation by routes, fleet requirements for the year 2032 is worked out for different fleet mix scenario presented in Table 49 below.

Table 49: Total fleet requirement for FY2032 – by scenario

Scenarios		Mini	Midi	Standard	Total Buses	Buses/ 1000 Pop (Chandigarh + Surrounding)	Buses/ 1000 Pop (Chandigarh +Mohali)
1	Standard + Midi buses with improved frequency at 10min	-	455	295	750	0.29	0.42

Scenarios		Mini	Midi	Standard	Total Buses	Buses/ 1000 Pop (Chandigarh + Surrounding)	Buses/ 1000 Pop (Chandigarh +Mohali)
2	Frequency Approach - All Midi Buses - All routes at 10min hdw	-	750	-	750	0.29	0.42
3	LF approach - All Midi at 15min capped headway	-	689	-	689	0.27	0.39
4	LF approach - Standard + Midi, headway capped at 15min	-	575	68	644	0.25	0.36
5	LF approach - Midi + Mini, headway capped at 15min	567	292	-	858	0.33	0.48
5A	LF approach - Midi + Mini, headway capped at 10min	659	292	-	950	0.37	0.54
6	LF approach – Standard + Midi + Mini, headway capped at 10min	365	273	68	706	0.27	0.40

The total fleet requirement is ranging from 650 to 950 depending on fleet type, load factor and headways levels. For each of the scenarios, buses per 1000 population has been worked out and it can be seen that it is in the range 0.25-0.37, indicating improvement in service levels as per Service Level Benchmarks from LOS 3 to LOS 2 / LOS1.

Table 50 below presents the fleet procurement plan by bus type for each scenario. The plan has been prepared considering existing fleet will serve till its full life and the scrapping plan as discussed above. Route wise frequency and fleet requirement in 2032 for each fleet mix scenario is presented in Annexure 8.

Table 50: New fleet procurement plan for each scenario for Moderate demand scenario (20%)

Scenario -->	**Scen-1: 10min HDW – Standard + Midi Buses**		**Scen-2: 10min HDW - All Midi Buses**	**Scen-3: LF 60% - All Midi, hdw cap at 15min**	**Scen-4: LF 60% - Standard + Midi, hdw cap at 15min**		**Scen-5: LF 60% - Midi+Mini, hdw cap at 15min**		**Scen-5A: LF 60% - Midi+Mini, hdw cap at 10min**		**Scen-6: LF 60% - Standard + Midi + Mini, hdw cap at 15min**		
Bus Type -->	**Standard**	**Midi**	**Midi**	**Midi**	**Standard**	**Midi**	**Midi**	**Mini**	**Midi**	**Mini**	**Standard**	**Midi**	**Mini**
2023	28	115	144	196	13	151	120	135	120	158	13	116	91
2024	0	0	0	0	0	0	0	0	0	0	0	0	0
2025	112	144	257	232	26	189	51	216	51	251	26	47	147
2026	7	8	15	16	2	12	4	17	4	19	2	3	11
2027	103	113	201	122	18	99	53	113	53	132	18	48	77
2028	0	0	0	0	0	0	0	0	0	0	0	0	0
2029	44	37	67	91	10	75	43	85	43	99	10	39	57
2030	0	0	0	0	0	0	0	0	0	0	0	0	0
2031	0	37	67	31	0	50	21	0	21	0	0	20	0
2032	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Standard/ Midi/ Mini Fleet	295	455	750	689	68	575	292	567	292	659	68	273	384
Total Fleet	750		750	689	644		858		950		706		

5 Financial Analysis

The main objective of financial analysis is to assess operational viability and sustainability of the system. The plan includes estimation of operational expenditure and revenues for services proposed in each year along with operational cost recovery levels which will aid to formulate the business strategies and the sources of other funds and subsidies/ grant.

This section presents the existing cost expenditure, capital cost investment and future operational cost estimates.

5.1 Existing Operations Expenditure

CCBSS is operating services within Chandigarh and also in surrounding cities. The existing costs per km for different components of operations by depots for last three years are presented in Table 51 below. Depot 2 operates all midi buses, Depot 4 operates all standard buses and Depot 3 operates mix of midi and standard buses. Depot 3 operates regional routes along with city & suburban routes. Average cost per vehicle km for Depot 2 i.e. midi buses is Rs.61 annually of this staff cost contributes to about 64% in overall cost for Depot 2.

Table 51: Operating cost per vehicle Km of CTU & CCBSS (2016-17 to 2018-19)

Per km Expenditure	**2016-17**				**2017-18**				**2018-19**			
	Depot-II	**Depot-III**	**Depot-IV**	**CTU OVER ALL**	**Depot-II**	**Depot-III**	**Depot-IV**	**CTU OVER ALL**	**Depot-II**	**Depot-III**	**Depot-IV**	**CTU OVERALL**
Fuel and Lubricants Cost	9.97	11.91	22.67	13.39	10.66	14.31	23.46	14.53	12.01	16.75	27.11	16.79
Bus maintenance repair cost (Tyres, AMC, Repairs)	1.63	1.62	10.73	3.49	1.66	2.48	9.22	3.39	2.80	3.03	11.29	4.26
Insurance and Taxes (MACT, RR Tax, MVT Tax, Insurance, DRF)	4.44	3.56	4.23	4.48	4.63	5.20	4.67	4.98	4.46	3.49	4.91	4.77
Staff Cost (Salaries. Overtime, uniform, Welfare etc.)	31.17	31.82	29.32	29.12	33.97	28.73	23.05	27.63	39.42	30.60	25.15	30.17
Other Miscellaneous Expense (Generator, Ticket printing, Water & Electricity, Diesel (other than buses),Misc./Postage)	1.64	0.20	0.16	1.06	1.76	0.28	0.13	1.29	1.55	0.30	0.25	1.65
Interest and CCBSS	0.30	0.19	0.41	0.24	2.67	2.77	0.37	2.18	0.28	0.19	0.37	0.43
Total Costs/ Veh Km	**49**	**49**	**68**	**52**	**55**	**54**	**61**	**54**	**61**	**54**	**69**	**58**

(Source: CTU, 2020)

5.2 Cost Estimates

Operations cost estimates in this section is presented for single standard, midi and mini AC Electric buses. As discussed with manufactures, costs of standard, midi and mini AC buses are as presented in Table 52 below; which includes ITS inbuilt equipment such as GPS, camera and on-board PIS system. As part of proposal, 100% AC electric buses are proposed for new procurement. The cost with Fame II subsidy and without Fame II subsidy is presented in Table 52. Fame II subsidy is available up to 2022, however given the emphasis of the national government towards electrification, it is assumed that the similar amount of subsidy will be available in the future also or the battery costs will go down with scaling up of electric vehicle operations in India, bringing down the costs (Table 53 and Table 54 below).

Table 52: Bus type and price on road

Bus Size & Type	EV - AC Bus - w/o Subsidy from Fame II	EV - AC Bus - with Subsidy as per Fame II
Standard	170 lakhs	120 lakhs
Midi	130 lakhs	80 lakhs
Mini	100 lakhs	50 lakhs

Some of the physical performance assumptions considered are:

- Life of the fleet taken as 10 years
- Fleet utilization is considered at 95% for first three years of new purchased bus and 90% for rest of the life of bus
- Vehicle Utilization (VU) per bus per day is taken as 200km considering opportunity charging facilities would be developed at a few terminal locations.
- Fuel efficiency (mileage) and Annual Maintenance Contract (AMC) value per vehicle km are taken after interviewing manufacturers and few sector experts.
- In EV, charging infrastructure cost at depots and opportunity charging facilities at major terminals also needs to be considered, about Rs.5cr. for each depot and Rs.3cr. for opportunity charging at major four terminals have been considered.

Table 53: Mileage and unit Repair-Maintenance cost

EV --> Mileage (Units KWH/km)	Standard EV - AC	1.1
	Midi EV - AC	0.9
	Mini EV - AC	0.75
Repair & Maintenance (Rs./km) -->	Standard EV - AC	12.7
	Midi EV - AC	10.46
	Mini EV - AC	6.7

Table 54: Cost of Operations (at 2020 prices) per vehicle km by components

Cost Components	Standard Bus Rs./ km	Midi Bus Rs./ km	Mini Bus Rs./ km	Basis/Inputs/Assumptions
Fuel (Power supply cost)	Rs.4.4 (2023-32)	Rs.3.6 (2023-32)	Rs.3.0 (2023-32)	• Unit rate for electricity supply is taken Rs.4

Cost Components	**Standard Bus Rs./ km**	**Midi Bus Rs./ km**	**Mini Bus Rs./ km**	**Basis/Inputs/Assumptions**
Repair and Maintenance (R & M) cost	Rs.12.7 (2023-32)	Rs.10.5 (2023-32)	Rs.6.7 (2023-32)	• Maintenance staff cost (Workshop) is considered as part of AMC.
Insurance, Motor vehicle tax	Rs.4.5 (constant from 2023-32)	Rs.3.0 (constant from 2023-32)	Rs.1.9 (constant from 2023-32)	• Insurance is assumed at 3% of procurement cost after deducting depreciation cost from that at each year. • M V Tax for Chandigarh is Rs.13600, Rs.8000 and Rs.4000 per year for standard, midi and mini buses. (www.vahan.parivahan.com)
Staff cost	Rs.15.2 (constant from 2023-32)	Rs.15.2 (constant from 2023-32)	Rs.15.2 (constant from 2023-32)	• Overall staff ratio is assumed at 5.5 staff per bus considering 2.5 drivers, 2.5 conductors and 0.5 for HO, account and admin staff. • As per details available; existing average salary per staff is Rs.28000 per month and average salary considered per staff is Rs.15000 per month in case of private operator/ OEM.
ITMS Operation cost	Rs.1.0 (constant from 2023-32)	Rs.1.0 (constant from 2023-32)	Rs.1.0 (constant from 2023-32)	• As ITMS facilities in under development, the AMC considered for ITMS is Rs.2.3cr. based on sector experts' consultation. • Communication cost is assumed at Rs.3600 per bus per year.
Cost of depreciation (for fleet and charging facilities)	Rs.20.2 (constant from 2023-32)	Rs.13.7 (constant from 2023-32)	Rs.8.9 (constant from 2023-32)	• Life of the bus is considered of 10 years, the total depreciation cost is estimated with straight line method. • Cost of charging infrastructure at depot and terminal are considered based on assumption stated above.
Cost of fund	Rs.9.4 (2023-32)	Rs.6.3 (2023-32)	Rs.3.9 (2023-32)	• The current operating contract is Net Cost Contract however it has been seen nationally as well as internationally recognized that Gross Cost Contract or Gross Cost Hybrid Contract suits best for any city bus services. In GCC, buses are generally procured by operator where cost of fund in terms of rate of interest on borrowed fund and rate of return on own fund needs to be consider in operations. • Debt Equity ratio assumed at 75:25 • Rate of return on own fund and interest rate on borrowed fund, both are assumed at 12%. • Repayment period for borrowed fund is taken as 5 years.
Miscellaneous cost	Rs.3.3 (2023-32)	Rs.2.6 (2023-32)	Rs.2.0 (2023-32)	• Miscellaneous cost is assumed at 5% of total operating cost.

****** Cost estimates are in consultation with bus operators in Ahmedabad*

5.2.1 Lifecycle Cost for different bus types

Cost of operations are estimated at current prices for different bus types to understand the difference in the lifecycle cost of a single vehicle. Figure 42 below shows life cycle cost per km (by component) for Standard, Midi, Mini and Mini without conductor buses.

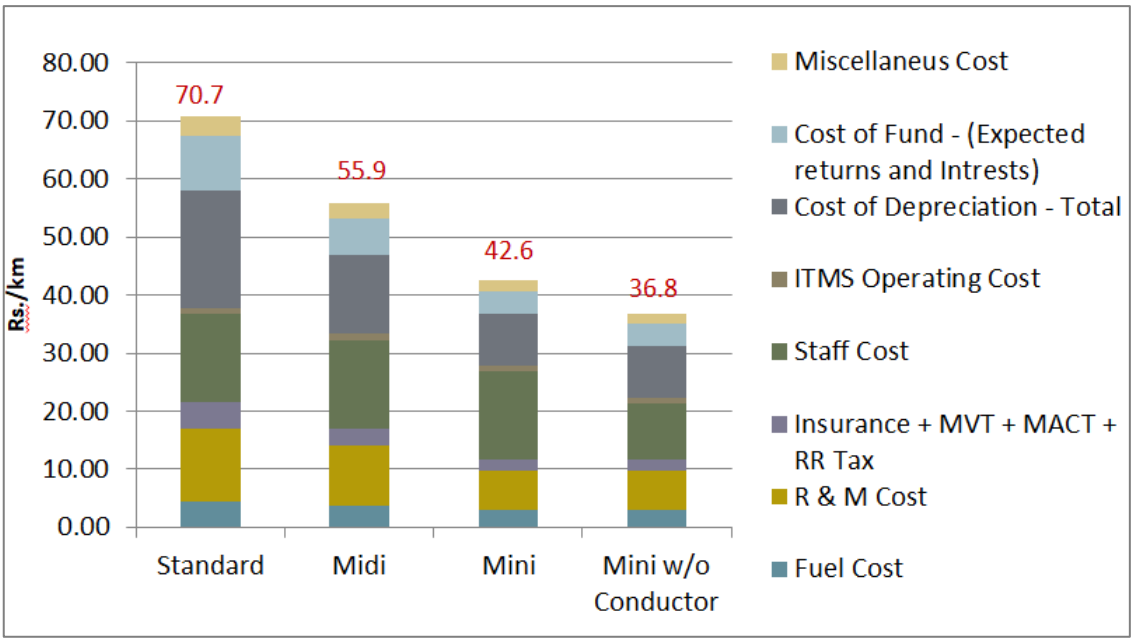


Figure 42: Life cycle cost in Rs/km (at current prices) for one sample bus type

5.2.2 Cost Estimates for Fleet Mix Scenarios

The total operational cost is estimated for future years for all fleet mix scenarios. Entire cost estimation is done based on constant prices taking 2020 cost as base which is escalated using WPI factors and labour commission rates for man-power costs.

The bus costs are escalated at 4.00%[2] annum for man power related cost based on historical labour commission wage scale rise whereas fuel-lubricant and other cost components are escalated with 2.53%[2] historical WPI rise. Generally, interest, depreciation and insurance are at fixed rate, however new fleet is added incrementally in phased manner which changes the overall cost of depreciation and cost of fund. Table 55 below presents the total operational cost for 10 years which also includes cost of fund and cost of depreciation as presented in the section above. The operational costs are varying significantly as the fleet requirement for each scenario is different.

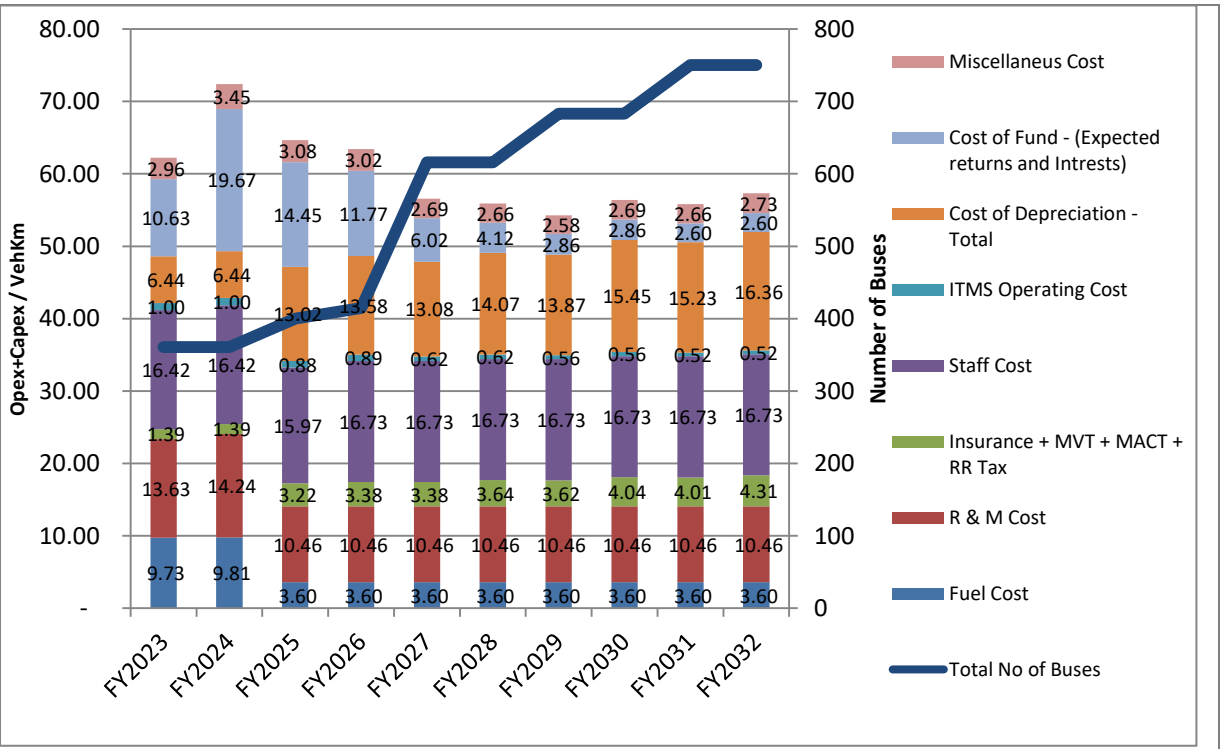
The cost of depot is not part of operational cost but it cannot be looked separately as well. Depot requirement essentially depends on fleet size and its type therefore the cost of depots becomes important to see along with the total cost estimates for each fleet mix and type scenario. Details related to depots are also presented in section below in Business Plan Summary. Table 55 and Figure 43 below presents the comprehensive cost assessment for FY2023 to FY2032 with all components associated with fleet mix scenarios.

