SHAKTI
SUSTAINABLE ENERGY FOUNDATION

FUTURE BUS DEMAND AND RESOURCE REQUIREMENTS

For SUMNET Bus to Recovery Campaign in Seven Partner Cities

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Sustainable Urban Mobility Network

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1 Introduction

CEE India as a part of SUM NET India, has initiated a national campaign to support the cause of bus based public transport in multiple cities with a theme – "Bus to Recovery". As a part of this campaign CEE India along with their city partners will be focusing their effort to build a consensus on demanding and providing fresh or improved bus based public transport including cleaner fleet with Euro 6 Diesel or electric buses, in Tier 2 and Tier 3 cities, in order to counter the increasing ill effects of private motorized modes in these cities. These include both cities with an existing bus based public transport system and those where an organized bus transport currently does not exist. SGA as a part of the extension of the 'Long Range Planning Tool for STUs in India,' is supporting CEE India in this campaign by providing resource requirement to meet the vision of bus based public transport (BBPT) in these partner cities. These inputs aim to highlight the need and the gap in the availability of an affordable and accessible public bus system in each of the focus cities along with broad understanding actions required to overcome it, through city discussions involving different stakeholders. SGA has used the thumb rule estimator in the upgraded FLEET Tool version 1.71_A to estimate the resource requirement for BBPT in the focus cities. These outputs serve as evidence-based data which are expected to trigger a dialogue in the city around the current gaps in BBPT and the resources required to address them.

As a part of this initiative, SGA has supported CEE India and SUM NET with estimates of resource requirements for BBPT in seven Indian cities. These requirements have been presented to these cities and the findings from the same explained as a part of the city dialogue in each of these cities. A list of partner cities and the date of the webinars for city dialogues has been presented below.

- Chennai on July 22, 2020
- Lucknow on August 07, 2020
- Vishakhapatnam on August 11, 2020
- Dehradun on August 12, 2020
- Delhi on August 22, 2020
- Jaipur on August 28, 2020
- Ahmedabad on September 11, 2020

2 Key Findings

Though detailed resource requirements for the next 30 years were generated for all seven partner cities and same have been presented in subsequent sections, important findings, observed in all but two cities is that there is a huge gap in demand and supply due to which potential trips which can be catered by bus based public transport are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system. This constitutes a huge (untapped) latent demand in these cities. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in most Indian cities.

Based on the results from Fleet Tool's future bus demand and resource requirements estimator, it has been observed that for each small size cities (population < 1 million) in short term (i.e., in next five years) approximately 300 to 1,000 buses need to be acquired/inducted in the fleet over the next decade, to bridge the demand and supply gap. These are both for augmenting fleet size and for replacing old fleet. This number for medium size cities (population between 1 to 10 million) is about 1,000 to 10,000 buses and for large size cities (population greater than 10 million) it is between 8,000 to 16,000. Apart from this, in order to meet the resource requirements for providing a user responsive and efficient BBPT in cities, transport departments will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in respective cities Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services.

A city bus corporation or a city public or semi-public bus company is preferred for cities with more than 80 buses. The key tasks for this organization (or a group of organizations) should include route planning, contract management, service planning as well regulation and monitoring of (private and public) operators. Hence, in cities where there are no corporation or public/semi-public bus companies/operators, city authorities should consider constituting an independent corporation or public bus company outside state transport corporation, with a dedicated budget head in Transport Department. In expanding cities, there is a scope for widening of route network hence authorities shall keep exploring context specific interventions and shall plan to keep the system attractive specifically for low income and low trip length and by increasing frequency, adding routes, etc.

Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome the land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3 City specific Findings for the Partner Cities

The FLEET Tool outputs using secondary (city level) estimator in the tool, provide data on resource requirements for each of the seven partner cities. These have been presented below, along with a broad outline of the action plan required to overcome the current gaps between what exists and what is desired.

3.1 Lucknow

Following are the findings for BBPT resource requirement in the city of Lucknow.

3.1.1 Current City Status and Gaps in BBPT

Lucknow city is the capital city of Uttar Pradesh (U.P) which is the most populated state in India. It is the 5th highest populated city in the state. As per 2011 Census data, population of Lucknow city was 2,817,105. Lucknow Municipal Corporation (LMC) was developed by Uttar Pradesh Government. Current Population of Lucknow city (as of 2020) is estimated at 37 lakhs with 2.5% of average annual growth rate. As per (CDP, 2006), the future population of Lucknow in year 2021 is estimated to be around 45 lakhs due to its high growth rate.

As per (SCP, 2016), modal split of Lucknow city is: Private motorized modes - 47% (4-Wheelers - 5%, 2-Wheelers - 42%); Intermediate Public Transport (IPT) - 17% (Auto rickshaws-9%, Cycle Rickshaw - 8%); Public Transport (PT) - 3%, NMT - 33% (Walk - 17%, Bicycle - 16%). The average trip length in the city is between 5 to 6 Km. Currently, there are 160 buses in the city owned and operated by Lucknow Transport Corporation (LTC). Of these 40 buses are electric buses. Currently LTC plies buses on 20 routes in the city. Additionally, many private bus operators are operating buses for schools and colleges schools, colleges, and to serve other outer connecting areas of the city.

In 2017, metro train was introduced in the city. The current route length of metro is 22.8 km with 22 metro stations with a daily ridership of 60,000. Including Metro and Bus the PT share in the city is between 3 to 4%. Of this, the mode share by Metro is 1%, while that by Bus is between 2 to 3%. Due to lack of an effective public bus transport system in the city, the current potential public transport trips are lost to private modes, i.e. mainly motorized two wheelers. This leads to negative externalities such as higher air pollution and increasing accident related deaths.

In Indian cities, each urban public bus on an average carry 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Lucknow city has 25% trips with a length of between 6 to 15 km. This is the travel distance attractive for bus use. Which means that in the absence of adequate supply of buses, close to 20% trips in the city are lost daily inefficient private transport modes, mainly two wheelers.

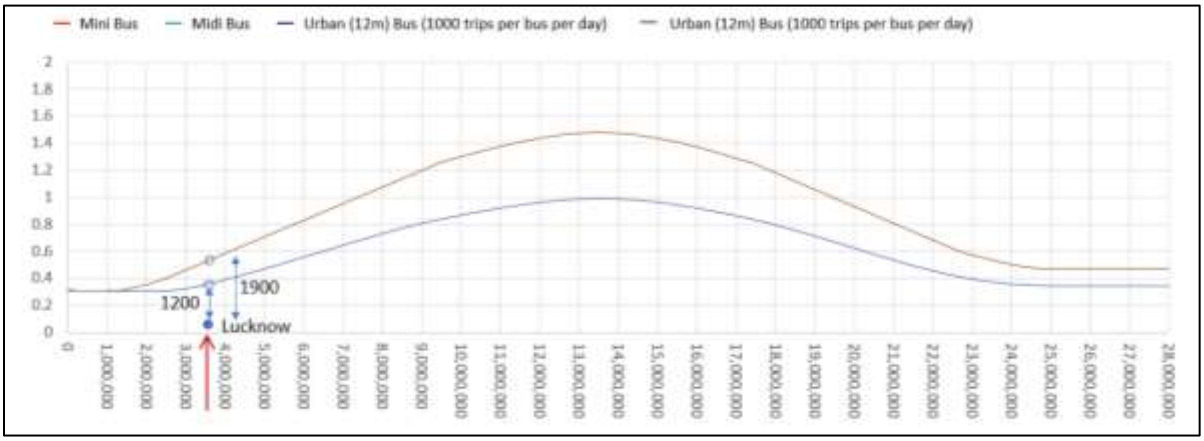
3.1.1.1 Current Bus Operations

Lucknow city is growing rapidly with an annual average growth rate of 2.5% which means in next 10 years, the city population will increase by 28% i.e., almost by 1/3rd. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Lucknow city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Lucknow is estimated at 160, which translates to about 4 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 1.6 lakh trips per day in the city. However, with the potential bus mode share of 25%, it is estimated that more than 12 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in the city.

3.1.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[1] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 1, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 1: Graphical representation of bell curves for calculating buses/lakh population



[1] Source: Urban Bus Toolkit, World Bank

Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Lucknow is at 14 lakh today. This is almost nine times the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 36 increasing to 68 in 2050, as compared to the current situation of 4 buses per lakh population in the city. This means, that there is a huge gap between current and desired bus fleet inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is between 1400 and 1900[2]. Thus, there is a minimum requirement of 1200 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Lucknow can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for the city of Lucknow have been presented in Table 1 and have been discussed further in the following section.

Table 1: Current and Desired Fleet of Lucknow city

Year	Population	Buses per 1 lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	4	160	1.6	2.9%
Desired - 2020	7,588,040	36	1376	13.8	25.2%
2025	8,805,162	38	1674	16.7	26.8%
2030	10,217,510	42	2073	20.7	29.4%
2040	13,758,165	52	3324	33.2	36.8%
2050	18,525,758	68	5483	54.8	47.4%

3.1.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Lucknow city population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Lucknow have been presented in Table 2. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses[3], include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[2] Basis 1000 or 600 passenger trips per bus per day respectively

[3] If the fleet is 100% electric, the annual budgetary requirement go up by 1.6 times.

