Evaluation of BMTC Initiatives on Modal Share

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CENTER FOR STUDY OF SCIENCE, TECHNOLOGY & POLICY

Evaluation of BMTC Initiatives on Modal Share

1. Impact of Metro on Bus Ridership
2. Feasibility of New Routes for High-end AC Buses
3. Impact of Cab Aggregators on Vayu Vajra Services
4. Improvement and Extension of Chartered Bus Services
5. Exploring Potential of BMTC Land Resources

Final Report

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Background to the Study

About Bengaluru

Bengaluru, the capital of Karnataka, is one of the fastest growing metropolitan cities in India. It is home to major information technology companies, public sector undertakings and major educational and research institutions. The city of Bengaluru has an area of 741 sq. km. with a population of 8.52 million (Census of India 2011). In 2001, Bengaluru's area was 531 sq. km. and population was 5.10 million. Bengaluru has experienced rapid population and urban growth during the last decade (2001-2011).

With rapid urbanisation and population growth, there is a huge demand for improving urban infrastructure, of which public transport is critical. In Bengaluru, as per a study conducted by the Directorate of Urban Land Transport, 27% of all trips are by public transport, 31% of the trips are by two-wheelers and cars, 35% of the trips are by non-motorised transport (walk and bicycle) and 7% by intermediate public transport (autos and taxis) (DULT 2010).

About BMTC

Bengaluru Metropolitan Transport Corporation (BMTC) provides public transport bus services to Bengaluru metropolitan region. BMTC tries to keep pace with the changing urban mobility demand by operating various services such as chartered services, Vayu-Vajra services, Vajra services and ordinary services.

BMTC operates 6,383 buses and carries approximately 5.02 million passengers daily, generating a revenue of INR 5.76 crore per day (BMTC 2017). The gross revenue for BMTC in 2016-17 was INR 2,106 crore, of which traffic revenue contributed to INR 1,770 crore (~84%), while non-traffic contributed to INR 336 crore (16%).

In the recent past, BMTC has seen a reduction in ridership and revenue on account of competition from other modes. The introduction of the Metro Rail and cab aggregators has seen key BMTC corridors being financially affected. In order to assess the impact of other transport modes on BMTC ridership, this study focused on the impact of the Metro on BMTC operations, and the impact of cab aggregators on BMTC airport bus services.

BMTC also aims to increase its revenue through expansion of its AC bus services, monetisation of its land resources and increasing its presence for shared mobility (chartered/dedicated bus services). This study also analyses the feasibility of new AC bus services, suggests measures

to monetise land resources and proposes a financial model for increasing revenue from chartered/dedicated services.

In order to carry out the study, Government of Karnataka has engaged Center for Study of Science, Technology and Policy (CSTEP) as a technical research institution. Karnataka Evaluation Authority (KEA) has been appointed as the coordinating and nodal agency to ensure timely completion of this work.

Acknowledgement

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Initiative 1: Impact of Metro on Bus Ridership

Initiative 1: Impact of Metro on Bus Ridership

Abbreviations and Acronyms

Abbreviations	Full Form
BDA	Bengaluru Development Authority
BMRCL	Bangalore Metropolitan Rail Transport Corporation
BMTC	Bengaluru Metropolitan Transport Corporation
CSTEP	Center for Study of Science, Technology and Policy
ETM	Electronic Ticketing Machine
GIS	Geographical Information Systems
HB	High Boarding
IVTT	In Vehicle Travel Time
KBS	Kempegowda Bus Station
KEA	Karnataka Evaluation Authority
KSRTC	Karnataka State Road Transport Corporation
LB	Low Boarding
O-D	Origin Destination
ODK	Open Data Kit
RMC	Regulated Market Committee
RP	Revealed Preference
SP	Stated Preference
SRS	Simple Random Sampling

Executive Summary

Bengaluru Metropolitan Transport Corporation (BMTC), which started operations in 1997, was the only public transport service provider for urban, sub urban and rural areas of Bengaluru. It was one of the very few profit making state transport undertakings in India, until three years ago. More recently, with the completion of Phase I of Metro by Bangalore Metro Rail Corporation Limited (BMRCL), a new rapid mass transportation system is now available for Bengaluru.

The complete Phase I (East–West and North–South corridors) of Metro started operations in 2017. With the introduction of this new mode of public transport, commuters have shifted from BMTC bus to Metro. BMTC has taken up several initiatives to reduce the impact of this shift by re-routing the existing bus services, introducing new feeder routes, extending operations beyond Metro reach and reducing the number of schedules.

However, BMTC would like to understand the full impact of the Metro on its operations, through a scientific study, towards which the Center for Study of Science, Technology and Policy (CSTEP) has carried out a detailed research.

For assessing the impact of Metro on BMTC ridership, CSTEP conducted a Metro passenger opinion survey at 12 select Metro stations. The study identified the commuter's reasons for shift from bus to Metro and also identified impacted routes. For the impacted routes identified, revenue and ridership analysis was carried out to understand the most impacted stretch along the identified routes.

The study revealed that 38% of the respondents shifted from BMTC to Metro. The majority of these commuters are in close proximity (< 2km) to the Metro station. The results indicate that the major reason for shift from BMTC to Metro is due to reduction in travel time and to avoid traffic congestion.

With the completion of Metro Phase I, and with current Metro Phase II construction, it is important for BMTC to reduce the number of schedules running parallel to Metro corridors. These buses could be redeployed in corridors which witness heavy demand for BMTC services, in BMTC underserved areas and in Metro influence areas as feeder services

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1. Introduction

Till 2011, BMTC was the sole public transport provider for the city of Bengaluru. However the Metro rail operations started in 2011 and full operation of Phase I commenced in 2017. As of 2016-17, BMTC witnessed a decrease in service kilometres provided, from 12.21 lakh km per day in 2015-16 to 11.52 lakh km per day. A component of this reduction of ridership and revenue may be attributed to the introduction of new transport options in the city.

This study aims to understand the nature of this shift from BMTC services to Metro, the reasons for this shift and the impacted bus routes in terms of ridership.

2. Log Frame/Theory of Change/Programme Theory

Till 2011, BMTC was the primary public transport service provider for Bengaluru city. In 2011, the Bangalore Metro Rail Corporation Limited (BMRCL) commenced operations of Metro. Since Phase I Metro (Mysore Road to Baiyappanahalli and Nagasandra to Yelachenahalli) commencement in June 2017, the city has two major public transport service providers: BMTC and BMRCL.

With the Metro operating on high density traffic corridors, BMTC witnessed a change in ridership. Hence this study aims at identifying the impacted routes and assessing the changes in ridership.

	Intervention Logic	Verifiable Indicators of Achievement	Sources and Means of Verification	Assumptions
Overall Objectives	*What are the overall broader objectives to which the activity will contribute?* • Assessing the impact of Metro on BMTC's bus ridership	*What are the key indicators related to the overall objectives?* • Percentage change in ridership for the identified bus routes before and after commencement of Metro Phase I operations	*What are the sources of information for these indicators?* • Primary survey of Metro passengers • Secondary data of affected routes	
Specific Objectives	*What specific objective(s) is the activity intended to achieve to contribute to the overall objectives?* • To identify percentage shift from BMTC bus to Metro • To identify impacted BMTC bus routes	*Which indicators clearly show that the objective of the activity has been achieved?* • Percentage of previous bus-using respondents who now use the Metro • BMTC routes experiencing maximum number of respondents shifting to Metro • Percentage change in ridership of these routes post Metro	*What are the sources of information that exist or can be collected? What are the methods required to get this information?* • Primary survey (Metro passenger opinion survey at Metro stations) • Secondary data (ridership and revenue data for the routes identified)	*Which factors and conditions outside the PI's responsibility are necessary to achieve that objective? (external conditions)* *Which risks should be taken into consideration?* • Willingness of competent authority to permit the survey • Willingness of competent authority to share the required data

Expected Results	*The results are the outputs envisaged to achieve the specific objective.* *What are the expected results? (enumerate them)* • Percentage shift from BMTC bus to Metro • List of impacted BMTC bus routes due to this shift • Reasons for shift • Change in ridership for impacted routes	*What are the indicators to measure whether and to what extent the activity achieves the expected results?* • Previous mode of travel • Previous bus users route no. • Revenue and ridership data for the impacted routes pre and post Metro	*What are the sources of information for these indicators?* • Primary survey (Metro passenger opinion survey at Metro stations) • Secondary data (ridership and revenue data for the routes identified)	*What external conditions must be met to obtain the expected results on schedule?* • Willingness of competent authority to share the data
Activities	*What are the key activities to be carried out, and in what sequence, in order to produce the expected results?* *(group the activities by result)* 1. Primary Survey – Metro passenger opinion survey at select Metro stations 2. Identifying the previous bus using passengers 3. Identifying impacted routes due to this shift	*What are the means required to implement these activities, e. g. personnel, training, studies, etc.* • Survey experts • Transport planning experts	*What are the sources of information about action progress?* • Date and time captured during the primary survey • CSTEP supervision during primary survey • Regular follow up with BMTC & BMRCL on secondary data	*What pre-conditions are required before the action starts?* • Permission by competent authorities to conduct the survey • Willingness of competent authority to share the required data

3. Progress Review

For this section, the base data for comparison are the pre-Metro bus revenue and ridership details of the impacted routes. However, as the two corridors (East-West & North-South) of the Metro started operations over a period of time, the timeline has been divided into two timeframes (pre Metro operations and post Metro operations).

4. Problem Statement

To understand the impact of Metro Phase I operations on BMTC's bus ridership.

As stated above, until Metro was operational, BMTC was the sole public transport service provider in Bengaluru. It is expected that after commencement of Phase 1 Metro operations, there could be some impact on BMTC ridership. This study aims to estimate and understand Metro's impact on BMTC's ridership in order to enable BMTC to plan future operations.

5. Objectives and Issues for Evaluation

Objectives:

- To assess the potential impact of Metro operations on BMTC bus ridership
- To identify the impacted routes due to shift from bus to Metro

Scope:

- Geographical coverage - East West and North South Phase I Metro corridors
- Target population - The target population for this study are the Metro passengers.

6. Evaluation Design

6.1. Information Sources

For this evaluation, both primary as well as secondary data collection methods are considered. The information sources for secondary data were:

- BMTC – Ridership and revenue data for the impacted routes
- BMRCL – Boarding and alighting data for the Metro stations
- Bengaluru Development Authority (BDA) Revised Master Plan, 2015

A gap analysis between the data requirements for the study and the data available from the secondary sources was carried out to derive the type and quantum of surveys to be undertaken. Based on the same, the following primary survey was planned:

- Metro passenger opinion survey

This survey was conducted at selected 12 Metro stations along both East-West and North-South corridor to assess the impact of Metro on BMTC operations. Details of the survey are given in Table 1.

Table 1: Primary survey details

Type of Survey	No. of Locations and Sample Size	Mode of Data Collection	Date of Survey
Metro passenger opinion survey	12 Locations 2,312 Samples	Open Data Kit (ODK) App based survey	20th February - 28th February 2018

6.2. Evaluation Criteria or Indicators

The evaluation criteria for impact assessment of Metro on bus ridership are:

- Percentage of passengers shifting from BMTC bus to Metro (estimated from the Metro passenger opinion survey)
- Changes in the ridership and revenue of impacted routes (from ridership and revenue data from BMTC).

7. Evaluation Methodology

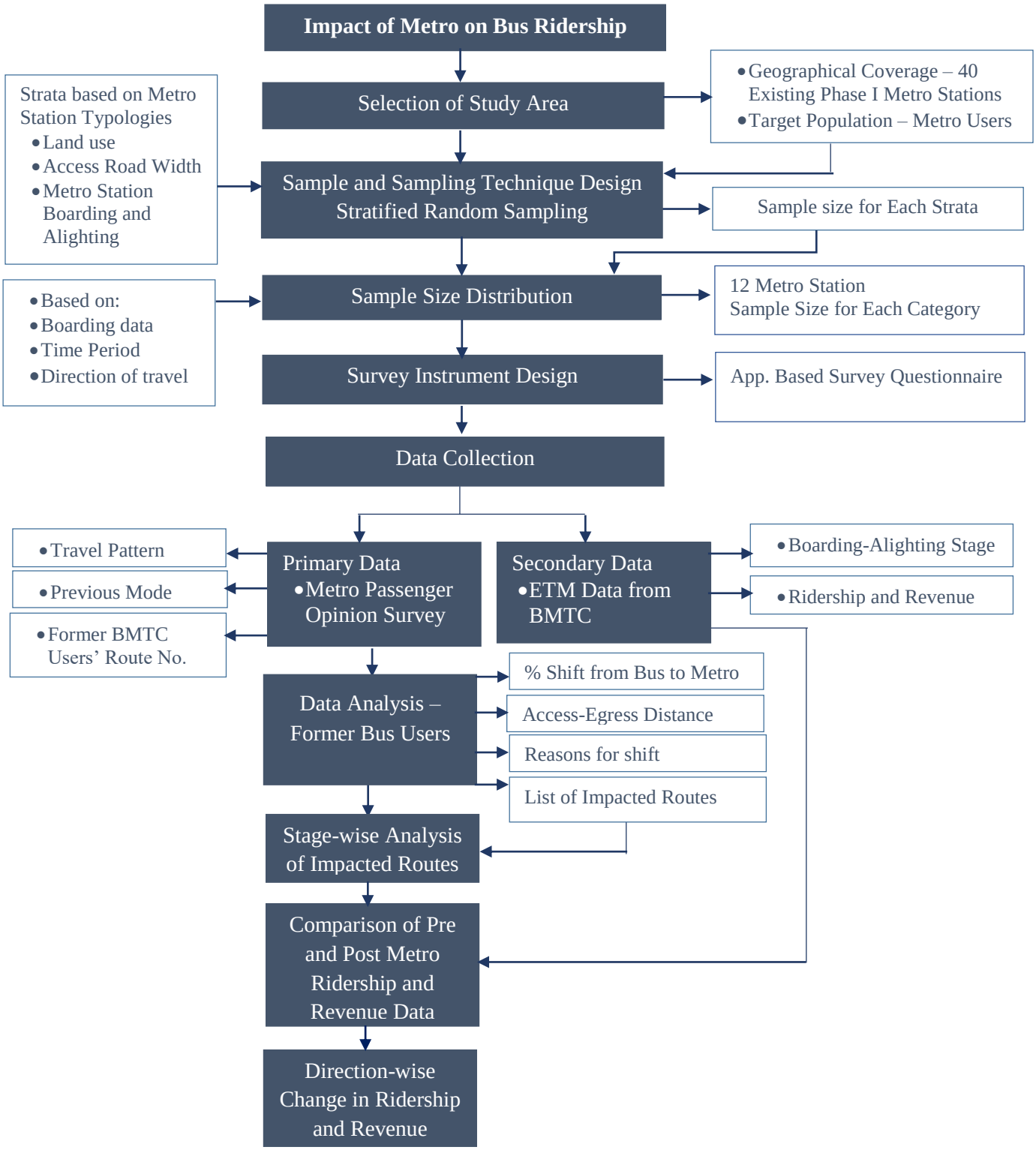

Figure 1: Methodology for assessment of impact of Metro on BMTC bus ridership

7.1. Sample and Sampling Design

7.1.1. Stratified Random Sampling

A stratified random sampling technique was used to arrive at an appropriate sample size at each Metro station. The existing 40 Metro stations were stratified based on the parameters given below:

1. Land-use in 500m radius of the Metro station
2. Access road width
3. Boarding type (high and low boarding).

The six station typologies are described below:

Type 1 – Transport hubs which are connected with other public transport modes in the vicinity

Type 2 – Metro stations which are located in predominantly residential areas, with high boarding and access road width in the range of 30 to 80 metres

Type 3 – Metro stations which are located in predominantly non–residential areas, with high boarding and access road width of 30–50 metres

Type 4 – Metro stations which are located in predominantly residential areas, with high boarding and access road width of 12–30 metres

Type 5A – Metro stations which are located in predominantly residential areas, with low boarding and access road width of 30–80 metres

Type 5B - Metro stations which are located in areas of mixed-land use, with low boarding and access road width of 30–80 metres

Type 6 – Metro stations which are located in predominantly residential areas, with low boarding and access road width of 12–30 metres.

Metro station typologies are given in the Table 2 below:

Table 2: Metro station typologies

Station Name	Predominant Land Use				Access Road Width			Boarding Data		Type	
	Residential	Commercial/ Public–Semi-Public	Industrial	Transport	50 m – 80 m	30 m – 50 m	12 m – 30 m	HB	LB		
Majestic										1	Transport Hubs
Yeshwanthpur											
Baiyappanahalli											
City Railway Station											
Nagasandra										2	High Residential, 30-80 m Road, HB
Dasarahalli											
Yelachenahalli											
Rajajinagar											
Banashankari											
J. P. Nagar											
Vijayanagar											
Trinity											
Sandal Soap Factory										3	Non-Residential, 30-50 m Road, HB
M.G.Road		ü									
Mysore Road											
National College										4	Residential, 12-30 m Road, HB
Southend Circle											
R.V. Road											
Indiranagar											
Sampige Road											
Vidhana Soudha		ü									
Sir M. Visveshwaraya		ü									

Station Name	Predominant Land Use				Access Road Width			Boarding Data		Type	
	Residential	Commercial/ Public-Semi-Public	Industrial	Transport	50 m – 80 m	30 m – 50 m	12 m – 30 m	HB	LB		
Hosahalli										5 A & 5 B	Residential, 30-80 m Road, LB
Deepanjali Nagar											
Mahalakshmi											
Halasuru											
Attiguppe											
Jalahalli											Mixed Land Use, 30-80 m Road, LB
Peenya Industry											
Peenya											
Goraguntepalya											
Cubbon Park		ü									
S.V. Road											
Chickpet		ü								6	Residential, 12-30 m Road, LB
K. R. Market		ü									
Kuvempu Road											
Srirampura											
Jayanagar											
Lalbagh											
Magadi Road											

Legend:

- Residential
- Public/Semi Public
- Commercial
- Green
- Industrial
- Transport
- 50-80 m Wide Road
- 30-50 m Wide Road
- 12-30 m Wide Road
- High Boarding (HB)
- Low Boarding (LB)
- ü Other Additional Land Use (Defined by Colour)

Twelve representative Metro stations from each strata were selected for further study, as shown in Table 3. For each of the strata, the total population was the sum of the boarding passengers' at all Metro stations falling under it.

Simple Random Sampling (SRS) technique was used to estimate the statistically relevant sample size for each strata, using the formula given below:

$$n_1 = \frac{Z^2 \times p(1-p)}{e^2}$$

$$n_1' = \frac{n_1 \times N_1}{n_1 + N_1}$$

$$n = n_1 + n_2 + n_3 + \text{------} + n_h$$

Where,

n_1 = Sample size for each stratum

n_1' = Finite population correction for stratum

N_1 = Population for stratum

n = Total sample size

Z = Z – Score (Z-Table value for 95% confidence interval is 1.96)

e = Margin of Error (5%)

p = Prior judgment of the correct value (probability), which is 0.5 here

Table 3 shows the Metro stations selected for survey.

Table 3: Metro passenger opinion survey locations and sample size

Sr. No.	Metro Station	Total Sample Size
1	Majestic	173
2	Baiyappanahalli	209
3	Nagasandra	160
4	Banashankari	222
5	Mysore Road	172
6	M.G.Road	210
7	Indiranagar	251
8	Vidhana Soudha	153
9	S.V. Road	200
10	Attiguppe	181
11	Kuvempu Road	171
12	Goraguntepalya	210
Total		**2,312**

After arriving at an appropriate sample size, the sample to be collected at each Metro station was distributed temporally as well as directionally. The temporal distribution was done for three time periods in a day, morning peak (8 AM to 11 AM), evening peak (5 PM to 8 PM) and off peak (2 PM to 4 PM). The directional distribution was based on the location and type of the Metro station. A detailed sample distribution is shown in the Annexure I.

7.2. Type of Data Collected from Various Sources

7.2.1. Secondary Sources

1. Station-wise boarding and alighting Metro passenger data
2. Electronic Ticketing Machine (ETM) data for revenue and ridership
3. Land use data for Bengaluru

7.2.2. Primary Surveys

Metro Passengers Opinion Survey for Assessment of Impact of Metro on BMTC Operations

- Travel pattern of Metro passengers (origin-destination, mode of travel used for first and last mile connectivity, etc.)
- Reasons for shifting to Metro
- BMTC route no. from previous bus users

7.3. Instruments for Data Collection

7.3.1. Secondary Sources

For collecting data from secondary sources, a data requirement template was prepared and shared with the concerned agencies (Annexure II).

7.3.2. Primary Surveys

For primary data collection, a structured closed-end survey questionnaire was used to capture the data required for the current study. The questionnaire for this survey is given in Annexure III.

Metro passenger opinion survey questionnaire comprised of three sections:

1. Passenger information
2. Travel information
3. Information about their current mode choices and stated preferences about mode choice under changed conditions (scenarios considering existing fare and frequency and decreased fare and increased frequency).