[2] Labour commissionaire office, The state of Maharashtra

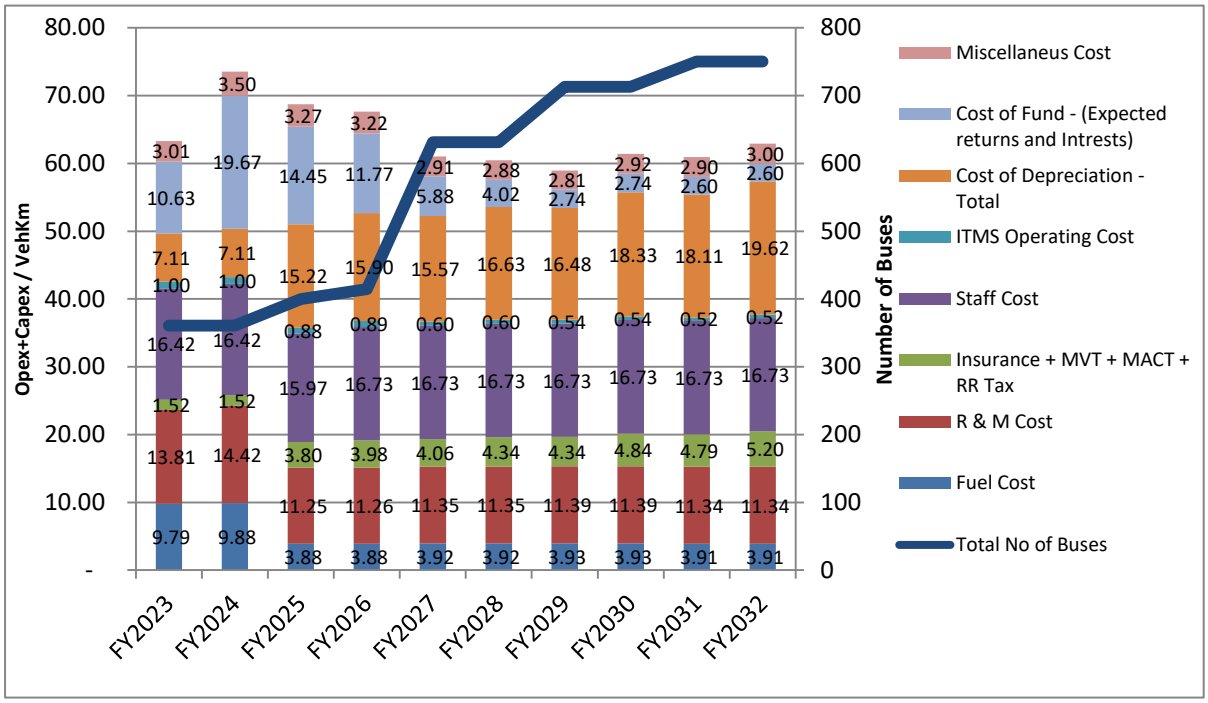
Table 55: Total Operational Cost Estimates at constant prices with 2020 as the base (2023-2032)

Fleet Mix Scenario →	**1**	**2**	**3**	**4**	**5**	**5A**	**6**
	10min HDW – Standard + Midi Buses	10min HDW - All Midi Buses	LF 60% - All Midi, (hdw cap at 15min)	LF 60% - Standard + Midi, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 10min)	LF 60% - Standard + Midi + Mini, (hdw cap at 15min)
Total Standard Buses	682	682	625	522	516	598	660
Total Midi Buses	295			68			68
Total Mini Buses	455	750	689	575	292	292	273
Total Buses					567	659	384
Fleet Cost	750	750	689	644	858	950	725
Total Cost of Ownership (TCO) (Life Cycle Cost)	**2824**	**2607**	**2556**	**2396**	**2734**	**2961**	**2482**
CPKM in Rs./km (2023-2032)	74	69	69	71	60	59	64
Cost/Pax-Km at 60% LF	2.41	2.75	2.75	2.66	3.32	3.34	3.05
Depot requirement and cost estimates							
Depot Area Requirement (in acre)	**32.96**	**30.01**	**27.54**	**23.01**	**30.54**	**33.62**	**23.09**
Existing Depot Area (in acre)	20.50	20.50	20.50	20.50	20.50	20.50	20.50
Additional Area Requirement for Depots	12.46	9.51	7.04	2.51	10.04	13.12	2.59
Additional No of Depot (Unit area per depot would vary)	2.00	2.00	2.00	1.00	2.00	2.00	1.00
Cost for Depot development for additional area requirement	37.37	28.52	21.13	7.54	30.13	39.37	7.76
Land Cost for additional Depot area	90.43	69.03	51.14	18.24	72.91	95.28	18.77
Cost of Depot with land (for additional Depot)	128	98	72	26	103	135	27
Total Cost associated with Fleet Mix Scenarios (TCO + Depots)	**2952**	**2705**	**2628**	**2421**	**2837**	**3096**	**2508**

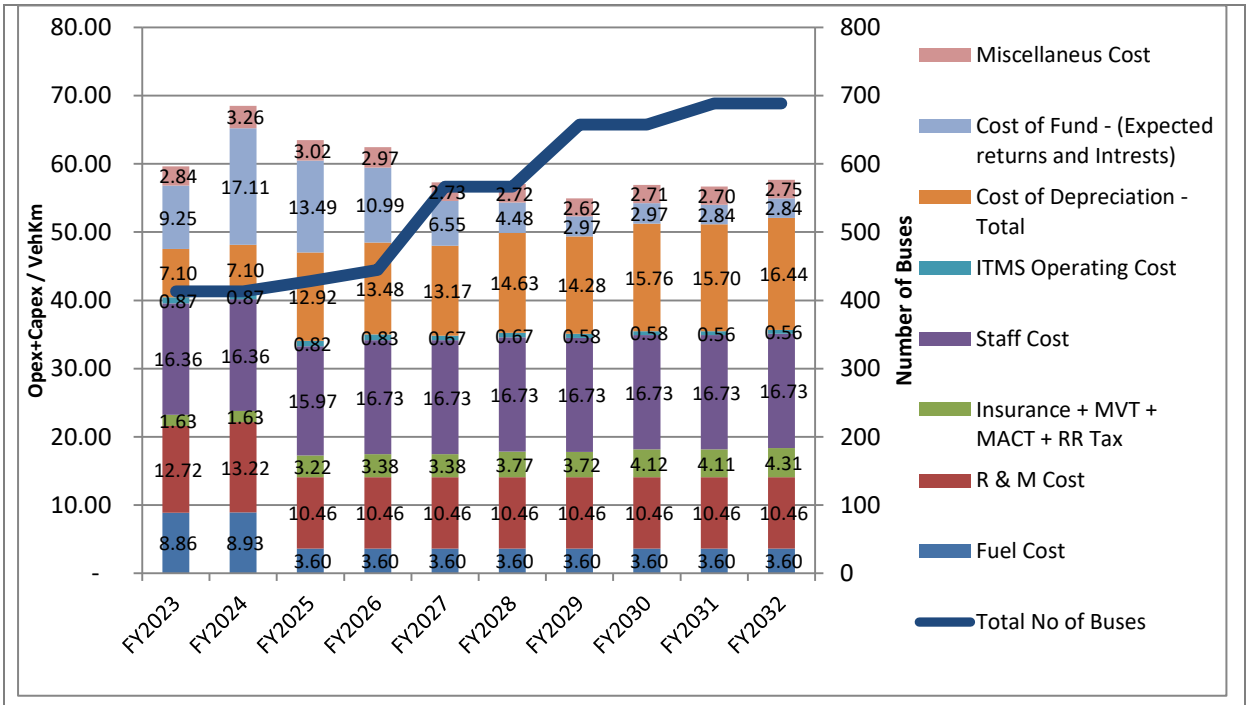
All costs are in INR in crore



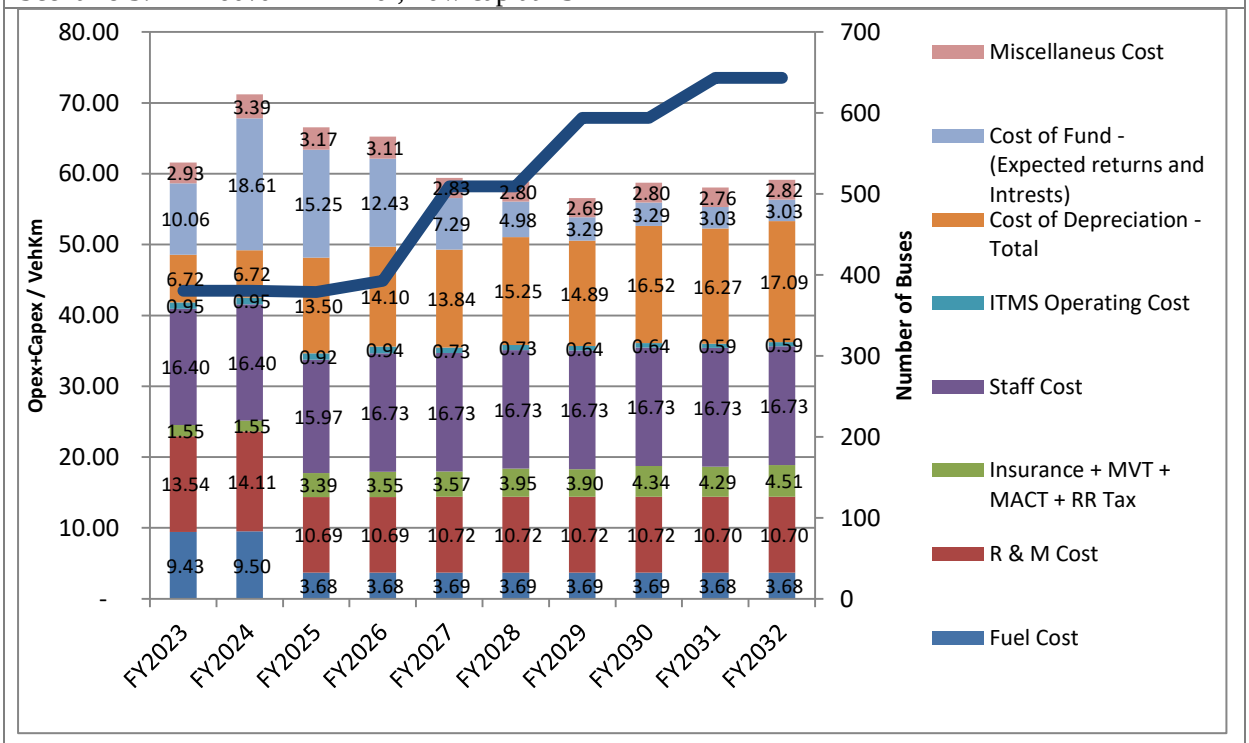
Scenario 1: - 10min HDW - All Midi Buses



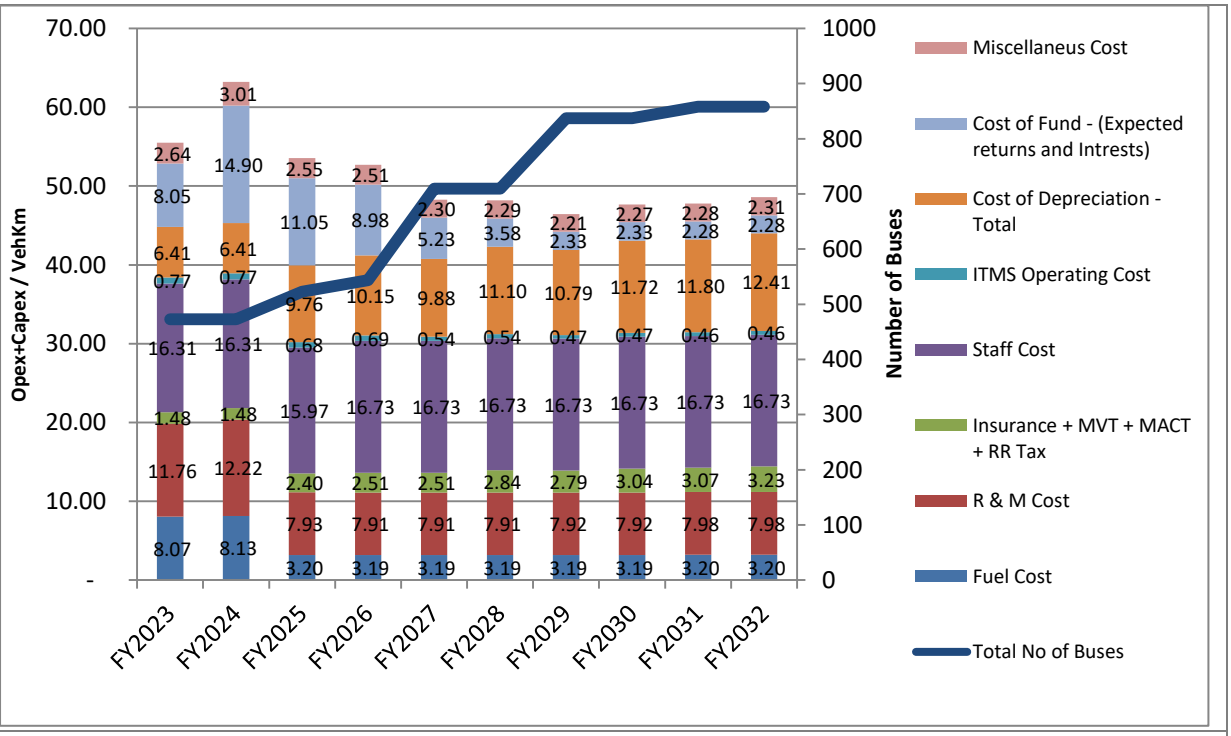
Scenario 2 :- 10min HDW – Standard + Midi Buses



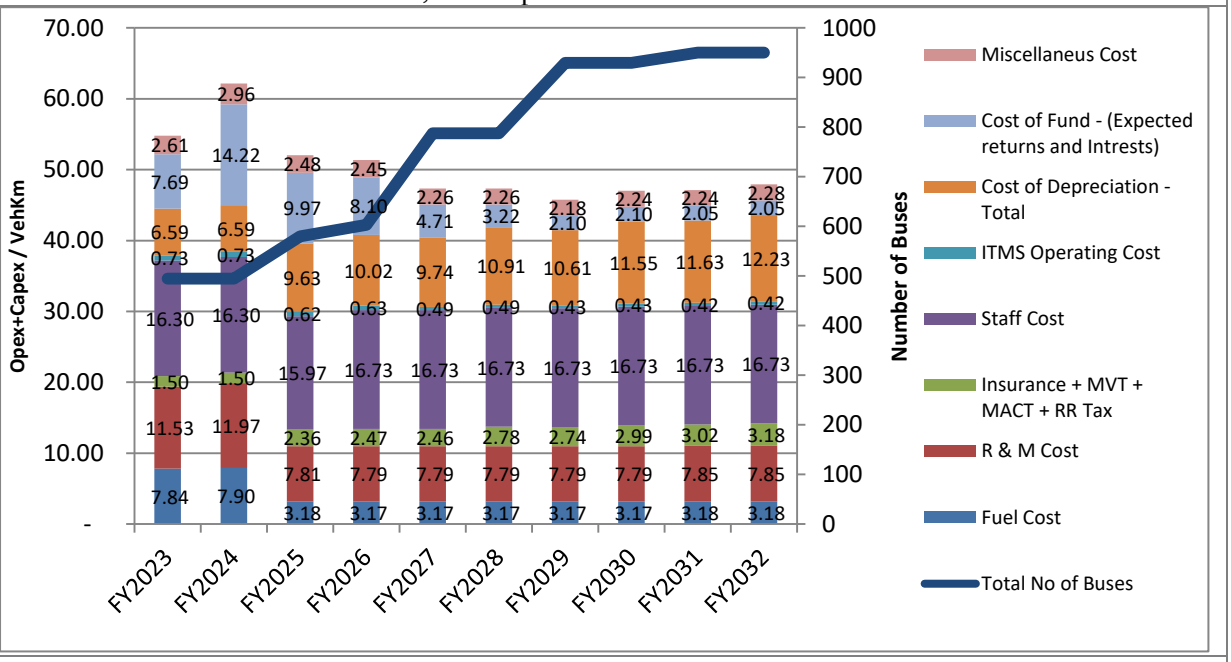
Scenario 3: - LF 60% - All Midi, hdw cap at 15min



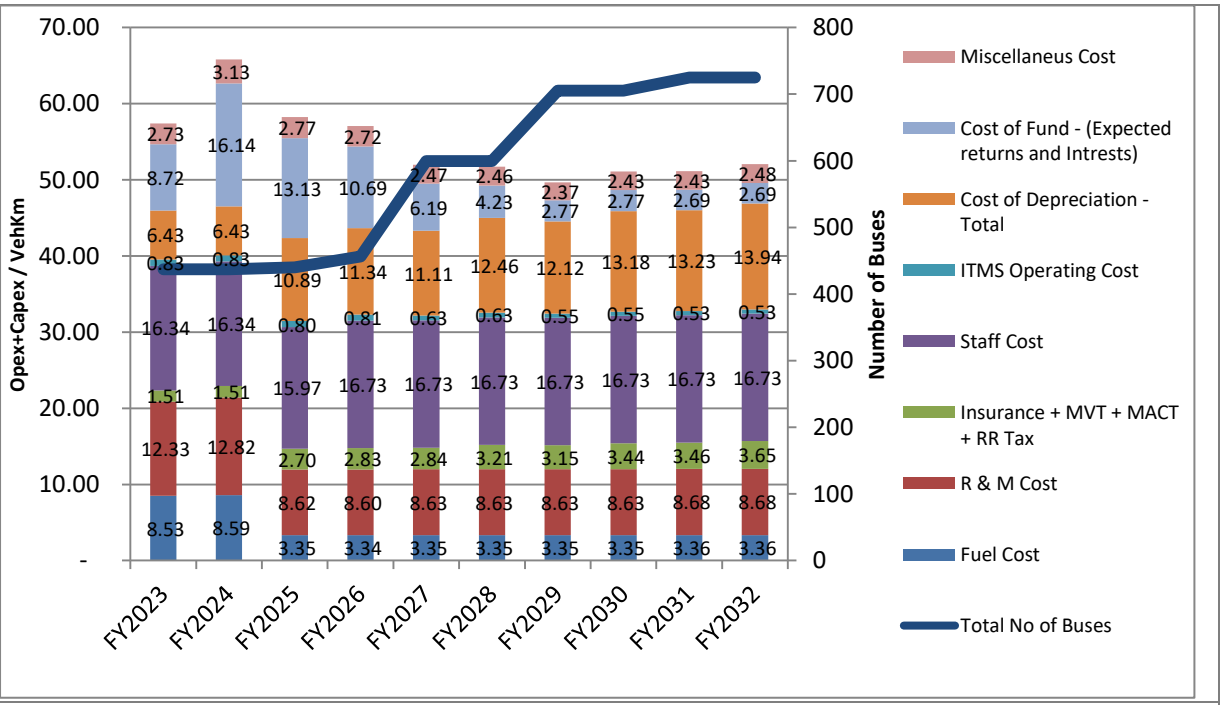
Scenario 4: - LF 60% - Standard + Midi, hdw cap at 15min



Scenario 5: - LF 60% - Midi + Mini, hdw cap at 15min



Scenario 5A: - LF 60% - Midi + Mini, hdw cap at 10min



Scenario 6: - LF 60% - Standard + Midi + Mini, hdw cap at 15min

Figure 43: Fleet mix scenarios – per km operating cost by cost components

5.3 Revenue Estimation

Financial analysis includes the revenue estimation and comparison of the relevant cost estimates and the revenue estimation.