Table 2: Resource requirement for Lucknow (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	4	160	1.6	2.9%	3	-	-	-
Desired - 2020	0.37	36	1,376	13.8	25.2%	26	-	-	832
2021	0.38	36	1,428	4.6	26.8%	11	316	285	2,406
2022	0.39	36	1,485	7.7	27.3%	17	316	273	3,980
2023	0.40	37	1,544	10.7	27.7%	25	316	301	5,555
2024	0.41	38	1,606	13.7	28.3%	31	316	289	7,129
2025	0.42	38	1,674	16.7	28.8%	38	316	317	8,703
2026	0.43	39	1,744	17.4	29.4%	41	84	124	9,070
2027	0.44	40	1,819	18.2	29.9%	41	88	105	9,459
2028	0.45	40	1,899	19.0	30.6%	44	93	134	9,875
2029	0.46	41	1,983	19.8	31.2%	47	98	138	10,312
2030	0.47	42	2,073	20.7	31.9%	47	103	120	10,778
2031	0.48	43	2,167	21.7	32.7%	50	108	149	11,270
2032	0.49	44	2,268	22.7	33.4%	52	114	156	11,796
2033	0.51	45	2,376	23.8	34.2%	55	423	342	12,354
2034	0.52	45	2,488	24.9	35.0%	58	429	344	12,940
2035	0.53	47	2,608	26.1	35.9%	60	436	352	13,564
2036	0.55	48	2,736	27.4	36.8%	63	443	364	14,226
2037	0.56	49	2,872	28.7	37.7%	66	452	368	14,932
2038	0.57	50	3,014	30.1	38.7%	69	226	245	15,671

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	0.59	51	3,165	31.7	39.7%	72	240	257	16,459
2040	0.60	52	3,324	33.2	40.7%	77	252	289	17,286
2041	0.62	54	3,494	34.9	41.7%	80	267	286	18,167
2042	0.63	55	3,672	36.7	42.8%	85	281	315	19,092
2043	0.65	57	3,860	38.6	43.9%	88	296	313	20,072
2044	0.67	58	4,058	40.6	45.1%	94	312	348	21,101
2045	0.68	59	4,267	42.7	46.2%	99	633	539	22,190
2046	0.70	61	4,487	44.9	47.4%	103	649	539	23,334
2047	0.72	63	4,718	47.2	48.6%	108	667	571	24,533
2048	0.73	64	4,961	49.6	49.8%	113	687	593	25,797
2049	0.75	66	5,216	52.2	51.0%	119	707	612	27,122
2050	0.77	68	5,483	54.8	0.0%	127	493	519	28,512

3.1.3 Short, Medium- and Long-Term Action Plan

Table 3 suggests that in order to meet the requirements of BBPT in Lucknow in the future, the city needs to invest towards closing the current supply and demand gap. This investment requirement is not just for buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring significant land. If the current fleet deficit is met, the immediate land requirement is close to 23 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Lucknow is required to ensure resource requirements can be planned for in advance. Table 3 compiles the key annual resource requirements for BBPT in Lucknow in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 3: Key annual resource requirements for BBPT in Lucknow

Lucknow BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	1,700	1,600	1,500	35	30	13
2026-30	2,100	500	600	12	8	3
2031-40	3,300	3,100	2,900	27	25	11
2041-50	5,500	5,000	4,600	50	44	18

Table 3 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Lucknow city will need to access an average of 320 buses, 7 hectares of land, develop 6 terminals and between 2 and 3 depots per year for the next five years. For this it will require (excluding land cost) a dedicated average budget of rupees 300[4] crores per year over the next five years. In the short term, the city will require to access on an average 100 new buses, between 2 to 3 hectares of land, develop 2 new bus terminals and less than 1 new depot per year for the subsequent five years (up to 2030).This will require an average bus budget of 120 crore per year. In the medium term that is the subsequent 10 years (up to 2040) the city will need to access on an average 310 new buses, about 3 hectares of land, develop between 2 and 3 new terminals and about 1 new depot per year. This will require an average budget of close to 290 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access and average of 500 buses, 5 hectares of land, develop between 4 and 5 terminals and close to 2 depots per year. This will require an average annual budget of about 460 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Lucknow, LTC will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in the Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could

[4] All costs are at current value of money and include VGF to cover operational losses.

include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.2 Jaipur

Following are the findings for BBPT resource requirement in the city of Jaipur.

3.2.1 Current City Status and Gaps in BBPT

Jaipur Municipal Corporation or Jaipur Nagar Nigam is the municipal corporation of Jaipur city in Rajasthan, India. Jaipur city is the largest and most populated city in the state. As per 2011 Census data, population of Jaipur city was 30,46,163 (Census, 2011). Current Population of Jaipur city (as of 2020) is estimated at 40 lakhs with 2.85% of average annual growth rate. The future population of Jaipur in year 2021 is estimated to be around 42 lakhs due to its high growth rate.

The modal split of Jaipur city is: Private motorized modes - 35% (4-Wheelers - 8%, 2-Wheelers - 27%); Intermediate Public Transport (IPT) – 4%; Public Transport (PT) - 22%, NMT – 39% (Walk –26% & Bicycle – 13%). The average trip length in the city is 6 Km (MOUD, Government of India, 2008). Currently, there are 400 (low floor) buses in the city owned and operated Jaipur City Bus Services Ltd. (JCTSL). Currently LTC plies buses on 26 routes in the city. Additionally, there are about 1,400 minibuses that are directly competing with the JCTSL buses for ridership and revenue.

In 2015, metro train was introduced in the city. The current route length of metro is 9.63 km with 9 metro stations with a daily ridership of 17,649. Including Metro and Bus the PT share in the city is around 22%. Due to lack of an effective public bus transport system in the city, the potential public transport trips are currently lost to private modes of travel, i.e. mainly motorized two wheelers. This leads to negative externalities such as higher air pollution and increasing accident related deaths.

In Indian cities, each urban public bus on an average carry 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Jaipur city has significant trips with a length of between 6 to 15km. This is the travel distance attractive for bus use. Which means that in the absence of adequate supply of buses, close to 12 lakh trips in the city are lost daily inefficient private transport modes, mainly two wheelers.

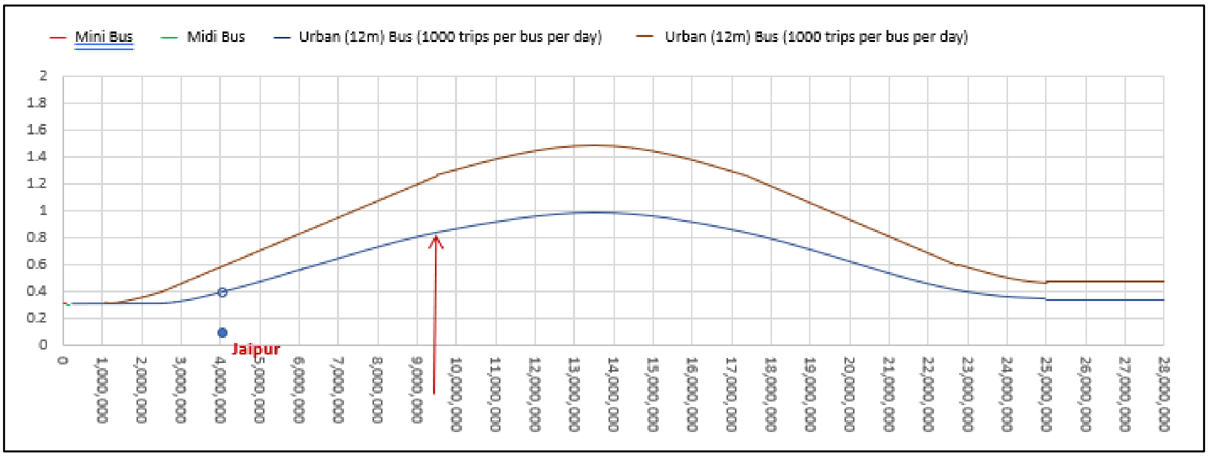
3.2.1.1 Current Bus Operations

Jaipur city is growing rapidly with an annual average growth rate of 2.85% which means in next 10 years, the city population will increase by 32% i.e., almost 1/3rd. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Jaipur city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Jaipur is estimated at 400, which translates to about 9 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 1.6 lakh trips per day (25% of requirement) in the city. However, with the potential bus mode share of 17%, it is estimated that more than 12 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in the city.

3.2.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[5] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 2, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 2: Graphical representation of bell curves for calculating buses/lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Jaipur at 16 lakh today. This is almost four times the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 38 increasing to 81 in 2050, as compared to the current situation of 9 buses per lakh population in the city. This means, that there is a huge gap between current and desired bus fleet inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is between 1600 and 2264[6]. Thus, there is a minimum requirement of 1200 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Jaipur can be estimated for 30

[5] Source: Urban Bus Toolkit, World Bank
[6] Basis 1000 or 600 passenger trips per bus per day respectively

years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for the city of Jaipur have been presented in Table 4 and have been discussed further in the following section.

Table 4: Current and Desired Fleet of Jaipur city

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	9	400	4.0	7%
Desired - 2020	0.40	38	1593	15.9	17%
2025	0.46	41	2024	20.2	29%
2030	0.53	47	2628	26.3	33%
2040	0.71	62	4609	46.1	43%
2050	0.94	81	8039	80.4	57%

3.2.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Jaipur city population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Jaipur have been presented in Table 5. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses7, include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[7] If the fleet is 100% electric, the annual budgetary requirement goes up by 1.6 times.