All project related data was then compiled and reviewed thoroughly till a firm database was evolved for the fruitful outcome of the study.

7.4. Protocols for Data Collection and Ethics Followed

Secondary data for the current study was collected from BMTC and BMRCL. For the primary field survey, permission letters from BMRCL and BMTC were taken for conducting surveys within the Metro stations. Care was taken by the survey team to ensure that regular movement of passengers and duties of the workers were not hampered.

8. Data Collection and Analysis

8.1. Data Collection and Cleaning

8.1.1. Primary Data

The survey sample details for the primary survey are given in Table 4 below. Effort was also made to ensure that equal number of men and women responded to the survey.

Table 4: Metro passenger opinion survey sample details

Heading	Required	Collected
Survey Sample Size	2,312	2,430
Bus Users	-	915 (37.6%)

The survey was carried for a time period of 12 hours (8:00 AM-8:00 PM) at all the select Metro locations covering morning peak, off peak and evening peak on a normal working day. The survey locations are given in Table 3. The locations were duly identified based on Metro station typology. The survey was carried out using Open Data Kit (ODK) suite, an android based mobile app that replaces paper-based forms. Specially trained field investigators and trained enumerators, under the close guidance of supervisory staff were utilised for this purpose. The compiled data was subjected to a thorough verification and analysis.

The data from the primary survey was extracted in Excel spreadsheet. This data was then checked for complete and incomplete responses, invalid samples and data entry errors. After all these filters, a clean data set was prepared for analysis.

8.1.2. Secondary data

For the selected impacted routes, daily revenue and ridership data for one week, stage-wise, was collected for the following period:

- Before commencement of Metro (pre Metro operations) – May 2017
- After commencement of Metro (post Metro operations) – July 2017

8.2. Data Analysis

The primary data analysis was done with the following objectives:

- To understand the Metro passenger's access and egress distance to the Metro station
- To estimate the percentage shift from bus to Metro
- To understand the reasons for this shift
- To identify the impacted BMTC routes.

The secondary data analysis was done with the following objectives:

- To classify Metro stations with respect to each strata
- To analyse the stage-wise revenue and ridership change.

8.3. Data Analysis Techniques

For analysing the primary as well as secondary data set, Excel and Geographical Information Systems (GIS) were used. Excel was used to create the analysis template, graphs and charts and GIS was used to locate the origin-destinations of the respondents and analyse the stretch-wise impact on BMTC routes.

8.4. Preliminary Analysis

8.4.1. Profile of Metro Passengers Shifted from Bus

The socio-economic profile of the Metro passengers who have shifted to Metro from BMTC bus is shown in Annexure IV. Out of the total former bus users interviewed 54% were men and 46% were women. The current study reveals that maximum shift from bus to Metro was seen in the age group of 31-50 years (46%) and 19 - 30 years (44%). It was observed that maximum shift with respect to monthly household income range is INR 20,000 – 50,000. Income group INR 10,000 – 20,000 comes next with 21% shift. 63% respondents were from working class and for 64% respondents the purpose of trip was work, followed by education trips (14%).

Previous Mode of Travel

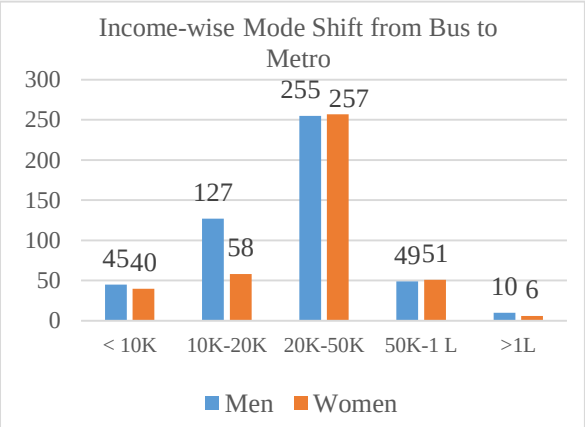

Figure 2: Income-wise mode shift from bus to Metro

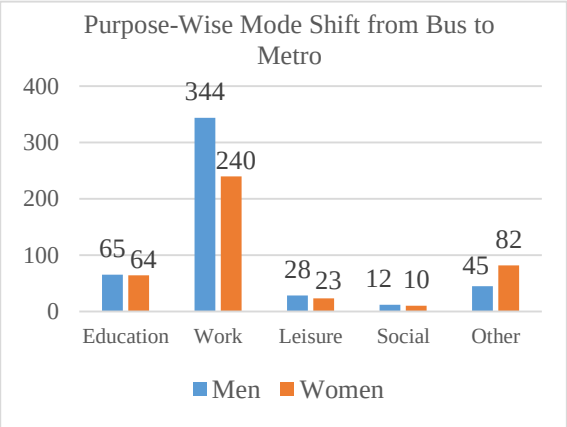

Figure 3: Purpose-wise mode shift from bus to Metro

The details of the previous mode of travel of Metro Passengers are presented in Table 5. Out of 2,431 respondents interviewed, about 38% of the commuters were bus users who have now shifted to Metro.

Table 5: Previous mode of travel

Previous Mode of Travel	Count	Percentage
Cycle	6	0.2%
Two wheeler	744	31%
Auto	89	4%
Bus	915	38%
Private Car	285	12%
Taxi	165	7%
Others	227	9%
TOTAL	**2,431**	**100%**

9. Findings and Discussions

9.1. Shift from Bus to Metro

The station-wise shift from bus to Metro are presented in Figure 4. The maximum percentage shift is seen at Kuvempu Road (67%). The other locations experiencing a higher shift from bus to Metro are Banashankari Metro station, M. G. Road and Mysore Road.

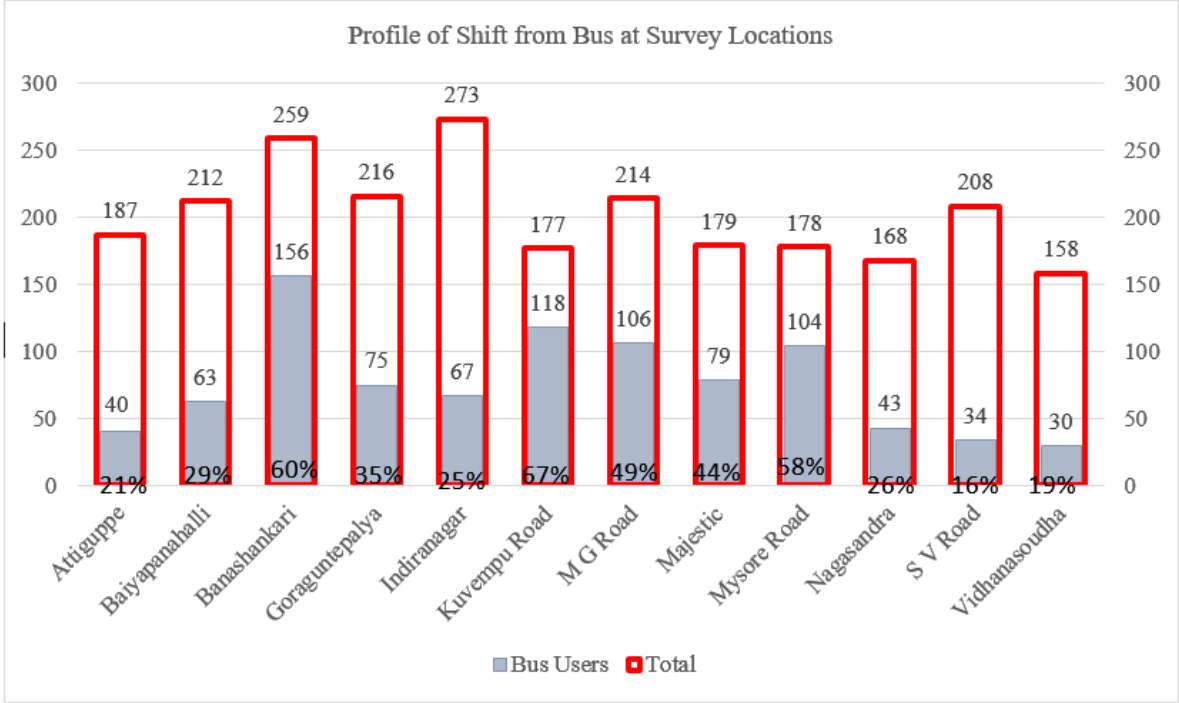

Figure 4: Profile of bus to Metro shift at survey locations

9.2. Reasons for Shift from Bus to Metro

Out of the 915 previous bus users interviewed, 910 responded to survey questions regarding reasons for the shift to Metro. The respondents had a choice to select multiple reasons for their mode shift. The reasons in the questionnaire include: reduction in travel time, comfort, low bus frequency, reasonable metro fare and avoiding traffic jams and pollution. 95% of the respondents cited reduction in travel time as the reason for their shift and 60% responded saying they wanted to avoid traffic jams. Table 6 shows that travel time, avoiding traffic jams and comfort were the major three reasons for the mode shift and that more weightage was given to time related factors than expense (reasonable Metro fare).

Table 6: Reasons to shift from bus to Metro

Reason to Shift	Count	Percentage
Travel Time	869	95%
Avoid Traffic Jam	543	60%
Comfort	412	45%
Low Bus Frequency	89	10%
Reasonable Metro Fare	62	7%

9.3. Impacted Routes

This study also aims at identifying the BMTC routes impacted due to Metro operations. The routes were identified using two methods:

1. Direct response of the former bus using respondents
2. Origin-destination of the former bus using respondents (whose route numbers were not known).

The top impacted routes are given in the Table 7 below.

Table 7: List of impacted routes

Route No.	Origin	Destination	Parallel Metro Corridor
258	Nelamangala	KR Market	N-S
215	Amruth Nagara	KR Market	N-S
317	Hosakote	KR Market	E-W
335	Sai baba hospital	KR Market	E-W
315	KBS	KR Puram	E-W
210	Uttarahalli	KR Market	N-S
252	KBS	Peenya 2nd stage	N-S
61A	KBS	Chandra Layout	E-W
138	Jeevan Bhimanagara Bus stand	KBS	E-W
304	Arehalli	KR Market	E-W
225	Channasandra	KR Market	E-W
314	Shivajinagar Bus Station	CGHS Nagavar Palya	E-W
250	Chikkabanawara Railway Gate	KR Market	N-S
253	Krishnarajendra Market	Hesaraghatta Indo Danish Farm	N-S
401K	Yelahanka	Kengeri	E-W
201	Domulur TTMC	Srinagara	E-S

9.4. Stretch-wise Impacted Route Analysis

After identifying the impacted routes from Metro passengers' response, a four months stage-wise ridership data for select two routes was considered for analysis. This data was collected for Jan - Feb 2017 for pre-Metro and Aug - Sept 2017 that is two months after commencement of full Phase I Metro corridor.

9.4.1. Stretch-wise Impact Analysis of Route No. 258

258-UP (KR Market to Nelamangala)

The route 258 UP runs from KR Market to Nelamanagala and has a route length of 30 Km. Of this, around 16 Km (~50%) runs parallel to the Metro North-South corridor (from Nagasandra to KR market).

Table 1 shows the change in ridership of the BMTC route 258 after commencement of Metro Phase I.

Table 8: Stage-wise change in ridership (Route no. 258UP)

Sl.No	Stage Names	% difference in boarding ridership (UP)	Pre-Metro Ridership	Post-Metro Ridership
1	KR Market	-68%	1792	570
2	Kempegowda Bus Station	-35%	1663	1084
3	Corporation	-68%	161	51
4	Central	-15%	532	452
5	11th Cross Malleswaram	-50%	469	236
6	Yeshwanthpur TTMC	-48%	1540	804
7	RMC Yard	-22%	1102	862
8	SRS Peenya	-13%	342	298
9	Jalahalli Cross	-27%	2847	2081
10	Marison Factory	-28%	323	231
11	Anchepalya	-6%	343	324
12	Madanayakanahalli	-25%	233	175
13	Makali	-67%	215	71
14	Adakimaranahalli	-100%	11	0
15	Dasanapura	-65%	83	29
16	Arishinakunte	-49%	146	75
17	Binnamangala	-58%	425	179

The route seems to have an overall loss of about 44% in its ridership after commencement of Phase I Metro (overall monthly ridership in January 2017 was 1,22,212, this reduced to 7,517 in September 2017). The stage-wise analysis observed a significant reduction in ridership at KR Market (68%). Overall ridership at KR Market reduced to 570 in September from 1,790 in January. Also inter-stage trips shows that there is an average drop of 60% in ridership for the trips from KR Market to Yeshwanthpur TTMC and Dasanapura. Since KR Market bus station is in close proximity to the Metro station there is a high possibility of passengers opting for Metro.

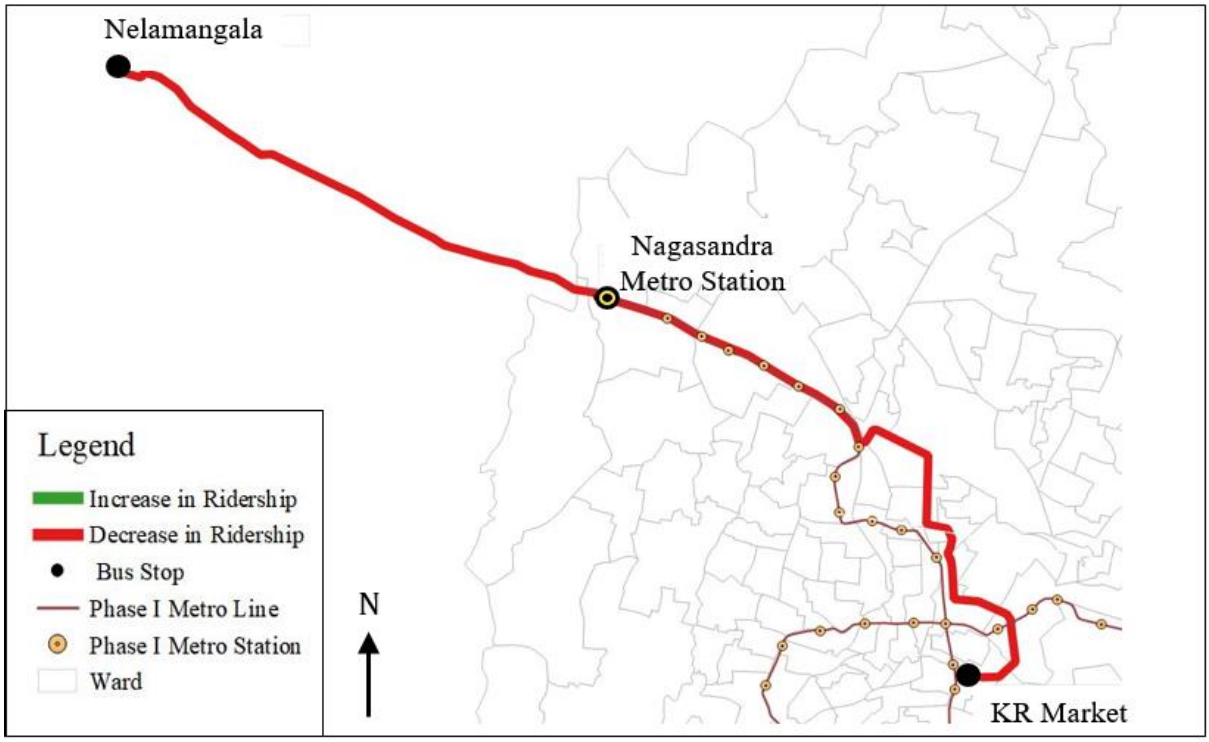

Figure 5: Stage-wise impact on BMTC route no. 258-UP

258- DN (Nelamangala to KR Market)

For the down journey (from Nelamangala to KR Market), a reduction of 27% was observed from Arishanakunte to Maharanis College. The ridership seems to go up by approximately 20% on the initial stretch (from Nelamanagala to Arishanakunte). It also showed that the commuters were using this route for a shorter trips from Nelamangala and Binnamangala. A slight increase in ridership from Nelamangala to Marison Factory (26 in January to 52 in September), indicated that passengers could be using this as feeder for their first mile connectivity.

Table 9: Stage-wise change in ridership (Route no. 258 DN)

Sl. No.	Stage	% difference in boarding ridership (DN)	Pre- Metro Ridership	Post-Metro Ridership
1	Nelamangala	14%	1645	1875
2	Binnamagala	21%	71	86
3	Arishinakunte	-38%	193	119
4	Dasanapura	-12%	296	261
5	Adakimaranahalli	-76%	67	16
6	Makali	-17%	814	674
7	Madanayakanahalli	-20%	1743	1391
8	Anchepalya	-13%	960	836
9	Marison Factory	-16%	2401	2006
10	Jalahalli Cross	-13%	773	672
11	SRS Peenya	-24%	742	562
12	RMC Yard	-23%	706	541
13	Yeshwanthpur TTMC	-19%	1157	941
14	8th Cross Malleswaram	-25%	693	518
15	Swastik Sheshadripuram College	-49%	212	108
16	Ananda Rao Circle	-52%	97	47
17	Maharanis College	45%	62	90
18	Corporation	-6%	192	181

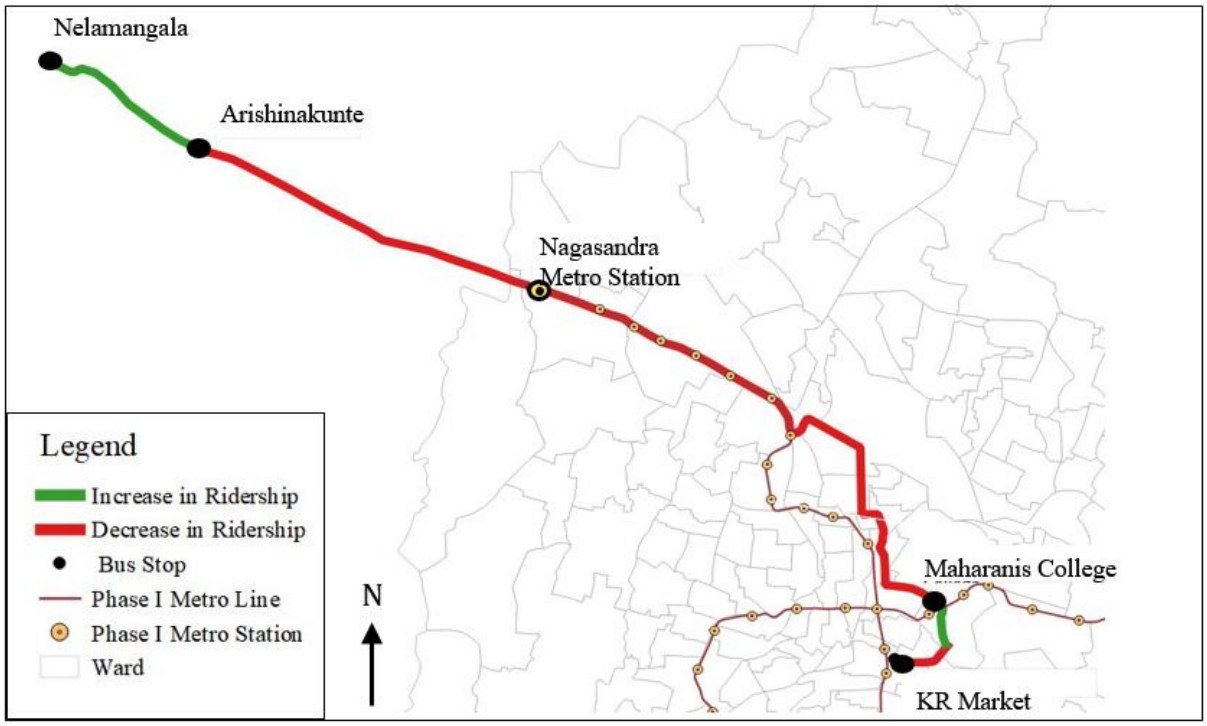

Figure 6: Stage-wise impact on BMTC route no. 258-DN

9.4.2. Stretch-wise Impacted Route Analysis – 401 K

The route 401-K UP runs from Kengeri TTMC to Yelahanka Old Town and has a route length of 37 Km. This route runs radial to Metro corridor. About 10km stretch of this route (from Mallatahalli Cross to Yeshwanthpur TTMC) runs parallel to Metro.

Table 1 below shows the change in ridership of the BMTC route 401-K after commencement of Metro Phase I.