5.3.1 Demand Estimation for fleet mix scenarios

As presented in Demand Assessment section; users' perception survey & logit model outcomes suggests wait time and fare are the highest weighing variables for PT users, therefore it is important to see the average wait time offer in different fleet mix scenarios as fleet size is varying significantly.

Fleet estimation was conducted at route level based approach and criteria explained in fleet requirement section, therefore fleet requirement is different for each route which results in to different headways in each fleet mix scenario. Table 56 below presents the headway distribution for all proposed 42 routes based on its estimated fleet size for each route.

Table 56: Demand estimation for fleet mix scenarios

Scenarios	1	2	3	4	5	5A	6
	10min HDW – Standard + Midi Buses	10min HDW - All Midi Buses	LF 60% - All Midi, (hdw cap at 15min)	LF 60% - Standard + Midi, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 10min)	LF 60% - Standard + Midi + Mini, (hdw cap at 15min)
Total Buses	750	750	689	644	858	950	725
Expected % PT share	18%-20%	18%-20%	13%-17%	13%-17%	13%-17%	18%-20%	13%-17%
Approx. daily pax in 2032 (in lakhs)	3.1	3.1	2.6	2.2	2.9	3.5	2.8
z							

Scenario	10min HDW - Std+Midi Buses	10min HDW - All Midi Buses	LF 60% - All Midi, hdw cap at 15min	LF 60% - Stand+Midi, hdw cap at 15min	LF 60% - Midi+Mini, hdw cap at 15min	LF 60% - Midi+Mini, hdw cap at 10min	LF 60% - Stand+Midi+Mini, hdw cap at 15min
<=3 min	0%	0%	0%	0%	0%	0%	0%
<=5 min	0%	0%	5%	0%	5%	5%	0%
<=10 min	100%	100%	14%	19%	45%	95%	36%
<=12 min	0%	0%	5%	5%	7%	0%	12%
<=15 min	0%	0%	76%	76%	43%	0%	52%
<=20 min	0%	0%	0%	0%	0%	0%	0%
<=30 min	0%	0%	0%	0%	0%	0%	0%
> 30 min	0%	0%	0%	0%	0%	0%	0%

Figure 44: Frequency distribution for proposed routes/ services

As evident from Figure 44 above it is obvious that the average wait time would be high where the headways are capped at 15min,. The existing average wait time is 13min as per 2020 routes frequency, all these fleet mix scenarios are better compared to existing however it becomes important to understand the tradeoff between fleet size and headways which essentially impacts the passenger demand.

5.3.2 Fare structure

Optimal fare structure shall be designed such that it is affordable, and it enables access of different user groups to the system. Fare revision is the continuous process to make the system sustainable. Table 57 below shows the previous fare from 2018 to Jan' 2020 and the current fare implemented for AC and Non AC services;

Table 57: Fare structure for year 2018 and 2020

Distance Range (km)	2018 to January 2020 Fare		January 2020 - Present	
	Non AC	AC	Non AC	AC
0-5	10	15	10	15
5-10	15	20	20	25
>10	20	25	25	30

5.3.3 Fare Proposal

Fare structure revision is one of the business strategies to attract more passengers and retain them on board. Though existing bus fare is lower compared to IPT, there is an opportunity to make it more

simple, affordable and attractive against other competing modes. It should be noted that only AC buses are proposed for future services, therefore fare structure and levels are for only one type of service.

5.3.3.1 Principles for fare revision

Following principles are considered for the fare proposal:

1. **Protecting Affordability:** More than 25% of IPT users and more than 15% of PT users do not own any motorised vehicle as per the primary surveys conducted in November 2019. Average household income in the city is estimated to be around Rs.32000/- and average expenditure of transport is about 10% as per CMP. Considering these facts, average affordability can be considered as Rs.30 per trip per person which is comparatively higher than the other Indian cities. This needs to be taken into account while proposing the fare revision.
2. **Ensuring System Sustainability:** The fare levels should aim to recover the operations cost of the transit system to the extent possible. Therefore, it is important to see revenue per pass. km for various options of fare structure to compare it with cost per pass km at full day Load Factor levels. Involving private operator in operations would reduce the load on cost part but at the same time it is recommended to remunerate them well and in timely manner. It is also recommended to revise the proposed fare every two years to be able to sustain the system in the longer term.
3. **Competitiveness with other modes:** Fare structure influences mode decisions of commuters. Fare structure therefore should be formulated taking into consideration costs of travel on other modes of transport. Fares should not exceed the nearest competing transportation system i.e. IPT and 2Wh, meaning the system which offers similar benefits in terms of time, comfort level etc. Another aspect to be considered here is the user affordability levels. At the same time fares should not be very low or they could impact sustainability. Low fare structure would affect the quality of bus services and inferior service levels would affect ridership adversely.
4. **Ridership augmentation:** A fare proposal must have flexibility to attract riders not only through affordable fares but also through fare concessions. The PT authority should therefore be able to offer special discounts and schemes to attract ridership. Currently in Chandigarh, as per ETM details received about 11% passengers are travelling with concession benefits, and about 17% passenger travel with discount benefits.

5.3.3.2 Suggested Fare Options

Based on above principles, a few fare options are presented below; it is also important to see and compare other cities' AC bus fare structure such as Delhi (DTC), Mumbai (BEST), Haryana, Agra along with fare of IPT and cost of two-wheeler (Table 58 below).

Table 58: Suggested fare options

Distance Range (km)	Existing NAC Fare	Existing AC Fare	DTC - AC	Haryana - AC	Agra - AC	BEST - AC	Fare Option 1	Fare Option 2	Fare Option 3	IPT Fare	2Wh Cost
0-1	10	15	10	10	10	6	5	5	5	10	2
1-2	10	15	10	10	10	6	5	5	5	10	4
2-3	10	15	10	10	10	6	10	10	10	10	6
3-4	10	15	10	10	15	6	10	10	10	10	8
4-5	10	15	15	10	15	6	10	10	15	20	10
5-6	20	25	15	20	20	13	10	15	15	20	12
6-7	20	25	15	20	20	13	10	15	20	20	14
7-8	20	25	20	20	25	13	15	15	20	30	16
8-9	20	25	20	20	25	13	15	20	20	30	18
9-10	20	25	20	20	25	13	15	20	20	30	20
10-11	25	30	20	30	30	19	15	20	25	30	22
11-12	25	30	20	30	30	19	20	25	25	30	24
12-13	25	30	25	30	30	19	20	25	25	30	26
13-14	25	30	25	30	30	19	20	25	25	30	28
14-15	25	30	25	30	30	19	20	25	25	30	30
15-16	25	30	25	40	35	25	25	30	25	30	32
16-17	25	30	25	40	35	25	25	30	25	30	34
17-18	25	30	25	40	35	25	25	30	25	30	36
18-19	25	30	25	40	35	25	25	30	25	30	38
19-20	25	30	25	40	35	25	25	30	25		40
20-21	25	30	25	50	40	25	30	30	25		42
21-22	25	30		50	40	25	30	30	25		44
22-23	25	30		50	40	25	30	30	25		46
23-24	25	30		50	40	25	30	30	25		48
24-25	25	30		50	40	25	30	30	25		50
25-26	25	30		60	45	25	30	30	25		
26-27	25	30		60	45	25	30	30	25		
27-28	25	30		60	45	25	30	30	25		
28-29	25	30		60	45	25	30	30	25		
29-30	25	30		60	45	25	30	30	25		

As presented above, most of the big cities have adopted a simple fare structure with much fewer stages in comparison to the existing Chandigarh fare. BEST has recently reduced the fare significantly by 35% to 40% and fixed it at Rs.6, Rs.13, Rs.19 and maximum fare of Rs.25 for AC services. DTC fare levels also starts from Rs.10 and maximum fare is Rs.25. Based on other cities' fare levels and cost of travel on other modes as IPT and 2W, three fare options have been worked out and represented in Figure 45 below. In all the three options, minimum fare is Rs.5 and max fare is Rs.25 and Rs.30 with varying stages.

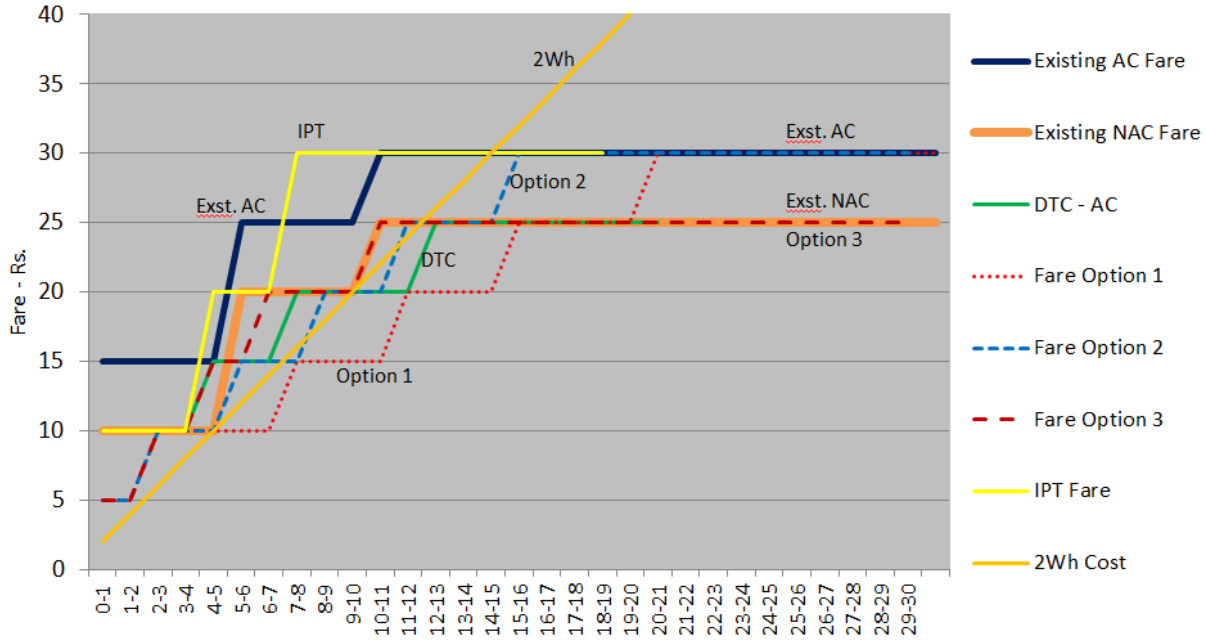


Figure 45: Suggested fare options and comparison with competitive modes

It is important to understand the trip length distribution of PT and IPT passengers while deciding fare stages for options. As IPT users are captive to PT, good level of public transport system with frequent services shall be provided. In overall ridership, about 55% ridership is on IPT where about 45% IPT users have <5km of trip length. Based on the conducted primary surveys, income and the affordability levels in Chandigarh are higher than other case cities. Thus, setting affordable fare levels with frequent AC bus services would certainly help in attracting more passengers on board.

It may be noted that fare options 1& 2 have maximum stages going upto Rs 30 as in case of existing AC bus fares. In comparison, fare option 3 is more similar to existing NAC fare, except that the minimum fare starts from Rs.5 and stages varies marginally lower for passengers travelling from 5 to 7 km. This is proposed to attract short distance passengers currently plying on auto services to city bus services.

The proposed fare structure may be implemented in the year 2021 and would aim to attract ridership from IPT which is extremely sensitive to fare. This fare can be revised every two years based on changes in the cost of operations.

5.3.3.3 Revenue per pax km

The Revenue per pax km is generally known as average fare per pax km which is also compared against operations cost per pax km. As presented in above section, the minimum fare is Rs.5 in all three suggested fare options is significantly low compared to existing AC fare Rs.15 and IPT fare Rs.10. This along with high frequency AC buses may help attract shorter trip length passengers on buses.

Table 59 below presents revenue/ paxkm (fare/paxkm) for the three fare options. Option 3 is lower by 6% compared to existing weighted (AC and NAC) fare/paxkm, however that does not translate to lower aggregate revenue, overall estimated revenue is calculated in the section below. It can be seen that revenue per paxkm is highest in Option 3 in comparison to Options 1&2.

Table 59: Revenue per pax km (Fare/ pax km)

Sr. No	Fare Scenario	Revenue/ PaxKm (Rs.)
1	Existing CTU/ CCBSS fare (AC and NAC weighted)	2.41
2	As per existing AC fare	2.78
3	As per existing NAC fare	2.20
4	DTC AC fare	2.24
5	BEST AC fare	1.31
6	Fare Option 1	1.79
7	Fare Option 2	2.15
8	Fare Option 3	2.28

5.3.3.4 Fare revision mechanism

A periodic revision method (specifying the cost index) for fare is necessary in order ensure system sustainability against any escalations in cost inputs (mainly O&M Costs). The below formula is proposed based on the fare revision process set out for Ahmedabad (AMTS), Ahmedabad BRTS and Surat city bus services.

The fare rates for each km slab shall be revised every two years based on following formula:

R = [R-base] + 1.2 X {[R-base x 0.5 x (F – F-base)/F-base] + [R-base x 0.5 x (W – W-base)/W-base]}

Where:

R is Applicable Kilometer Charge for the payment period

R-base is the Base Kilometer Charge

F is present Price of Fuel/unit

F-base is Base Year Price of Fuel/unit

W is Present Year Wholesale Price Index and W-base is Base Year Wholesale Price Index.

Fares should be rounded off to nearest rupee at time of revision.

Future WPI and future price of diesel are projected using the past trends and the same is used for future fare revisions. Option 3 fare with revised at every two years with the mentioned formula is presented in Table 60 below.

Table 60: Future fare revision on shortlisted fare option 3

Distance Range (km)	**2021 Fare proposed (Option 3)**	**2023 Fare revision**	**2025 fare revision**	**2027 fare revision**	**2029 fare revision**
0 – 2	5	6	7	8	9
2 – 4	10	12	14	16	18
4 – 6	15	17	19	22	25
6 – 10	20	23	26	29	33
>10	25	28	32	36	40

5.3.4 Ridership Build-up

Based on the fleet size and mode shares, the ridership build up is estimated as as per Figure 46 below from FY2023 to FY2032.

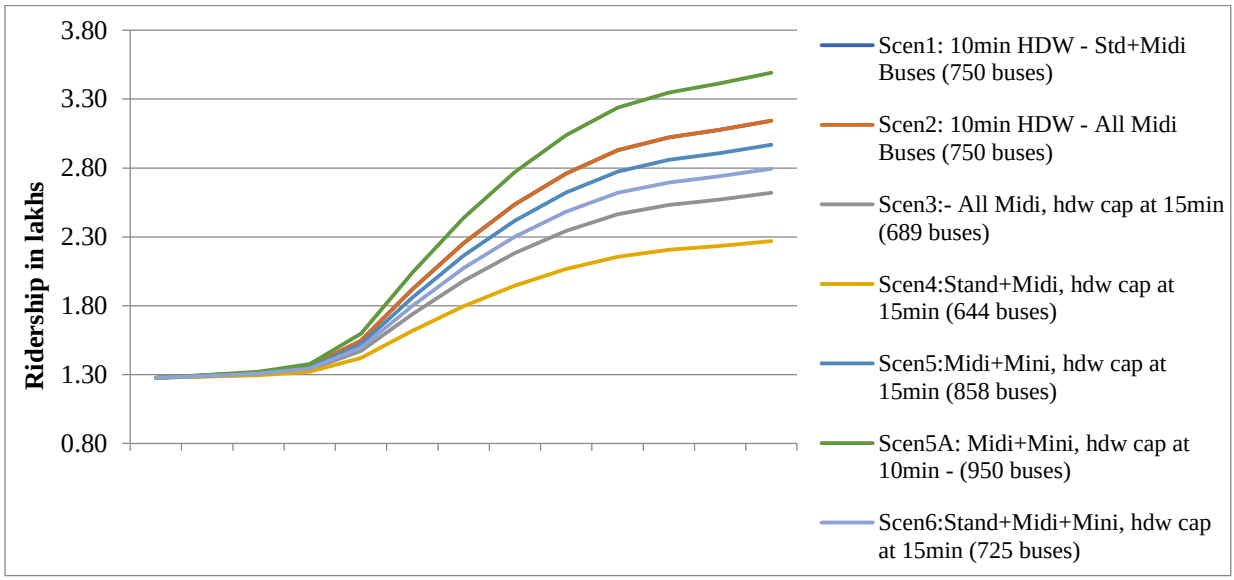


Figure 46: Ridership forecast by fleet mix scenarios

5.3.5 Fare Box Revenue

The key revenue source is the fare box revenue. One of the major concerns regarding fare-box revenue is the pilferage for which adequate safeguarding measures need to be put in place. A robust fare collection system which is convenient is important to ensure comfortable travel. A single ticket travel with smart card or QR code ticketing system would lead to economize the fare at passenger side by avoiding minimum fare paid by passenger while passenger transfer from one service/ route to another service/ route. Fares also have a role in facilitating a modal shift, particularly from shuttle auto-rickshaws in the city, due to this fare levels have been based lower than the auto fares.

Concessions and passes are means of incentivizing bus travel for certain sections of the society. Concessions for students, elderly etc. and passes for regular travelers can help in subsidizing travel for certain sections of society, achieving objective of access for different socio-economic groups.