Table 5: Resource requirement for Jaipur (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	9	400	4.0	7%	9	-	-	2100
Desired - 2020	0.40	38	1593	15.9	17%	39	-	-	8,700
2021	0.42	38	1667	7.2	29%	16	358	317	3769
2022	0.43	39	1747	10.5	30%	25	358	329	5458
2023	0.44	40	1834	13.7	30%	31	358	314	7148
2024	0.45	40	1925	17.0	31%	39	358	346	8837
2025	0.46	41	2024	20.2	29%	47	358	351	10526
2026	0.48	42	2129	21.3	33%	50	139	170	11073
2027	0.49	43	2242	22.4	34%	52	146	174	11659
2028	0.51	44	2362	23.6	35%	55	153	181	12283
2029	0.52	46	2491	24.9	36%	58	162	194	12951
2030	0.53	47	2628	26.3	33%	61	171	203	13668
2031	0.55	48	2775	27.7	38%	63	180	208	14429
2032	0.57	49	2932	29.3	39%	67	190	226	15244
2033	0.58	51	3099	31.0	40%	72	526	441	16115
2034	0.60	52	3277	32.8	41%	75	536	437	17040
2035	0.62	54	3466	34.7	42%	80	548	464	18025
2036	0.63	55	3668	36.7	43%	85	560	481	19076
2037	0.65	57	3883	38.8	45%	89	573	479	20192
2038	0.67	58	4112	41.1	46%	94	367	381	21380

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	0.69	60	4354	43.5	47%	100	388	404	22639
2040	0.71	62	4609	46.1	43%	105	409	423	23969
2041	0.73	64	4881	48.8	50%	113	433	469	25381
2042	0.75	66	5167	51.7	51%	119	458	467	26870
2043	0.77	67	5469	54.7	53%	126	482	513	28441
2044	0.79	69	5787	57.9	54%	133	508	521	30094
2045	0.81	71	6122	61.2	56%	141	860	750	31835
2046	0.84	73	6474	64.7	57%	149	888	780	33663
2047	0.86	75	6841	68.4	59%	157	915	810	35573
2048	0.89	77	7224	72.2	60%	166	943	833	37566
2049	0.91	79	7623	76.2	61%	176	972	884	39640
2050	0.94	81	8039	80.4	57%	185	783	770	41803

3.2.3 Short, Medium- and Long-Term Action Plan

Table 5 suggests that in order to meet the current and future requirements of BBPT in Jaipur, the city needs investments for closing the current supply and demand gap. This investment requirement is not just for augmenting the fleet size, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring significant land. If the current fleet deficit is met, the immediate land requirement is close to 30 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Jaipur is required to ensure resource requirements can be planned for in advance. Table 6 compiles the key annual resource requirements for BBPT in Jaipur in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 6: Key annual resource requirements for BBPT in Jaipur

Jaipur BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	2,000	1,800	1,700	38	32	14
2026-30	2,600	800	900	14	13	5
2031-40	4,600	4,300	4,000	44	39	16
2041-50	8,000	7,200	6,800	80	69	29

Table 6 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Jaipur city will need to access an average of 360 buses, 8 hectares of land, develop between 6 and 7 new terminals and between 2 and 3 depots per year for the next five years. For this it will require (excluding land cost) a dedicated average bus budget of rupees 340[8] crores per year over the next five years. In the short term, the city will require to access on an average 160 new buses, around 3 hectares of land, develop between 2 and 3 new bus terminals and 1 new depot per year for the subsequent five years (up to 2030).This will require an average bus budget of 180 crore per year. In the medium term that is the subsequent 10 years (up to 2040) the city will need to access on an average 430 new buses, about 4 hectares of land, develop 4 new terminals and more than 1 new depot per year. This will require an average budget of close to 400 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access and average of 720 buses, 8 hectares of land, develop between 6 and 7 terminals and close to 3 depots per year. This will require an average annual budget of about 680 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Jaipur, JCTSL will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in the Rajasthan Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. A strong bus system including along existing and proposed Metro corridors will serve as an efficient feeder to Metro. Additionally, the city government would need to start long term provisioning of land for bus services and

[8] All costs are at current value of money and include VGF to cover operational losses.

this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.3 Ahmedabad

Following are the findings for BBPT resource requirement in the city of Ahmedabad.

3.3.1 Current City Status and Gaps in BBPT

The city of Ahmedabad, now the seventh largest metropolis in India and the largest in the state of Gujarat. As per 2011 Census data, population of Ahmedabad city was 5,577,940. The Ahmedabad Municipal Corporation or the AMC, established in July 1950 under the Bombay Provincial Corporation Act, 1949, is responsible for the civic infrastructure and administration of the city of Ahmedabad. Current Population of Ahmedabad city (as of 2020) is estimated at 40 lakhs with 3% of average annual growth rate. The future population of Ahmedabad in year 2021 is estimated to be around 76 lakh due to its high growth rate (DMRC, 2014).

The modal split of Ahmedabad city is: Private motorized modes – 29.8% (4-Wheelers – 3.9%, 2-Wheelers – 25.9%); Intermediate Public Transport (IPT) – 6.1% (Auto rickshaws), Public Transport (PT) – 11.4% (Bus – 10.3% & BRTS – 1.1%), NMT – 46.2% (Walk – 37.2% & Bicycle – 9%) and Other – 6.3% (School bus, staff bus, ST bus, rail). The average trip length in the city is between 6 to 10Km (DMRC, 2014). Currently, there are 1072 buses out of which 848 buses operated by AMTS and 224 buses by Janmarg (BRT). Currently Ahmedabad Municipal Transport Service (AMTS) & Janmarg Bus Rapid Transit System (BRTS) plies buses on 196 and 37 routes respectively in the city. Additionally, many private bus operators are operating buses for schools and colleges schools, colleges, and to serve other outer connecting areas of the city.

In 2019, metro train was introduced in the city. The current operational route length of metro is 6.5 km with 4 metro stations with a daily ridership of 35,000. Including Metro and Bus the PT share in the city is between 11 to 12%. Of this, the mode share by BRTS is 1%, while that by city bus is 10.3%. Due to reliability and accessibility (including journey cost) issues, the current potential public transport trips are lost to private modes, i.e. mainly motorized two wheelers. This leads to negative externalities such as higher air pollution and increasing accident related deaths.

In Indian cities, each urban public bus on an average carries 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Ahmedabad city has 47% trips with a length of between 6 to 15km. This is the travel distance attractive for bus use. Which means that in the absence of adequate supply of buses, close to 20% trips in the city are lost daily inefficient private transport modes, mainly two wheelers.

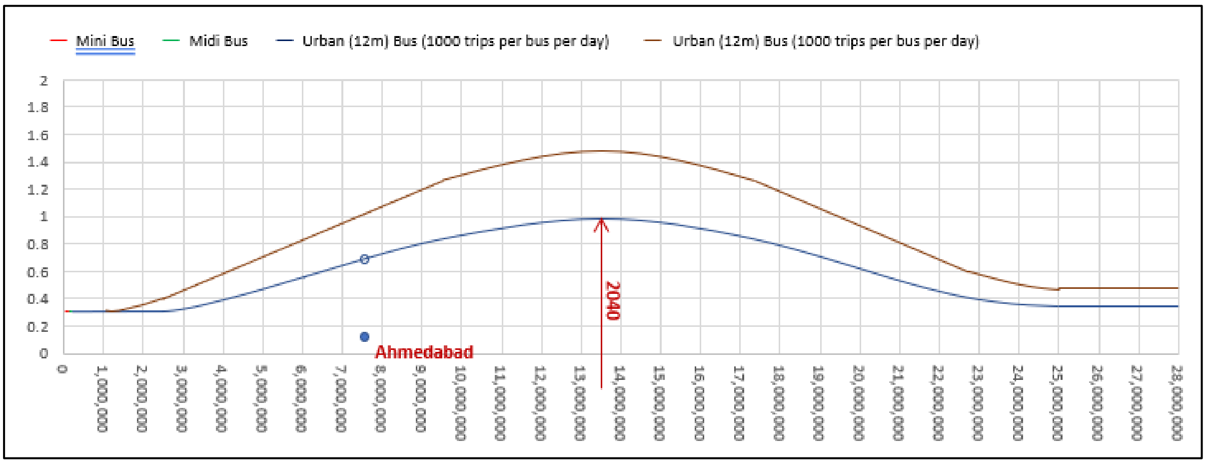
3.3.1.1 Current Bus Operations

Ahmedabad city is growing rapidly with an annual average growth rate of 3% which means in next 10 years, the city population will increase by 34% i.e., almost 1/3rd. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Ahmedabad city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Ahmedabad is estimated at 1072, which translates to about 14 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 10.7 lakh trips per day in the city. However, with the potential bus mode share of 47%, it is estimated that more than 42 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in the city.

3.3.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[9] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 3, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 3: Graphical representation of bell curves for calculating buses/ lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Ahmedabad at 53 lakh today. This is almost five times the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 66 increasing to 78 in 2050, as compared to the current situation of 14 buses per lakh population in the city. This means, that there is a huge gap between current

[9] Source: Urban Bus Toolkit, World Bank

and desired bus fleet inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is between 5300 and 8134[10]. Thus, there is a minimum requirement of 4228 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Ahmedabad can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for the city of Ahmedabad have been presented in Table 7 and have been discussed further in the following section.

Table 7: Current and Desired Fleet of Ahmedabad city

Year	Population	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	14	1072	10.7	9%
Desired - 2020	0.76	66	5305	53.1	47%
2025	0.88	77	7129	71.3	54%
2030	1.02	87	9391	93.9	61%
2040	1.38	99	14333	143.3	69%
2050	1.85	78	15161	151.6	55%

3.3.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Ahmedabad city population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Jaipur have been presented in Table 8. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses[11], include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[10] Basis 1000 or 600 passenger trips per bus per day respectively

[11] If the fleet is 100% electric, the annual budgetary requirement go up by 1.6 times.