Table 10: Stage-wise change in ridership (Route no. 401-K UP)

S.No	Stage Names	% difference in boarding ridership (UP)	Pre-Metro Ridership	Post-Metro Ridership
1	Kengeri TTMC	-33%	5834	3922
2	Jn of Kommaghatta	-27%	3786	2773
3	Shirke KHB Quarters	-24%	2410	1822
4	Mariyappanapalya	-30%	2802	1966
5	Mallathahalli Cross	-22%	2517	1974
6	Nagarabhavi Circle	-28%	2280	1643
7	Moodalapalya	-26%	3734	2759
8	Vijayanagara	-31%	2874	1984
9	Industrial Area Rajajinagara	-22%	947	736

10	ESI Hospital Rajajinagara	-37%	2541	1598
11	1st Block Rajajinagara	-20%	1668	1327
12	Govt Soap Factory	-13%	1056	914
13	Yeshwanthapura TTMC	3%	4329	4458
14	Mattikere	-29%	2279	1628
15	BEL Circle	3%	2008	2065
16	Nagaland Circle	-18%	1243	1015
17	Nanjappa Circle	-12%	1732	1522
18	Vidyaranyapura Bus Station	-24%	900	688
19	Chikka Bettahalli	-12%	789	692
20	Atturu Layout	-14%	1016	872
21	Yelahanka Satellite Town	4%	1204	1249
22	NES Office	-18%	531	434

The survey showed that respondents using Metro service from Yeshwanthpur Metro station (going till Vijayanagar /Mysore road Metro station) were using 401-K route before Phase I Metro was operational. These trips were majorly starting from Global Tech village/ Kengeri and ending at Mathikere or Yeshwanthpur.

The route (401-K UP) experienced an overall reduction in ridership of 32%, and the stretch which is running parallel to Metro corridor has observed an average reduction of 30%. Figure 1 shows that there is a slight increase in ridership at Yeshwanthpur TTMC, which is in close proximity to the Metro station. This could be due to Metro commuters using the bus service for their last mile connectivity.

The inter-stage trips data show a significant reduction in ridership for the trips from Kengeri to Govt. Soap Factory, Yeshwanthpur and Mathikere. One of the reasons for this reduction can be a commuter shift from bus to Metro.

Likewise, on the downward journey (401K-DN), it was observed that there was a constant decrease in ridership from Yelahanka Old Town to Moodalapalya (from 47335 in January to 40533 in September), and it slightly increased at Moodalapalya, which is in close proximity to Vijayanagar Metro station. Even though the ridership seems to increase on the last few stages, the route observed an overall reduction of 21%, and for the stretch parallel to Metro, it was around 18%.

The inter-stage trips show a reduction of 23% in ridership from Yelahanka to Vijayanagar, Moodalapalaya and Nagarbavi Circle. It is also observed that ridership has increased for shorter

trips from Vidyaranyapura and Nanjappa Circle to Govt. Soap Factory indicating that passengers might be using this stretch for their first mile connectivity.

Table 11: Stage-wise change in ridership (Route no. 401-K UP)

S.No	Stage Names	% difference in boarding ridership (DN)	Pre-Metro Ridership	Post-Metro Ridership
1	Yelahanka Old Town	-2%	5427	5326
2	NES Office	-20%	4443	3556
3	Yelahanka Satellite Town	-27%	2669	1957
4	Atturu Layout	-10%	1638	1470
5	Chikka Bettahalli	-24%	1433	1089
6	Vidyaranyapura Bus Station	-14%	3273	2821
7	Nanjappa Circle	-8%	3689	3407
8	Nagaland Circle	-23%	570	441
9	BEL Circle (Towards Mathikere)	-21%	1863	1478
10	Mattikere	-11%	3692	3282
11	Yeshawanthapura TTMC	-13%	2051	1789
12	Govt Soap Factory	-36%	1730	1100
13	1st Block Rajajinagara	-22%	3549	2759
14	ESI Hospital Rajajinagara	-18%	2061	1689
15	Industrial Area Rajajinagara	-13%	1619	1416
16	Vijayanagara	-20%	4719	3793
17	Moodalapalya	9%	2909	3160
18	Nagarabhavi Circle	4%	2193	2281
19	Mallathahalli Cross	-8%	898	829
20	Bengaluru University Quarters	-6%	1027	967
21	Mariyappanapalya	2%	1271	1295
22	Shirke KHB Quarters	-2%	283	277
23	Jn of Kommaghatta	133%	6	14
24	Police Station Kengeri	-2%	5427	5326

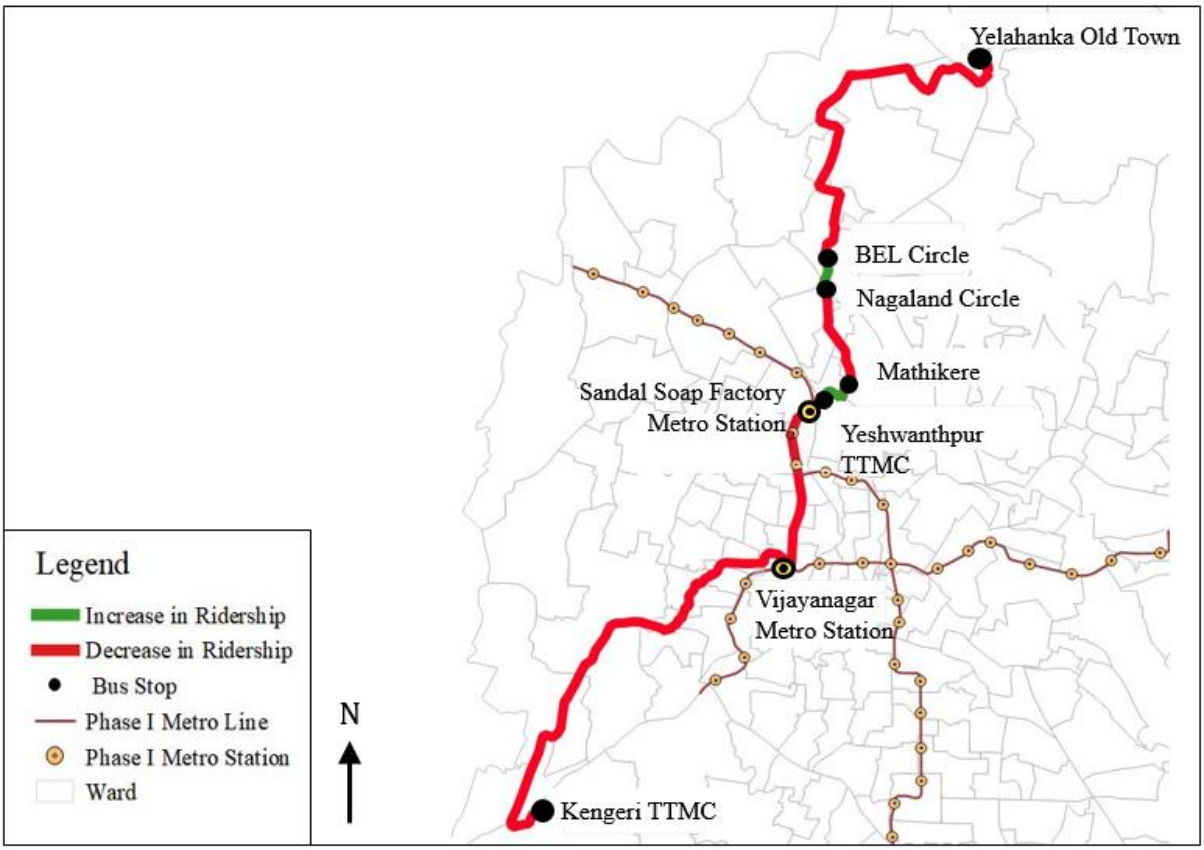

Figure 7: Stage-wise impact on BMTC route no. 401-K UP

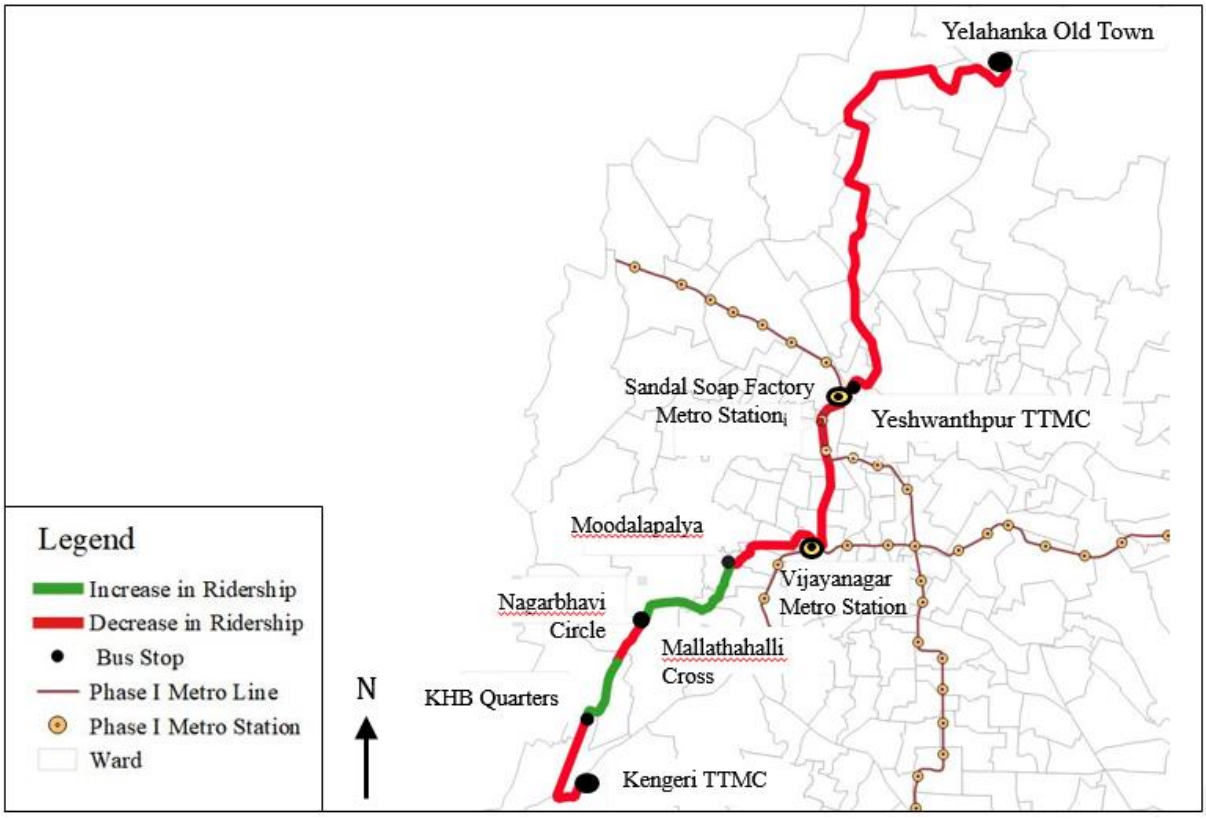

Figure 8: Stage-wise impact on BMTC route no. 401-K DN

10. Conclusion and Recommendations

Conclusions

Through this study, socio-economic and trip characteristics of former BMTC bus-users was captured through a Metro passenger opinion survey. Metro station-wise, percentage of shift from bus to Metro was estimated. The survey was also able to reveal the underlying reasons for this shift and identified the impacted bus routes. For the impacted routes, a stretch-wise assessment was carried out to identify the bus ridership variation.

According to the findings of the study, there is a shift from bus to Metro. The primary reason identified for this shift is reduction in travel time. From the impacted route analysis, it was also evident that due to this shift, there is a variation in bus ridership.

Recommendations

With the completion of Metro Phase I, and with current Metro Phase II construction, it is important for BMTC to reduce the number of schedules running parallel to Metro corridors. These buses could be redeployed in:

- Corridors which witness heavy demand for BMTC services
- Areas which are underserved by BMTC operations
- Influence area of Metro as feeder services

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Annexure I

Sample Size Distribution

SL No	Metro Station	Time Period			Total Sample Size	Direction			
		T1	T2	T3		N	S	E	W
1	Majestic	80	34	59	**173**	58	44	40	31
2	Baiyappanahalli	42	137	30	**209**	0	0	0	209
3	Nagasandra	36	91	33	**160**	0	160	0	0
4	Banashankari	63	99	60	**222**	222	0	0	0
5	Mysore Road	94	41	37	**172**	0	0	172	0
6	M.G.Road	60	100	50	**210**	0	0	105	105
7	Indiranagar	77	131	43	**251**	0	0	126	125
8	Vidhana Soudha	35	88	30	**153**	0	0	76	77
9	S.V.Road	79	86	35	**200**	0	0	0	200
10	Attiguppe	86	55	40	**181**	0	0	91	90
11	Kuvempu Road	53	80	38	**171**	85	86	0	0
12	Goraguntepalya	88	82	40	**210**	105	105	0	0
	Total				**2,312**				

T1 – Morning Peak (8:00am – 11:00am)

T2 – Evening Peak (5:00pm – 8:00pm)

T3 – Off Peak (12:00noon – 4:00pm)

Annexure II

Data Requirement Template for Impacted Route Stage-wise Data from BMTC

Route No.	Schedule No.	Date	Time	Boarding Stage	Alighting Stage	Ridership	Revenue

Annexure III

Metro Passenger Opinion Survey Questionnaire

(At Metro Stations)

Purpose: To identify feasible Metro feeder routes and also to assess the impact of Metro on BMTC services

Survey Location: Date & Time:

Gender	Male	Female

Age group	Less than 18	19 – 30	31 - 50	51 - 60	Above 60

1. Employment Type:
    a) Working
    b) Unemployed
    c) Retired
    d) Student
    e) Homemaker
    f) Others

2. Monthly Household income	Less than 10,000	Rs. 10, 000– 20,000	Rs. 20,000– 50,000	Rs. 50,000 – 1,00,000	More than 1,00,000

3.	Origin (Land mark, Nearest Bus stop & Pin code)	Destination (Land mark, Nearest Bus stop & Pin code)
	Boarding Metro Station	De-boarding Metro Station

4. Purpose of travel	Education	Work	Leisure	Social	Other

5. How often do you make this trip?	Daily	Weekly	Monthly

6. How long have you been using metro?

Less than 3 months	3 to 6 months	6 to 9 months	More than 9 months

7. What was your previous mode of travel?

Cycle	Two wheeler	Auto	Bus Route no.	Private car	Taxi/cab	Commuter rail

8. If the answer is BMTC, What prompted you to shift to metro?

Sr. No.	Reasons	Response
1	Travel Time	
2	Comfort	
3	Low bus frequency / High waiting time for BMTC	
4	Reasonable Metro fare	
5	Avoid traffic jams and pollution	

9. How did you reach the Metro station?

Walking	Car	Two wheeler	Auto	Bus Route no. _____	Cab/ taxi	Share taxi

10. Home to Metro station distance?

Less than ½ Km	½ -2Km	2 - 5 Km	More than 5 Km

11. Travel Time to reach Metro station? _____ Min

12. Do you use the same mode for returning to your origin? Yes/No

13. How will you reach your destination from the Metro station?

Walking	Car	Two wheeler	Auto	Bus Route no. _____	Cab/ taxi	Share taxi

14. Metro station to final destination distance?

Less than ½ Km	½ -2Km	2 - 5 Km	More than 5 Km

15. Travel Time to reach your destination from the Metro station? _____Min

16. Do you use the same mode to reach Metro station from destination? Yes / No

17. Do you park your Vehicle at Metro station? Yes / No

18. Do you pay for your parking? Yes / No

19. Scenarios & ranking (would you shift to Metro feeder if...)

Scenario	Travel Cost Current Mode	Travel Time Current Mode	Travel Cost with Metro feeder	Travel Time with Metro feeder (Min)	Comfort	Your Response	
						Current Mode	Metro Feeder
1				IVTT[1]+30	AC		
2				IVTT+24	AC		
3				IVTT+30	AC		
4				IVTT+24	AC		
5				IVTT+30	Non AC		
6				IVTT+24	Non AC		

20. Any other suggestions for improvement?

[1] IVTT – In Vehicle Travel Time

Annexure IV

Profile of Former Bus Users Currently Using Metro

Socio – economic Characteristics of Respondents	Category Range	Respondents	
		Count	Percentage
Gender	**Men**	494	54%
	Women	419	46%
Total		**913**	**100%**
Age	Less than 18	25	3%
	19-30	405	44%
	31-50	421	46%
	51-60	46	5%
	Above 60	18	2%
Total		**915**	**100%**
Employment Type	Working	572	63%
	Unemployed	78	9%
	Retired	23	3%
	Student	140	15%
	Homemaker	89	10%
	Others	13	1%
Total		**915**	**100%**
Monthly Household Income	Less than 10,000	85	9%
	INR 10,000-20,000	185	21%
	INR 20,000-50,000	514	57%
	INR 50,000-1,00,000	100	11%
	More than 1,00,000	16	2%
Total		**900**	**100%**

Initiative 2: Feasibility of New Routes for High-End AC Buses

Initiative 2: Feasibility of New Routes for High-End AC Buses

Abbreviations and Acronyms

AC	Air Conditioned
ASC	Alternative Specific Constant
BBMP	Bruhat Bengaluru Mahanagara Palike
BEL	Bharat Electronics Limited
BMRCL	Bangalore Metro Rail Corporation Limited
BMTC	Bengaluru Metropolitan Transport Corporation
DCM	Discrete Choice Modelling
HH	Household
INR	Indian Rupee
IPT	Intermediate Public Transport
IT	Information Technology
ITPL	International Tech Park Limited
IVTT	In Vehicle Travel Time
KBS	Kempegowda Bus Station
Km	Kilometre/s
K. R. Puram	Krishna Raja Puram
MNL	Multinomial Logit Model
NES	National Employment Service
O. Bus	Ordinary Bus
ODK	Open Data Kit
ORR	Outer Ring Road
P. Bus	Private Bus
RP	Revealed Preference
SP	Stated Preference
S. V. Road	Swami Vivekananda Road
TT	Tempo Traveller
TW	Two-wheeler

Executive Summary

Bengaluru Metropolitan Transport Corporation (BMTC) operates AC bus services (Vajra services) mainly along the IT corridors, Outer Ring Road (ORR) and other major transport corridors in the city. These services were earning profits till 2013-14, 2014-15 and 2015-16. However, 2016 onwards, they started incurring losses because of increased operational costs. Moreover, in the last few years, BMTC has witnessed a decrease in AC bus ridership as commuters are shifting to Metro and app-based cab aggregators. Due to decreasing AC bus ridership and increasing operational costs, it was challenging for BMTC to operate these services.

In an effort to retain its ridership, BMTC introduced initiatives such as flexible tariff during non-peak hours and reduction in fare. The reduction in fare (introduced in January 2018) has yielded a 44% increase in AC bus ridership, compared with the previous year. To further increase the ridership of AC bus services, BMTC intends to determine the potential demand for such services. In this context, this study aims to explore the feasibility of introducing new, high-end AC buses in Bengaluru for better service to commuters. The study also aims to identify the feasible directions of operation of AC bus services for the locations surveyed.

For this study, a commuter survey was conducted at eight select locations. From the survey data, passengers' travel characteristics and patterns were analysed. The study estimates the willingness to shift to AC bus services from existing modes of transport (two-wheelers, cars, ordinary[1] buses, private buses, autos and cabs). The study concludes with the identification of potential corridors for introduction of AC bus services. The results indicate that approximately 25% of the respondents were willing to shift to AC bus services, irrespective of the variation in fare and time. It was observed that the maximum potential shift was from autos and two-wheelers to AC bus services, and there was minimal shift from ordinary bus services and private bus services.

[1] Ordinary bus refers to non-AC bus.

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1. Introduction

BMTC started AC bus services (Vajra) on select corridors of the city in 2006 (Financial Express 2006), with a view to provide a premium bus service to commuters. Vajra services mainly operate in the IT corridors and a few residential areas of Bengaluru. Currently, BMTC operates around 89 routes under the Vajra services, with 845 AC buses (Philips 2017).These services were profitable till 2015-16, and were compensating the losses from ordinary services (P K 2012). However, from 2013 onwards, this service has incurred losses due to high operational costs per km. Moreover, in the past few years, BMTC has witnessed a decrease in AC bus ridership as commuters are shifting to Metro and app-based cab aggregators. Due to the decrease in AC bus ridership and increase in operational cost, it was challenging for BMTC to operate these services.

In an effort to retain its ridership, BMTC reduced the fare for AC bus services in January 2018. This reduction in fare has seen an increase in ridership by almost 50% till May 2018. To further increase the ridership of AC bus services, BMTC intends to determine the potential demand for such services.

2. Log Frame/Theory of Change/Programme Theory

AC bus services play a vital role in BMTC bus operations especially along the IT corridors. Given their current coverage, BMTC would like to explore the possibility of expanding such services to cater to the potential demand from commuters using other modes. This could provide a premium public transport for people using private vehicles.

The primary survey for this study was carried out at eight important junctions[2] in the city. These junctions are shown in Figure 1.