Based on average trip length of passengers and average revenue per pax km, the total expected fare revenue is estimated. The fare box revenue is estimated considering 100% passengers travelling with tickets.

As per ETM details (Aug 2019) current share of concessional pass holders is about 11% and discounted pass holders is 17%, both the shares are not high as compared to other Indian cities with established PT system but there is an opportunity to increase this share. For the revenue estimation the reasonable increase in share from 28% to 40% by 2032 with an improved bus service levels and quality. It is expected that there would be an increase in the regular users traveling using discounted passes.

Currently system has daily pass, general pass, student pass, govt. or public organization employee pass etc. for both AC and Non-AC services.

Table 61 below presents the major categories of discount and concession types of passes with the current prices and proposed price:

Table 61: Types of passes and their price - proposed

Category	**Discount/ Concession pass type**	**Existing AC price**	**Existing Non AC price**	**Proposed price** (should be implemented from 2021)
Concession	Child passenger	50% of adult fare	50% of adult fare	50% of adult fare
	Student pass	Rs.400/ month	Rs.200/ month	Rs.200/ month
	Employee Pass	Rs.800/ month	Rs.300/ month	Rs.300/ month
	Others category	Rs.5/ trip	Rs.5/ trip	Rs.5/ trip
Discount	Day Pass	Rs.60/ day	Rs.50/ day	Rs.40/ day
	General public pass	Rs.800/ month	Rs.600/ month	Rs.600/ month

Apart from the above categories of passes, there are different fare structures for Punjab and Haryana passengers traveling on city/ sub urban services. This varied fare structures are suggested to be withdrawn so that the same fare structure can be used for all the passengers.

With all concessions and discounts, fare revision and ridership build up; overall fare box revenue is estimated from 2023 to 2032 for each fleet mix scenarios as represented in Table 62 below;

Table 62: Fare box revenue estimation for fleet mix scenarios

	1	**2**	**3**	**4**	**5**	**5A**	**6**
Scenarios →	10min HDW – Standard + Midi Buses	10min HDW - All Midi Buses	LF 60% - All Midi, (hdw cap at 15min)	LF 60% - Standard + Midi, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 15min)	LF 60% - Midi + Mini, (hdw cap at 10min)	LF 60% - Standard + Midi + Mini, (hdw cap at 15min)
FY2023	87	87	85	84	86	88	86
FY2024	96	96	91	88	94	99	93
FY2025	129	129	117	109	125	137	121
FY2026	151	151	133	120	145	164	139
FY2027	192	192	165	147	183	210	174
FY2028	209	209	177	156	198	230	188
FY2029	250	250	210	184	237	276	224
FY2030	258	258	216	188	244	286	230
FY2031	297	297	248	216	281	329	264
FY2032	303	303	253	219	286	337	269
Total Revenue	**1971**	**1971**	**1695**	**1512**	**1879**	**2155**	**1787**

All revenues are in INR in crore

5.3.5.1 Non-fare box Revenue

Non-fare box revenue includes non-ticket sales and may include revenue from advertisement, commercial development, cross subsidy, property rental, etc. Non-fare box revenue sources are crucial

for covering up the operating deficits and making operations viable. In case of Chandigarh, non-fare revenues have been considered to be increase from 18% to 24% over the span of next 10-12 years.

5.4 Financial Evaluation for fleet mix scenario

The total associated cost with fleet mix scenarios and the revenue were estimated and the summary outputs are presented below. Operating cost, revenue estimate, load factor and operating ratio for various fleet mix scenario is presented in Annexure 9. Evaluation framework includes criteria of EPKM/ CPKM recovery, average load factor, cost per pass-km and operating ratio (Table 63 below):

- Scenario 3, 4 and 5 should not be given preference as they are not performing well in terms of overall revenue and revenue-cost ratio is also quite less compared to other scenarios.

- Scenario 6 is moderate in terms of overall revenue as well as revenue to cost ratio, however operating three different types of buses under the same system may be difficult.

- Scenario 2 and 5A can be shortlisted based on revenue and cost indicators. Also these scenarios may be able to attract more passengers on board because of less travel time. These two have least cost/ pass-km amongst all other scenarios.

- Scenario 1 can also be considered as it has a mix of standard and midi bus (40:60 ratios) similar to the existing situation. This scenario also scores well with revenue to cost ratio however cost/ pass-km is a little high in comparison to the Scenarios 2 and 5A.

- Building a depot infrastructure is also a constraint where Scenarios 3, 4, 5 and 6 perform better.

Table 63: Evaluation Framework (Dashboard) – Fleet Mix Scenarios

Scenario →	**1** 10min HDW – Standard + Midi Buses	**2** 10min HDW - All Midi Buses	**3** LF 60% - All Midi, (hdw cap at 15min)	**4** LF 60% - Standard + Midi, (hdw cap at 15min)	**5** LF 60% - Midi + Mini, (hdw cap at 15min)	**5A** LF 60% - Midi + Mini, (hdw cap at 10min)	**6** LF 60% - Standard + Midi + Mini, (hdw cap at 15min)
Cost Estimates							
Total Buses	750	750	689	644	858	950	725
Fleet Cost	1109	922	837	822	783	854	747
Cost/Pax Km at 60% LF	2.41	2.75	2.75	2.66	3.32	3.34	3.05
Total Cost of Ownership (TCO) (Life Cycle)	**2824**	**2607**	**2556**	**2396**	**2734**	**2961**	**2482**
Additional Area Requirement for Depots	12.46	9.51	7.04	5.92	10.04	13.12	6.62
Cost of additional depots with land	128	98	72	61	103	135	68
Total Cost (TCO + Depots)	**2952**	**2705**	**2628**	**2456**	**2837**	**3096**	**2550**
Revenue Estimates							
Expected % PT share range	18%-20%	18%-20%	13%-17%	13%-17%	13%-17%	18%-20%	13%-17%
Approx. daily passengers in 2032 (in lakhs)	3.1	3.1	2.6	2.2	2.9	3.5	2.8
Fare Box Revenue	**1971**	**1971**	**1695**	**1512**	**1879**	**2155**	**1787**
Evaluation parameters							
CPKM in Rs./km (2023-2032)	74	69	69	71	60	59	64
EPKM in Rs./km (2023-2032)	52	52	46	45	41	43	46
EPKM/ CPKM ratio (Revenue/ TCO)	71%	76%	66%	63%	69%	73%	72%
Average LF (2023-2032)	0.35	0.43	0.38	0.36	0.48	0.51	0.46
Cost/Pax Km carried	4.15	3.83	4.34	4.54	4.20	3.99	4.00
Operating Ratio (2023-2032)	0.98	1.03	0.91	0.89	0.91	0.94	0.97

6 Operating Model

6.1 Service Delivery

One of the key questions is how the services will be delivered. This section discusses different types of bus operations model followed by discussion of existing operating model in case of Chandigarh City. The subsequent section presents the key observations and recommendations.

6.1.1 Overview of Bus Operations Model

There are broadly three options for bus operations model:

1. **Public Monopoly:** This model suggests that bus services in city shall be owned and operated by State Transport Undertakings (STUs)/state agencies as they are more likely to have the society's interests at heart and can theoretically operate at lower costs than the private sector. However, state operations have typically failed due to mentioned reasons:
    a. State agencies often suffer from the dilemma of providing profit making services or have a reduced need for subsidies while at the same time provide services at reduced rates (regulated low fares).
    b. Authorities highly rely on subsidies from government with low focus on passenger demand and customer service resulting in a 'supply-oriented' service rather than 'demand-oriented'. This often leads to financial pressures resulting in cost-cutting and service level reduction further declining passenger numbers and consequently, dwindling revenue.
2. **Private Sector Monopoly:** This model suggests the bus operations to be fully privatized, where the private sector carries the responsibility for transport outcomes. The market forces are left to dictate the balance between supply and demand under this model. The major drawback of this model is that the operators yield control over both service quality and fares. The private operators could not bear the risk of balancing both service quality with providing optimal fare to ensure customer-oriented services.
3. **Public Private Partnership (PPP) model:** This is a partnership contract between private operator and public agencies with clearly defined objectives and stating roles and responsibilities of both parties. It is typically a medium to long-term arrangement between the public and private sectors whereby services that are typically the responsibility of the public sector are transferred to the private sector. There are two aspects of a PPP contract that make it valuable and useful in the management of city bus services:
    a. the inherent 'contractual' basis of the agreement

i. Clear definition of roles and responsibilities, obligations, procedures of each party are mentioned in the contractual conditions of the contract agreement; it enforces both the parties to achieve intended outcomes.

ii. Performance based remunerations are easier to enforce under contract conditions with developed payment mechanisms and penalty regimes. Also allows removal of poorly performing operator.

b. the aspect of 'partnership' suggesting financial viability to both parties, risk distribution for better management.

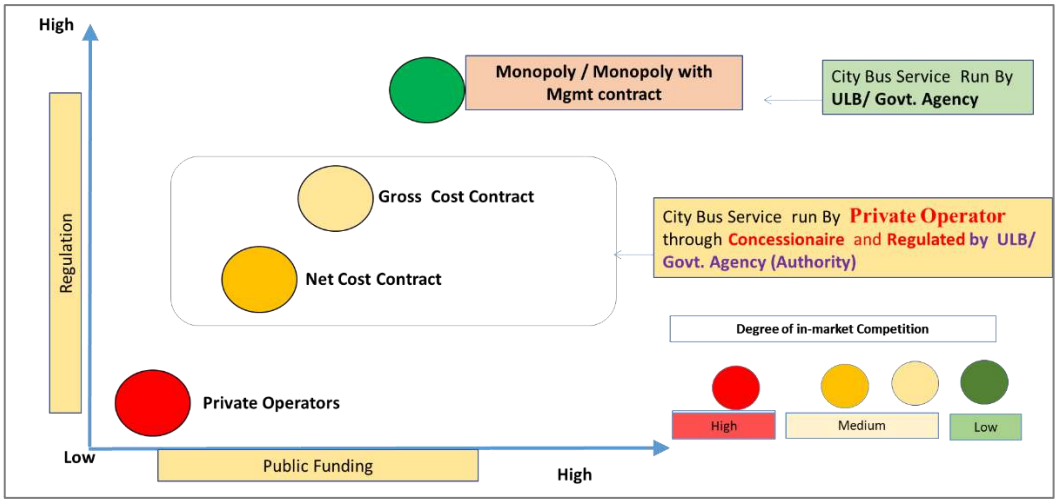


Figure 47: Bus Operation model approach

6.1.2 PPP Operating Model Contract types

The contract types of PPP model (Figure 48 below) varies from a Gross Cost Model, where the entire revenue risk is with the authorities, to a Net Cost Model, where the operator takes the responsibility of managing the revenue risk. The contracts also include hybrid models, which act more like a 'partnership' and are balanced in terms of risk sharing and partnering toward a common objective. The activity chart of all the four contract types is presented in figure below.

GCC	GCC Hybrid	NCC	NCC Hybrid
Private Operator: • Owns, operates, and maintains bus fleets • Owns and maintains plant and equipment • Maintain workshops and depot infrastructure • Receives Km Charge Rate (KCR)	Private Operator: • Same as in GCC except • Receives KCR fixed + Variable based on LF	Private Operator: • Retains Fare box Revenue • Owns, operates and maintains bus fleets, plant and equipment • Maintain depot infrastructure • Receives System Mgmt. Fees (SMF '+' or '-')	Private Operator: • Same as in NCC • Receives Pre-fixed subsidy for selected routes

Figure 48: Activity chart of PPP model contract types

The four types of PPP contracts along with the merits and demerits for both authority and private operator are described in Figure 49 below.

1. **Gross Cost Contract (GCC):** This contract grants higher control to the government authority as it manages the network, by contracting the operators and paying them to provide a set level of services under set quality standards. Under this type of contract, the authority carries the revenue risk, plans overall services, manages the contract for Level of Service (LOS) and quality, and is ultimately responsible for customer service. This contract sets overall Service Levels (SL)/Key Performance Indicators (KPIs) and requires close monitoring by the authority.
2. **Net Cost Contract (NCC):** In the NCC, most of the service planning and revenue risks are carried by operator and the authority performs only regulatory role. Though the service quality levels and KPIs are set as conditions for awarding the NCC the authority has lesser control mechanisms which typically results in a loss of control and risk leading to undesirable outcomes.
3. **Hybrid Gross Cost Contract:** It is a variant of GCC where the authority still carries prime responsibility for passenger service outcomes and sets explicit service obligations (SL), but incentivizes the operator through additional payment for ridership growth sharing the revenue risk.
4. **Hybrid Net Cost Contract:** It is a variant of NCC where the authority supports non-commercial routes where service on the routes needs to be provided as a public service obligation (PSO). This contract type is suitable for more skilled, willing, and experienced operators who are capable of undertaking service planning and managing almost all the revenue risk. The authority sets overall SL/Quality KPIs and needs to monitor outcomes. But, by its inherent nature, the level of control by the authority is less. The characteristics of hybrid NCC and Hybrid GCC contract types are mentioned in Figure 49 below.

PPP	**Gross Cost Contract:** Revenue risk is with authorities	**Net Cost Contract:** Revenue risk is with operators
Types	**GCC** Private Operator: • Owns, operates, and maintains bus fleets • Owns and maintains plant and equipment • Maintain workshops and depot infrastructure • Receives Km Charge Rate (KCR) **GCC Hybrid** Private Operator: • Same as in GCC except • Receives KCR fixed + Variable based on LF	**NCC** Private Operator: • Retains Fare box Revenue • Owns, operates, and maintains bus fleets, plant and equipment • Maintain depot infrastructure • Receives System Mgmt.Fees (SMF '+' or '-') **GCC Hybrid** Private Operator: • Same as in NCC • Receives Pre-fixed subsidy for selected routes
Merits	**For Authority** • Funds Requirement – Low • Investment Risk – Low • Overall Risk evenly distributed leading to - Larger bidding competition - Better Price discovery • Competition – High • Operating Flexibility – Excellent • Data availability – Excellent • Contractual Enforcement – Good • Operational Safety – High • Cartelling Possibility – Nil **For Private Operator** • Bankability – High • Revenue and Operation Risk – Low • Fare Revision concerns – Nil • Incentives for: - Cost Reduction - High - Managerial efficiency improvement - High	**For Authority** • Funds Requirement – Low • Investment Risk – Low • Revenue and Operations Risk – Nil • Monitoring & Control Needs/Cost – Minimal • Competition – High • Force Majeure Risk – Minimum **For Private Operator** • Functional Integration - High • Incentives for: - Revenue maximization – High - Service Quality Improvement - High - Cost Reduction - High - Managerial efficiency improvement - High
Demerits	**For Authority** • Revenue Risk – Medium • Functional integration – Medium • Monitoring & Control Need/Cost – Medium • Service Quality Assurance – Low **For Private Operator** • Incentives for: - Revenue Maximization - Nil - Capacity Utilization Maximization – Nil • Payment Risk - Medium	**For Authority** • Risk concentration leading to poor: - Bidding competition - Price discovery • Operating flexibility - Poor • Data availability – Poor • Contractual enforcement – Poor • Service Quality Assurance – Poor • Operational Safety – Low • Cartelling Possibility – High • Overlapping operations – Inter POs disputes / un-healthy & dangerous competition on roads **For Private Operator** • Fare revenue concerns - High • Traffic/Revenue Projections – Difficult • Viability Gap payment – High Uncertainty • Bankability – Poor • Force Majeure Risk - Medium

6.1.3 Existing bus operations in Chandigarh

Chandigarh Transport Undertaking (CTU) is a government undertaking under the Union Territory Administration of the Central Government which initiated its operations in 1966. A special society, Chandigarh City Bus Services Society (CCBSS) was set up on 29th April, 2014 by the Chandigarh Administration as an extended arm of the CTU. It was laid under JnNURM Scheme-II as an SPV for the operation of the city bus services. The major responsibilities of CCBSS are:

1. To perform functions of administration, planning, setting standards, contracting, regulation, monitoring, coordination and controlling bus service operations within Chandigarh.

2. To efficiently utilize, maintain the infrastructure such as bus terminals, depots, land and buildings, etc., created by the Chandigarh Administration for city bus services and develop passenger information system for the commuters regarding operation of services.

3. To regulate display of advertisements on the city bus services and within the bus terminals.

4. To purchase, maintain and operate buses for efficient transport system.

Currently the city and suburban services from Depot 2 and 4 are operated under CCBSS and all the services from Depot 1 and 3 are operated by CTU. All the buses are being maintained by CTU with its own staff, except for 100 buses operated from Depot-4 which are being maintained under comprehensive maintenance contract by Tata.

At present all bus depots have their own parking and workshops facilities where vehicle maintenance operations are being done. These include facilities for bus fueling, washing and cleaning, inspection pits, tools and equipment for major and minor routine servicing and mechanical repairs, and facilities for changing and maintaining tyres. All depots have workshops and all repairs are taken care internally in the depot except Depot-4, where comprehensive maintenance contract is given to TATA Motors. CTU is also planning to outsource the Comprehensive Annual Maintenance Contract (CAMC) for Depot-2 in future.

The manpower for 480 HMV drivers and 480 HMV conductors has been out sourced to M/s Secure Guard Security and Maintenance Services and M/s Dignus services respectively. The current operating ratio is around 0.22 and VGF/grants are provided by UT administration to CTU.

6.1.4 Proposed infrastructure and manpower

As per the Business Plan, fleet size would increases up to 950 and 689 by FY2032 with 20% and 15% PT share respectively. Given the current mode share of buses is around 10% and existence of high latent demand, it is important to deliver high frequency and high-quality bus services to facilitate a shift to PT. Along with increase in proposed fleet size, the infrastructure and man-power requirement also increases substantially. The infrastructure requirement and the cost is presented in section 5.3. Manpower requirement would increase from about 1600 of operational (Drivers and Conductors) staff to about 5250 and 3790 by FY2032 assuming 5.5 staff per bus ratio.

Based on this infrastructure and man-power size, system is going to be larger by 2 to 3 times by FY2032 compared to present situation, where it becomes essential to understand pros and cons of existing operating model. The section below presents more about tasks list associated with the upgraded public transport system and the responsibilities associated based on the model adopted.