Table 8: Resource requirement for Ahmedabad (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	14	1072	10.7	9%	25	-	-	-
Desired - 2020	0.76	66	5305	53.1	47%	25	-	-	5574
2021	0.78	68	5634	22.8	19%	53	1301	1137	11874
2022	0.81	71	5980	34.9	29%	80	1301	1165	18174
2023	0.83	73	6345	47.1	38%	108	1301	1197	24474
2024	0.85	75	6728	59.2	46%	135	1301	1229	30773
2025	0.88	77	7129	71.3	54%	163	1301	1265	37073
2026	0.91	79	7548	75.5	55%	174	508	613	39252
2027	0.93	81	7985	79.9	57%	185	526	640	41523
2028	0.96	83	8439	84.4	58%	194	543	642	43883
2029	0.99	85	8908	89.1	60%	204	559	683	46324
2030	1.02	87	9391	93.9	61%	216	571	708	48831
2031	1.05	89	9886	98.9	63%	227	585	729	51409
2032	1.08	91	10392	103.9	64%	240	595	768	54036
2033	1.12	93	10903	109.0	65%	251	1812	1468	56696
2034	1.15	94	11419	114.2	66%	262	1817	1484	59379
2035	1.19	96	11935	119.3	67%	274	1817	1502	62061
2036	1.22	97	12446	124.5	68%	287	1812	1528	64721
2037	1.26	98	12948	129.5	69%	298	1803	1516	67332
2038	1.30	98	13434	134.3	69%	309	994	1059	69855
2039	1.34	99	13898	139.0	69%	320	990	1065	72269

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2040	1.38	99	14333	143.3	69%	329	978	1049	74530
2041	1.42	99	14731	147.3	69%	339	957	1062	76599
2042	1.46	98	15082	150.8	69%	348	923	1027	78427
2043	1.50	97	15379	153.8	68%	354	882	986	79971
2044	1.55	96	15613	156.1	67%	359	828	952	81186
2045	1.60	94	15772	157.7	66%	362	1971	1594	82012
2046	1.64	92	15847	158.5	64%	364	1892	1545	82406
2047	1.69	89	15832	158.3	62%	364	1801	1461	82324
2048	1.75	86	15716	157.2	60%	361	1697	1396	81722
2049	1.80	82	15494	154.9	57%	356	1581	1321	80567
2050	1.85	78	15161	151.6	55%	348	661	776	78837

3.3.3 Short, Medium- and Long-Term Action Plan

Table 8 suggests that in order to meet the current and future requirements of BBPT in Ahmedabad, the city needs to invest towards closing the current supply and demand gap. This investment is not just in buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring significant land. If the current fleet deficit is met, the immediate land requirement is close to 23 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Ahmedabad is required to ensure resource requirements can be planned for in advance. Table 9 compiles the key annual resource requirements for BBPT in Ahmedabad in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 9: Key annual resource requirements for BBPT in Ahmedabad

Ahmedabad BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	7,100	6,500	6,000	139	122	50
2026-30	9,400	2700	3,300	52	45	20
2031-40	14,300	13,200	12,200	113	99	40
2041-50	15,200	13,200	12,100	19	16	7

Table 9 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Ahmedabad city will need to access an average of 1300 buses, 28 hectares of land, develop between 24 and 25 terminals and 10 depots per year for the next five years. For this it will require (excluding land cost) a dedicated average budget of rupees 1200[12] crores per year over the next five years. In the short term, the city will require to access on an average 540 new buses, between 10 to 11 hectares of land, develop 9 new bus terminals and less than 4 new depot per year for the subsequent five years (up to 2030).This will require an average bus budget of 660 crore per year. In the medium term that is the subsequent 10 years (up to 2040) the city will need to access on an average 1320 new buses, about 11.3 hectares of land, develop between 9 and 10 new terminals and about 4 new depot per year. This will require an average budget of close to 1,220 crores per year. In the long term, i.e. in the subsequent 10 years (up to 2050), the city will need to access and average of 1320 buses, 1.9 hectares of land, develop between 1 and 2 terminals and less than 1 depot per year. This will require an average annual budget of about 1,210 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Ahmedabad, AMTS & Janmarg will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a separate new budget head in the Transport Department Budget to address AMTS & Janmarg VGF, which should cover the annual budgetary requirements of all State and City Transport services. Authorities shall plan the system to keep it attractive for low income and low trip length, operational subsidy (by keeping the fare between Rs. 0 to 1.0 per km), increasing

[12] All costs are at current value of money and include VGF to cover operational losses.

frequency. It is an expanding city, hence, there is scope for widening of route network (including BRT). Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.4 Dehradun

Following are the findings for BBPT resource requirement in the city of Dehradun.

3.4.1 Current City Status and Gaps in BBPT

Dehradun city is the winter capital and most populous city in the Indian state of Uttarakhand. The city is governed by Dehradun Municipal Corporation (DMC). As per 2011 Census data, population of Dehradun city was to 5,69,578. Current Population of Dehradun city (as of 2020) is estimated at 9.2 lakhs with 2.68% of average annual growth rate. The future population of Dehradun in year 2021 is estimated to be around 9.6 lakh (CDP, 2007).

In City Development Plan (CDP) of Dehradun, the mode share in the city is: Private motorized modes - 44% (4-Wheelers – 5%, 2-Wheelers – 39%); Intermediate Public Transport (IPT) – 29% (Tempos – 24%, Auto Rickshaw – 5%); Public Transport (PT) – 15% (Buses), NMT – 12% (including Walk). The average trip length in the city is expected to be in between 5 to 6Km (CDP, 2007).

As per CDP, Dehradun, the existing intra-city public transport system is being operated by private operators through bus and tempos (Vikram). The private buses are operating on 10 routes having a fleet of about 141 buses. About 10 main tempo routes are operating with as many as 1,900 tempos (CDP, 2007). However, at present, there are 389 buses in the city out of which 270 buses are operating covering 16 intra city routes (DMC & MDDA, 2016). Also, for Dehradun, as per Smart City proposal 30 Electric buses have been proposed for the city.

In CDP of Dehradun, two MRTS corridors of about 15 km length have been suggested in a long-term improvement to cater for likely future travel demand (CDP, 2007).

In Indian cities, each urban public bus on an average carries 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Dehradun city has 13.5% trips with a length of between 6 to 15km. This is the travel distance attractive for bus commute. The current capacity of the bus system is to serve 11.8% trips thus relatively there is lower demand for buses in the city.

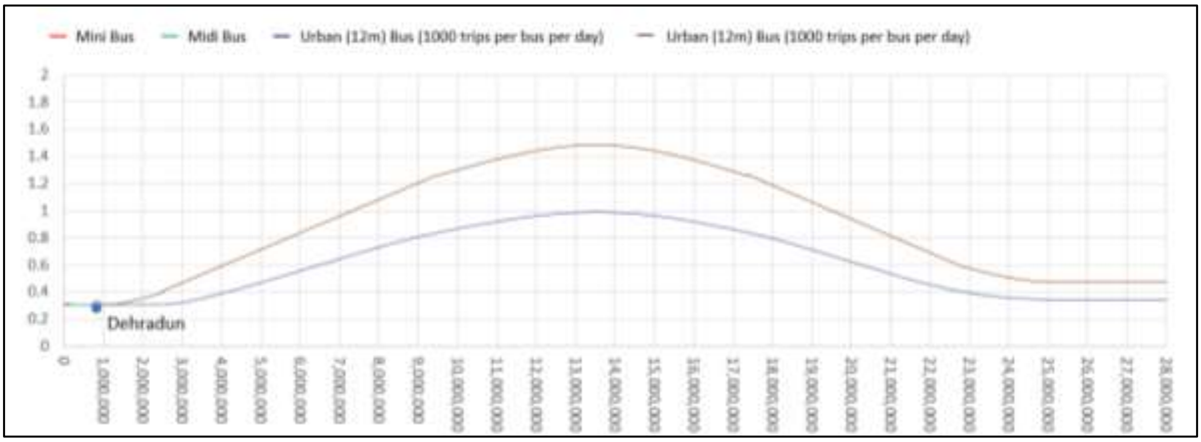
3.4.1.1 Current Bus Operations

Dehradun city is growing rapidly with an annual average growth rate of 2.68% which means in next 10 years, the city population will increase by 30% i.e., almost 1/3rd. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Dehradun city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Dehradun is estimated at 270, which translates to about 29 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 1.62 lakh trips per day in the city. Current fleet size in the city is about 90% of the requirement. This means most of the potential bus trips can be served by current fleet, though there is still scope for improvement (especially service planning) and planning for future as current operations in the city are taken place by individual private operators.

3.4.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[13] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 4, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 4: Graphical representation of bell curves for calculating buses/lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Dehradun at 1.9 lakh today. This is slightly lesser than the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 32 increasing to 35 in 2050, as compared to the current situation of 29 buses per lakh population in the city. This means, that there is a minor gap between current and desired bus fleet inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is around 311. Thus, there is a minimal requirement of 41 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Dehradun can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and

[13] Source: Urban Bus Toolkit, World Bank

supply requirements for the city of Dehradun have been presented in Table 10 and have been discussed further in the following section.

Table 10: Current and Desired Fleet of Dehradun city

Year	Population	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	29	270	1.6	11.8%
Desired - 2020	0.09	32	311	1.9	13.5%
2025	0.10	32	354	2.1	13.5%
2030	0.12	32	405	2.4	13.5%
2040	0.16	33	541	3.2	13.9%
2050	0.20	35	748	4.5	14.7%

3.4.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Dehradun city population increases, buses required per lakh population will slightly go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Dehradun have been presented in Table 11. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses14, include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[14] If the fleet is 100% electric, the annual budgetary requirement goes up by 1.6 times.