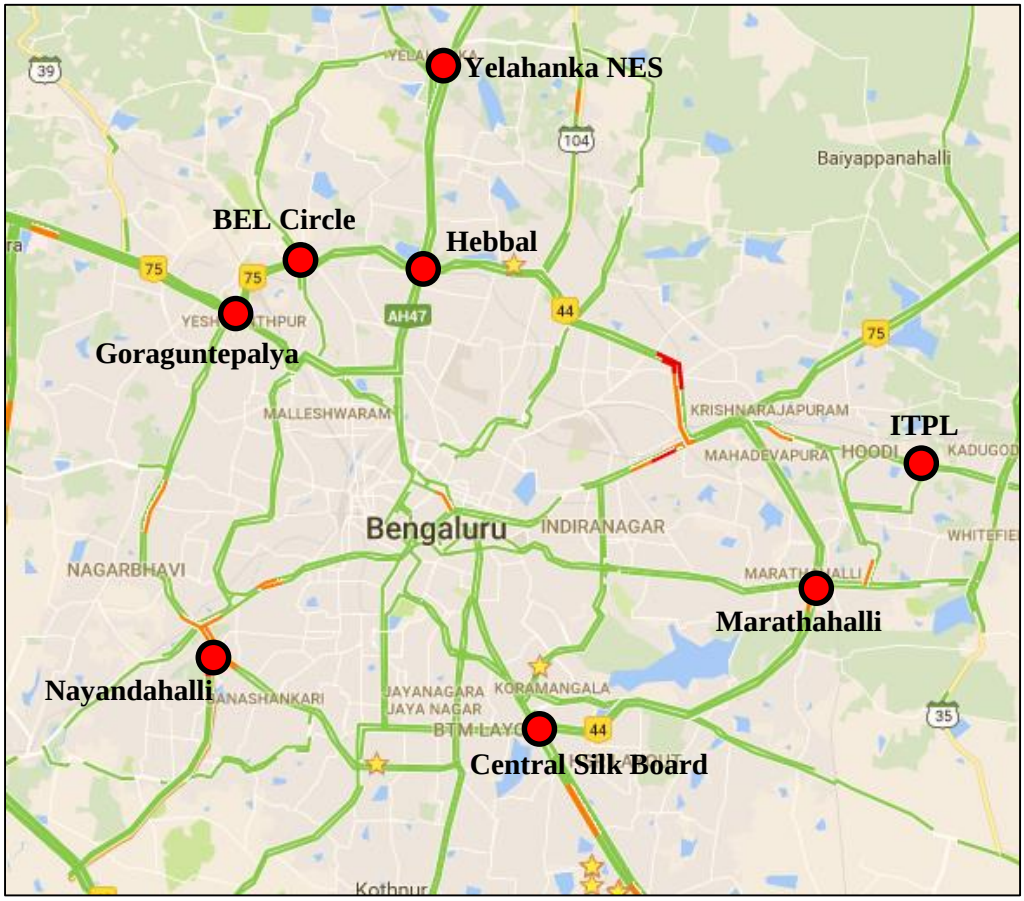

Figure 1: Map showing survey locations

[2] Selection of junctions and directions were finalised in consultation with BMTC.

	Intervention Logic	Verifiable Indicators of Achievement	Sources and Means of Verification	Assumptions
Overall Objectives	*What are the overall broader objectives to which the activity will contribute?* • To determine the feasibility of new AC bus services in Bengaluru	*What are the key indicators related to the overall objectives?* • Willingness of commuters to shift from their current mode to the new AC bus services	*What are the sources of information for these indicators?* • Primary survey of non-AC bus users, private vehicle users (two-wheelers and cars), IPT users (auto and cab) and private bus users	
Specific Objectives	*What specific objectives is the activity intended to achieve to contribute to the overall objectives?* • To identify the willingness of commuters to shift to AC services • To identify potential corridors for extension of existing AC bus services and introduction of new AC bus services	*Which indicators clearly show that the objective of the activity has been achieved?* • Probability of commuters shifting from their current mode to new AC bus services • For each survey location, direction-wise predominant trip pattern	*What are the sources of information that exist or can be collected? What are the methods required to get this information?* • Primary survey of non-AC bus users, private vehicle users (two-wheelers and cars), IPT users (auto and cab) and private bus users • Discrete choice modelling (Multi-nominal Logit Model) method to determine the probability of shift from current mode to new AC bus services	*Which factors and conditions outside the PI's responsibility are necessary to achieve that objective?* *Which risks should be taken into consideration?* • Willingness of competent authority to permit the survey • Willingness of competent authority to share the required data • Being able to obtain timely and appropriate responses from the respondents

Expected Results	*The results are the outputs envisaged to achieve the specific objective.* *What are the expected results? (enumerate them)* • Willingness of commuters to shift to new AC bus services • Suggest feasible directions to operate the new AC bus services	*What are the indicators to measure whether and to what extent the activity achieves the expected results?* • Questions addressed by the respondents for different scenarios	*What are the sources of information for these indicators?* • Primary survey of non-AC bus users, private vehicle users (two-wheeler and cars), IPT users (auto and cab) and private bus users • Secondary analysis (probability to shift from current mode to new AC bus service)	*What external conditions must be met to obtain the expected results on schedule?* • Timely availability of survey data from all the survey locations
Activities	*What are the key activities to be carried out and in what sequence in order to produce the expected results?* *(group the activities by result)* 1. Obtain survey locations from BMTC 2. Conduct primary survey (commuter survey) at these locations 3. Measure commuters' willingness to shift to BMTC's AC bus services 4. Identify potential corridors 5. Validate the suggested corridors with the stakeholder	***Means:*** *What are the means required to implement these activities, e. g. personnel, training, studies, etc.?* • Transport planning experts • Survey experts	*What are the sources of information about action progress?* • Date and time captured during the primary survey • CSTEP supervision during the primary survey • Secondary data from BMTC about existing AC bus services	*What pre-conditions are required before the action starts?* • Permission from competent authorities to conduct the survey • Willingness of competent authority to share the required data

3. Progress Review

BMTC AC services mainly operate along IT corridors, Outer Ring Road (ORR) and to and from the airport. As on March 2018, BMTC runs 845 schedules for approximately 85 AC bus routes. The average route length is about 30 km, with a maximum length of 55 km (Hebbal to Attibele) and a minimum of 13 km (S. V. Road to Whitefield). There are 75 schedules running from Kempegowda Bus Station (KBS) to Kadugodi (which is the highest). Other schedules connect KBS to Attibele, Banashankari to ITPL, and Hebbal to Central Silk Board.

4. Problem Statement

To determine the feasibility of introduction of AC bus services on high traffic density corridors in Bengaluru.

BMTC intends to expand the reach of its AC bus services to improve connectivity and comfort. This study aims to determine the feasibility of introducing AC bus services at eight major junctions covering important corridors in the city.

The study will identify the potential corridors for BMTC to introduce the new AC bus services, based on commuters' willingness to shift from their current mode of transport to such services.

5. Objectives and Issues for Evaluation

Objectives

- To determine the feasibility of introduction of new AC bus services along important corridors
- To identify the feasible direction for operation of AC bus services

Scope

Target population: The target population for this study are all motorised commuters (except BMTC AC bus users) who pass through the select junctions at each survey location.

Geographical coverage: Bengaluru city

6. Evaluation Design

6.1. Information Sources

Primary survey at select junctions in the city and secondary data from BMTC and various relevant literature served as the basis of information for this study.

For primary data collection, a commuter survey was conducted. This survey helped understand the socio-economic characteristics of the respondents and provided information on their travel pattern, origin–destination, commuting cost, time, distance and frequency. It also helped to estimate the willingness of the commuters to shift to new AC bus services with respect to variation in the fare under two different scenarios.

6.2. Evaluation Criteria or Indicators

The feasibility of operating new AC bus services is evaluated on the basis of commuters' willingness to shift from their current mode of transport to new AC bus services.

7. Evaluation Methodology

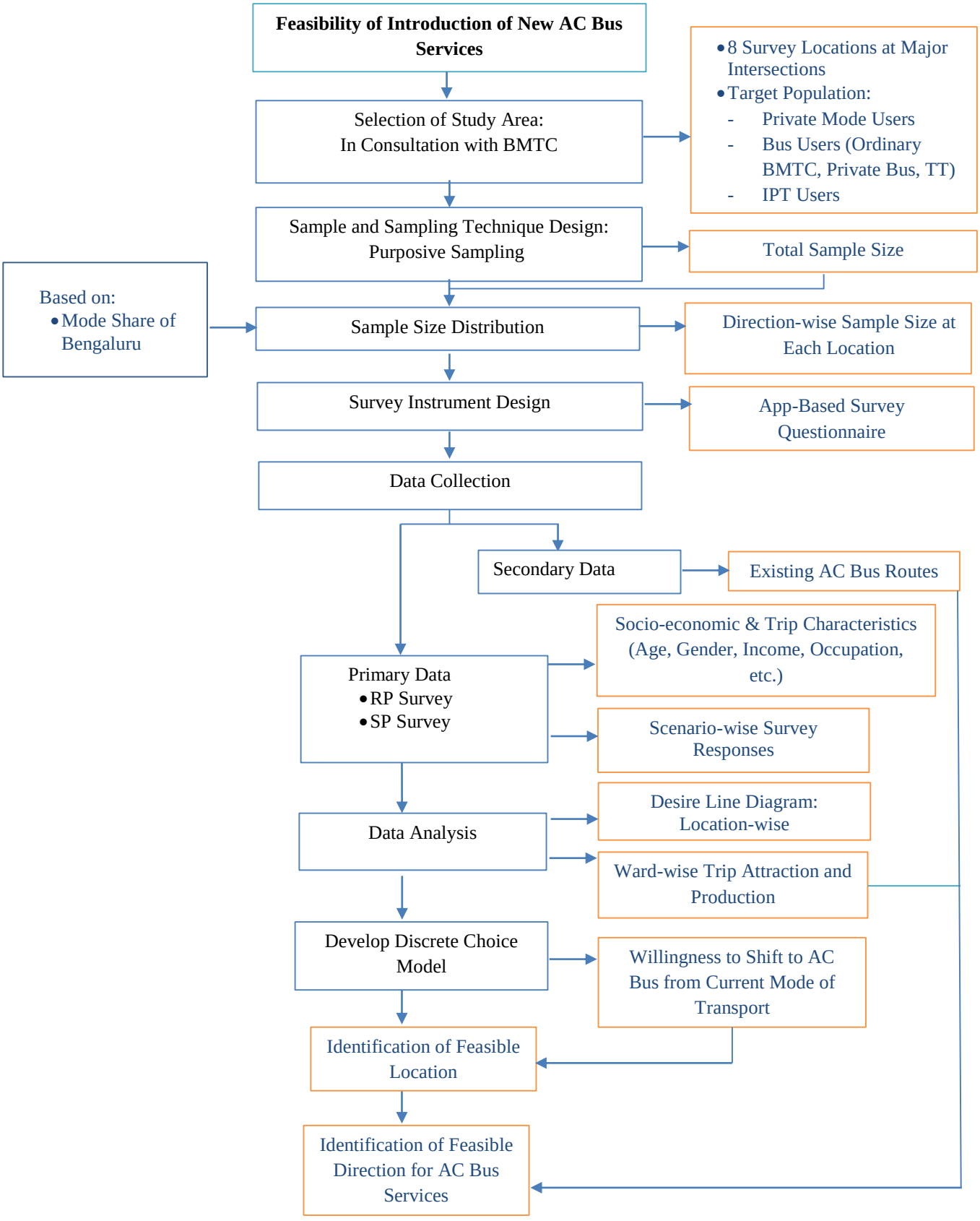

Figure 2: Determining feasibility of introduction of new AC bus services

A systematic and phased approach was adopted for carrying out the study and delivering the results within the stipulated timeframe. The methodology adopted for determining the feasibility of introducing new high-end AC bus routes is explained in the following sections.

7.1. Sample and Sampling Design

The survey locations (Figure 1) are major interchange junctions in the city. The survey sample was distributed at each junction in different directions to capture the required data.

To determine a representative sample size from an infinite population (where the population size is greater than 50,000), the Simple Random Sampling (SRS) formula was used (Sarmah and Hazarika 2012).

$$n_0 = \frac{Z^2 \times p(1-p)}{e^2}$$

Where

n_0 = Sample Size

Z = Z Score Value

e = Margin of Error (5%)

p = Prior Judgment of the Correct Value (probability), which is 0.5 here

Using the equation presented above, the minimum sample size comes out to be approximately 384 for 95% confidence level and approximately 666 for 99% confidence level (calculations are shown in Annexure I). Therefore, a minimum sample size of 600 was considered for this survey. At junctions where a multi-directional survey was planned, the sample size considered for this study was 800 or 1,000.

The sample size thus arrived at (for each location) was distributed across different modes of transport, such as two-wheelers, autos, cabs, cars, private bus and ordinary BMTC bus, based on the mode share of Bengaluru (DULT 2010). The survey locations and directions are given in Figure 3, and the direction and mode-wise sample size at each location are given in Table 1.

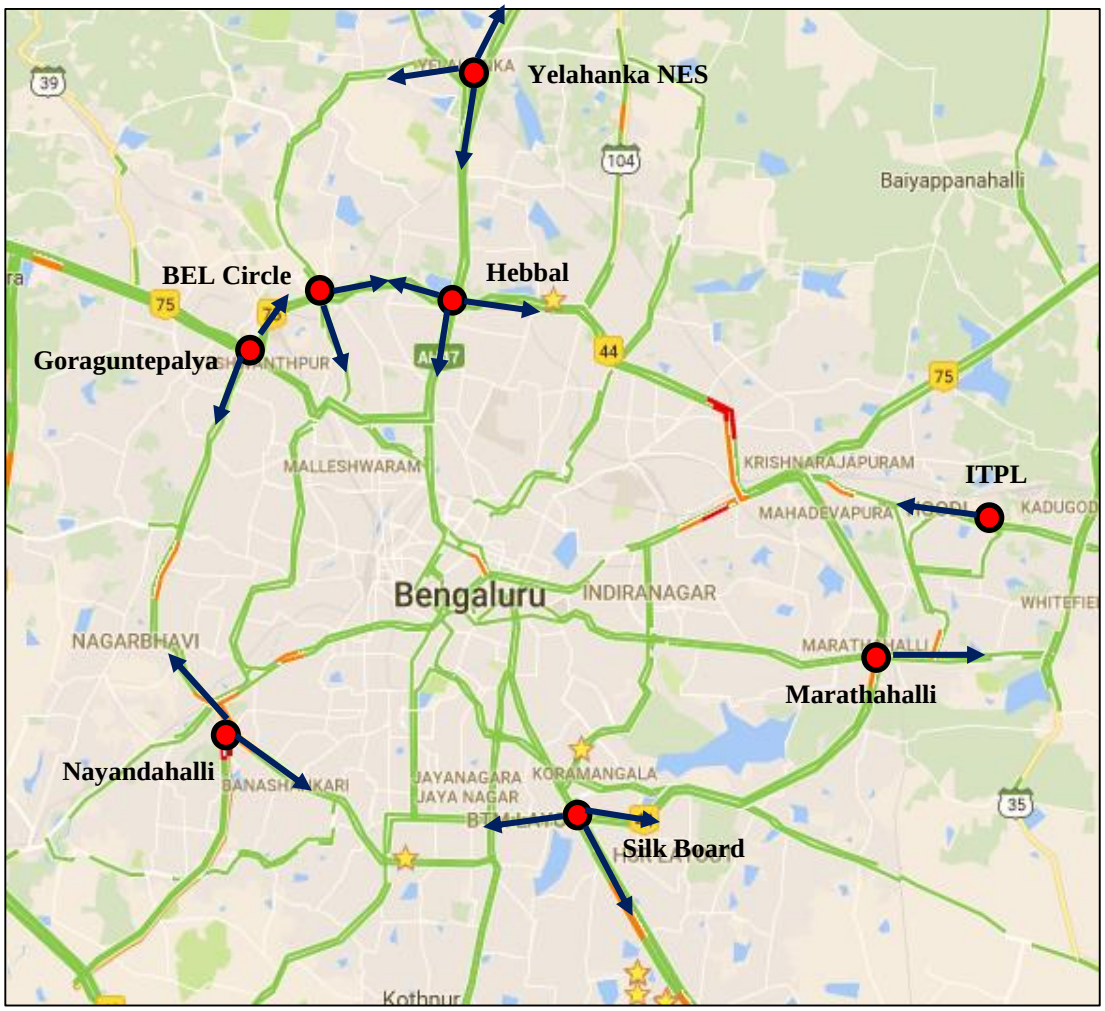

Figure 3: Survey location with direction

Table 1: Location, direction and mode-wise sample size distribution

Location	Modal Share							Sample Size	Direction	
	O. Bus	P. Bus	Cab	TT	Car	Auto	TW		Towards	Sample Size
Nayandahalli	150	150	50	50	100	100	200	800	Banashankari	400
									Goraguntepalya	400
Goraguntepalya	150	150	50	50	100	100	200	800	Outer Ring Road towards Hebbal	500
									Ring Road towards Nayandahalli	300
ITPL	150	150	50	50	100	100	200	800	Outer Ring Road / K. R. Puram	800
Yelahanka NES	150	150	50	50	100	100	200	800	Hebbal	300
									Peenya	300
									Doddaballapur	200
Central Silk Board	200	200	50	50	120	120	260	1,000	ITPL	400
									Electronic City	400
									Banashankari	200
Marathahalli Bridge	120	120	30	30	75	75	150	600	ITPL	600
Hebbal	200	200	50	50	120	120	260	1,000	K. R. Puram	300
									Tumkur Road	200
									City Centre	300
									Airport	200
BEL Circle	120	120	30	30	75	75	150	600	Majestic (via Mathikere)	300
									Hebbal	300
Total								6,400		

7.2. Type of Data Collected from Various Sources

The following data sets were collated from the primary and secondary data collected:

7.2.1. Secondary Sources

Secondary sources comprised a list of existing AC bus routes from BMTC (BMTC 2018a) (Refer Annexure II for data collection template).

7.2.2. Primary Sources

Primary sources involved commuter survey (of those using motorised modes of transport) to assess willingness to shift to AC bus services (except BMTC AC bus users):

- Travel pattern of commuters (origin-destination, mode of travel, trip purpose and frequency)
- Probability of shift to AC bus services: location-wise & mode-wise

7.3. Instruments for Data Collection

7.3.1. Secondary Sources

A data collection template was shared with BMTC and is provided in Annexure II.

7.3.2. Primary Surveys

For primary data collection, a structured survey questionnaire was used to capture the data. The questionnaire for this survey is given in Annexure III. Open Data Kit (ODK), an Android-based mobile app, was used to collect the primary data[3].

The commuter survey questionnaire comprised three sections:

1. Socio-economic information
2. Travel information
3. Scenarios (varying fare)

7.4. Protocols for Data Collection and Ethics Followed

Secondary data for the current study was collected from BMTC. Before conducting the primary field survey at major intersections, necessary permission letters were obtained from the Commissioner of Police (Bengaluru City) and BMTC. It was a voluntary survey, and care was taken to preserve the anonymity of the respondents. For example, no particular bus company was targeted for the private bus category; similarly, no particular class of two-wheelers / four-wheelers was targeted for the private vehicle category.

8. Data Collection

8.1. Primary Data – Commuter Survey

The structured questionnaire was discussed with BMTC and was revised to incorporate the suggested changes. This questionnaire was then tested by conducting a pilot survey at select locations (ITPL and Goraguntepalya). The pilot survey revealed that it was difficult to capture the travel cost per trip for private vehicle users (cars and two-wheelers). So, the travel cost for cars and two-wheelers was calculated based on the travel distance and fuel cost.

The survey was carried out at 8 locations from February 20, 2018 to March 2, 2018 on regular working days, covering around 6,400 samples. The respondents included ordinary BMTC bus

[3] https://opendatakit.org/

users, private bus users, cab users, Tempo Traveller users and private vehicle (cars, autos and two-wheelers) users.

The locations and directions at which the samples were to be collected were finalised based on discussions held with BMTC, and the survey was conducted using ODK. Specially trained field investigators and enumerators under the close guidance of supervisory staff were utilised for this purpose. The data thus collected was compiled and subjected to thorough verification and analysis. The data from the primary survey was extracted in MS Excel format. This data was then checked for completeness, invalid samples and data entry errors and considered for analysis.

8.1.1. Data Digitisation

Data digitisation consisted of plotting the origin and destination of respondents based on landmarks and locations collected during the survey. To achieve this, the GIS location (latitude and longitude) of the respondent is required. This is accomplished by a Python script, which fetches the passenger's landmark from the collected data set and uses the Google Maps Application Programming Interface (API) to get the required GIS information.

8.2. Data Analysis

8.2.1. Socio-Economic Profile of Respondents

The data collected through the survey showed that 65% of respondents were male and 35% were female (Figure 4). 55% of the respondents belonged to the age group of 19 to 30 years (Figure 5).