6.1.5 Proposed Operating Model

The bus market would have to be developed, understanding well that facilitating a shift towards PT from private transport is challenging. It would therefore be important to put in place a high frequency and high-quality bus service in all parts of the city in order to attract passengers. While doing so, revenue risk would need to lie with CTU/CCBSS, as passenger build-up may need time. Other complementary demand management measures like parking controls and charges would also have to be put in place to ensure shift from private modes.

It is also important to note that while market is being developed, bus routes would need to be flexible and may have to be tweaked based on the travel patterns of passengers. At the same time, while the new routes are being introduced, the existing routes may have to be removed, modified or gradually withdrawn. The services would also need to be adapted due to uncertainties of demand.

Also as the transition to electric buses is undertaken, being a new technology, the operations would have to be undertaken by the OEMs.

Considering the above points, two operating model options can be considered as below:

- Option 1 - Existing model in 3 depots & GCC for additional depots: The option two suggests a mix of existing operations model and GCC model. The existing 3 depots may be operated by CCBSS as per present operating model and the maintenance and services of the proposed depots may be outsourced or contracted out to private operators. This would work only in cases when partial fleet electrification is undertaken.
- Option 2 - GCC Model for all the depots: This option suggests adoption of GCC model for both existing as well as proposed depot operations and management. This model would be most suitable in case of electric fleet operations. As per this option, CCBSS shall be responsible for the revenue risk, planning of overall services and managing the contract services & quality. All the operations and management work shall be outsourced or contracted out to OEMs who would manufacture, operate and maintain the buses. The OEMs would also be responsible for all necessary equipments along with maintenance of workshop and depot infrastructure.

The responsibility matrix of authority and operator for both the above-mentioned options is presented in Table 64 below:

Responsibility matrix – Operator and Authority

Table 64: Responsibility Matrix – Operator and Authority

Sr no	Allocation of Functions/Activities	Sub-Category	Proposed Model Options			
			Option 1		Option 2	
			CCBSS	PO	CCBSS	PO
1	**Assets – ownership and Investment**	Providing depot for the operation of bus services, Central workshop for monitoring operations of bus services, all the infrastructure and facilities needed in the central workshop, bus station terminals and bus queue shelters	✓	--	✓	--
		Providing all the equipment and facilities needed in the depot	✓	✓	--	✓
		Providing bus queue shelters	✓	--	✓	--
		Procuring buses as per specifications	✓	✓	--	✓
		Providing in-bus PIS facilities as LED Displays, announcements, etc	✓	✓	--	✓
		Providing PIS at bus stations and terminals	✓	✓	--	✓
		Procuring ETVMs machines and others equipment required for the machine	✓	✓	--	✓
2	**Assets – Repair & Maintenance**	Maintaining depot infrastructure	✓	✓	--	✓
		Maintenance and repairing of all plants and equipment provided in the depot	✓	✓	--	✓
		Repairing and maintaining central workshop infrastructure, all plants and equipment provided in the central workshop and infrastructure and facilities provided at bus station terminals	✓	--	✓	--
		Maintaining all infrastructure and facilities provided at bus queue shelters	✓	--	✓	--
		Maintaining cleanliness on buses and maintain adequate level of inventory for repair and maintenance of buses	✓	✓	--	✓
		Maintenance of all ITMS facilities provided in buses	✓	✓	--	✓
		Maintenance of all ITMS facilities provided at bus stations	✓	✓	--	✓
		Maintaining all ETVMs equipment procured	✓	✓	--	✓
3	**Planning**	Strategic Planning of bus services (Vision, developing objectives and envying steps for reaching targets)	✓	--	✓	--
		Assessing future passenger demand in bus services	✓	--	✓	--
		Developing bus service route network	✓	--	✓	--
		Planning of infrastructure services required for successful performance of bus services	✓	--	✓	--
		Estimating bus fleet size and types	✓	--	✓	--
		Planning in-board and off-board ITMS facilities required	✓	--	✓	--
		Planning fare collection infrastructure and equipment	✓	--	✓	--
		Setting service quality standards for proper monitoring of bus services	✓	--	✓	--
		Estimating staff required for functioning of bus system	✓	--	✓	--
		Setting fare fixation methodology	✓	--	✓	--
4	**Preparing**	Provision of bus specifications and standards	✓	--	✓	--

Sr no	Allocation of Functions/Activities	Sub-Category	Proposed Model Options			
			Option 1		Option 2	
			CCBSS	PO	CCBSS	PO
	Specifications / designs / plans / Procurement and other documents / RfQPs for:	Providing design plan layouts for depots, terminals, central workshops, bus queue shelters at planned locations	✓	--	✓	--
		Preparing RFP documents and laying specifications for requirement of equipment and plant infrastructure at depots and Central workshops	✓	--	✓	--
		Preparing design specification and documents on requirement of ITMS infrastructure, Fare Collection requirements (ETVMs)	✓	--	✓	--
		Preparing documents for hiring staff required and laying qualifications	✓	--	✓	--
		Hiring Private Operator, Revenue Collection Agency and Agency for procurement, management, and monitoring of ITMS infrastructure	✓	--	✓	--
5	**Procurement**	Procuring infrastructure contractors for development of depots, Central workshops, terminals and bus queue shelters	✓	--	✓	--
		Procurement of plants and equipment required at central workshop	✓	--	✓	--
		Procurement of staff required at CCBSS	✓	--	✓	--
6	**Finance and Accounts**	Planning funds, sourcing, allocation and control	✓	--	✓	--
		Management of Revenue and Payments, Salary and Wages, Accounts (Banking), Record Keeping and Internal Audit	✓	--	✓	--
7	**Administration and Personnel Affairs functions**	General Admin, Personal (HRD), Legal, Company Affairs/ Board Secretariate, Security and Vigilance	✓	--	✓	--
8	**Marketing and Branding**	Advertising on buses, bus stops and other locations	✓	--	✓	--
9	**Management Information System (MIS) / Monitoring and Control:**	Managing quality of services provided according to the set service quality standards (Data collection, analysis, evaluation, generation of reports)	✓	--	✓	--
		Managing and monitoring roles and responsibilities of service provider contracts as per the agreements	✓	--	✓	--
		Managing and control of payments and revenue	✓	--	✓	--
Colour Legend			✓	Functions/activities to be undertaken fully by CCBSS or PO		
			✓	Functions/activities can be undertaken by CCBSS or outsourced		
			✓	CCBSS to outsource the activities		

7 Key Performance Indicators

Performance indicators are useful tools for ensuring monitoring the quality of the delivered transit services. It is important to identify indicators of relevance as "what gets measured, gets attention" (TCRP 88).

Performance measures help to assess how well the services are delivered to the customers, identify areas of improvement and assess whether their actions are leading to improvement in performance levels. A good performance measurement system should also take into consideration the goals and objectives set by the transit agency. The aim of the transit agency should be that the service provision is undertaken as efficiently as possible so that the goals and objectives are met and over the years improvement in service quality would help in retaining existing riders while also attracting new riders on the system.

In case of Chandigarh, CCBSS/ CTU uses certain service quality standards for the regular monitoring of bus operations, which was compiled from discussion with CTU officials and CIRT published reports as per Table 65 below;

Table 65: Service quality standards/ indicators for the bus service operations

Sr No	Quality Parameter	Formula	Objective
1	Fleet Utilization	No of buses operated*100/ total number of buses	Provides the indication on quality of fleet maintenance.
2	Vehicle Utilization	Km operated by all buses/ Total no of buses held	Provides an indication of Utilisation of vehicle, higher the utilisation more the utilisation of capital investment
3	Dead km	Non revenue km	Gives the indication on modifying the schedule to minimize this
4	Trip operating ratio	No of trips operated*100/ No of trips scheduled	Service delivery quality attribute, higher the % more effective the service delivery.
5	Reliability of bus	Total number of breakdowns*10000/ Total kms operated	Service delivery quality attribute
6	Accident compensation (Rs. In lakhs)	No of accidents*100000/ Total kms operated	Provides the safety indicator, should be targeted 0 rate
7	Staff per bus ratio	Total number of staff/ total number of buses held	Aids to decide on staff procurement
8	Amount of fines collected	-	
9	Average vehicle mileage	Total vehicle km/ total fuel consumed	Mileage for each bus would indication on bus maintenance quality as well indicates on driving quality.
10	Passengers by route	Total number of passenger for each route	Aids to identify the high demand routes and helps to decide the supply on the route.
11	Revenue by route	Total revenue for each route	
12	Revenue per vehicle km	Total revenue per vehicle km on each route	Gives the indication on operational financial sustainability
13	Cost per vehicle km	Total cost of operations incurred per vehicle km for each route	

While the above set seems to be focused more on authority/ agency as well as users , a link with overall vision and goals for the bus services is also important. Also, provision of quality bus services is

expected to lead to improved ridership on the system. Therefore, measures which focus on assessing service effectiveness in terms of ridership levels are critical.

7.1 Performance Measures and Vision & Goals of CTU/ CCBSS

The goals and objectives as defined by a transit agency shall be used to help outline performance measures. The vision, mission and strategic directions of the plan is presented in Figure 50 below. It can be seen that these focuses on both commuters as well as operator/agency perspectives.

Figure 50: Vision, Mission and Strategic Directions

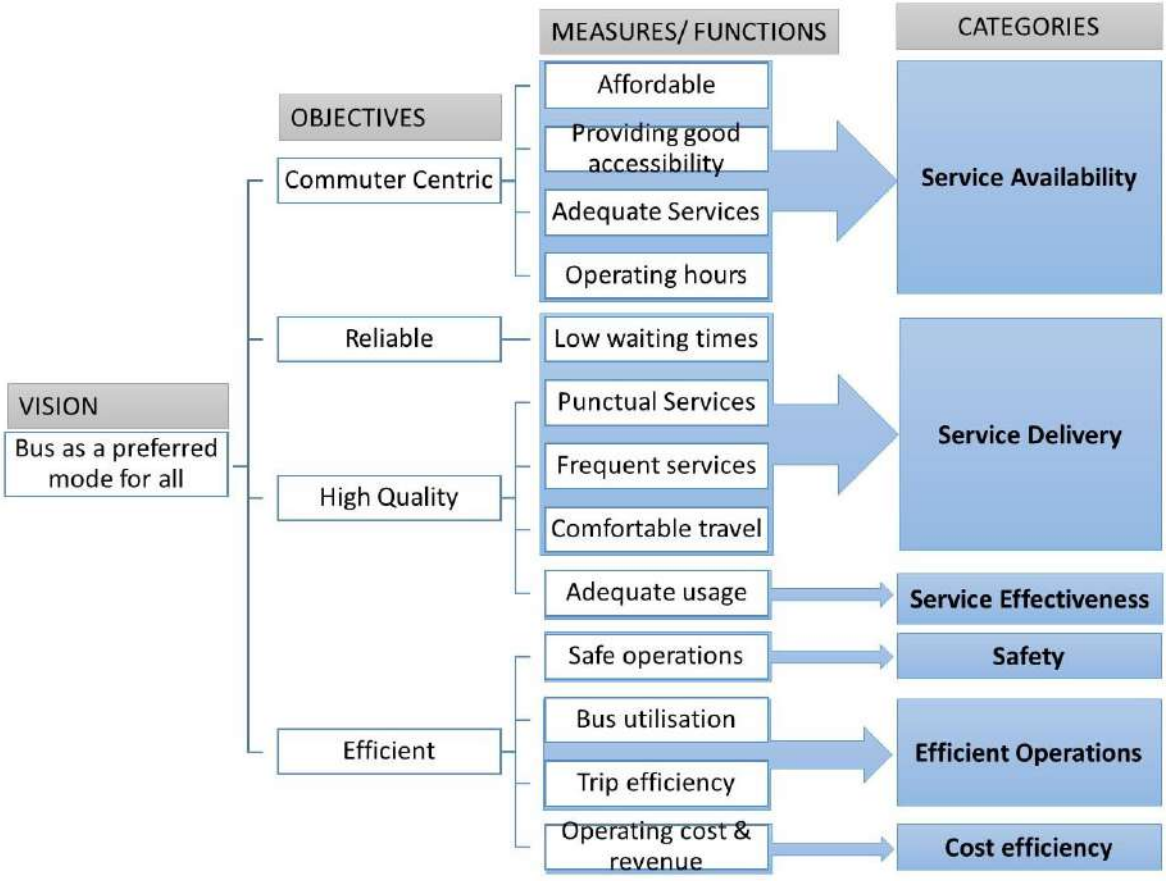


Figure 51: Objectives and Performance Measures of the Service Plan

In line with the Vision, Mission and Strategic Directions, objectives and measures have been defined taking into consideration qualitative perception survey outputs.

As shown in Figure 51 above, the performance measures can be categorised as under:

1. Service Availability
2. Service Delivery
3. Service Effectiveness
4. Safety
5. Efficient Operations
6. Cost Efficiency

7.2 Proposed performance measures

The existing indicators are checked against the identified performance measure categories in Table 66 below to assess their adequacy, identify gaps and need for any new indicators.

Table 66: Proposed performance categories and status

Performance Measure Categories	**Existing indicators**	**Remarks**
Service availability		Currently not covered. Some of the indicators could be: Area coverage, high frequency network/area, span of service, % area accessible within 15 minutes travel time.
Service delivery	• Reliability of bus (Total no of breakdowns*10000/ Total kms operated) • Trips operating ratio (Trips operated/ trips schedule)	Only considers breakdowns and cancellation of trips Other indicators could be: • Schedule adherence • Travel time reliability • maintenance of regular headways • Excess Wait Times
Service Effectiveness	• Passenger per route • Revenue per route • Cost per veh-km	Does not consider any service effectiveness indicators. Following indicators may be considered: • Ridership per bus • Passengers per veh-km • Cost per veh-km (CPKM) vs. Revenue per veh-km (EPKM) ratio • Operating ratio
Safety of operations	Safety of Operations (No of accidents*100000/ Total kms operated)	
Efficient Operations	• Fleet Utilization • Bus utilisation • Trip operating ratio (No of trips operated*100/ No of trips scheduled) • Completion of entire trip (Total kms operated per trip*100/ Total route length)	
Cost efficiency		Financial indicators not considered

It can thus be seen from Table 66 above that the existing indicators are not adequate and do not cover service availability, service effectiveness and cost efficiency categories. Therefore, additional set of indicators are defined as seen in Table 67 below:

Table 67: Proposed indicators for performance measures

Sr. No.	Performance Measure Categories	Indicators	Existing/New	Pertains to perspective of	Remarks
1	Service Availability	Extent of Supply-Availability of Public Transport	New	User	This indicator highlights fleet supply available in PT Service to serve city's population. SLB gradings suggests extent to which fleet supply should be serving the city's commuters. Higher LOS suggests better extent of fleet supply in the city
2		Service Coverage of Public Transport	New	User	This indicator measures share of PT service plying with less than 20min frequency in the city. Higher route service frequency in bus operations provides commuters to opt PT service as a mode of the travel to their destined locations.
3		Accessibility	New	User	This indicator suggests reach of PT services to % of city's population. Higher percentage indicates better accessibility of PT network to residents in the city.
4	Service Delivery	Breakdown probability	Existing	Operator	This indicator measures daily bus breakdowns. The lesser the no of breakdowns the higher the trip operating efficiency or better schedule adherence. Higher value indicates lower efficiency.
5		Travel time reliability	New	User	This indicator suggests deviation in travel time reached due to delay in completion of bus trips during peak hours. Higher value of standard deviation indicates trip cancellation and late departures and arrivals of fleet at terminals.
6		Passenger waiting time	New	User	This indicator measures time required for an individual or a group of people to catch bus service to their destined location in the city. The lower the waiting time of bus services, higher the chances riders choosing PT as their mode of transport
7		Skip Stops	New	Authority	This indicator measures stoppage violation caused by driver's during service operation in the city. This gap will leave commuters to alight or board at the farther distance to their desired location and violate schedule adherence.
8		Punctuality: Adherence to the time schedule	Existing - Modified	Authority	This indicator measures adherence of buses to schedules provided to fulfil the travel demand of commuters in the city. Low figures indicate trip cancellation and more breakdown of buses in the city.

Sr. No.	Performance Measure Categories	Indicators	Existing/New	Pertains to perspective of	Remarks
9		Customer satisfaction	New	User	This indicator suggests improvement and advancement of bus service quality, accessibility required in the system to cater to more reliable service operation in the city.
10		Occupancy Ratio (Load Factor)	New	User	This indicator measures passengers per seat. As a measure of comfort, it is more suitable for inter-city services because the journey is fairly longer than that in intra-city services.
11	Service Effectiveness	Ridership per bus per day	Existing	Authority	This indicator normalizes bus ridership by bus fleet size, and reflects the asset utilization. A higher value means that on average, a bus carries more passengers and suggests better asset utilization.
12		Average Daily passenger km per vehicle km	New	Authority	This indicator measures the average system loading, in other words, how well the operating capacity has been utilized. A higher value suggests better performance.
13		Boarding per 1000 population	New	Authority	This indicator tracks no of passengers using the system throughout the year, indicating improving performance and efficiency of bus operations in the city.
14	Safety of operations	Safety	Existing	User	This indicator outlines no. of casualties in the city due to the PT service. Authority and operator should target to achieving zero casualties. Any value higher than zero suggest driver training.
15	Efficient Operations	Fleet Utilization	Existing	Authority	Fleet Utilization prompts for higher buses operating on road. The closer the figure to 100%, higher the optimum utilization of buses
16		Vehicle utilization	Existing	Authority	Vehicle Utilization reflects daily kms operated by on-road buses. The higher the value, the higher is the trip efficiency of buses.
17		Trip efficiency	Existing (Trips operating ratio) – Modified	Authority	This indicator measured trip efficiency of the bus system. The lesser the trips delayed or cancelled the higher the percent value.
18		Route kms missed	New	Authority	This indicator suggests route violation caused by drivers due to the lack of information or training thereby margining complete reachability of the bus services in the city.

Sr. No.	Performance Measure Categories	Indicators	Existing/New	Pertains to perspective of	Remarks
19		Non-revenue km share	Existing	Authority	This indicator measures the non-revenue bus kms. The closer the depot locations to the bus start terminals the lesser the dead kms. The lower the kms more the kms gains profits. Values are suggested to be as lower as possible.
20	Cost Efficiency	Operating cost per passenger km	New	Operator	This indicator measures the cost required to deliver every kilometre a passenger travel. As operating cost is largely fixed (e.g. manpower cost, fuel cost) once the route and schedule are determined, a higher ridership and longer trip distance would lead to higher operational efficiency.
21		Revenue earned per passenger km	New	Authority	This indicator measures how much a commuter pays for one km he/she travels in the PT system.