Table 11: Resource requirement for Dehradun (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	29	270	1.6	11.8%	6	-	-	-
Desired - 2020	0.09	32	311	1.9	13.5%	8	-	-	1404
2021	0.09	32	318	1.9	13.5%	7	70	67	1653
2022	0.10	32	327	2.0	13.5%	7	32	29	1702
2023	0.10	32	336	2.0	13.5%	7	31	27	1746
2024	0.10	32	345	2.1	13.5%	8	32	28	1795
2025	0.10	32	354	2.1	13.5%	8	31	27	1839
2026	0.11	32	364	2.2	13.5%	8	33	29	1894
2027	0.11	32	374	2.2	13.5%	8	32	29	1943
2028	0.11	32	384	2.3	13.5%	9	33	33	1998
2029	0.12	32	395	2.4	13.5%	9	33	30	2053
2030	0.12	32	405	2.4	13.6%	9	33	30	2107
2031	0.12	32	417	2.5	13.6%	9	34	31	2168
2032	0.13	32	428	2.6	13.6%	11	34	55	2228
2033	0.13	32	441	2.6	13.6%	11	83	60	2293
2034	0.13	32	454	2.7	13.7%	11	45	38	2359
2035	0.14	32	466	2.8	13.7%	11	44	38	2425
2036	0.14	32	480	2.9	13.7%	11	46	43	2496
2037	0.14	33	495	3.0	13.8%	11	46	40	2573
2038	0.15	33	509	3.1	13.8%	11	48	41	2649

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	0.15	33	525	3.2	13.9%	12	48	46	2731
2040	0.16	33	541	3.2	13.9%	13	49	63	2813
2041	0.16	33	558	3.3	14.0%	13	50	44	2901
2042	0.16	33	576	3.5	14.1%	14	51	49	2994
2043	0.17	33	594	3.6	14.1%	14	52	46	3087
2044	0.17	34	613	3.7	14.2%	14	53	47	3186
2045	0.18	34	633	3.8	14.3%	14	103	81	3290
2046	0.18	34	654	3.9	14.4%	14	66	56	3399
2047	0.19	34	676	4.1	14.5%	16	66	80	3514
2048	0.19	34	699	4.2	14.6%	16	69	59	3635
2049	0.20	35	723	4.3	14.7%	16	70	60	3760
2050	0.20	35	748	4.5	14.9%	17	73	67	3892

3.4.3 Short, Medium- and Long-Term Action Plan

Table 11 suggests that in order to meet the requirements of BBPT in Dehradun in the future, the city needs to invest a little in closing the current supply and demand gap. As evident from the current and future estimates, there is no huge gap between demand and supply. However, emphasis needs to be given to improving the service planning. Currently routes and fares are regulated but operations and services are not. Due to which there are less takers for non-profitable routes.

However, for meeting the current gap, this investment requirement is not just in buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires land allocation by the city. If the current fleet deficit is met, the immediate land requirement is close to 2 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Dehradun is required to ensure resource requirements are met. Table 12 compiles the key annual resource requirements for BBPT in Dehradun in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 12: Key annual resource requirements for BBPT in Dehradun

Dehradun BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	350	200	180	2.5	7	3
2026-30	410	160	150	0.4	1	0
2031-40	540	480	460	4.9	3	2
2041-50	750	650	590	3.3	4	1

Table 12 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Dehradun city will need to induct an average of 40 buses, access 0.5 hectares of land, develop between 1 and 2 terminals and about 1 depot, per year for the next five years. For this it will require (excluding land cost) a dedicated average budget of rupees 36[15] crores per year over the next five years. In the short term, the city will require to access on an average 32 new buses per year for the subsequent five years (up to 2030) whereas 0.4 hectares of land and develop 1 new bus terminals (in 5 years). This will require an average bus budget of 30 crore per year. In the medium term that is the subsequent 10 years (up to 2040) the city will need to access on an average 50 new buses, about 0.5 hectares of land, develop less than 1 new terminal and less than 1 new depot per year. This will require an average budget of close to 46 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access and average of 65 buses, 0.33 hectares of land per year and develop less than 4 new terminal and 1 depot (in 5 years). This will require an average annual budget of about 59 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Dehradun, DMC will need an active support of the State and City Government. A city bus corporation is preferred for cities with more than 80 buses. Hence,

[15] All costs are at current value of money and include VGF to cover operational losses.

Dehradun should consider constituting a city bus corporation under Municipal Corporation with key task of route planning, contract management, service planning as well regulation and monitoring of (private and public) operators. Additionally, it shall constitute two SPVs – one as a public operator of buses and one as developer and manager of bus infrastructure - to be used by both public and private operator for a fee. In first year, 70 buses (including 30 electric buses) should be assigned to public operator (rest to remain under private operations). Routes should be bid out/allocated to private and public operator

Here mobility will need to be viewed as essential service to be provided at subsidized rates by the state. It thus means that the State Government will need to define a new budget head in the Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.5 Delhi

Following are the findings for BBPT resource requirement in the city of Delhi.

3.5.1 Current City Status and Gaps in BBPT

Delhi is officially known as National Capital Territory (NCT) of Delhi, is a union territory of India. New Delhi is the capital and the second highest populated city of India. As per 2011 Census data, population of NCT of Delhi was 1,67,87,941. The local civic administration of NCT of Delhi has, since the trifurcation of the former Municipal Corporation of Delhi (MCD) in January 2012, been in the hands of five local bodies namely East Delhi Municipal Corporation, North Delhi Municipal Corporation, South Delhi Municipal Corporation, New Delhi Municipal Council (NDMC) and Cantonment Board. Current Population of NCT of Delhi (as of 2020) is estimated at 19.3 million with 1.94% of average annual growth rate. The future population of NCT Delhi in year 2021 is estimated to be around 19.6 million (Census, Organization of India, 2011).

The modal split of NCT of Delhi is: Private motorized modes – 23% (4-Wheelers – 9%, 2-Wheelers – 14%); Intermediate Public Transport (IPT) – 7% (Auto rickshaws – 5%, Cycle Rickshaw – 2%); Public Transport (PT) – 31% (Bus – 27%, Metro – 3% and Train (EMU) – 1%), NMT - 39% (Walk – 35% & Bicycle – 4%) (GNCTD, Department of Transportation, 2007). The average trip length in the city is between 10 to 12Km (MOUD, Government of India, 2008). Currently, there are 3781 buses by Delhi Transport Corporation (DTC), and 2208 buses operated by Delhi Integrated Multi-Modal Transit System (DIMTS). Currently DTC & DIMTS plies buses on more than 1100 and 600 routes respectively in the city.

In 2002, Delhi metro train started its operation in the city. Presently, the Delhi Metro network consists of about 389 Km with 285 stations, which are a mix of underground, at-grade, and elevated stations. Delhi Metro is being built and operated by the Delhi Metro Rail Corporation Limited (DMRC), a state-owned company with equal equity participation from Government of India and Government of National Capital Territory of Delhi. As of 2018-19, daily average ridership in Delhi Metro amounted to 2.29 million.

In Indian cities, each urban public bus on an average carries 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Delhi has 44% trips with a length of between 6 to 15km. This is the travel distance which constitute very large potential bus trips in the city. Less than 20% trips in the city are currently on buses. Which means that in the absence of adequate supply of buses, close to 24% trips in the city are lost daily to inefficient private transport modes, mainly two wheelers.

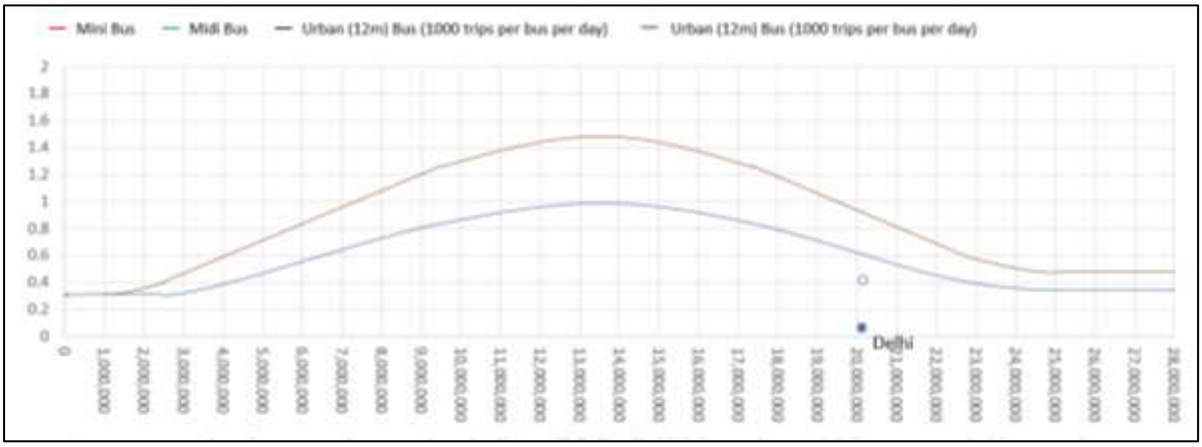
3.5.1.1 Current Bus Operations

Delhi is growing rapidly with an annual average growth rate of 1.94% which means in next 10 years, the city population will increase by 21% i.e., almost 1/4th. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Delhi, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Delhi is estimated at around 6000, which translates to about 30 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 60 lakh trips per day in the city. However, with the potential bus mode share of 40%, it is estimated that more than 70 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in the city.