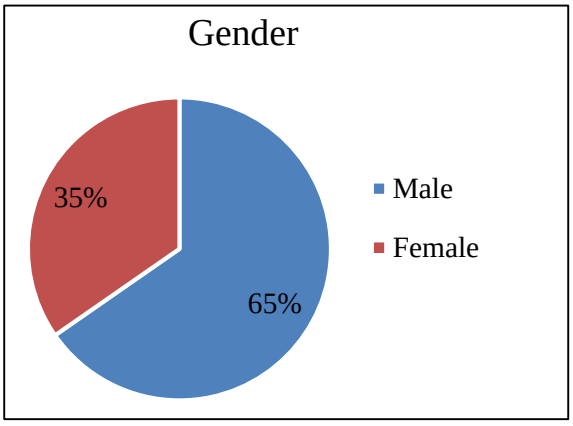

Figure 4: Gender of respondents

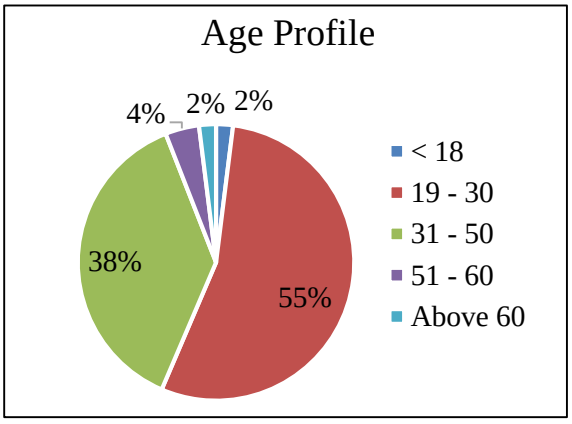

Figure 5: Age profile of respondents

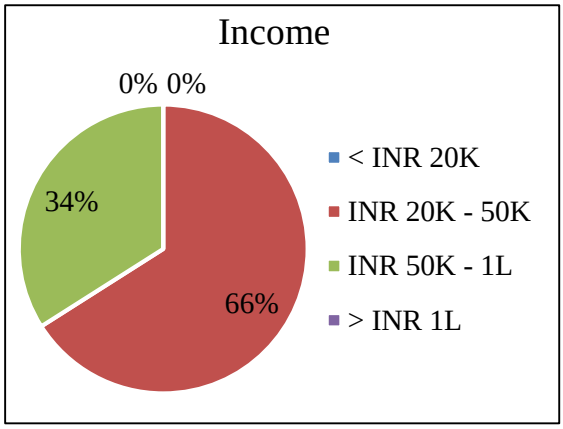

Figure 6: Income profile of respondents

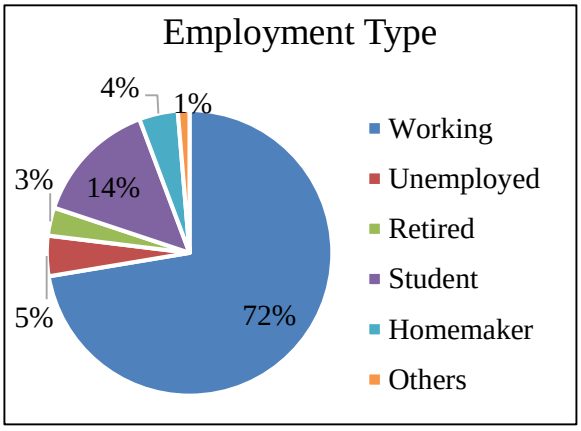

Figure 7: Employment profile of respondents

66% of the respondents (Figure 6) had a monthly HH income in the range of INR 20,000–50,000. 72% of the respondents were in the working group (Figure 7).

8.2.2. Purpose and Frequency of Travel

Of the total trips, 72% were work trips, while 15% were educational (Figure 8). In terms of frequency (Figure 9), a majority of the trips were daily trips (81%).

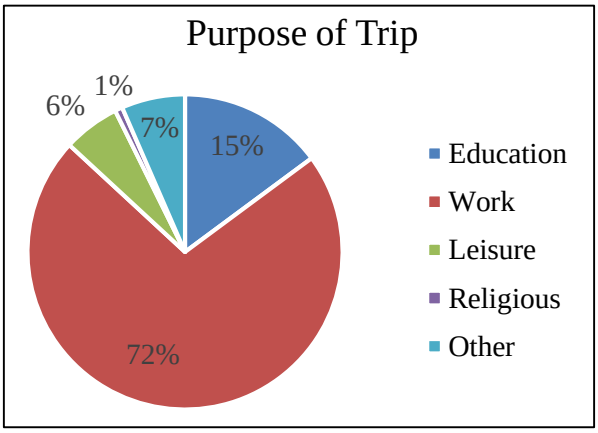

Figure 8: Purpose of Travel

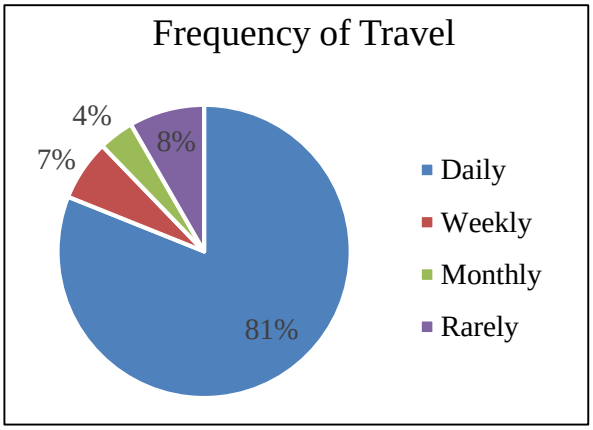

Figure 9: Frequency of Travel

8.2.3. Travel Pattern of Respondents

The commuter survey was conducted at major interchange locations in the city. Hence, the trip captured for each respondent is divided into two parts: from the origin to the survey location (origin trip) and from the survey location to the destination (destination trip). These trips were then plotted for further analysis. All the origins and destinations of the survey respondents were assigned to the corresponding wards and plotted to understand the travel patterns of the

respondents. Figure 10 represents the survey location, ward boundary and number, trips from the origin to the survey location and trips from the survey location to the destination. This desire line[4] diagram served as an input for understanding the direction of travel at the major survey locations.

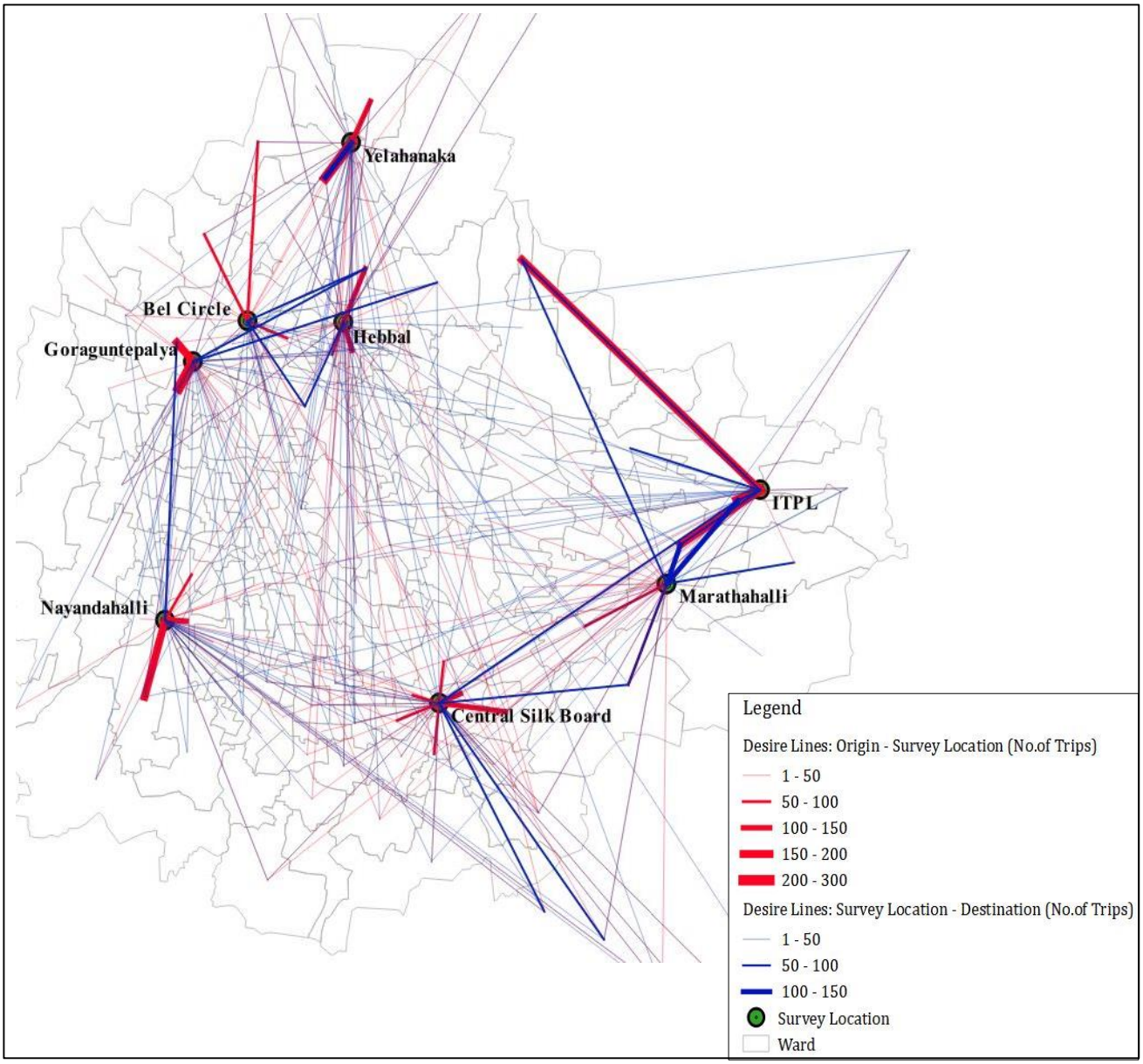

Figure 10: Origin – destination desire lines: All locations

[4] Desire line diagram connects two points (origin and destination) with straight lines; the thickness of the lines is typically proportional to the number of trips between the points.

Figure 11 shows origin trips (red lines) and destination trips (blue lines), to and from the survey location. The total number of trips (origin and destination) is over 50. The highest number of trips are from Rajarajeshwari Nagar to Nayandahalli Junction, HMT to Goraguntepalya, Yelahanka Satellite Town to Yelahanka Junction, Yelahanka Old Town to Yelahanka Junction and Amrutahalli to Hebbal.

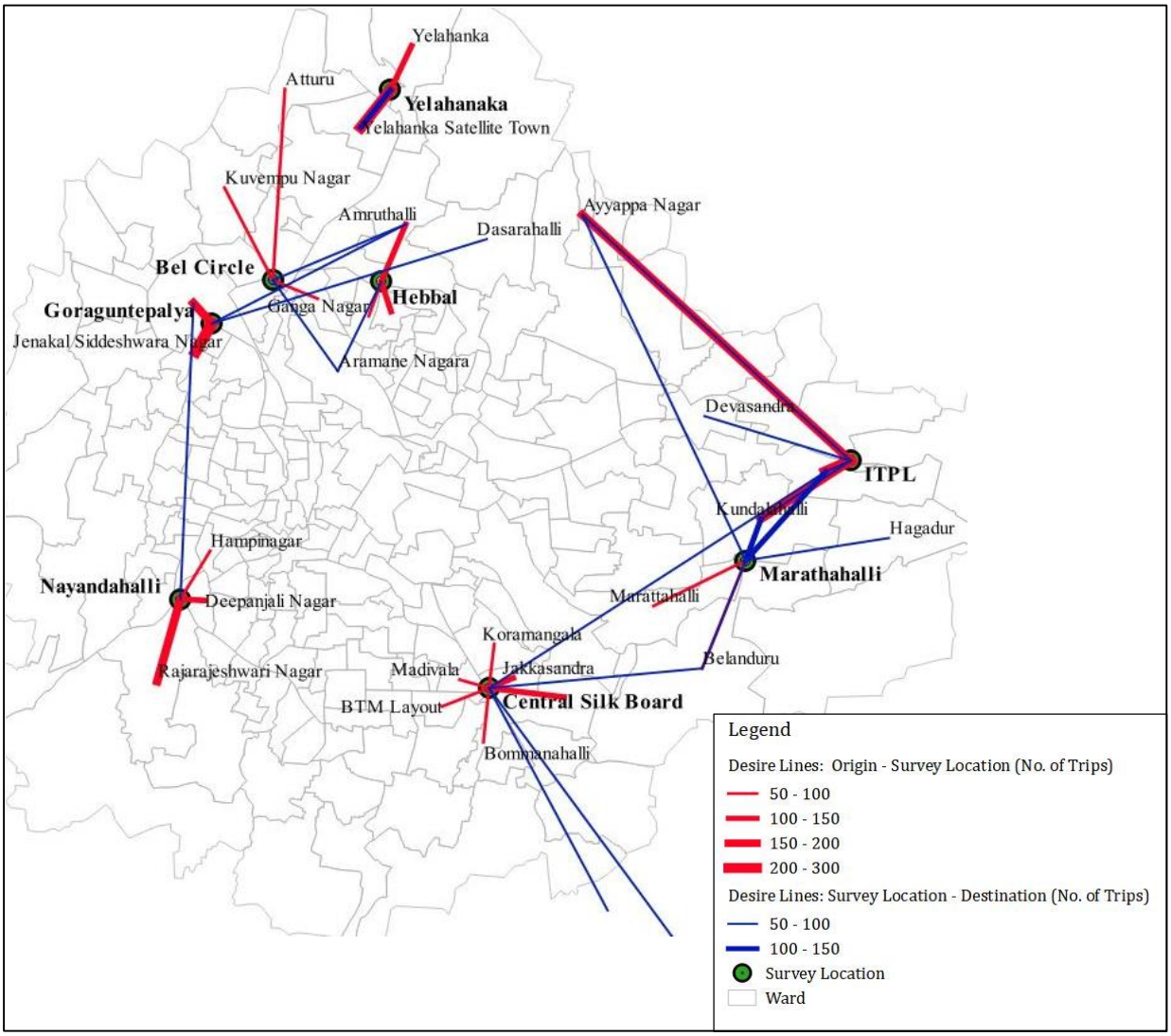

Figure 11: Origin – destination desire lines: Maximum trips

Table 2 shows the average trip characteristics (trip length, travel time and travel cost) for each mode. The average trip length was approximately 15 km and the average travel time was approximately 45 minutes, considering all modes. The average travel costs for cab and auto are very high.

Table 2: Average trip characteristics

Mode	Average Trip Length (km)	Average Travel Time (Min)	Average Travel Cost (INR)
BMTC Ordinary Buses	15.09	54	23
Private Bus / Tempo Traveller	13.25	44	24
Cab/Taxi	15.37	44	184
Auto	13.63	42	180
Private Car	17.03	48	68
Two-Wheeler	16.21	47	32

8.2.4. Relationship between Mode of Transport and Distance

Figure 12 shows the mode-wise trip length distribution. On an average, 45%–50% trips by all the modes are within a distance of 10–20 km.

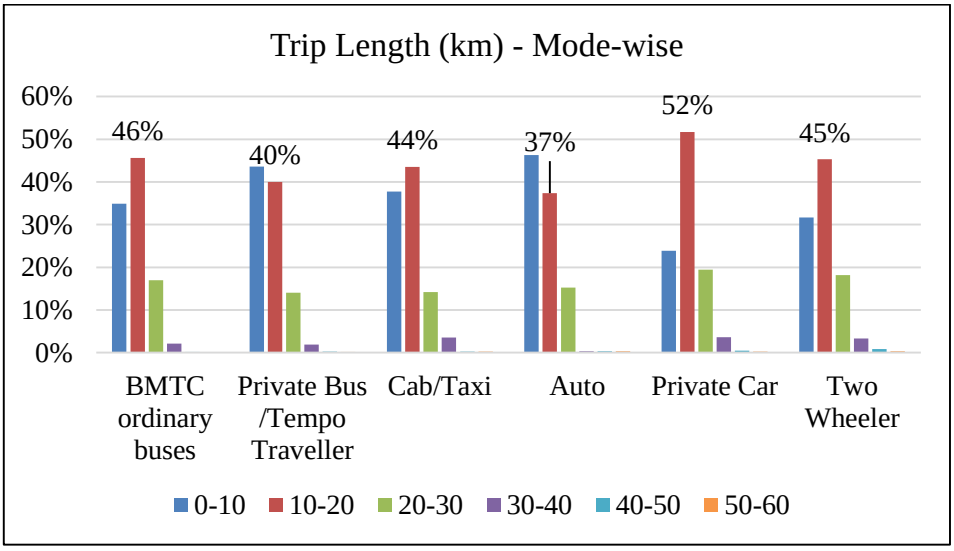

Figure 12: Relationship between mode of transport and distance

9. Findings and Discussion

Results of the detailed analysis are described in this section.

9.1. Willingness to Shift to AC Bus Services

In this study, the discrete choice model (DCM) was used to estimate the probability of shift from commuters' current mode of transport to AC bus services. The socio-economic data, travel characteristics data and willingness to shift to AC bus from current modes of transport (captured during the survey) served as inputs for the DCM. A detailed explanation of the DCM is given in Annexure IV.

To understand this shift, a multinomial logit discrete choice model (Koppelman and Bhat 2006) was developed using Biogeme[5] (Bierlaire 2017), considering the revealed preference[6] (RP) and stated preference[7] (SP) survey data (collected from the survey). The current mode of transport was considered from the RP data, and the preferred mode of transport was considered from the SP data. The probability of shift was calculated for two different scenarios.

Two scenarios based on travel cost were designed to understand the respondents' preferences. Details of the scenarios are given in Table 3.

Table 3: Scenario details

Scenarios	Travel Cost	Frequency
Scenario 1	Equivalent to existing AC bus fare	15 minutes
Scenario 2	20% reduction in existing AC bus fare	15 minutes

The expected willingness to shift to AC bus services from current modes of travel is shown in Table 4. Under both scenarios and for all locations, about 25% of the commuters are expected to shift to AC bus services. From Table 4, the maximum shift is expected from ITPL, BEL Circle, Nayandahalli and Marathahalli Bridge.

5 Biogeme is an open-source software product used to estimate discrete choice models.
6 Revealed preference survey: In this study, the RP survey captures the respondents' current mode of transport, that is, bus (ordinary or private bus), car, two-wheelers, auto and cab/taxi.
7 Stated preference survey: In this study, the SP survey captures the survey respondents' preferred mode of transport, between a given proposed mode of transport (AC bus) and their current mode of transport.

Table 4: Location-wise willingness to shift to AC bus service

Survey Location	Scenario 1	Scenario 2
BEL Circle	26%	27%
Central Silk Board	24%	24%
Goraguntepalya	23%	23%
Hebbal	24%	24%
ITPL	27%	27%
Marathahalli Bridge	26%	26%
Nayandahalli	25%	26%
Yelahanka NES	21%	22%

Table 5 represents the location-wise mode share with and without AC bus services under Scenario 1. The current mode share in Table 5 is a representative combined mode share of all survey locations. For example, at BEL Circle, the current mode share without introduction of AC bus services was 13% for car, 25% for two-wheeler, 13% for auto, 6% for cab, 19% for private bus and 25% for ordinary bus. The modal shift observed at this location was 4% from car, 7% from two-wheelers, 8% from auto, 4% from cabs, 1% from private bus and 2% from ordinary bus, thus arriving at a total modal share of 26% for AC bus services.

The maximum shift was observed from autos—a total of 8%. Two-wheeler commuters starting from locations such as ITPL, BEL Circle and Marathahalli Bridge show a high probability of shifting to new AC buses.

Table 5: Location-wise SP mode share: Scenario 1

Survey Location	Car	TW	Auto	Cab	Private Bus	Ordinary Bus	AC Bus
BEL Circle	9%	17%	5%	2%	18%	23%	26%
Central Silk Board	9%	19%	4%	2%	20%	22%	24%
Goraguntepalya	10%	17%	4%	2%	19%	26%	23%
Hebbal	9%	20%	5%	2%	18%	22%	24%
ITPL	9%	17%	5%	2%	17%	23%	27%
Marathahalli Bridge	10%	17%	4%	2%	18%	23%	26%
Nayandahalli	9%	17%	4%	2%	19%	24%	25%
Yelahanka NES	10%	19%	4%	2%	18%	26%	21%
Current Mode Share	13%	25%	13%	6%	19%	25%	0%
Average Estimated Mode Share	10%	18%	5%	2%	19%	24%	25%

Table 6 represents the location-wise mode share when AC bus services were introduced under Scenario 2. The maximum shift (from 13% to 4%) was observed from autos. The second highest shift was observed from two-wheelers (from 25% to 18%). Two-wheeler and auto commuters starting from locations such as ITPL, BEL Circle, Marathahalli Bridge and Nayandahalli show a high probability of shifting to new AC buses.

Table 6: Location-wise SP mode share: Scenario 2

Survey Location	Car	TW	Auto	Cab	Private Bus	Ordinary Bus	AC Bus
BEL Circle	10%	17%	5%	2%	17%	23%	26%
Central Silk Board	9%	19%	4%	2%	20%	22%	24%
Goraguntepalya	9%	17%	4%	2%	19%	26%	23%
Hebbal	10%	20%	4%	2%	18%	22%	24%
ITPL	9%	17%	5%	2%	17%	23%	27%
Marathahalli Bridge	10%	17%	4%	2%	18%	23%	26%
Nayandahalli	9%	17%	4%	2%	19%	23%	26%
Yelahanka NES	10%	19%	4%	1%	18%	26%	22%
Current Mode Share	13%	25%	13%	6%	19%	25%	0%
Average Estimated Mode Share	10%	18%	4%	2%	18%	24%	25%

The following observations were made from the study:

- 25% of the respondents were willing to shift to AC bus services from their current mode of transport.
- Of the 8 locations surveyed, the maximum willingness to shift was observed from ITPL, BEL Circle, Marathahalli Bridge and Nayandahalli.
- The majority of the shift to AC bus services was from commuters using autos and two-wheelers.
- There was minimal shift from ordinary buses and private buses.