The following Table 68 details out evaluation data required and process to analyse the key performance indicators. The table also explains details on measuring indicators derived from service level benchmark's in terms of level of service rankings.

Table 68: Key Performance Indicators results for future year 2032

Key Performance Indicators					
S. No.	**Indicators**	**Existing**	**Proposed Scenario 2032**		
			Scenario 1	**Scenario 2**	**Scenario 5A**
Service Availability					
1	**Extent of Supply-Availability of Public Transport**				
a	**No of buses available in a city on any day**	330	750	750	950
b	**Total population of the city**	1946190	2467089	2467089	2467089
c	Total no of buses available (a)/Total population*1000 (b)	**0.17**	**0.3**	**0.3**	**0.39**
SLB Level of Service (LOS) Grading		**3**	**2**	**2**	**2**
This indicator highlights fleet supply available in PT Service to serve city's population. SLB grading suggests extent to which fleet supply should be serving the city's commuters. Higher LOS suggests better extent of fleet supply in the city. The Identified ranges of the supply are suggested as:- 1) LOS1 - >= 0.4, 2) LOS2 - > 0.25 & < 0.4, 3) LOS3 - > 0.1 & < 0.25 and 4) LOS4 - <= 0.1					
2	**Service Coverage of Public Transport within Chandigarh**				
a	**Transit Access Area (sq kms)**	58.78	77	77	77
b	**Total developed area (sq km)**	87.85	87.85	87.85	87.85
c	Total transit access area (a)/ Total Area (b)	**67%**	**88%**	**88%**	**88%**
SLB Level of Service (LOS) Grading		**3**	**2**	**2**	**2**

Key Performance Indicators					
S. No.	**Indicators**	**Existing**	**Proposed Scenario 2032**		
			Scenario 1	**Scenario 2**	**Scenario 5A**
This indicator measures share of PT service plying with less than 20min frequency in the city. Higher route service frequency in bus operations provides commuters to opt PT service as a mode of the travel to their destined locations. The identified SLB ranges can be referred in the list below:- 1) LOS1 - >= 1, 2) LOS2 - > 0.7 & < 1, 3) LOS3 - > 0.3 & < 0.7 and 4) LOS4 - < 0.3					
3	**Accessibility**				
a	Transit Access Area (sq kms)	58.78	77	77	77
b	**Transit Access Area with high freq stops (sq kms) <10 min**	55.16	72.5	72.5	72.5
c	Total Transit Access Area with high freq stops (b)/ Total Transit Access Area (a)*100	**94%**	**94%**	**94%**	**94%**
Service Delivery					
4	**Breakdown Probability**				
a	No. of breakdown * 10000				
b	Total no of kms operated	59139	117000	125200	172800
c	No. of breakdowns*10000 (a)/ Total kms (b)				
5	**Travel Time Reliability**				
a	Scheduled time of travel				
b	Standard Deviation of actual time of travel				
c	Scheduled (a) - SD Actual (b) / Scheduled time of travel				
6	**Passenger waiting time**				
a	**Avg. passenger waiting time (mins)**	13.5	5	5	3.7
7	**Skip Stops**				
a	No of stops where the bus stopped				
b	**Total no of stops on the route**	267	317	317	317
c	Bus Stoppage count *100 (a)/ Total no of stops (b) *100				
8	**Punctuality**				
a	Total no of trips starts on time as per bus schedule				
b	**Total no of trips scheduled**	2780	9954	9954	12267
c	Total no of trips starting on time (a) / total no of scheduled trips (b) *100				
9	**Customer Satisfaction**				
a	No of complaints registered * 1000				
b	Total no of trips operated	2780	9954	9954	12267
c	Total no of complaints (a)/ Total no of trips (b)				
10	**Occupancy Ratio (Load Factor)**				
a	**Total passenger kms**	1079156	1725224	1990643	2654190
b	Total bus supply kms (total fleet*carrying capacity*Avg. VU)	3466650	7713750	8250000	10450000
c	Total passenger km (a)/ Total bus supply km(b)	**0.3**	**0.42**	**0.33**	**0.55**
SLB Level of Service (LOS) Grading		**1**	**1**	**1**	**1**
Service Effectiveness					

Key Performance Indicators					
S. No.	**Indicators**	**Existing**	**Proposed Scenario 2032**		
			Scenario 1	**Scenario 2**	**Scenario 5A**
11	**Ridership per bus per day**				
a	**Daily ridership**	127630	314312	314312	349236
b	Total no. of buses (On road)	**330**	**682**	**682**	**864**
c	Total passengers carried (a)/Total no. of buses (b)	387	460 (Standard + Midi Buses)	460 (All Midi Buses)	404 (Midi + Mini Buses)
12	**Average Daily passenger km per vehicle km**				
a	Passenger km	**1079156**	**2388771**	**2388771**	**2654190**
b	**Vehicle km**	59139	136400	136400	172800
c	Total passenger kms (a)/Total effective kms (b)	**18**	**18**	**18**	**15**
13	**Boarding per 1000 population**				
a	Total Boardings	127630	314312	314312	349236
b	Population	1946190	2467089	2467089	2467089
c	Boardings*1000 (a) / Population (b)	**66**	**127**	**127**	**142**
SLB Level of Service (LOS) Grading		**4**	**3**	**3**	**3**
This indicator tracks no of passengers using the system throughout the year, indicating improving performance and efficiency of bus operations in the city.SLB indicator suggestion for the indicators are mentioned in the array below:- 1) LOS1 - >= 500, 2) LOS2 - > 250 & < 500, 3) LOS3 - > 250 & < 100 and 4) LOS4 - <= 100					
Safety of Operations					
14	**Safety**				
a	Total no. of accidents				
b	Total no. of accidents (a)/ million km				
Efficiency of Operations					
15	**Fleet Utilization**				
a	Total no. of buses	~365	750	750	950
b	**Total no. of on-road buses**	330	682	682	864
c	Total no of on-road buses (a)/ Total no of buses (b) *100	**90**	**91**	**91**	**91**
16	**Vehicle Utilization**				
a	Vehicle km	59139	136400	136400	172800
b	Total no. of on-road buses	310	682	682	864
c	Total vehicle kms (a)/ Total no of on-road buses(b)	**191**	**200**	**200**	**200**
17	**Regularity of Service**				
a	Total actual trips operated				
b	Total scheduled trips	2780	9954	9954	12267
c	Total actual trips operated (a)/ Total scheduled trips (b)*100				
18	**Route km missed**				
a	Total bus kms per trip				
b	Total scheduled route kms				
c	Total compliance with route (a)/ Total route kms (b)*100				
19	**Non-Revenue kms share**				

Key Performance Indicators					
S. No.	**Indicators**	**Existing**	**Proposed Scenario 2032**		
			Scenario 1	**Scenario 2**	**Scenario 5A**
a	Total Dead km				
b	Total vehicle kms operated	59139	136400	136400	172800
c	Total dead km /Total operated vehicle kms (b)				
Cost Efficiency					
20	**Operating cost per passenger km**				
a	**Operating Cost Annually in Cr.**	183.7	271.1	285.4	306
b	Passenger km in Cr.	39.4	63.0	72.7	96.9
c	Total operating cost (a)/Total passenger km (b)	**4.7**	**4.3**	**3.9**	**3.2**
21	**Revenue earned per passenger km**				
a	**Traffic revenue generated annually in Crs.**	82.0	303.2	303.2	336.9
b	Passenger km in Cr. - Annual	39.4	87.2	87.2	96.9
c	Total traffic revenue (a)/ Total passengers km (b)	**2.1**	**3.5**	**3.5**	**3.5**

8 Organizational Structure

Efficient management of bus operations is critical for ensuring quality of bus services and attracting new passengers on to the system. The bus operations in Chandigarh since its inception was operated by CTU and later by both CTU and CCBSS. The organizational structure and staffing of the agency vary depending on whether the services are operated in-house or if they are contracted out. This section therefore is structured in a way that, first it deals with the existing organizational structure followed by existing staff details and the gaps in existing structure. It also presents the alternative organisation structure and the responsibilities of the departments for suggested Operating Models in the previous chapter.

8.1 Existing structure of CTU and CCBSS

The organization structure of CTU is relatively large and comprehensive. Most of CTU's experience comes from operating long-distance bus services in the region and surrounding states. The existing CTU organization is established at two levels viz. central office level and depot level. The structure of both CTU and CCBSS is same at depot level. The bus operations are under four depots Depot I to Depot IV. Depot II and IV are solely responsible for the city bus service operations and are functioning under CCBSS. The long route operations are carried out from Depot I and III, which are managed by CTU. Additionally, Depot III also operates a few city bus service routes.

CTU and CCBSS both functions under supervision of Secretary, Transport, Chandigarh Administration. The Director, Transport, carries out day-to-day management of buses operating in the city as well as long distance buses. The Director, Transport is to be assisted by four General Managers, two of whom are responsible for local bus services and the remaining two are responsible for regional bus services. However, currently only two of these positions are filled, one handling city bus services and other regional services. Existing structure of CTU and CCBSS is presented in Figure 52 below:

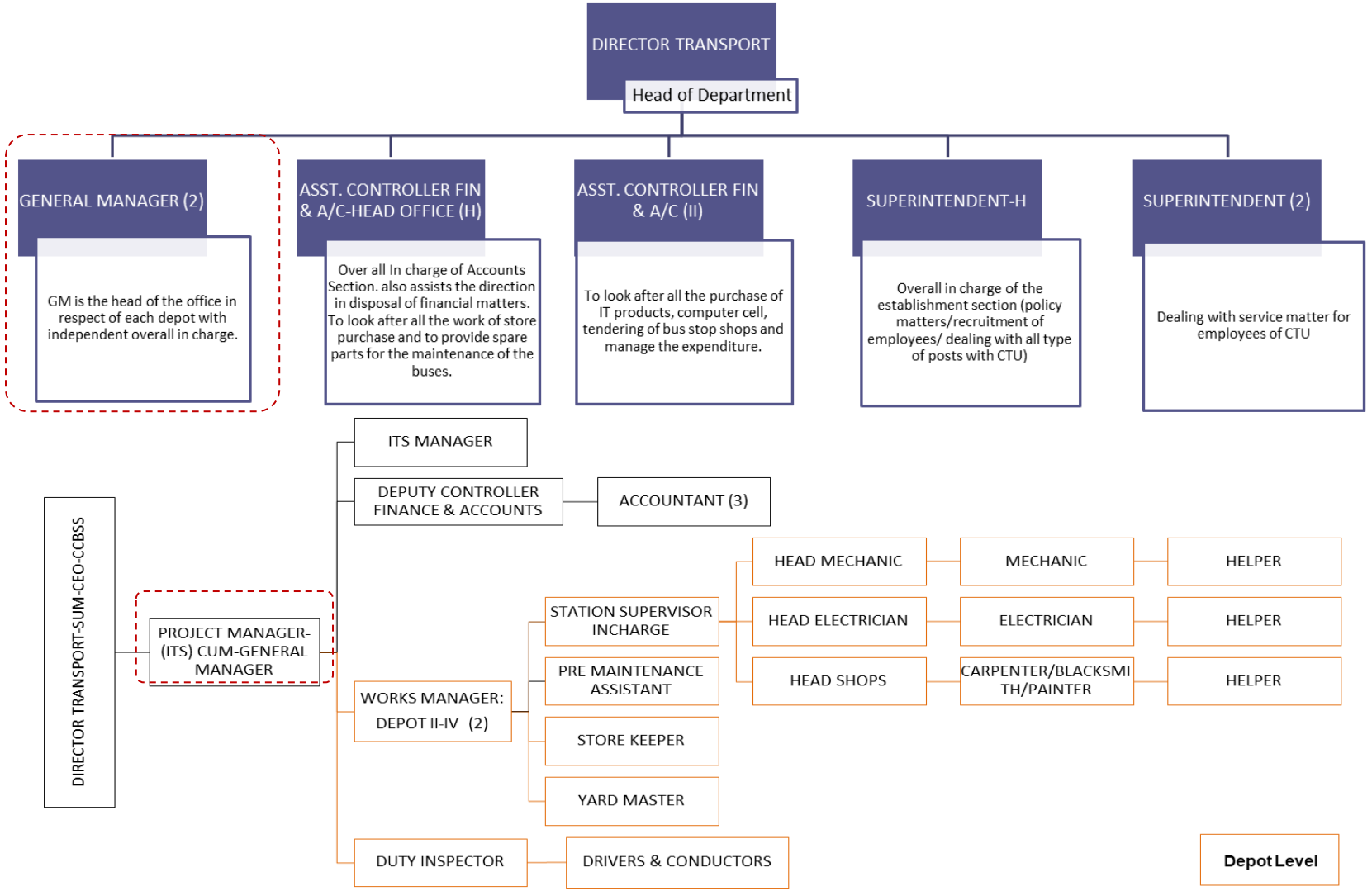


Figure 52: Existing Organization Structure

Table 69 below details the responsibilities for various positions under CTU and CCBSS.

Table 69: Roles and Responsibilities of staff in CTU and CCBSS

Sr. No.	Name of the Post	Responsibilities
1	Director Transport, U.T., Chandigarh/ CEO CCBSS	Head of the department / Appointing authority
2	General Manager/Project Manager	G.M. is the head of the office in respect of each depot with independent overall in charge. Being head of the office, s/he is also overall in charge of respective workshop attached with the depot. S/He is the competent authority to grant leave for the staff working under him/her and submission of proposals to the D.T. regarding operative function of the work and all other duties assigned by the Director Transport.
	Traffic Manager	To look after all the work of traffic side i.e. timetables, operation of buses & checking of buses on routes.
	Works Manager/ Asst. Divisional Manager	Overall, in charge of workshops and responsible for maintenances of workshop and repair & fitness of buses before plying on routes
	Duty Inspector	Responsible for scheduling duties of the crew (drivers/conductors)
	Station Supervisor	Responsible for ISBT-17/43; and overall controlling of buses at bus stand
3	Asstt. Controller Finance & Accounts (F&A)-Head Office (H)	Overall, in charge of Accounts Section and also Audit Party / cash branches. Drawing and disbursing authority. To look after all the work of store purchase and to provide spare parts for the maintenance of the buses.
4	Asstt. Controller (F&A)-II	To look after all the purchase of IT products, computer cell, tendering of bus stop shops and manage the expenditure. Looks after the revenue and receipt from bus operations.
5	Superintendent	In charge of the establishment section (policy matters/recruitment of employees/ dealing with all type of posts with CTU)
6	Deputy Controller F&A	In charge of Accounts Section and also Audit Party / cash branches. S/He also assists the direction in disposal of financial matters for CCBSS
7	Nazir	He is responsible for stores, office stationery as well as maintaining of record of issue of uniforms to employees of CTU.

8.1.1 Observations and Recommendations

The organisation structure of CTU/ CCBSS presented in Figure 52 above seems well structured however as system grows and technology comes in system, roles and responsibilities also needs to update. Below are few observations and recommendations listed;

- It is observed that most of the responsibilities defined are more towards authority's benefits which focus more on finance and operational cost monitoring, however responsibilities towards activities oriented to passenger's benefits seems unattended.
- It is observed that pro-active decision on service coverage and level of service planning through strategic planning approach is somehow not given the importance in current responsibilities. General Manager/ Operation Manager with the help of Traffic Manager should conduct this exercise periodically, which may also include route network planning, service frequency

planning, new service type initiative, passenger oriented performance measures etc. These would also help to achieve towards the strategic vision.

- General Manager along with traffic manager should also focus on planning vehicle type and size depending on the route physical performance indicators which will bring efficiency in operations.
- Technical functions and procurement: decisions of vehicle type, size and technology for procurement, fleet size, technical specification of buses, RfP preparation and bid process management, inspection of buses, monitoring of bus repair and maintenance
- It is observed that ITS manager responsibilities are not defined very well. With control center being constructed and soon to be operational, responsibilities of ITS manager becomes essential. This would include analysing MIS reports for operations for identification of operational issues, performance monitoring of services, traffic, man-power etc.
- Branding and Marketing activities to increase visibility of the system in the city and attract passenger ridership should also be taken up.

8.2 Proposed Divisions and functions

In comparison to existing structure, four major departments are suggested under CCBSS and their responsibilities have been suggested. In proposed models, responsibilities on finance department and operations department are going to increase because of auditing and monitoring private operators' bills and their physical performance.

As presented and explained in Operating Strategies section, Model I or Model II are recommended for the proposed services, depending on the level of electrification in city bus operations. Table 70 below presents the departments and their responsibilities.