3.5.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[16] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 5, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 5: Graphical representation of bell curves for calculating buses/lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Delhi at 1.3 crore today. This is twice the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 66 and 38 in 2050, as compared to the current situation of 30 buses per lakh population in the city. This means, that there is a significant gap between current and desired bus fleet

[16] Source: Urban Bus Toolkit, World Bank

inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is between 13,815 and 19,551[17]. Thus, there is a minimum requirement of 7,811 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Delhi can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for the city of Delhi have been presented in Table 13 and have been discussed further in the following section.

Table 13: Current and Desired Fleet of Delhi

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	30	5989	59.9	20%
Desired - 2020	2.00	66	13815	138.1	40%
2025	2.20	49	11462	114.6	35%
2030	2.42	39	9904	99.0	27%
2040	2.94	38	11749	117.5	27%
2050	3.56	38	14238	142.4	27%

3.5.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Delhi population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for Delhi have been presented in Table 14. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses18, include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[17] Basis 1000 or 600 passenger trips per bus per day respectively

[18] If the fleet is 100% electric, the annual budgetary requirement goes up by 1.6 times.

Table 14: Resource requirement for Delhi (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	30	5989	59.9	20%	115	-	-	31143
Desired - 2020	2.00	66	13815	138.1	40%	309	-	-	69600
2021	2.04	62	13380	70.8	23%	163	1594	1399	36835
2022	2.08	59	12917	81.8	26%	188	1594	1428	42527
2023	2.12	56	12436	92.7	29%	213	1594	1453	48219
2024	2.16	53	11945	103.7	32%	238	1594	1486	53911
2025	2.20	49	11462	114.6	35%	264	1594	1534	59603
2026	2.24	47	11002	110.0	33%	254	39	303	57211
2027	2.29	44	10587	105.9	31%	243	84	320	55054
2028	2.33	42	10244	102.4	29%	235	156	354	53270
2029	2.38	40	10004	100.0	28%	229	259	409	52022
2030	2.42	39	9904	99.0	27%	229	399	490	51502
2031	2.47	38	9988	99.9	27%	229	583	611	51940
2032	2.52	38	10075	100.7	27%	232	585	631	52389
2033	2.57	38	10271	102.7	27%	237	1789	1368	53407
2034	2.62	38	10469	104.7	27%	240	1793	1355	54441
2035	2.67	38	10673	106.7	27%	245	1797	1383	55498
2036	2.72	38	10880	108.8	27%	251	1801	1395	56576
2037	2.77	38	11091	110.9	27%	254	1804	1379	57671
2038	2.83	38	11306	113.1	27%	260	255	506	58793

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	2.88	38	11525	115.3	27%	265	303	544	59931
2040	2.94	38	11749	117.5	27%	270	380	590	61097
2041	2.99	38	11977	119.8	27%	276	486	662	62280
2042	3.05	38	12209	122.1	27%	281	632	748	63489
2043	3.11	38	12446	124.5	27%	287	820	868	64721
2044	3.17	38	12687	126.9	27%	292	826	878	65974
2045	3.23	38	12934	129.3	27%	298	2036	1586	67255
2046	3.30	38	13184	131.8	27%	304	2043	1597	68558
2047	3.36	38	13440	134.4	27%	309	2053	1609	69888
2048	3.43	38	13701	137.0	27%	315	2062	1622	71245
2049	3.49	38	13967	139.7	27%	320	2071	1634	72630
2050	3.56	38	14238	142.4	27%	328	525	769	74037

3.5.3 Short, Medium- and Long-Term Action Plan

Table 14 suggests that in order to meet the current and future requirements of BBPT in Delhi, the city needs to urgently invest in closing the current supply and demand gap. This investment is not just in buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring significant land. If the current fleet deficit is met, the immediate land requirement is close to 194 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Delhi is required to inform the decision makers and to ensure resource requirements can be planned for in advance. Table 15 compiles the key annual resource requirements for BBPT in Delhi in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 15: Key annual resource requirements for BBPT in Delhi

Delhi BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	11,500	8,000	7,300	150	110	46
2026-30	9,900	900	1,900	0	0	0
2031-40	11,800	11,100	9,800	5	6	2
2041-50	14,200	13,600	12,000	58	50	19

Table 15 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Delhi city will need to access an average of 1600 buses, 30 hectares of land, develop 22 terminals and between 9 and 10 depots per year for the next five years. For this it will require (excluding land cost) a dedicated average bus budget of rupees 146019 crores per year over the next five years. In the short term, the city will only require accessing on an average 200 new buses per year for the subsequent five years (up to 2030). This will require an average bus budget of 380 crore per year. In the medium term i.e. the subsequent 10 years (up to 2040) the city will need to access on an average 1,200 new buses, about 0.5 hectares of land, develop less than 1 new terminal and less than 1 new depot per year. This will require an average budget of close to 980 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access and average of 1400 buses, 5.8 hectares of land, develop 5 terminals and close to 2 depots per year. This will require an average annual budget (State support for VGF) of about 1200 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Delhi, municipal bodies of Delhi will need an active support of the State Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in the Delhi Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to

[19] All costs are at current value of money and include VGF to cover operational losses.

transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.6 Vishakhapatnam

Following are the findings for BBPT resource requirement in the city of Vizag.

3.6.1 Current City Status and Gaps in BBPT

The City of Vishakhapatnam, commonly known as Vizag, is Andhra Pradesh's largest city, both in terms of population and economy. Located on the south eastern part of India, it is one of the largest municipal corporations with a population of 17,28,128 (Census, 2011). Vizag city is governed by Greater Visakhapatnam Municipal Corporation (GVMC) which was formed in 2005. It is the highest populated city in the state. Current Population of Vizag city (as of 2020) is estimated at 22.3 lakhs with 1.34% of average annual growth rate. The future population of Vizag in year 2021 is estimated to be around 22.6 lakhs.

The modal split of Vizag city is: Private motorized modes - 17% (4-Wheelers - 2% & 2-Wheelers – 15%), Intermediate Public Transport (IPT) – 9% (Auto rickshaws), Public Transport (PT) - 18% (Bus), NMT - 55% (Walk – 52% & Bicycle – 3%). The average trip length in the city is between 4 to 6Km (iTrans, 2014). The City bus system of Visakhapatnam is managed by the Andhra Pradesh State Road Transport Corporation (APSRTC), a Government owned State Transport Undertaking (STU). The city has a total fleet size of 670 buses divided across 133 bus routes operating from 4 depots. Additionally, many private bus operators are operating buses for schools and colleges schools, colleges, and to serve other outer connecting areas of the city.

In Vizag city, due to the lack of a strong administrative structure, the 42 kilometers of Bus Rapid Transit (BRT) corridors that has been completed in 2012, has not been operational. Apart from this, Metro rail project has also been planned by GVMC to control chaotic traffic condition on the streets. The proposal was submitted by the GVMC in February 2014 and work on Detail Project Report is going to start soon.

In Indian cities, each urban public bus on an average carry 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Vizag city has very less trips with a length of between 6 to 15km. This is the travel distance attractive for bus commute. Thus, relatively there is lower demand for buses in the city.

3.6.1.1 Current Bus Operations

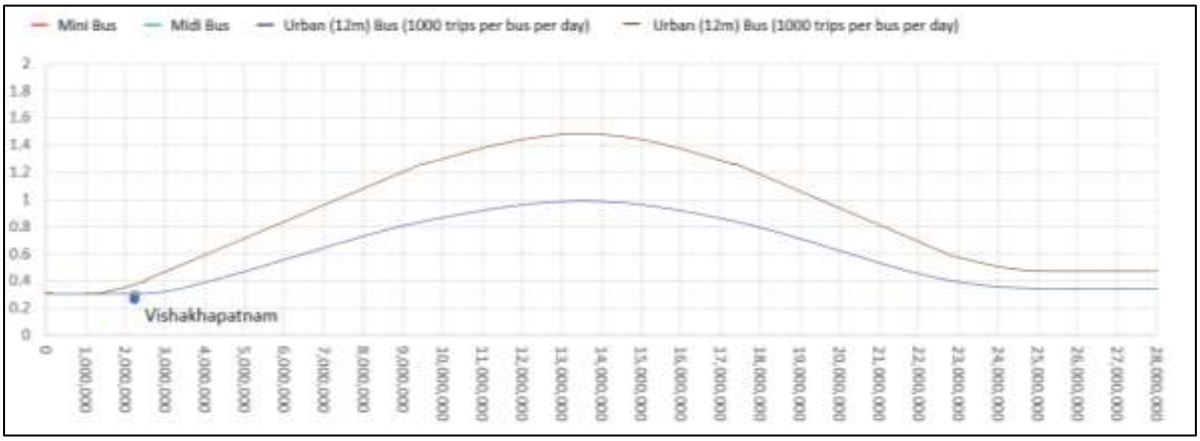
Vizag city is growing with an annual average growth rate of 1.34% which means in next 10 years, the city population will increase by 15% i.e., almost 1/6th. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Vizag city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational city buses in the city of Vizag is estimated at 670, which translates to about 30 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 6.7 lakh trips per day in the city. However, with the potential bus mode share of 22%, it is estimated that around 0.8 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. Current fleet size in the city is already 90% of the requirement. This means most of the potential bus trips are captured by current services, though there is still scope for improvement (especially service planning) and planning for future in the city.

There is thus a little need to bridge the gap between supply and demand by introducing more buses in the city.

3.6.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[20] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 6, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 6: Graphical representation of bell curves for calculating buses/lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Vizag at 7.5 lakh today. This is almost 90% the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 32 increasing to 34 in 2050, as compared to the current situation of 30 buses per lakh population in the city. This means, that there is a negligible gap between current and desired bus fleet inventory in the city. Using the thumb rule calculator, it can be estimated that the current bus

[20] Source: Urban Bus Toolkit, World Bank

fleet size required to meet the potential passenger trip demand, is between 754 and 853[21]. Thus, there is a minimum requirement of 84 additional buses today to bridge the demand and supply gap in the city. Similarly, such resource requirements for an effective bus based public transport (BBPT) in the city of Vizag can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for the city of Vizag have been presented in Table 16 and have been discussed further in the following section.