9.2. Potential Direction for AC Bus Services

Based on the DCM results and desire line diagram, the following locations were identified as feasible for introducing new AC bus services:

- ITPL
- BEL Circle
- Hebbal
- Marathahalli
- Nayandahalli

ITPL and Marathahalli, which are well connected with BMTC AC bus routes, are not considered for further analysis. Wards that have the highest demand (attract and generate the most trips) were identified around each survey location to determine the feasible direction for operating AC bus services. The location-wise potential direction of travel for BEL Circle and Yelahanka are represented in Figure 13 and Figure 14.

The number of trips originating from and terminating at each ward was identified for Hebbal, as shown in Figure 13. Most of the trips originate at close proximity to the survey location, as well as in Yelahanka. The feasible direction of service for Hebbal could be towards the north, because a significant number of trips are observed from Yelahanka and Yelahanka Satellite Town.

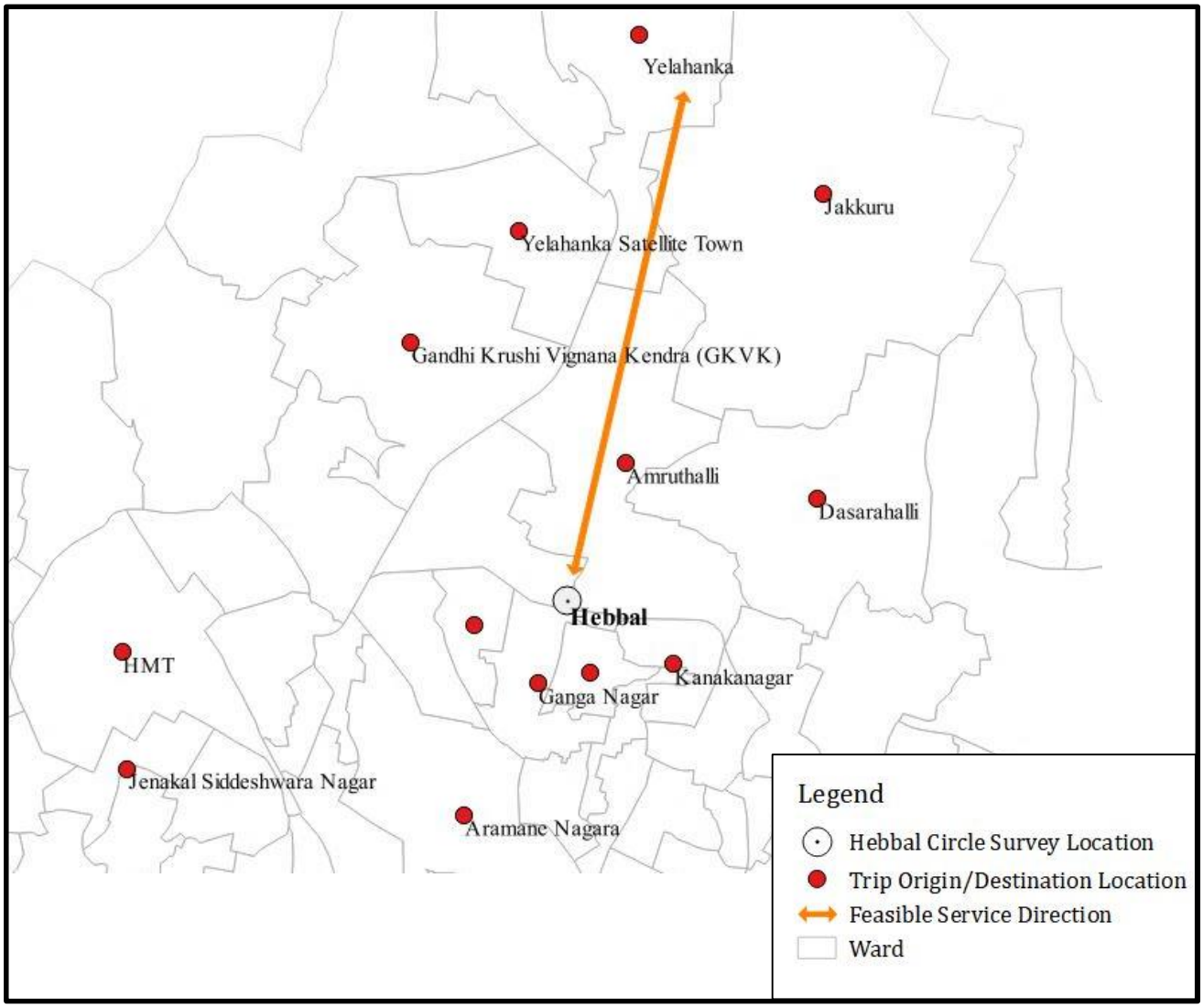

Figure 13: Feasible direction of new AC bus service, Hebbal

The number of trips originating from, and terminating at, each ward were also identified for BEL Circle, as shown in Figure 14. Most of the trips originate around Yelahanka. The feasible direction of AC bus services for BEL Circle could be towards Yelahanka via Kuvempu Nagar and Atturu.

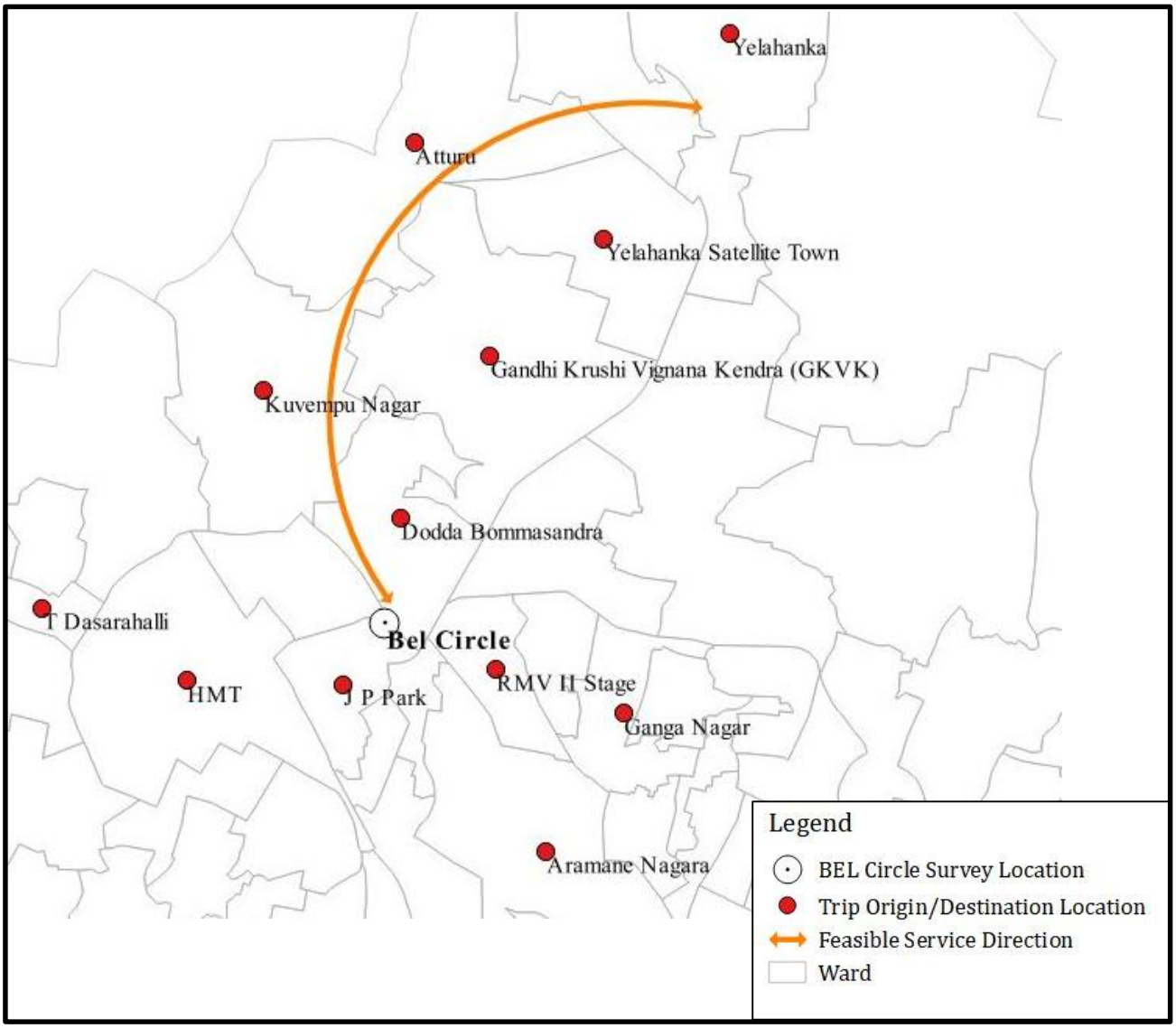

Figure 14: Feasible direction of new AC bus service, BEL Circle

The survey analysis reveals that several trips are originating and terminating at Amruthahalli. Hence further analysis of Amruthahalli was carried out. Figure 15 below shows trips terminating at Amruthahalli have their origins at Yelahanka, Yelahanka Satellite Town, HMT and Jenakal Siddeshwara Nagar. Similarly, Figure 16 shows trips originating at Amruthahalli have their destinations at Yelahanka, Yelahanka Satellite Town, HMT and Aramane Nagar. Hence the

feasible route for BMTC could be Yelahanka – Yelahanka Satellite town – Amruthahalli – Hebbal – BEL circle – HMT (~15km).

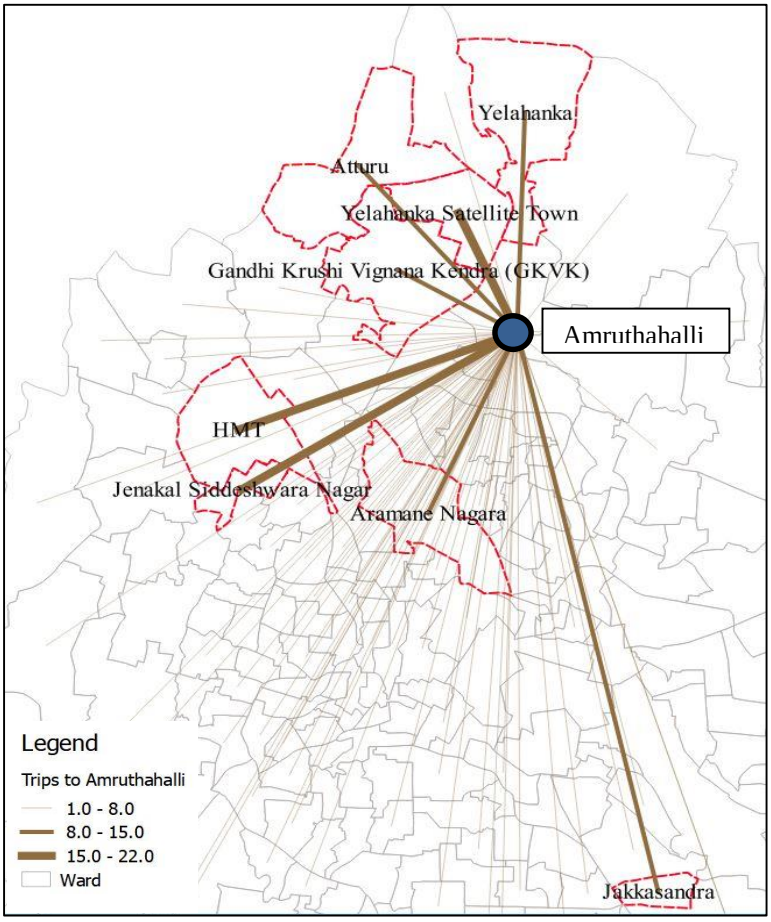

Figure 15: Trips terminating at Amruthahalli

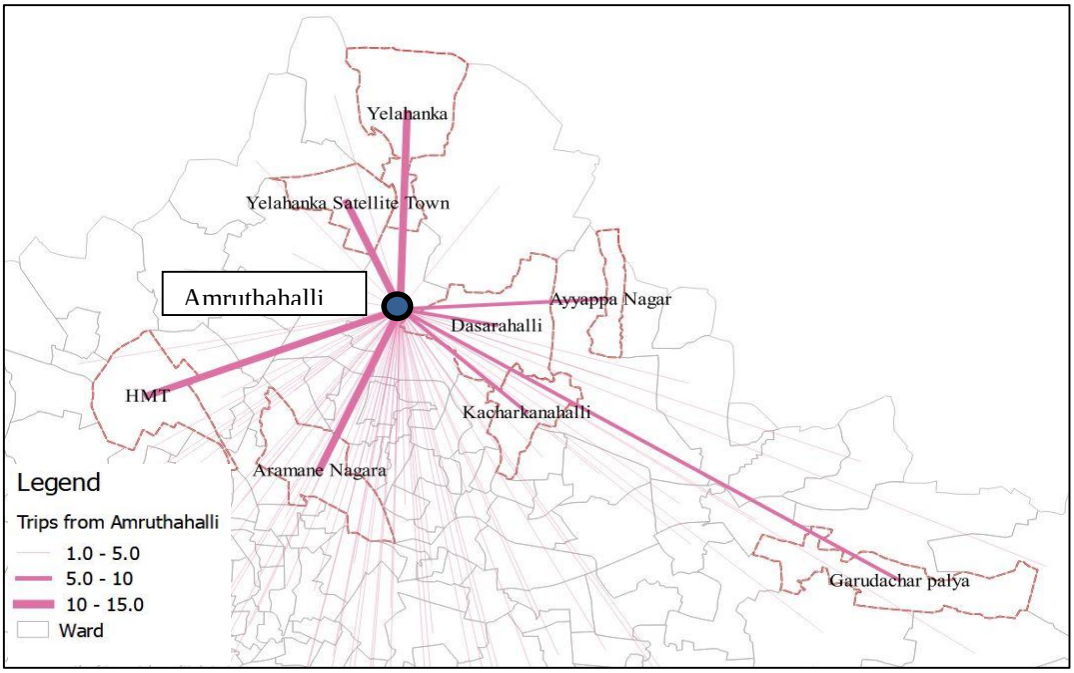

Figure 16: Trips originating at Amruthahalli

10. Conclusion

In this study, commuter survey was conducted at eight major junctions in Bengaluru. The survey captured socio-economic characteristics and trip characteristics of private vehicle users (TW and car), bus users (ordinary and private) and intermediate public transport (IPT) users (auto and cab). The survey determined users' willingness to shift to AC bus under two different scenarios (with varying travel cost). DCM was used to analyse the location-wise probability of shift from respondents' current mode of transport to AC bus. Wards with the highest demand (that attract and generate the most trips) were studied to identify the routes and direction for the new AC bus services.

The study determined that commuters using IPT (auto) and two-wheelers display the greatest willingness to shift to AC buses, both at the current ticket rates and after a 20% fare reduction. On the other hand, commuters who use private buses or non-AC BMTC buses are not willing to shift to AC buses, even after 20% fare reduction.

11. Recommendations

A trial AC bus service can be operated in the directions suggested from the analysis. This will help understand the actual demand for such services. This study can serve as a basis to identify potential areas and routes to introduce AC bus services.

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Annexure I

Sample Size Calculation

The minimum sample size required for an infinite population will be as follows (Sarmah and Hazarika 2012);

$$n_0 = \frac{Z^2 \times p(1-p)}{e^2}$$

Where

n_0 = Sample Size

Z = Z Score Value

e = Margin of Error

p = Prior Judgment of the Correct Value (Probability)

Taking a confidence level of 95% with a margin of error of $\pm$ 5%, probability of 50% and Z Score value of 1.96, the required sample size will be

$$n_0 = \frac{(1.96)^2 \times (0.5)(1-0.5)}{(0.05)^2}$$

$$= \sim 384$$

Taking the confidence level as 99% with a margin of error of $\pm$ 5%, probability of 50% and Z Score value of 2.58, the required sample size will be

$$n_0 = \frac{(2.58)^2 \times (0.5)(1-0.5)}{(0.05)^2}$$

$$= 665.64$$

$$= \sim 666$$

Annexure II

Data Collection Template

Route No.	Origin	Destination	No. of Schedules

Annexure III

Commuter Survey

(At specific locations)

Purpose: To determine the willingness of passengers to shift to AC bus services

Do you use AC bus services? Yes/No

Survey Location: Direction: _____ Date & Time:

Name _____ Phone Number _____

Passenger Information

Gender	Male	Female

Age group	Less than 18 years	19–30 years	31–50 years	51–60 years	Above 60 years

1. Employment type
   a) Working
   b) Unemployed
   c) Retired
   d) Student
   e) Homemaker
   f) Others

Monthly household income:	Less than INR 20,000	INR 20,000–50,000	INR 50,000 – 1,00,000	More than INR 1,00,000

Travel Information

2. What is the mode of travel?

BMTC Ordinary Buses (Route No. . . .)	Private Bus / Tempo Traveller	Cab/Taxi _____	Auto	Private Car	TW	Others _____

3.

Origin: landmark and PIN code	Destination: landmark and PIN code
Boarding point (bus users)	Alighting point (bus users)

4. Purpose of travel:

Education	Work	Leisure	Religious	Other

5. How often do you make this trip?

Daily	Weekly	Monthly

6. i) Total travel time (including waiting time; in minutes):
_____

ii) Total travel distance (km):
_____

iii) Total travel cost (INR):
_____

7. What is your preferred boarding time?
i) Onward Journey _____
ii) Return Journey _____

Willingness to Shift

8. What will encourage you to use AC bus service?

Scenario	Current Mode Travel Time	Current Mode Travel Cost	AC Bus Travel Time	AC Bus Travel Cost	Your Response	
					Current Mode	AC Bus
1	---	----	IVTT+15+10	X_1		
2	---	----	IVTT+15+10	X_2		

IVTT: In-Vehicle Travel Time
15 min – Frequency of AC bus
10 min – Waiting time at the bus stop
Suggestion: _____

Annexure IV

Discrete Choice Model

The study developed a multinomial logit model (MNL) to understand commuters' willingness to shift to AC bus services from their current modes of transport, based on their SP and RP survey (commuter survey). The socio-economic data, travel characteristics data and willingness to shift (captured in the survey) served as inputs to the model.

The general expression for the probability of choosing an alternative 'i' (i = 1, 2, … j) from a set of j alternatives is:

$$P_r(i) = \frac{exp\ (V_i)}{\sum_{j=1}^{J} exp\ (V_j)}$$

Where,

P_r (i) is the probability of the decision-maker choosing the alternative i, and V_j is the deterministic utility function of the alternative j, which is generally represented by:

$$V(X_i) = \gamma_1 \times X_{i1} + \gamma_2 \times X_{i2} + \cdots \ldots \ldots \gamma_k \times X_{ik} + ASC$$

Where,

γ_k is the parameter that defines the direction and importance of the effect of the attribute k on the utility of an alternative,

X_{ik} is the value of the attribute k for the alternative i, and

ASC is the alternative specific constant (error term which is unobserved and unmeasured).

The respondents were given two scenarios and asked to choose between the given mode (AC bus) and their current mode of access. The scenarios based on travel cost (considered for the study) are shown in Table 3.

Travel time for the proposed AC bus was considered based on in-vehicle time and out-vehicle time. The in-vehicle time was estimated by dividing the distance between respondents' origin and destination by the average journey speed in Bengaluru, that is, 15 kmph (Urban Mass Transit Company Limited 2011). The out-vehicle time was estimated considering walking time of five minutes (Diyanah, Hafazah, and Mohd Zamreen 2012) to reach the bus stop and the waiting time at the bus stop (based on the frequency of buses).

Travel time and travel cost for car, two-wheelers, auto, cab, private bus and ordinary bus were also calculated based on the in-vehicle travel time stated above. Travel costs for two-wheelers and cars were based on the fuel price and mileage of the respective modes. For auto, the fare was calculated by considering a minimum charge of INR 25 for the first 2 km and INR 13 for each additional km (travel2karnataka 2017). For cab and private bus, average fare per km was calculated based on the travel cost determined from the RP survey. For bus, fare was considered from the BMTC stage-wise fare data (BMTC 2018b).

Model Structure

Utility of a mode is defined in terms of mode attributes such as travel time and travel cost as well as socio-economic characteristics (Raturi and Verma 2017). The multinomial logit model was developed by considering the current mode of travel and BMTC AC bus.