Table 70: Functions of proposed departments

Department / Designation / Position	Main Functions
Corporate office / Chief Executive Officer (CEO) CCBSS	**Overall Management of** CCBSS
Department: Administration and Personnel **Chief Administrative Manager (CAM)** **Supported by:** ▪ Manager HRD & Admin ▪ Manager Legal & company Affairs ▪ Other Staff (Assistant Manager & below)	• Overall Administration • HRD – staffing, capacity building, career progression, Leave and wage Administration • Security and Vigilance • Legal and regulatory • Company Affairs / Board Secretariat • Taxes, rates and rents, • All other administrative matters / functions not covered by other departments
Department: Operations **Head: Chief Operations Manager (COM)** **Supported by:** ▪ Manager Operation Planning, Branding & Marketing, Advertising ▪ Manager Depots, checking, revenues, field Operations ▪ Other Staff (Assistant Manager & below) **Staff per depot in PPP model:** ▪ AM Operations ▪ Traffic Inspectors	• Overall operations management • Travel Demand Assessment – spatial and temporal • Route network planning • Operations Planning • Operations Scheduling – route wise / trip wise • Service Quality (SQ) Planning – Setting Service Quality SQ Standards, Benchmarking SQ parameters • Checking delivery of scheduled services / SQ • User Grievance / complaints – analysis and addressing / user communication • Preparing Service / Operations related Service Level Agreements (SLAs) for PO, RCA, Others • Overall management of Revenue Collection System – revenue planning, revenue generation, revenue leakage • Attending to / ensuring prompt attention to Accidents, other hazards / incidents / events on-road • Branding and Marketing of PT services, • Advertisement Management – on buses, other assets, • Generating sources of other than tariff revenues • Monitoring and Control of services / service providers wrt Agreements / SLAs / SQ / Revenues / Others • Any and all other activities / functions / aspects related to Operations
Department: Technical **Head: Chief Technical Manager (CTM)** **Supported by:** ▪ Manager Technical - Fleet ▪ Manager Procurement ▪ Manager Infra ▪ Manager ITMS	Overall Management of Technical Functions / Services for PT Operations • Planning for: o Fleet -- type, category, size, nos., o Depots / Terminals / BQS- Locations, sizes, designs, acquisition docs, bid process management, supervision, quality assurance, etc at all stages including that of repair and maintenance o Plant and equipment for DWS and CWS, o Stores and Purchase set ups o ITMS o ETVMs o Staffing

Department / Designation / Position	Main Functions
Assisting Staff (Assistant Manager and below) **Staff per depot in PPP model:** ▪ **A**M ▪ **Supervisors**	○ All other items / activities / functions for Technical deptt. • Development of Specifications / Designs / Standards for: ○ Buses ○ Plant and Equipment, ETVMs, ITMS, etc ○ Depots, Terminals, BQS, any other civil infra items / functions ○ Physical performance of buses and other items / Service Level Agreements (SLAs) ○ Repair and Maintenance of buses, plant and equipment / ITMS / ETVMs, etc ○ Staff ○ Any other activity / functions • Procurement function / Activity: ○ Preparation of RfQP documents for all purchases (Infrastructure, buses, Service providers – PO, RCA, ITMS, ETVMs) ○ Bid Process management, finalisation of preferred bidder for PO, RCA, ITMS, ETVMs, Plant and equipment, and follow up of deliveries, Finalisation of agreements / Guarantees / Purchase orders ○ Quality Assurance of above ○ Installation / commissioning as required ○ Storage and Distribution ○ Staff ○ Any other items / function • Monitoring and Control of: ○ All Technical Activities, ○ SLAs for service providers. ○ Physical performance etc ○ Quality of Repair and Maintenance Activities, ○ Condition of bus fleets and other Assets ○ Collection, compilation, evaluation of related data and generation of required reports for corrective actions ○ Staff performance
Department: Finance and Accounts **Head: Chief Accounts Manager (CAM)** **Supported by:** ▪ Manager Finance and Internal Audit ▪ Manager Accounts ▪ keeping, bills payment, etc ▪ Assisting Staff **Staff per depot in PPP model:** AM Cashiers	• Planning for: ○ Funds Requirement ○ Sources of funds ○ Productive deployment of surplus funds at any time, if any ○ Inter and external Audit ○ Banking operations and management, ○ Cash collection from RCA and banking mechanism ○ Payments – bill verification, ○ Wages and Salaries ○ Book keeping and Accounting ○ Vetting of all purchases, ○ Management of PF, Gratuity, ESIC as applicable ○ Any other related function

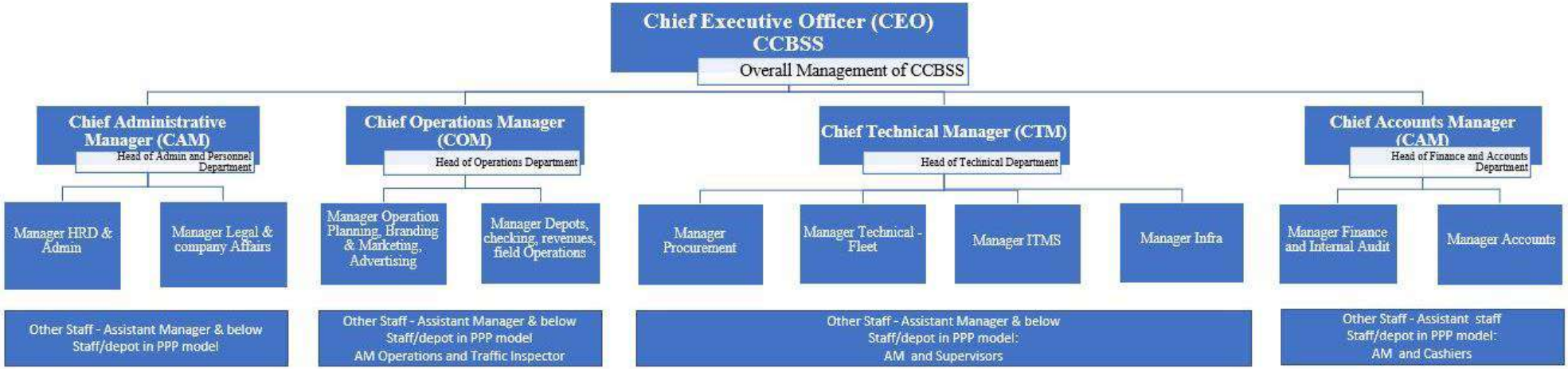


Figure 53: Proposed Organization Structure – CCBSS

8.3 Summary

CCBSS is an extended arm of CTU which looks after the city and sub urban services from two of the depots (Depot 2 and 4). As per the Business Plan for 2032, bus fleet is expected to increase from 750 - 950 buses depending on the fleet type opted by the city. To ensure that a quality bus system is delivered, apart from monitoring of the outcome, setting up of a process monitoring system is essential. Increase fleet size is increasing the increasing the depot requirement from 3 to 5 which would also need to add the depot level technical staff for each depot separately. Depot level technical staff (Assistant Manager(s) with Supervisors) could undertake this task of checking of service schedule preparation as per SLAs, regular maintenance of buses, etc, and also help in ensuring coordination with operator, ITMS agency and revenue collection agency. A process monitoring system along with outcome monitoring may prove to have a better effectiveness in achieving delivery of quality services.

As mentioned in business plan, CTU/ CCBSS are aiming to phase out all the diesel buses to electric buses over the next decade. The overall staff requirement of CCBSS can be a little high at 0.2 personnel per bus up to 100 buses owing to the new EV technology and 0.10 per bus for more than 100 buses. Creation of four divisions for administration, operations, technical and account are proposed. Since entire Gross Cost Contract is being suggested, revenue management would be a major task; hence a separate account/ finance department would be essential which would also look after internal audit. Depending on the fleet size and mix scenario, the manpower requirements would have to be worked out. For e.g. in case of a standard and midi and all midi bus scenarios with a fleet size of 750 would need about total staff of 85 and midi and mini fleet mix scenario with fleet size of 950 would need about total staff of 100.

9 Complementary Measures

Public transport is essential for inclusive growth of Chandigarh city and the bus is central to the public transport offering intra-city connections. The city bus services is facing serious challenges in terms of system utilisation and capturing desired ridership owing city has high average income level, high vehicle ownership (683 passenger vehicles per 1000 population) and availability infrastructure facilities promoting private vehicles like parking in all the sectors in the city. All these factors have impacted bus ridership and have led to a shift to private modes as well as shared auto rickshaws. While the city is keen on reforming the bus services and has a vision of *"Chandigarh city services as an attractive and everyday mobility choice for residents",* other complementary measures would be required to help achieve the vision.

This plan focuses on planning for a quality bus service for the city of Chandigarh with technological interventions to provide an integrated public transport. The objective is to develop a bus network that works for everyone and decreases the need for private vehicular trips which in turn helps to improve air quality in the region.

The focus will be to put in place bus service that is flexible enough to adapt to changing travel patterns and accommodating increases in travel demand in the short term. In the medium to long term, focus should be on interchange and integration which would aid in improving connectivity between jobs, housing and education for the city residents.

9.1 Parking Management

Extensive parking facilities including paid parking for 2-wheelers, 3-wheelers, 4-wheelers and taxis are available at every sector in the city. Apart from all the on-ground parking locations some commercial and office spaces are also occupied with multilevel parking facilities. Some of the major parking locations in the city are ISBT17, sector 26 market, Housing board, IT Park, Sukhna Lake, Elante Mall etc. Parking facilities are provided at all street edges and building upfronts with commercial and recreational spaces. Few images of parking facility in Chandigarh are shown in Figure 54 below.

Figure 54: Images of parking locations in Chandigarh city

To facilitate a shift from personalized modes of travel, “carrot and stick” measures would have to be adopted. While improved service quality is important to attract passengers, regulation on private traffic in terms of high parking charges or control on availability of parking spaces would be important to push people away from private to PT modes.

10 Business Plan Summary

A detailed analysis of fleet size and type with respect to infrastructure requirements, cost and revenue along with estimated PT mode shares was presented in section 5. This section summarizes the possible scenarios for the business plan. Trajectory of vision realisation and the timeline is a function of agency's intent and drive along with constraints like financial resources and land availability for infrastructure facilities. Alternative scenarios are hence presented as part of the business plan, which the cities could choose from for deciding on an appropriate business strategy for bus services in the city.

10.1 Fleet size and mix

In terms of operating ratios and estimated mode shares, three fleet-mix scenarios seem to be performing well (Table 71 below). These scenarios along fleet type requirements by 2032 are:

a) Standard and Midi Fleet type with 750 buses (295 standard & 455 midi; 40:60 ratio)

b) All midi-buses with a fleet size of 750

c) Midi and mini-buses with a fleet size of 950 (292 Midi + 659 Mini)

Table 71 Shortlisted Business Plan Scenario

Scenario No	Total Fleet Size	Additional Depot Requirement	Remarks
1	750 (295 standard + 455 Midi)	2 (12.5 acre of land)	The fleet mix is similar to the existing scenario. However, it is assumed that all the fleet would be transitioned to AC electric buses over the plan horizon of 2032.
2	750 (all Midi)	2 (9.5 acre of land)	This particular scenario considers all electric AC midi buses instead of standard buses. This would enable managing all buses of a single fleet type and would also have a lower demand on depot space.
5A	950 (292 Midi + 659 Mini)	2 (13.1 acre of land)	Chandigarh being a largely private mode dependent city, enabling a shift to buses would require provision of a high quality service which is quicker and comfortable. While AC buses have been considered for all the scenarios, provision of a mix of midi and mini buses may enable offering of a more frequent service and a better fleet utilisation especially during the ridership build up period.

10.2 Fleet Procurement Phasing Plan

Table 72 below presents fleet procurement plan for total fleet by bus type for each shortlisted scenario. Fleet procurement plan is prepared considering that the existing fleet will serve till its full life. Fleet utilisation is assumed to be 95% for first three years and 90% for the rest of the years.

Table 72: Total fleet (on road + extra fleet) procurement plan – shortlisted scenarios

Scenario -->	**Scen-1: Standard + Midi Buses**		**Scen-2: All Midi Buses**	**Scen-5A: Midi + Mini**	
Bus Type -->	Standard	Midi	Midi	Midi	Mini
2023	28	115	144	120	158
2024	0	0	0	0	0
2025	112	144	257	51	251
2026	7	8	15	4	19
2027	103	113	201	53	132
2028	0	0	0	0	0
2029	44	37	67	43	99
2030	0	0	0	0	0
2031	0	37	67	21	0
2032	0	0	0	0	0
Total Standard/ Midi/ Mini Fleet	295	455	750	292	659
Total Fleet	750		750	950	

From the existing 10% PT share to targeted PT share of 20% - 25% by 2032 would require significant quantitative as well as qualitative improvements in the bus services.

The fleet mix concept is not new for the city as CTU/ CCBSS operating standard and midi buses, however city may consider transitioning of standard-midi mix to all midi or midi-mini mix to offer frequent services to the citizens which would induce IPT and private vehicle users to shift to PT.

The requirement of number of smaller buses would be more compared to requirement of standard buses because of lesser capacity; however it is estimated that the operating ratios would improve due to the potential of higher passenger ridership levels with better service headways and connectivity. Preferably lower demand routes should be operated with smaller buses which aid improving the load factor by providing frequent services to citizens. Switching to a different bus type should not pose a big challenge as the average age of a bus is 8-10 years and hence the transition could happen gradually as old buses get phased out. With congestion levels continuously increasing in the city, operating smaller vehicles may also be easier in the city.

Like other Indian cities in Chandigarh also, auto-rickshaws operating as shuttle service compete with the buses despite high fare levels. Facilitating a shift from them would require buses which are affordable, frequent and have good coverage and accessibility. With smaller bus sizes (Midi / Mini), it may be possible to offer a high frequency service with better load factor levels.

10.3 Depot requirements

Locations of new depots are important to plan in a way that it does not lead to an increase in the non-revenue km. Currently city authority does not have any provision for land for depot locations; therefore, tentative directional locations have been suggested in the map below and the fleet of proposed routes are allocated to depots in such a way that it minimizes the dead km in future years. Additional depot and area requirements estimated for the shortlisted scenarios are presented in Table 73 below:

Table 73: Depot area requirement for future

Scenario	Scenario 1 Standard + Midi	Scenario 2 All Midi	Scenario 5A Midi + Mini
Total Depot Area Requirement (in acre) - 2032	32.96	30.01	33.62
Existing Depot Area available (in acre) *(existing depot 3 considered with 50% capacity)*	20.50	20.50	20.5
Additional Area Requirement for Depots (in acre)	12.5	9.5	13.1
Additional number of Depots	2.00 (~6 acre of land near Mani Majara & ~6.5 acre land near PGI)	2.00 (~4 acre of land near Mani Majara and ~4.5 acre land near PGI)	2.00 (~6.5 acre of land near Mani Majara and ~6.5 acre land near PGI)

The non-revenue distance covered by a bus to travel from the depot to a terminal and back to the depot from terminal at the start and end of service hours is marked as dead kms. Minimizing dead kms is an important consideration as it affects the operational cost. With increase in number of buses from 330 on road buses to 682 (total 750) and 863 (total 950) on-road buses, land for depots would have to be procured as shown in Figure 55 below. Table 74 below presents the estimated dead km and the expenditure on that.

Table 74: Dead kms estimation for future years

	Existing 2020	Scen 1 (FY2032)	Scen 2 (FY2032)	Scen 5A (FY2032)
No of Routes	69	42	42	42
No of buses (on road)	330	682	682	863
Dead kms	4816	7748	7554	10301
% dead km minimized	6.8%	5.7%	5.5%	6.0%
Avg. yearly expenditure *(INR in crore)*	10.20	20.93	19.02	22.18

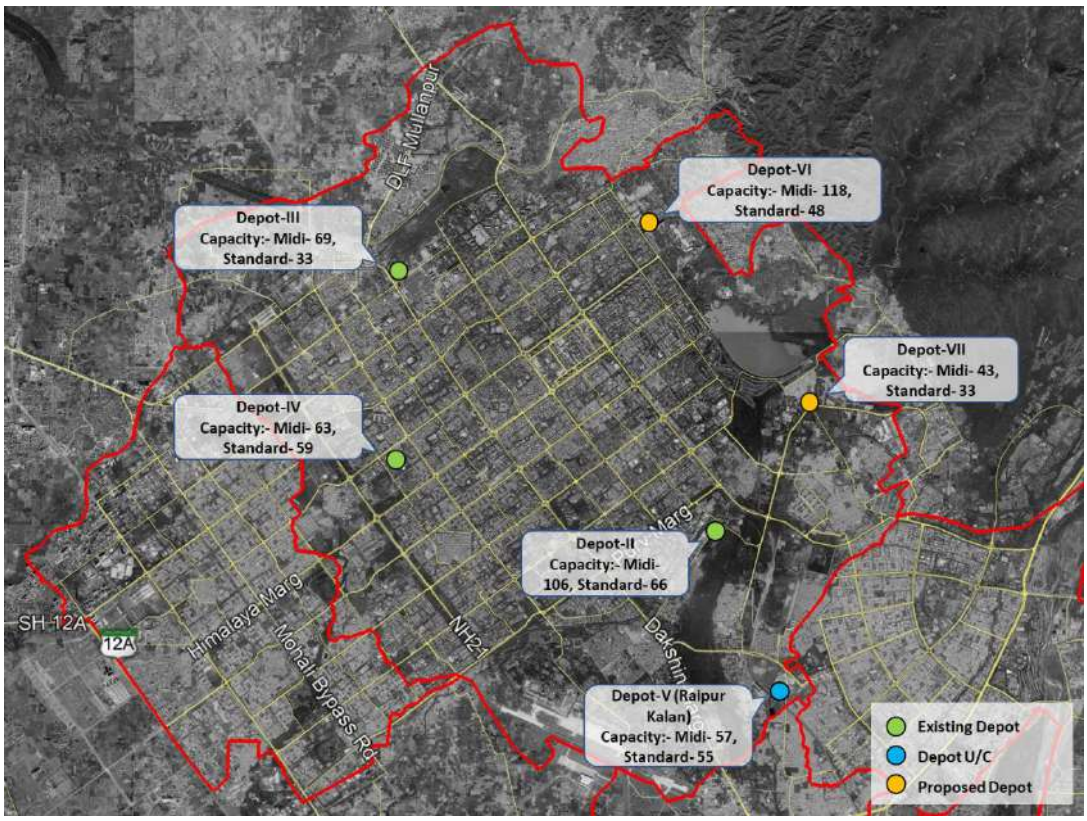
Table 75 presents the fleet allocation by depots for future year 2032 for the three shortlisted scenarios;

Table 75: Fleet allocation to depots (FY2032)