Table 16: Current and Desired Fleet of Vizag city

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	30	670	6.7	20%
Desired - 2020	0.22	32	754	7.5	22%
2025	0.24	32	806	8.1	23%
2030	0.26	32	861	8.6	23%
2040	0.29	33	1004	10.0	23%
2050	0.33	34	1195	11.9	24%

3.6.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Vizag city population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Vizag have been presented in Table 17. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses[22], include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[21] Basis 1000 or 600 passenger trips per bus per day respectively

[22] If the fleet is 100% electric, the annual budgetary requirement goes up by 1.6 times.

Table 17: Resource requirement for Vizag (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	30	670	6.7	20%	16.1	-	-	-
Desired - 2020	0.22	32	754	7.5	22%	17.6	-	-	3484
2021	0.23	32	764	7.6	22%	16.8	150	117	3974
2022	0.23	32	775	7.7	22%	16.8	66	59	4029
2023	0.23	32	785	7.9	22%	19.0	66	83	4083
2024	0.24	32	795	7.9	22%	19.0	65	59	4133
2025	0.24	32	806	8.1	22%	19.0	67	61	4193
2026	0.24	32	817	8.2	22%	19.0	66	60	4248
2027	0.25	32	827	8.3	22%	19.4	66	65	4302
2028	0.25	32	839	8.4	22%	19.4	67	61	4363
2029	0.25	32	849	8.5	22%	19.4	66	61	4417
2030	0.26	32	861	8.6	22%	19.4	67	62	4477
2031	0.26	32	873	8.7	22%	19.4	67	62	4538
2032	0.26	32	885	8.9	22%	19.7	68	67	4603
2033	0.27	32	899	9.0	23%	19.7	164	119	4675
2034	0.27	32	913	9.1	23%	21.7	80	91	4746
2035	0.27	32	927	9.3	23%	22.0	81	76	4822
2036	0.28	32	942	9.4	23%	22.0	80	72	4899
2037	0.28	32	957	9.6	23%	22.0	82	73	4976
2038	0.28	32	973	9.7	23%	22.0	82	74	5058

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	0.29	33	988	9.9	23%	22.4	82	78	5140
2040	0.29	33	1004	10.0	23%	22.4	83	75	5222
2041	0.30	33	1021	10.2	23%	24.3	83	95	5309
2042	0.30	33	1038	10.4	23%	24.6	84	81	5397
2043	0.30	33	1056	10.6	23%	24.6	85	78	5490
2044	0.31	33	1074	10.7	23%	24.6	86	79	5583
2045	0.31	33	1093	10.9	23%	25.0	183	139	5682
2046	0.32	33	1112	11.1	23%	25.0	99	87	5780
2047	0.32	34	1132	11.3	24%	25.3	101	93	5884
2048	0.32	34	1153	11.5	24%	27.3	101	109	5994
2049	0.33	34	1174	11.7	24%	27.3	103	91	6103
2050	0.33	34	1195	11.9	24%	27.6	103	96	6213

3.6.3 Short, Medium- and Long-Term Action Plan

Table 17 presents a snapshot of the current and future requirements for BBPT in Vizag. The city needs relatively less resources to close the current supply and demand gap. As evident from the current and future estimates, there is no huge gap between demand and supply though, focus needs to be on improving the service planning.

However, for meeting the current gap, the investment estimated is not just in buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring land pockets in the city. If the current fleet deficit is met, the immediate land requirement is close to 1.5 hectares. A short-term, medium-term, and long-term action plan for BBPT in Vizag is required to ensure resource requirements can be planned for in advance, in order to ensure that the supply and demand gap does not widen in the future. Table 18 compiles the key annual resource requirements for BBPT in Vizag in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 18: Key annual resource requirements for BBPT in Vizag

Vizag BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	800	420	380	3	3	1
2026-30	860	330	310	0.4	1	0
2031-40	1000	870	790	3	3	1
2041-50	1,200	1,030	950	5.3	4	2

Table 18 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Vizag city will need to access an average of 100 buses, 0.6 hectares of land, develop 1 terminal and about 1 depot per year for the next five years. For this it will require (excluding land cost) a dedicated average bus budget of rupees 76 crore per year over the next five years. In the short term, the city will require to access on an average 70 new buses per year for the subsequent five years (up to 2030), close to 0.4 hectares of land, develop only 1 new bus terminals per year from 2025 to 2030. This will require an average budgetary requirement of 62 crore per year. In the medium term i.e. the subsequent 10 years (up to 2040) the city will need to purchase or induct on an average 100 new buses, about 3 hectares of land, develop 3 new terminals and about 1 new depot per year (in 10 years). This will require an average budget of close to 79 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access an average of 103 buses, 0.53 hectares of land, develop 1 new terminal and 2 depots per year (in 10 years). This will require an average annual budget of about 95 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Vizag, GVMC will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in the Andhra Pradesh Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. In the long-term Vizag should consider an independent corporation or public bus company outside APSRTC, with a dedicated budget head in Andhra Transport Department. Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

3.7 Chennai

Following are the findings for BBPT resource requirement in the city of Chennai.

3.7.1 Current City Status and Gaps in BBPT

Chennai, the capital city of Tamil Nadu, is the most populated city in the state. The Greater Chennai Corporation is the civic body that governs the city of Chennai. As per (Census, 2011), population of Chennai Metropolitan Area (CMA) was 86,53,521. Current Population of CMA (as of 2020) is estimated at 1.08 crore with 2.5% of average annual growth rate. As per (CMDA, 2019), the future population of Chennai in year 2021 is estimated to be around 1.26 crore due to its high growth rate.

The modal split of CMA is: Private motorized modes – 36.7% (4-Wheelers – 7.10%, 2-Wheelers – 29.6%); Intermediate Public Transport (IPT) – 7.1% (Auto rickshaws); Public Transport (PT) – 28.2% (Bus – 22.6%, Rail – 5.6%), NMT – 28% (Walk – 25.1% & Bicycle – 2.9%). The average trip length in the city is 9.9 km and majority of the work trips are having trip length ranging from 6.8 to 15,7 km (CMDA, 2019). Currently, there are 4000 buses operated by Metropolitan Transport Corporation (Chennai). Currently MTC plies buses on 730 routes in the city. Chennai had the most crowded buses in the country with 1300 passengers per bus in each direction per day.

In 2015, metro train was introduced in the city. The current route length of metro is 45.1km with 32 metro stations with a daily ridership of 1,25,000. Including Metro and Bus, the PT share in the city is 28.2%. Of this, the mode share by Metro is 5.6%, while that by Bus is between 22.6%. Due to lack of an effective public bus transport system in the city, the current potential public transport trips are lost to private modes, i.e. mainly motorized two wheelers. This leads to negative externalities such as higher air pollution and increasing accident related deaths.

In Indian cities, each urban public bus on an average carry 600-1000 passengers trips per day. Work undertaken by the FLEET project team to plot trip length and city population relationship suggests that Chennai city has 64% trips with a length of between 6 to 15km. This is the travel distance which constitute very large potential bus trips in the city. Which means that in the absence of adequate supply of buses, more than 50 lakh trips in the city are lost daily inefficient private transport modes, mainly two wheelers, every day.

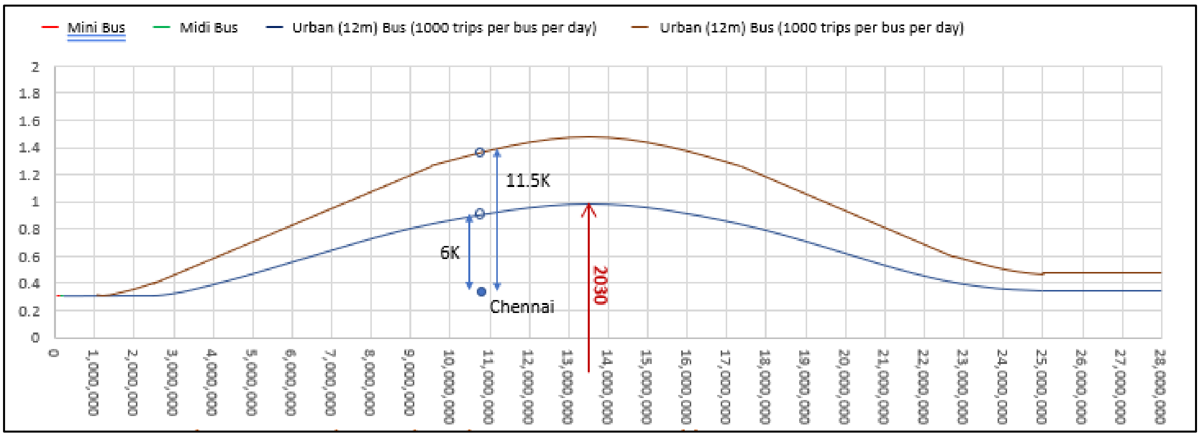
3.7.1.1 Current Bus Operations

CMA is growing rapidly with an annual average growth rate of 2.5% which means in next 10 years, the city population will increase by 28% i.e., almost 1/3rd. To cater the mobility demand of an increasing urban population an efficient and sustainable mode of transport is needed. In Chennai city, nearly all potential bus trips are either on walk, cycle or two wheelers and can be easily attracted by a reliable high frequency bus system, as and when the same is available. The current number of operational buses in the CMA is estimated at 4000, which translates to about 35 buses per lakh population. This means that the current fleet size has a maximum capacity of catering to 52 lakh trips per day in the city. However, with the potential bus mode share of 64%, it is estimated that more than 51 lakh trips per day are either not realized or are lost to inefficient modes such motorized two wheelers. There is thus a strong need to bridge the gap between supply and demand by introducing more buses in the city.