The utility function for each alternative in RP and SP is given in Equations 1 and 2 respectively. Utility equations corresponding to SP are multiplied with a parameter λ, an unknown parameter to reflect the impact of unobserved factors that are necessarily different in real-choice situations than in hypothetical survey situations (Train 2002). The explanatory variables considered are alternative specific constant (ASC), travel cost (Cost), travel time (Time) and household income (Income). Two-wheelers were considered as the base or reference alternative, so the ASC of two-wheelers was fixed at zero.

$$U_j^{RP} = ASC_j^{RP} + \beta_1 \times Time_j + \beta_2 \times Cost_j + \beta_{3j} \times Household\ Income \quad (1)$$

$$U_j^{SP} = (ASC_j^{SP} + \beta_1 \times Time_j + \beta_2 \times Cost_j + \beta_{3j} \times Househole\ Income)\lambda \quad (2)$$

Estimated Parameters

The model considered data from 19,720 responses [considered only respondents who had responded to RP (6,574 responses) and both scenarios under SP (13,146 responses)]. The contribution of each attribute to the utility of an alternative is indicated by the sign of its coefficients. A positive value indicates a direct correlation with the utility, and a negative value indicates an inverse correlation (Bajracharya 2008). Negative signs of travel time and travel cost indicate that higher the travel time and cost, lower is the probability of choosing that alternative.

Table 7: Estimated parameters from MNL model

Name	Value	Std. Error	t-test	p-value
ASC_AC_SP	3.16	0.14	22.61	0
ASC_AUTO_RP	0	fixed		
ASC_AUTO_SP	0	fixed		
ASC_BUS_RP	1.06	0.0855	12.42	0
ASC_BUS_SP	2.34	0.134	17.43	0
ASC_CAB_RP	-2.29	0.136	-16.77	0
ASC_CAB_SP	-2.46	0.161	-15.28	0
ASC_CAR_RP	-0.994	0.0928	-10.7	0
ASC_CAR_SP	-0.0126	0.101	-0.13	0.9
ASC_PB_RP	0.816	0.0875	9.33	0
ASC_PB_SP	2.06	0.127	16.27	0
ASC_TW_RP	-0.109	0.0857	-1.27	0.21
ASC_TW_SP	0.872	0.111	7.87	0
B_COST	-0.113	0.03	-3.76	0
B_INCOME_BUS	-0.125	0.0119	-10.55	0
B_INCOME_CAB	0.17	0.0207	8.23	0
B_INCOME_CAR	0.0527	0.0132	3.98	0
B_INCOME_PB	-0.122	0.0126	-9.68	0
B_INCOME_TW	-0.0437	0.0117	-3.74	0
B_TIME	-4.61	0.155	-29.77	0
LAMBDA	0.884	0.0366	24.15	0

Initiative 3: Impact of Cab Aggregators on Vayu Vajra Services

Initiative 3: Impact of Cab Aggregators on Vayu Vajra Services

Abbreviations and Acronyms

Abbreviations	Full Form
BMTC	Bengaluru Metropolitan Transport Corporation
CSTEP	Center for Study of Science, Technology and Policy
GoK	Government of Karnataka
IPT	Intermediate Public Transport
KEA	Karnataka Evaluation Authority
KIA	Kempegowda International Airport
KSRTC	Karnataka State Road Transport Authority
KSTDC	Karnataka State Tourism Development Corporation
SRS	Simple Random Sampling

Executive Summary

Bengaluru is one of the fastest growing metropolitan cities in India. With rapid urbanisation and population growth, the city experiences a significant demand for infrastructure in different sectors, including transportation.

Bengaluru's new international airport commenced operations in 2008. This airport is well connected to the city by taxi services, app-based cab aggregators and BMTC airport bus services.

BMTC started the airport bus service (Vayu Vajra)[1] in 2008. This is a dedicated AC bus service which connects the city to the airport. However, the introduction of app-based taxi services, at the airport, has impacted BMTC Vayu Vajra bus ridership. In this context, Government of Karnataka has engaged Center for Study of Science, Technology and Policy (CSTEP) as a technical research institution, to assess the impact of cab aggregators on BMTC's Vayu Vajra service.

This study aims to identify the primary reason for this shift from Vayu Vajra to cab services and to identify the impacted Vayu Vajra routes. For this assessment, an airport passenger opinion survey was conducted at Bengaluru International Airport (KIA), collecting responses from 800 commuters of which 70% were BMTC airport bus users. Major reasons for shift from Vayu Vajra bus services to cab aggregators were lack of luggage space, expensiveness compared to cabs and poor first and last mile connectivity. The study also identified the impacted routes based on the responses. Routes which were affected include KIAS 10, KIAS 5, KIAS 8, KIAS 12 and KIAS 7.

To improve Vayu Vajra bus ridership, BMTC needs to provide dedicated luggage space, promote a group discount scheme as opposed to an individual discount scheme in the range of 10-15% and address issues of first and last mile connectivity. Additionally, the survey also revealed respondents opinion about their suggestions for Vayu Vajra service. BMTC needs to provide real time passenger information systems at major exit points of the airport and signage leading to the bus bays. Within the city limits, there is a need for dedicated Vayu Vajra bus stop signs.

[1] The Terms 'Vayu Vajra'and 'BMTC airport buses' have been used interchangeably in this report.

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1. Introduction

BMTC started a premium AC bus service (Vayu Vajra), in 2008, which connects different parts of the city with Bengaluru International Airport (KIA) (Bangalore Mirror 2008). BMTC operates 11-Vayu Vajra bus routes with more than 250 trips per day catering ~10,000 commuters.

However, the introduction of app-based cab aggregators at the airport has impacted BMTC Vayu Vajra bus ridership. This study assess the impact of cab aggregators on Vayu Vajra services, specifically reasons for shift, socio-economic profile and travel characteristics of commuters who shifted from Vayu Vajra services to cabs.

2. Log Frame/Theory of Change/Program Theory

This study aims to assess the impact of cab aggregators on Vayu Vajra bus services. This involves a survey at the airport to understand the socio-economic and trip characteristics of airport commuters. The responses were collected from cab users of which 70% were previous BMTC bus users and 30% used other modes of transport. The reasons for shift from BMTC bus to cab were analysed in this study. Also the impacted BMTC airport bus routes were identified.

	Intervention Logic	Verifiable Indicators of Achievement	Sources and Means of Verification	Assumptions
Overall Objectives	*What are the overall broader objectives to which the activity will contribute?* • Assessing impact of cab aggregators on BMTC's Vayu Vajra service	*What are the key indicators related to the overall objectives?* • Impacted Vayu Vajra routes	*What are the sources of information for these indicators?* • Passenger Opinion Survey of cab users at KIA	
Specific Objectives	*What specific objectives is the activity intended to achieve to contribute to the overall objectives?* • To identify commuters' reasons to shift from Vayu Vajra to cab • To identify most impacted Vayu Vajra routes	*Which indicators clearly show that the objective of the activity has been achieved?* • Commuters' response on reason to shift to cab • Vayu Vajra routes (maximum number of respondents shifting)	*What are the sources of information that exist or can be collected? What are the methods required to get this information?* • Airport Passenger Opinion Survey of cab users at KIA	*Which factors and conditions outside the PI's responsibility are necessary to achieve that objective? (external conditions)* *Which risks should be taken into consideration?* • Willingness of competent authority to permit the survey
Expected results	*The results are the outputs envisaged to achieve the specific objective.* *What are the expected results? (enumerate them)* • Major reason for the shift from Vayu Vajra to cabs	*What are the indicators to measure whether and to what extent the activity achieves the expected results?*	*What are the sources of information for these indicators?*	*What external conditions must be met to obtain the expected results on schedule?*

	• Most impacted Vayu Vajra routes due to this shift.			
Activities	*What are the key activities to be carried out and in what sequence in order to produce the expected results?* *(group the activities by result)* 1. Primary Survey - Passenger Opinion Survey of cab users at KIA 2. Identifying the reasons for shift from Vayu Vajra to cab 3. Identifying impacted routes due to this shift	***Means:*** *What are the means required to implement these activities, e. g. personnel, training, studies, etc.* • Urban planning experts • Transport planning experts • Training for conducting passenger opinion survey	*What are the sources of information about action progress?*	*What pre-conditions are required before the action starts?* • Permission by competent authorities to conduct the survey

3. Problem Statement

To assess the impact of cab aggregators on BMTC's Vayu Vajra services

4. Objectives and Issues for Evaluation

Objectives:

- To identify the major reason for the shift from Vayu Vajra to cab aggregators
- To identify the impacted Vayu Vajra routes

Scope:

Target Population: The target population for this study is the passengers at KIA who use cabs for city-airport commute.

Geographical Coverage: Vayu Vajra service coverage area

5. Evaluation Design

5.1. Information Sources

Primary Survey: Airport Passenger Opinion Survey

Airport passenger opinion survey was conducted at KIA. The survey captured the socio-economic data, trip characteristics and the reasons for shift from BMTC airport bus to cabs through a questionnaire (Annexure I).

6. Evaluation Methodology

The details of the steps followed in the methodology have been discussed below:

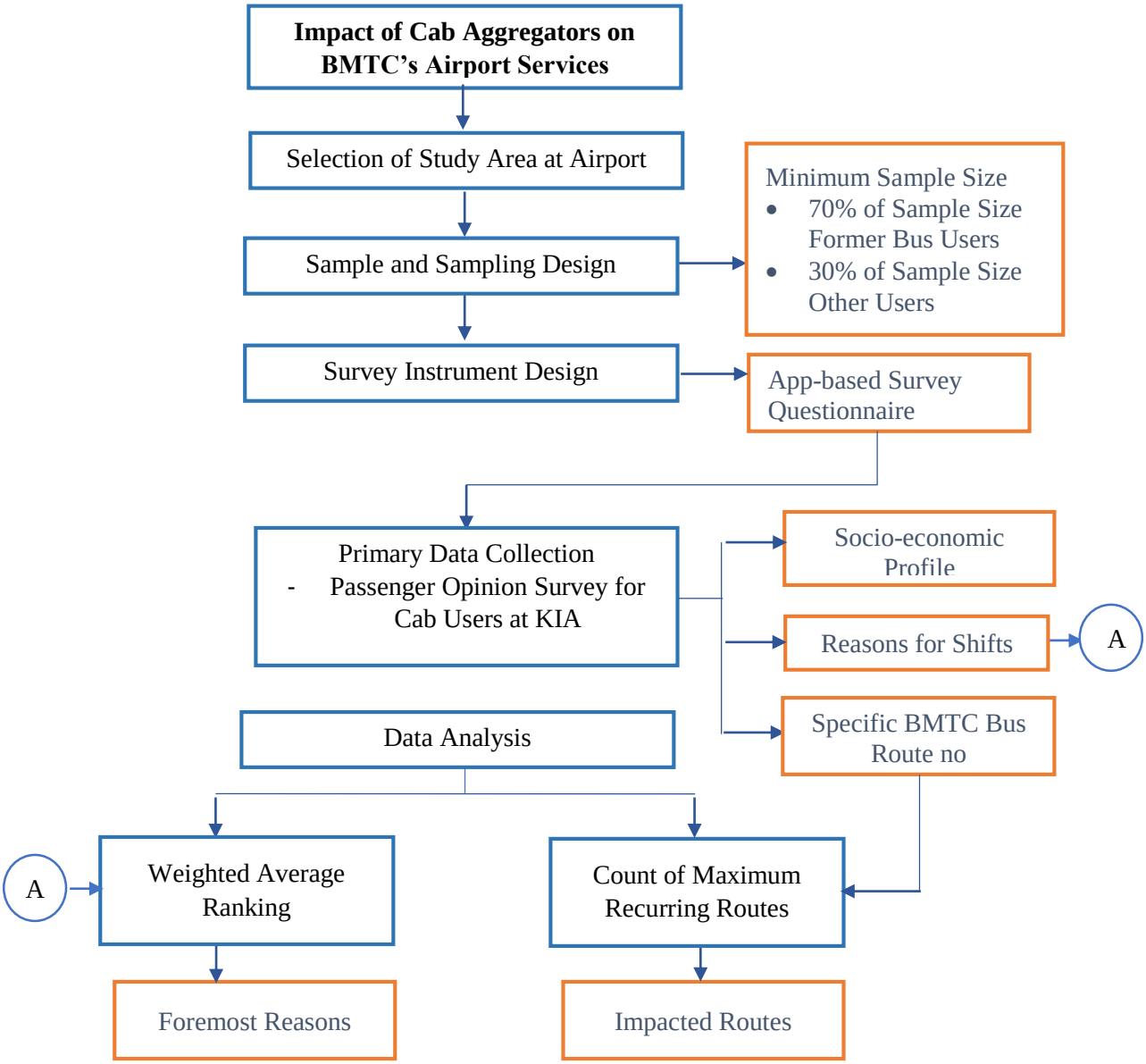

Figure 1: Process of assessing impact of cab aggregators on BMTC's Vayu Vajra service

6.1. Sample and Sampling Technique

Sample and Sampling (SRS) Design:

As mentioned in the scope of this study, the target population for this study included the cab users at KIA. As this forms a uniform set with no strata, a Simple Random Sampling (SRS) technique was used to arrive at the sample size. Formula for SRS:

$$n_1 = \frac{Z^2 \times p(1-p)}{e^2} \quad \text{Equation 1}$$

$$n_2 = \frac{N \times n_1}{N + n_1} \quad \text{Equation 1}$$

Where,

n_1= Sample Size

n_2 = Finite Population Correction

N = Total Population

Z = Z – Score (Z – Table value at 5% of level of significance)

E – Margin of Error

P – Prior Judgment of the Correct Value (Probability)

The following Table 1 shows the simple random sampling details for the Passenger Opinion Survey of Cab Users at KIA.

Table 1: Simple random sampling

Passenger Opinion Survey of Cab Users at KIA						
Population (Daily Passenger Traffic at KIA)	Confidence Level	Z value	Margin of Error - (e)	Sample Size (n1)	Finite Population Correction (n2)	Sample Size chosen
60,000	95%	1.96	0.05	384.16	382	800

The above table shows that for target population of 60,000 and 95% confidence level, 382 is the minimum sample size required. In consultation with BMTC and to ensure higher precision, this study considered a sample size of 800.

6.2. Type of Data Collected from Various Sources

Primary Survey: Airport Passenger Opinion Survey

- Socio-economic profile of commuters
- Travel pattern of commuters (origin-destination, mode of travel, frequency)
- Reasons for shifting from BMTC airport bus to cabs

6.3. Instruments for Data Collection

For the primary data collection, a structured survey questionnaire was prepared to capture the required data. The survey questionnaire is presented in Annexure I.

6.4. Protocols for Data Collection and Ethics Followed

For the primary survey, permission letters from BMTC, KIA and the Commissioner of Police, Bengaluru City were taken for conducting survey at Kempegowda International Airport. Care was taken by the survey team that traffic flow and general activities, duties of any traffic police and workers at KIA were not disrupted. The willingness of the respondents to participate in the survey was obtained before administering the survey questionnaire.

7. Data Collection and Analysis

The survey was conducted at KIA arrival area (within the airport premises), on two regular working days, covering around 800 samples. Only the cab users travelling from the airport to their respective destinations were interviewed. The survey questions were designed to identify the cab users and previous bus users, so as to capture 70% previous bus users and 30% other mode users. The survey was carried out using Open Data Kit (ODK) suite, an android based mobile app that replaces paper-based forms. Trained enumerators under the close guidance of supervisory staff were appointed for this purpose. All the data collected, was compiled and subjected to a thorough verification and analysis. The details of the samples collected are given in Table 2 below.

Table 2: Details of collected survey samples

Heading	Required	Collected
Survey Sample Size	800	841
Women Respondents	400	397
Men Respondents	400	444
Bus Users	560 (70%)	583
Women Bus Users	-	298
Men Bus Users	-	285

The data collected from the primary survey was processed in Microsoft Excel Software to remove the erroneous entries and obtain samples with the most relevant response.

7.1. Data Analysis

Detailed analysis of the data collected from the primary survey was carried out to understand the travel patterns of commuters, reasons for shifting to app-based cabs, impacted routes and their operational details and willingness of passengers to shift to the AC bus service.

7.1.1. Profile of Former Bus using Respondents

Socio-economic Profile:

The data fetched from the primary survey was filtered on the basis of gender, age, income, employment type and purpose of travel. 57% of the former bus using respondents (almost equal number of men and women) were from the age group 31–50 years. 83.5% of the respondents had monthly household incomes of INR 50,000 or above. This consisted of 55% having monthly household income between INR 50,000 and 1 lakh, and 28.5% having more than INR 1 lakh. 81% of the former bus users belonged to working class.

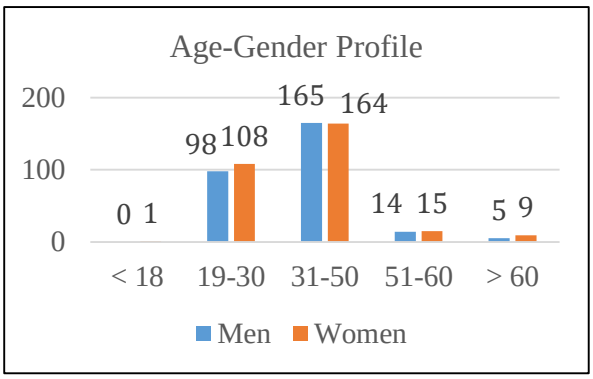

Figure 4: Age-gender profile of former bus users

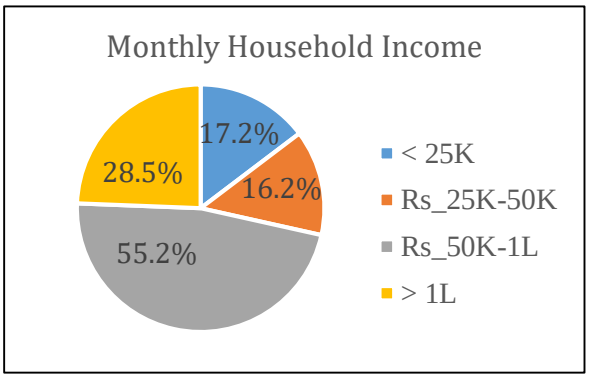

Figure 5: Monthly household income of former bus users

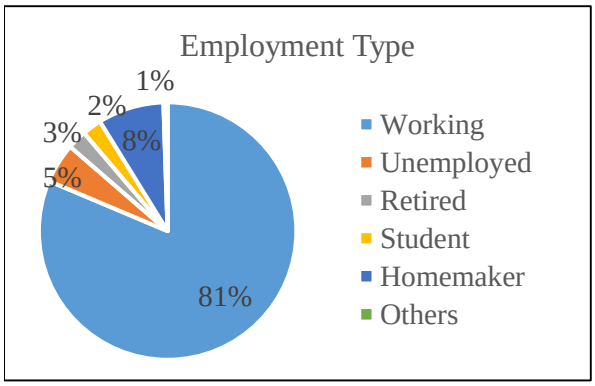

Figure 3: Employment type of former bus users

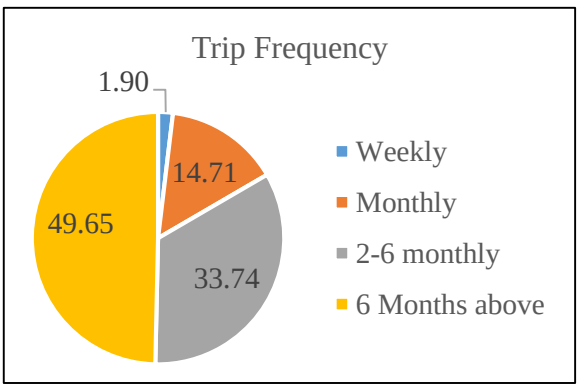

Figure 2: Frequency of travel of former bus users

Trip Character:

Almost 50% of the former bus users travelled at a frequency of only once in more than six months. All the respondents used the same route for their onward and return journey.

7.1.2. Profile of Non-BMTC Users

Socio-economic Profile:

From the non-BMTC user group, 78% belonged to the age-group 31-50 years and within this, 68% were men. 95% of these respondents were working and 76% travelled by air only once in six months. 55% of the total non-bus users had a monthly income of more than INR 1 lakh whereas 42% had within a range of INR 50,000 to 1 lakh.