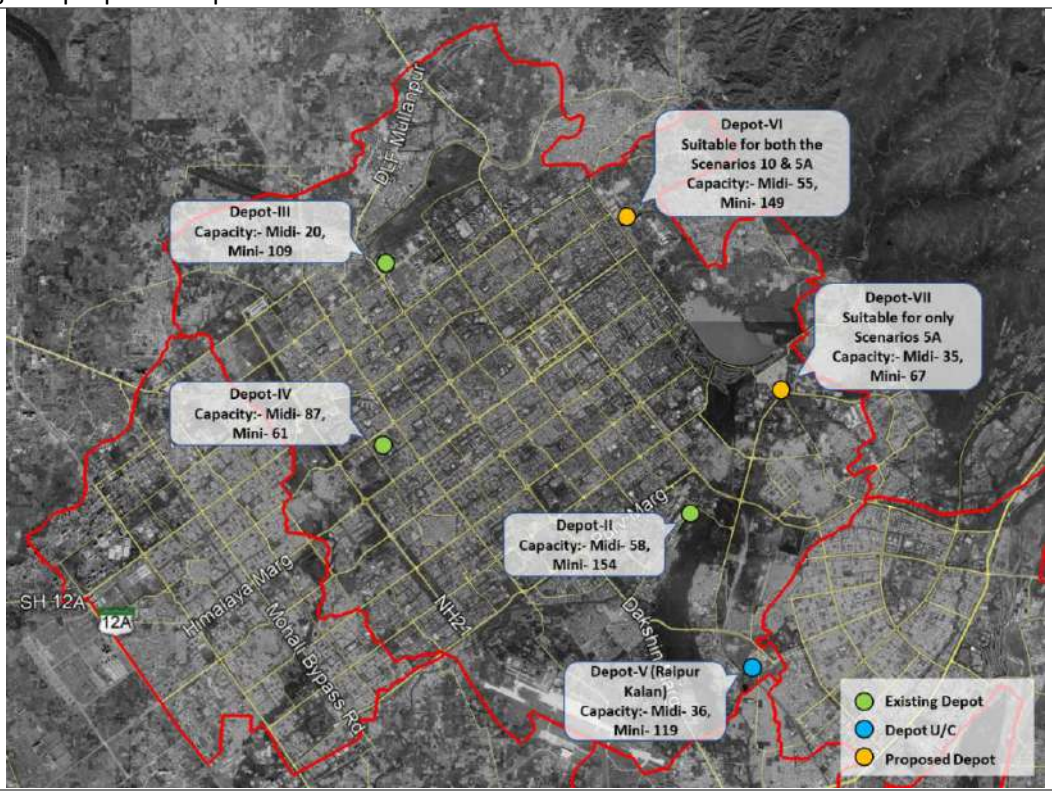
Capacity - requirement (2032)	Fleet type	Depot II	Depot III	Depot IV	Depot V (Raipur Kalan)	Depot VI (near PGI)	Depot VII (near Mani Majra)	Total Fleet
Scenario 1	Mini	0	0	0	0	0	0	0
	Midi	106	69	63	57	118	43	455
	Standard	66	33	59	55	48	33	295
	Total	**172**	**102**	**122**	**112**	**166**	**76**	**750**
Scenario 2	Mini	0	0	0	0	0	0	0
	Midi	178	110	137	98	179	47	750
	Standard	0	0	0	0	0	0	0
	Total	**178**	**110**	**137**	**98**	**179**	**47**	**750**
Scenario 5A	Mini	154	109	61	119	149	67	658
	Midi	58	20	87	36	55	35	292
	Standard	0	0	0	0	0	0	0

	Total	**212**	**129**	**148**	**155**	**204**	**102**	**950**

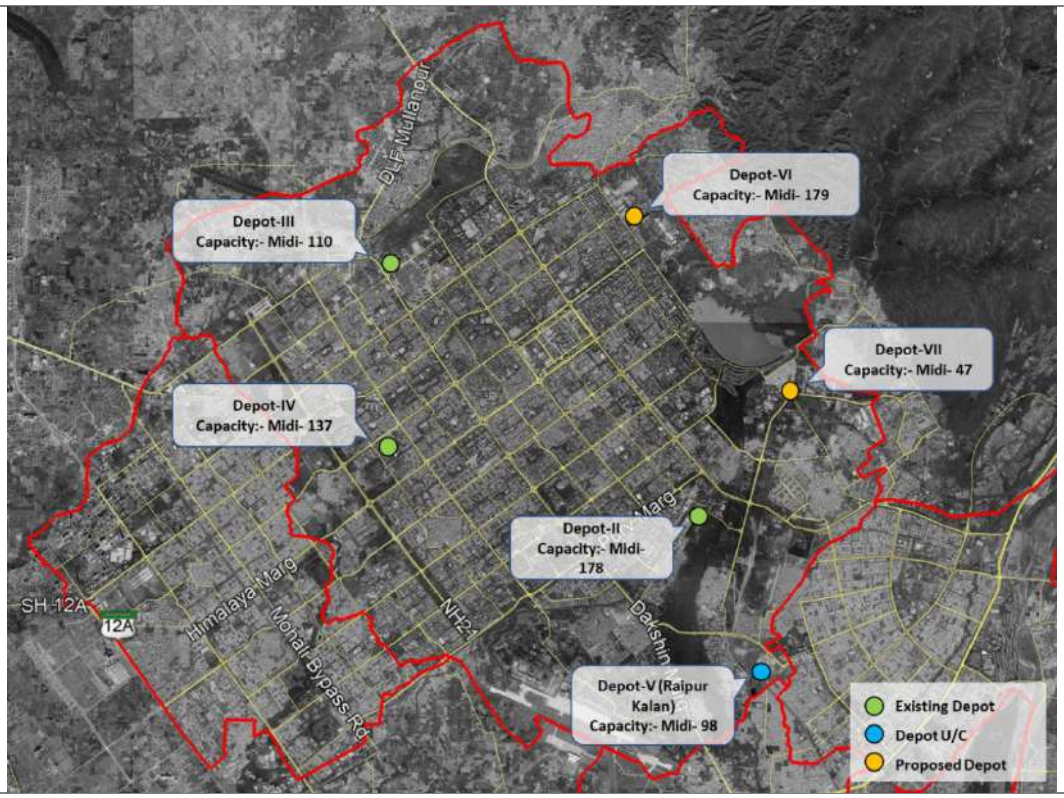
Figure 55 below presents the proposed tentative locations for proposed depots;



Existing and proposed depots locations and fleet distribution for Scenario 1



Existing and proposed depots locations and fleet distribution for Scenario 2



Existing and proposed depots locations and fleet distribution for Scenario 5A

Figure 55: Strategic locations for proposed depots

10.4 Drivers/Conductors halt facilities

Continuous driving leads to driver fatigue, hence driver should be provided with rest at regular intervals. Driver's facilities are hence, provided at trip end locations with small office space, rest rooms and wash rooms. As per traditional practice, drivers and conductors take rest at major terminals but in case of Chandigarh providing halt facilities at only major terminal stations would result in congesting these terminal and would occupy the bays for parking of buses, therefore it has been proposed to provide basic facilities at other ends of routes. These locations should have enough land capacity to accommodate parking of a bus for at least 5 to 10 mins before the next trip. The locations (presented in Table 76 below) are tentative and may vary after site feasibility.

Table 76: Few major Driver/Conductor halt facilities within Chandigarh

Halt Terminal Locations	No of buses		
	Scenario 1	Scenario 2	Scenario 5A
Bhago Majra	12	12	17
Gurudwara Singh Saheeda Sahib	18	18	22
Khizrabad	12	12	17
Derabassi	12	12	18
Zirakpur bus stand	18	18	20
Airport Chowk	6	6	10
Ram Darbar	6	6	9
Kharar	18	18	21

Halt Terminal Locations	No of buses		
	Scenario 1	**Scenario 2**	**Scenario 5A**
New Airport	12	12	15
Dhanas	6	6	15
ISBT Mohali	12	12	12
Maloya	12	12	12

10.5 Capital Costs

Table 77 below presents the cost estimates for infrastructure development which will be required from the years 2023-2032 for shortlisted three scenarios. All the costs are estimated at constant prices keeping 2020 as the base (escalation rates outlined in the cost estimates section).

Table 77: Total Capital Cost (in Cr.) Investment (2023 to 2032)

Item	Scenario 1- Standard & Midi	Scenario 2 – All midi	Scenario 5A – Midi & mini
New Bus Stops + Existing Bus Stops reconstruction (Within Chandigarh)	31.28	31.28	31.28
Terminals improvement + Driver conductor facilities at few locations	11.82	11.82	12.26
Depots cost (with land)	128	98	135
ETVM	5.4	5.5	6.84
Utilities & Recovery Vans – Depots	1.25	1.25	1.34
Capital infrastructure cost	**178**	**147**	**186**
Fleet cost	1109	922	854
Total Cost	**1287**	**1070**	**1040**

Overall investment for all three scenarios by 2032 will be around Rs.1040 to Rs.1290 crore. However, if the CCBSS opts for a Gross Cost Model for electric bus operations, fleet cost could also be built as part of the GCC rate reducing the capital budget requirements for CCBSS. The assumptions for the cost estimation are as mentioned in Table 78 below:

Table 78: Capital Cost Assumptions

Cost heads	Cost in INR
Bus stops (1 bay, 2 bay and 3 bays)	5 lakhs, 7 lakhs and 9 lakhs
Terminal (including bus shelters and seating area along with bus bays)	500 Lakhs
Cost of driver, conductor facilities at route end terminals	10 lakhs
Cost of Depot including tools and equipment for 5 acre of land	Rs.15 crore
Land cost for new depots (based on www.magicbricks.com) *however the land prices may vary also on the location and site accessibility*	Rs.15000 per sq yd
Electronic Ticketing Vending Machine (ETVM)	Rs.25000 per each, considering 2.5 machines per bus
Utility van and recovery van	One utility van per depot and one recovery van for 2 depots have been assumed and the cost considered is Rs.10 lakh and Rs.20 lakh each.

10.5.1 Operating Costs

The total operating costs varies from 2600-3000Cr over the plan period depending on the fleet mix scenario opted for.

Cost details	Cost in Cr		
	Scenario 1- Standard & Midi	**Scenario 2 – All midi**	**Scenario 5A – Midi & mini**
Fuel Cost	215.06	198.88	229.73
Lubricant Cost	0.65	0.65	0.65
R & M Cost	548.43	502.84	510.58
Insurance + MVT + MACT + RR Tax	157.24	129.84	131.34
Staff Cost	883.87	869.70	1155.06
ITMS Operating Costs	30.35	30.31	31.13
Cost of Depreciation - Total	608.21	506.20	518.48
Cost of Fund - (Expected returns & Interests)	239.76	239.76	239.76
Miscellaneous Cost	140.73	128.91	144.25
Total Operational Cost	**2824**	**2607**	**2961**

10.5.2 Proposed Fare Structure

The proposed fare structure is:

Distance Range (km)	Fare in Rs
Upto 2 km	5
2-4 km	10
4-6 km	15
6-10 km	20
More than 10 km	25

The fare rates for each km slab shall be revised every two years based on following formula:

R = [R-base] + 1.2 X {[R-base x 0.5 x (F – F-base)/F-base] + [R-base x 0.5 x (W – W-base)/W-base]}

Where:

R is Applicable Kilometre Charge for the payment period

R-base is the Base Kilometre Charge

F is present Price of Fuel/unit

F-base is Base Year Price of Fuel/unit

W is Present Year Wholesale Price Index and W-base is Base Year Wholesale Price Index.

Fares should be rounded off to nearest rupee at time of revision.

Future WPI and future price of diesel have been projected using the past trends and the same have been used for future fare revisions. Option 3 fare has been revised with this formula at every two years and is presented in Table 79 below;

Table 79: Future fare revision on shortlisted fare option 3

Distance Range (km)	2021 Fare proposed (Option 3)	2023 Fare revision	2025 fare revision	2027 fare revision	2029 fare revision
0 – 2	5	6	7	8	9
2 – 4	10	12	14	16	18
4 – 6	15	17	19	22	25
6 – 10	20	23	26	29	33
>10	25	28	32	36	40

10.5.3 Revenue Estimates

With proposed fare structure and revised fare mechanism, future revenue estimation build-up for shortlisted three scenarios is as below; which is revenue after concession and discounts for passengers; total estimated revenue is Rs.1971 cr (Table 80 below). for scenario 1 & 2, Rs.2155 cr. for scenario 5A.

Table 80 Fare box revenue estimation for fleet mix scenarios

Escalated Total Infrastructure Cost	1	2	5A
	Standard & Midi	**All midi**	**Midi & Mini**
2023	87	87	88
2024	96	96	99
2025	129	129	137
2026	151	151	164
2027	192	192	210
2028	209	209	230
2029	250	250	276
2030	258	258	286
2031	297	297	329
2032	303	303	337
Total Revenue	**1971**	**1971**	**2155**

10.5.4 Sources of Funding

The fare box revenues in public transport may not be entirely sufficient to recover the operations cost. Identification and earmarking of alternative funding sources is important.

Innovating funding sources like green tax, parking charges can also be explored. For funds for depots and terminals, developing these on a PPP basis can be explored. There is a large opportunity for Chandigarh to develop terminals being in the city centre with dedicated large size of land which would help in creating nodal activity centre in the city as well. Similarly depot land can also be developed with high FSI to contribute more in non-fare box revenue. With such measures, non-fare box revenue could be further increased which could be used for covering operating deficits and improving service levels. Further, any operating deficits would have to be covered through Viability Gap Funding by the Government of Chandigarh.

One of the major capital expenses is the cost of the fleet of around INR 800-1100 crores over the next 12 years. Various operating models could be tested – for example in GCC the operator could bring in buses as per CCBSS's specifications. In case, CCBSS's continues as per the current operations model, buses would have to be procured with funding support of the Chandigarh government in addition to capital subsidies under national level schemes.

10.6 Operating Model

Two operating model options have been suggested:

- Option 1 - Existing model in 3 depots & GCC for additional depots: The option two suggests a mix of existing operations model and GCC model. The existing 3 depots may be operated by CCBSS as per present operating model and the maintenance and services of the proposed depots may be outsourced or contracted out to private operators. This would work only in cases when partial fleet electrification is undertaken.
- Option 2 - GCC Model for all the depots: This option suggests adoption of GCC model for both existing as well as proposed depot operations and management. This model would be most suitable in case of electric fleet operations. As per this option, CCBSS shall be responsible for the revenue risk, planning of overall services and managing the contract services & quality. All the operations and management work shall be outsourced or contracted out to OEMs who would manufacture, operate and maintain the buses. The OEMs would also be responsible for all necessary equipments along with maintenance of workshop and depot infrastructure.

10.7 Management Structure

As per business plan proposal, fleet size is going to be 2 to 3 times in next 10 years that would raise the demand for depot also from 3 to 5. With increase fleet size and propose operating model of GCC for E-buses, it is crucial to ensure that a quality bus system is delivered. A process monitoring system along with outcome monitoring may prove to have a better effectiveness in achieving delivery of quality services. In this proposed model, responsibilities on finance department and operations department are also going to increase because of auditing and monitoring private operators' bills and their physical performance.

The overall management of the CCBSS operations would be by the Corporate Office under which the proposed organizational structure has four divisions:

- **Administration and Personnel:** This division would be responsible for overall administration, human resource development (staffing, capacity building, career progression), leave and wage administration, security and vigilance, legal and regulatory, Company Affairs / Board Secretariat, Taxes, rates and rents, and all other administrative matters / functions not covered by other departments.

- **Operation**s: This division would be responsible for overall operations management, route network and operations planning, scheduling, performance monitoring, branding and communication, redressal of user grievance / complaints, preparing Service / Operations related Service Level Agreements (SLAs) for PO, RCA, Others, overall management of Revenue Collection System – revenue planning, revenue generation, revenue leakage, attending to / ensuring prompt attention to Accidents, other hazards / incidents / events on-road, advertisement management – on buses, other assets, generating sources of other than tariff revenues, monitoring and control of services / service providers wrt Agreements / SLAs / SQ / Revenues / others, any and all other activities / functions / aspects related to operations.

- **Technical:** Overall management of technical functions and services for bus operations would be handled by this division. Planning for fleet, infrastructure facilities like depots, terminals, bus stations, ITMS, ETVMs, staffing; Development of specifications / designs / standards for buses, infrastructure, any other civil infra items / functions, Physical performance of buses and other items / Service Level Agreements (SLAs), Repair and Maintenance of buses, plant and equipment / ITMS / ETVMs, etc ; Procurement function / Activity, bid process management, quality assurance; monitoring and control of all technical activities. Depot level technical staff (Assistant Manager(s) with Supervisors) would also be needed to manage service schedule preparation as per SLAs, regular maintenance of buses, etc, and also help in ensuring coordination with operator, ITMS agency and revenue collection agency.

- **Finance and accounts:** Planning for funds requirement and sourcing of funds, productive deployment of surplus funds at any time, if any; inter and external audit, banking operations and management, cash collection from RCA and banking mechanism, payments – bill verification, wages and salaries, book keeping and accounting, vetting of all purchases, management of PF, Gratuity, ESIC as applicable, any other related function.

10.8 Other Measures

Improvising bus services alone will not be enough for enabling a shift towards PT. Several complementary measures would be required to facilitate the shift. Use of private vehicles in the city has been increasing rapidly, owing to higher income levels along with inadequate service level of the bus system. In order to attract passengers to the bus system, apart from putting in place a good quality bus system, marketing and branding is crucial to improve the overall image of the bus system. Some of the possible measures could be targeted marketing campaigns, color branding of routes, awareness and sensitization towards sustainable transport modes.

Different commuter groups may have different priorities. While a captive user may value availability of an affordable service highly, other user groups may desire a high quality vehicle along with a comfortable ride. Hence, different marketing strategies may have to be adopted for different commuter

groups. A thorough market study should be undertaken to understand user requirements and develop targeted marketing campaigns. Simplification of service improves user friendliness and thus apart from the route changes, colour coding of different bus routes and branding of the same may also help in creating different identities of different routes. Offering different service types like express bus routes and frequent services would all aid in creating an attractive image of the bus services. Organising car-free days, free rides for students during certain hours, lower fares in off-peak periods are all measures which would help attract non-regular users and familliarise them with the bus services in the city.

In addition, provision of accurate and reliable real-time information to existing and potential users is also important in improving the visibility of the system and building trust in the CCBSS. Variety of options could be used for sharing of the information. Apart from the route, service and fare information at bus stops and terminals, websites and apps could also be developed.

Apart from a comprehensive marketing strategy, a phased implementation of new bus routes has to be undertaken. New buses should be gradually inducted on new routes to allow for development of demand. At the same time, modification and removal of the old routes should be done with prior information and supported with alternative route details.

Prioritising buses on road such that the delays during travel could be minimized, would help in making the services reliable. Discussions with local authorities could be undertaken for prioritizing of bus services at junctions along with control on private vehicle usage on highly congested routes.

To facilitate a shift from personalized modes of travel, “carrot and stick” measures would have to be adopted. While improved service quality is important to attract passengers, regulation on private traffic in terms of high parking charges or control on availability of parking spaces would be important to push people away from private to PT modes.