3.7.1.2 Demand and Supply Gap

Ministry of road transport and highways (MoRTH) suggests a figure of 50 buses per lakh population in cities. As per world bank, a value of 50 to 120 buses per lakh population[23] has been suggested. It is understood that this bus requirement can vary by the city size and can be estimated on the basis of size of FLEET required to cater to all trips with a length of between 6 to 15 km. For smaller cities (less than 2.5 lakh population), though this number will need to be estimated basis the number required to provide a bus every 10 minutes within 500 m walking distance of every origin and destination in the city. This relationship has been plotted on a graph using trip length and road inventory data from 35 Indian cities. This graph has been presented in Figure 7, and has been used as a basis of estimation of the FLEET size for different cities projected in the future, using a rule of thumb based calculator in the FLEET tool. The graph represents a bell curve and suggests that as population increases in the city, number of buses required per thousand population will also increase, and peak at about 13.5 million. For cities smaller than 25 lakh population about 32 buses per lakh population are required, while those larger than 25 million population, about 38 buses per lakh population is required.

Figure 7: Graphical representation of bell curves for calculating buses/lakh population



Thumb rule calculator in FLEET tool estimates the latent per day demand for bus trips in Chennai at 103 lakh today. This is almost twice the current capacity. Using this relationship, it is known that the desired number of buses per lakh population in the city should be around 91 and 44 in 2050, as compared to the current situation of 35 buses per lakh population in the city. This means, that there is a significant gap between current and desired bus fleet inventory. Using the thumb rule calculator, it can be estimated that the current bus fleet size required to meet the potential passenger trip demand, is between 10,322 and 15513[24]. Thus, there is a minimum requirement of 6322 additional buses today to bridge the demand and supply gap in CMA. Similarly, such resource requirements for an effective bus based public

[23] Source: Urban Bus Toolkit, World Bank

[24] Basis 1000 or 600 passenger trips per bus per day respectively

transport (BBPT) in CMA can be estimated for 30 years in the future using the rule of thumb calculator in the FLEET Tool. Some of the future demand and supply requirements for Chennai have been presented in Table 19 and have been discussed further in the following section.

Table 19: Current and Desired Fleet of Chennai city

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)
Current - 2020	-	35	~4000	52.0	25%
Desired - 2020	1.08	91	10322	103.2	64%
2021	1.11	92	10745	56.9	34%
2025	1.22	97	12453	124.5	68%
2030	1.38	99	14400	144.0	69%
2040	1.77	84	15626	156.3	59%
2050	2.27	45	10794	107.9	32%

3.7.2 Resource Requirement for BBPT in Short Medium and Long Term

FLEET Tool outputs suggest that as the Chennai population increases, buses required per lakh population will also go up. With this all resource requirements such as budget, land staff, buses to be procured, etc. for BBPT in the city will also go up. It is important to note here that bus procurement estimates to meet the city requirements is not limited to the additional inventory to meet the increasing fleet size requirement, but also includes the replacement requirement of buses that achieve their serviceable age. Basis this the annual resource requirements for critical BBPT parameters as derived from FLEET Tool thumb rule estimator, for the city of Chennai have been presented in Table 20. These estimates are based on 50% low floor CNG/Diesel buses and 50% standard floor CNG/Diesel buses25, include estimated operational losses, include infrastructural development cost (bus terminals and depot) and consider the average bus age as 12 years. These estimates also build in a plan to cover the current supply and demand gap in five-year time period in order to spread out the immediate resource requirement to annual manageable levels.

[25] If the fleet is 100% electric, the annual budgetary requirement goes up by 1.6 times.

Table 20: Resource requirement for Chennai (Demand in BAU Scenario)

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
Current - 2020	-	35	4000	40.0	25%	91	-	-	-
Desired - 2020	1.08	91	10322	103.2	64%	238	-	-	20800
2021	1.11	92	10745	56.9	34%	130	2024	1771	29591
2022	1.13	94	11173	73.8	43%	171	2024	1835	38381
2023	1.16	95	11602	90.7	52%	209	2024	1856	47172
2024	1.19	96	12029	107.6	60%	248	2024	1904	55963
2025	1.22	97	12453	124.5	68%	287	2024	1949	64754
2026	1.25	98	12871	128.7	69%	295	751	875	66927
2027	1.28	98	13277	132.8	69%	306	740	902	69040
2028	1.32	99	13671	136.7	69%	314	727	877	71087
2029	1.35	99	14046	140.5	69%	323	709	880	73041
2030	1.38	99	14400	144.0	69%	331	687	872	74880
2031	1.42	99	14727	147.3	69%	339	661	865	76582
2032	1.45	98	15023	150.2	69%	345	629	826	78120
2033	1.49	98	15283	152.8	68%	351	2284	1796	79472
2034	1.53	96	15500	155.0	68%	356	2241	1768	80600
2035	1.56	95	15671	156.7	67%	361	2194	1741	81487
2036	1.60	94	15787	157.9	66%	364	2141	1692	82094
2037	1.64	92	15847	158.5	64%	364	2084	1631	82406
2038	1.68	89	15843	158.4	63%	364	747	851	82384

Year	Population (Cr.)	Buses per lakh population	Bus Fleet	Passengers per day (in lakhs)	Mode share % (bus)	Land required (Ha)	Buses to procure	Annual budget (Cr.)	Total staff strength
2039	1.73	87	15771	157.7	61%	362	667	801	82007
2040	1.77	84	15626	156.3	59%	359	583	747	81257
2041	1.81	81	15408	154.1	57%	354	491	687	80124
2042	1.86	77	15114	151.1	54%	348	392	620	78591
2043	1.91	73	14743	147.4	52%	339	290	549	76664
2044	1.95	70	14300	143.0	49%	329	186	476	74360
2045	2.00	65	13789	137.9	46%	317	1773	1382	71705
2046	2.05	61	13223	132.2	43%	304	1674	1308	68760
2047	2.10	57	12616	126.2	40%	290	1587	1241	65602
2048	2.16	53	11987	119.9	37%	276	1512	1180	62334
2049	2.21	49	11367	113.7	34%	262	1464	1136	59110
2050	2.27	45	10794	107.9	32%	248	173	374	56127

3.7.3 Short, Medium and Long Term Action Plan

Table 20 above suggests that in order to meet the current and future requirements of BBPT in Chennai, the city needs investments for closing the current supply and demand gap. This investment is not just in buses, but an equal focus is required on developing bus infrastructure including depot and terminal. This requires acquiring significant land to address the infrastructure deficit. If the current fleet deficit is met, the immediate land requirement is close to 23 hectares. It is thus evident that an immediate, short, medium- and long-term action plan for BBPT in Chennai is required to ensure resource requirements can be planned for in advance. Table 21 compiles the key annual resource requirements for BBPT in Chennai in to four time periods – up to 2025, 2026 to 2030, 2031 to 2040 and 2040 to 2050.

Table 21: Key annual resource requirements for BBPT in Chennai

Chennai BBPT Action Plan						
Year	Fleet size	Buses to procure	Budgetary requirement (Cr.)	Land Requirement (ha)	Terminals Required	Depots Required
2021-25	12,500	10,100	9,300	196	169	71
2026-30	14,400	3,600	4,400	44	39	16
2031-40	15,600	14,200	12,700	28	25	10
2041-50	10,800	9,500	9,000	0	0	0

Table 21 suggests that in order to meet the resource requirements for BBPT, in the immediate term, Chennai city will need to access an average of 2020 buses, 39 hectares of land, develop 34 terminals and between 14 and 15 depots per year for the next five years. For this it will require (excluding land cost) a dedicated average bus budget of rupees 1860[26] crores per year over the next five years. In the short term, the city will require to induct on an average 720 new buses, between 8 to 9 hectares of land, develop 8 new bus terminals and 3 new depot per year for the subsequent five years (up to 2030).This will require an average bus budget of 880 crore per year. In the medium term i.e. the subsequent 10 years (up to 2040) the city will need to access on an average 1420 new buses, about 3 hectares of land, develop between 2 and 3 new terminals and about 1 new depot per year. This will require an average budget of close to 1,270 crores per year. In the long term, that is in the subsequent 10 years (up to 2050), the city will need to access and average of 950 new buses per year. This will require an average annual budget of about 900 crores in this time period.

Clearly, in order to meet the resource requirements for providing a user responsive and efficient BBPT in Chennai, MTC will need an active support of the State and City Government. Here mobility will need to be viewed as essential service to be provided at subsidized rates by the State. It thus means that the State Government will need to define a new budget head in the Tamil Nadu Transport Department Budget, which should cover the annual budgetary requirements of all State and City Transport services. Additionally, the city government would need to start long term provisioning of land for bus services and this provision will need to be built into the future master plans. Additional strategies to overcome and land availability problems could include innovative use of land use provisions, similar to

[26] All costs are at current value of money and include VGF to cover operational losses.

transit-oriented development (TOD) policy, but applicable to buses. Thus, depot and terminal land parcels, or land parcels which include a minimum provision for bus services/infrastructure can benefit from additional FAR. Similarly, it can be made mandatory for large real estate projects such as development of shopping malls, housing etc., to make provision for bus infrastructure in the planning process.

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