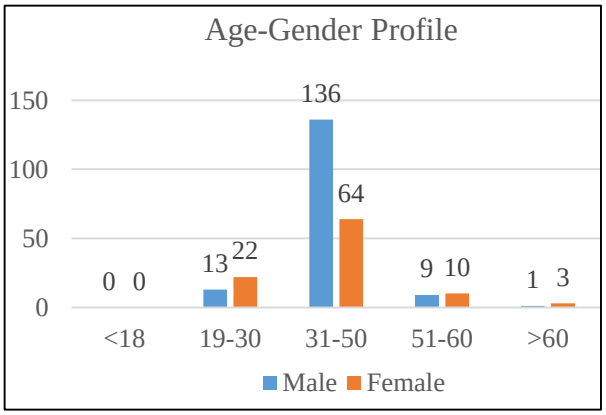

Figure 6: Age-gender profile of non-bus users

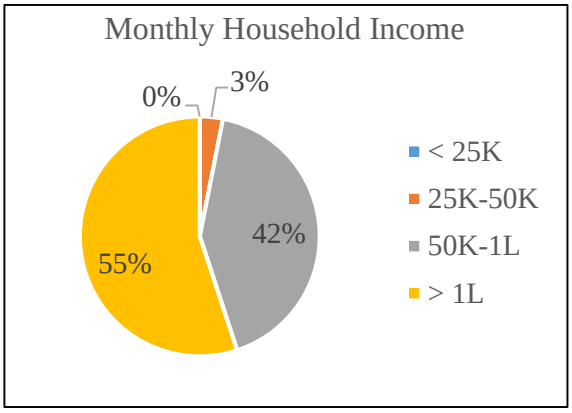

Figure 7: Monthly household income of non-bus users

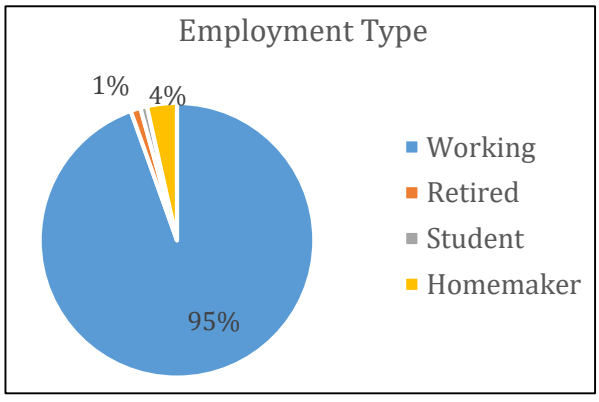

Figure 8: Employment type of non-bus users

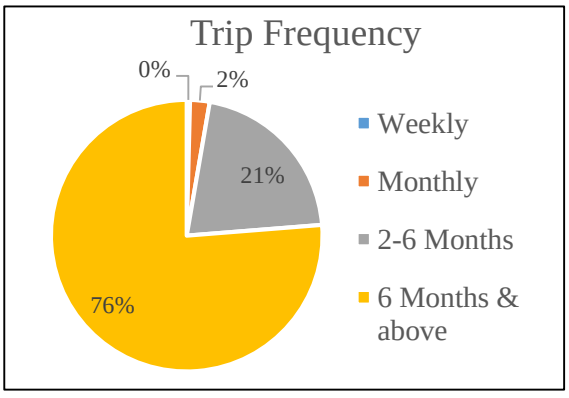

Figure 9: Frequency of travel of non-bus users

8. Findings and Discussion

The two major outputs of this survey were: 1) Reasons to shift from Vayu Vajra bus service to cab and 2) Impacted Vayu Vajra routes due to this shift.

8.1. Reasons to Shift from Vayu Vajra Bus to Cab

The respondents had to choose the reasons for shift listed in the questionnaire and rate each reason, on a scale of five. A weighted mean of all the reasons was thus calculated to understand the top priority reason for the shift from BMTC airport bus to cabs. From the analysis, it was observed that the luggage space and convenience was rated as the major reason for shift. This was followed by, Vayu Vajra bus services being more expensive compared to their current mode. Poor first and last mile connectivity also figured as a reason for shift. Table 5 below summarises the estimated weighted mean for each reason.

Table 3: Reasons for shift from Vayu Vajra to cab

Reasons for Mode shift	Weighted Mean
Luggage space and convenience	**4.307**
Expensive compared to current mode	**4.170**
Poor first / last mile connectivity	3.883
Low bus frequency / High waiting time for BMTC	3.864
Absence of direct AC bus connectivity	3.834
Travel time is more with BMTC buses	3.559
Overcrowding of BMTC Bus	3.553

This survey also captured response of commuters to shift back to Vayu Vajra bus services in the wake of proposed financial incentives- fare reduction (10-15%) and group discount (15%).Almost 96% of the total respondents (including other previous mode users) said that they might shift to Vayu Vajra service if the fare is reduced by 10-15%. Hardly any preference was given to the group discount of 15%.

8.2. Impacted Vayu Vajra Routes

From the response of the former bus users, it was found that 13% of them were travelling on KIAS 10 route. This route seems to be the most impacted among the routes from this survey. Out of the total respondents commuting on KIAS 10, 17% were travelling on the complete route.

Table 4: List of impacted routes

Route No.	Count	Percentage
KIAS 10	75	13%
KIAS 5	66	11%
KIAS 8	61	10%
KIAS 12	53	9%
KIAS 7	39	7%
KIAS 4	38	7%
KIAS 7A	36	7%
KIAS 8C	32	5%
KIAS 9	32	5%
KIAS 6	30	5%
Others	121	21%
Total	583	100%

9. Conclusions and Recommendations

Conclusions

The study relied on the Airport Passenger Opinion Survey for the required data. This survey identified the reasons for shift from Vayu Vajra bus to cabs and the impacted Vayu Vajra routes due to this shift.

'Lack of luggage space and convenience' was the major reason that prompted people to shift from Vayu Vajra to cab services. As there is no dedicated space for the luggage, it becomes uncomfortable for commuters to carry their own luggage during their journey between airport and their city origin/destination. Also, the fare for more than one passenger is cheaper for cabs than the Vayu Vajra fare. The study also identified the impacted routes based on the responses. Routes which were affected include KIAS 10, KIAS 5, KIAS 8, KIAS 12 and KIAS 7.

Recommendations

To improve Vayu Vajra bus ridership, BMTC needs to provide dedicated luggage space, reduce fares in the range of 10-15% and address issues of first and last mile connectivity.

Additionally, BMTC needs to provide real time passenger information systems at major exit points of the airport and signage leading to the bus bays.

Within the city limits, there is a need for dedicated Vayu Vajra bus stop signages.

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Annexure I

Impact of Cab Aggregators on BMTC Vayu Vajra Services

(At Kempegowda International Airport)

Purpose: To assess the impact of Cab Aggregators on BMTC Vayu Vajra services

Date & Time:

1. Are you a cab user

Yes	No

2. Were you using BMTC Airport bus service in last one year?

Yes Route no._____	No

3. Gender

Male	Female

4. Age group

Less than 18	19 - 30	31 - 50	51 – 60	Above 60

5. Employment Type:
   a) Working
   b) Unemployed
   c) Retired
   d) Student
   e) Homemaker
   f) Others

6. Monthly Household income

Less than Rs. 25,000	Rs. 25,000–50,000	Rs. 50,000–1,00,000	Above Rs. 1,00,000

Your trip from Airport:

Origin: **Airport**

7. Destination (Landmark, Nearest Bus Stop & Pin code):_____

8. Which cab service do you use? (Multiple choice)

Ola	Uber	Meru	KSTDC	Mega Cabs	Others _____

9. How often do you make this trip?

Weekly	Monthly	Once in two-six months	Six months and above

10. What was your previous mode of travel? (If Q.2 is 'No', then Q. 10)

Private car	Bike/ Scooter	Same as current (Cab)	Others _____

11. Is your trip '**To Airport'** same as this in terms of origin and mode of travel? (If yes, directly go to 17 Question)

Yes	No

Your trip to Airport:
Destination: **Airport**

12. Origin (Landmark, Nearest Bus Stop & Pin code):_____

13. What is/will be your current mode for the trip **to Airport**? (Multiple choice)

Private car	Bike/ Scooter	Taxi/cab	BMTC Bus Route no. _____

14. If cab, which cab service do you use? (Multiple choice)

Ola	Uber	Meru	KSTDC	Mega Cabs	Others _____

15. How often do you make this trip?

Weekly	Monthly	Once in two to six months	Six months and above

16. What was your previous mode of travel? (Multiple choice)

Private car	Bike/ Scooter	Taxi /cab	BMTC Bus Route no.	Same as current	Others _____ ___

17. If BMTC, what prompted you to shift to current mode from BMTC?

Lowest Priority … **Highest Priority**

Sl. No.	Reasons	1	2	3	4	5
1	Absence of direct AC bus connectivity					
2	Low bus frequency / High waiting time for BMTC					
3	Expensive compared to current mode					
4	Poor first / last mile connectivity					
5	Overcrowding of BMTC Bus					
6	Travel time is more with BMTC buses					
7	Luggage space and convenience					
8	Other please specify					

18. What will promote you to shift to Vayu Vajra service for this trip?	15% group discount	10-15% fare reduction	Other (Specify)

Name _____ Phone Number_____

Initiative 4: Improvement and Extension of Chartered Services

Initiative 4: Improvement and Extension of Chartered Services

Abbreviations and Acronyms

Abbreviations	Full Form
AC Bus	Air Conditioned Bus
BMTC	Bengaluru Metropolitan Transport Corporation
CPKM	Cost Per Kilometre
CSTEP	Center for Study of Science, Technology and Policy
EPKM	Earning Per Kilometre
INR	Indian Rupee
IT Industry	Information Technology Industry
Km	Kilometre(s)
KSRTC	Karnataka State Road Transport Corporation
Non AC Bus	Non Air-Conditioned Bus
OC	Operating Cost

Executive Summary

Bengaluru, the capital of Karnataka state, is one of the fastest growing metropolitan cities in India. With population growth, rapid urbanisation and development of the IT industry, different sectors of the city experienced a significant demand for urban infrastructure. Public transportation was one such crucial sector requiring infrastructure upgradation.

In order to cater to this growing transportation demand, BMTC introduced chartered/dedicated bus services in both AC and non-AC variants catering to corporate clients, educational institutions and government organisations in Bengaluru.

However, in the recent past (2015), with the entry of app-based cab services and competition from private bus operators[1], BMTC started losing some of its existing chartered/dedicated customers. In this context, Government of Karnataka has engaged the Center for Study of Science, Technology and Policy (CSTEP), as a technical research institution, to assess the feasibility of improving operational efficiency of these services.

This study proposes a model for estimation of the rate per km and pass rate structure of chartered and dedicated bus services, based on route length and varying average profit per bus per day. The proposed model recommends dead kilometres[2] to be charged for chartered bus services and also proposed a monthly pass rate structure for dedicated bus services aiming to attract potential new clients and retain existing clients. This study will also determine the additional bus fleet required to reach break-even profit with respect to the current profit levels from these services. It also helps in comparing these services with the normal bus services under different load factors to generate these profit margins.

This study also considers the existing clients' experiences with BMTC chartered/dedicated services. In addition to existing clients, it identifies challenges that may prevent potential clients from opting for BMTC chartered/dedicated bus services. For this assessment, key personnel of existing as well as potential new companies were interviewed. The feedback from existing and potential clients is incorporated in the report.

[1] Companies have recently started hiring private buses for chartered services.
[2] Dead kilometres represent the distance covered by the vehicle without carrying any passengers. For a trip, this includes the distance from the depot to the first passenger pick up location and the distance from the final drop location to the depot.

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1. Introduction

BMTC introduced chartered/dedicated bus services in 2006, with both AC and Non AC vehicle (BMTC 2013). Chartered bus services cater to corporates, educational institutions and government organisations on a per km basis. Companies/organisations hire BMTC buses to provide transport to their employees/students. For this service, BMTC charges for the total kilometres on each route per day. Dedicated bus services offer a monthly pass-based model for corporate customers. Currently, BMTC operates 432 chartered bus services for 65 clients with an annual revenue of INR 32.8 crore. The chartered bus services' revenue for the period 2014-2017 has seen a decrease of 13.8%. BMTC operates dedicated bus services for 16 clients with 367 buses, generating an annual revenue of INR 61.3 crore. This service has seen an increase of 3.3% in last four years. The total annual revenue generated from both these services in 2017 is INR 94.1 crore which is approx. 5% of the gross revenue generated by BMTC.

In the recent past, with the entry of private bus operators and app-based cab services/bus aggregators, BMTC has started losing some of its existing chartered/dedicated customers. The aim of this study is to assess the feasibility of improving the operational efficiency of these services to retain existing customers and attract new customers.

2. Problem Statement

To assess the extent to which BMTC can revise the existing dead kilometre model to retain its existing customers and increase customer base

Operating chartered/dedicated bus services for major firms in Bengaluru provides a business opportunity to BMTC to improve profitability of the organisation. As a business strategy, the pricing of these chartered/dedicated bus services has to be higher than the normal bus services for regular passengers in Bengaluru[3]. Currently, profit-generation centres on charging dead kilometres to these firms and the price is either charged as cost/km (chartered services) or monthly pass system (dedicated services). However, the current rate structure potentially limits the customers and thereby, the revenue. The research question here is what rate structure is optimal for increasing revenue for these services.

3. Objectives and Issues for Evaluation

Objective:

To propose a model to increase revenue from chartered/dedicated bus services.

Scope:

- Target Population: Existing and potential clients of chartered/dedicated bus services - corporates
- Geographical Coverage: Existing and upcoming Information Technology corridors.

4. Evaluation Design

4.1. Information Sources

Primary Data: Primary data for this study included interviews with key personnel from existing and potential customers for chartered/dedicated bus services. For existing customers, the line of enquiry focussed on current experiences related to chartered/dedicated bus services, criteria for engaging with BMTC (e.g. age of buses, clean buses), potential for additional bus demand and pre-requisites on part of BMTC (e.g. insurance, fitness certificate).

[3] Chartered/Dedicated buses are bus rental services which BMTC offers to clients. The bus operational routes are as per the client request during specific hours.

For potential customers, the line of enquiry focussed on identifying mobility patterns of their employees, criteria for engaging with BMTC and potential fleet requirement. During the study, four clients were interviewed for dedicated services and one, for chartered services.

Secondary Data: For the purposes of this study, secondary data included a complete client list of chartered/dedicated bus services and the number of buses used by the companies. In addition, financial data for chartered bus services – specifically, route data and the corresponding rate structure, as well as financial performance for the past five years – was obtained from BMTC. Data was also obtained on proposed measures to increase revenue from these services.

5. Evaluation Methodology

In this study, primary interviews were conducted with key personnel of existing and potential chartered/dedicated bus clients. Based on the secondary data collected, a model was proposed to recommend fare/km for chartered bus services and monthly pass rate structure for dedicated bus services. The details of the steps followed in the methodology have been discussed in this section. Figure 1 presents the methodology for the proposed model.

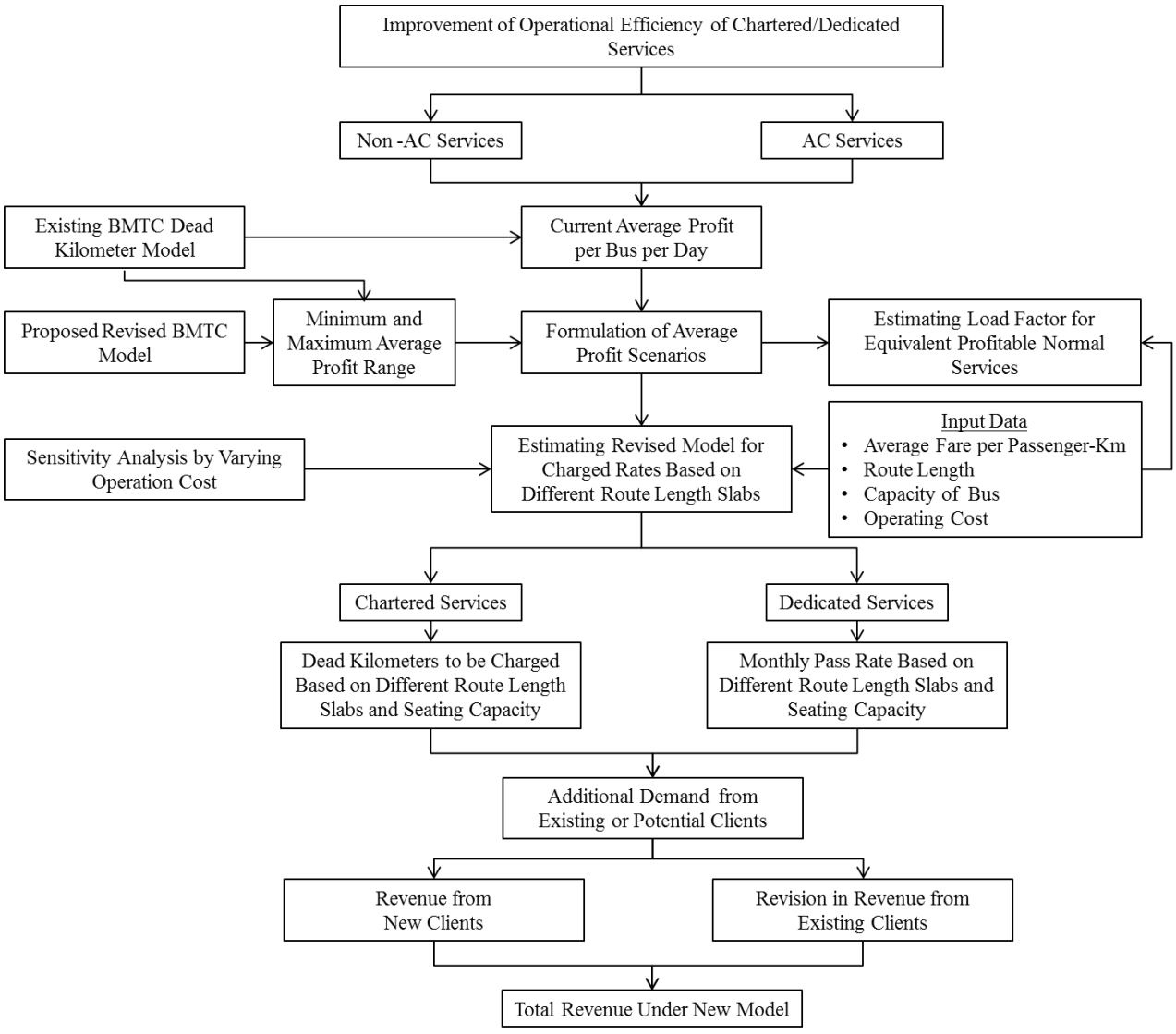

Figure 1: Methodology for the proposed model

The methodology aims to formulate a model to obtain dead kilometres to be charged for chartered services and monthly pass rate for dedicated services for a fixed average profit per bus per day[4]. The average profit per bus per day is equated to the profit function of normal services, to determine the required load factor. By comparing equivalent profitable normal services with the chartered/dedicated profit functions, the dead kilometres/monthly pass to be charged are determined for different route length slabs, as shown in Figure 2. Only the peak hour timeframe was considered as a majority of these services will be provided during peak hours. This study can, however, be extended to non-peak timeframes as well.

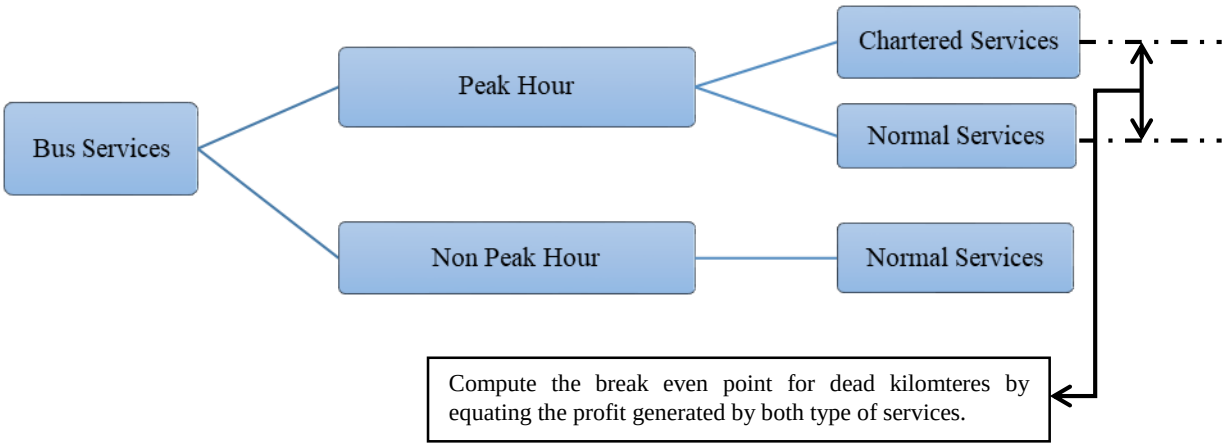

Figure 2: Computing dead kilometres by comparing normal and chartered services

To generate profit, normal bus services need to run during peak hours (8 am to 10 am) and have high load factors[5]. However, chartered/dedicated bus services can be profitable with a load factor of one (as they charge for dead kilometres. The break-even point for dead kilometres charged is the point where the intended average profit from normal bus services at these load factors (which generate profit) becomes equal to the profit from chartered/dedicated services. Any additional dead kilometre charged from this point will lead to higher profit compared to running a normal service.

Equations are provided below to compute the break-even dead kilometres. Scenarios are provided to showcase the additional profit generated by these services by charging higher dead kilometres from the break-even point. After dropping passengers off at their firms, these

[4] Per day indicates one round trip, i.e. from the origin to the destination and back (up and down trip).
[5] Load factor refers to the capacity utilisation of the bus service. It represents the ratio of number of passenger carried to the seating capacity of the bus.

services operate as normal bus services (resumed normal bus services) on pre-decided routes. For this analysis, the comparison should only be between the normal bus services operated during peak hour and chartered/dedicated bus services. For the analysis, the profit generated by these resumed normal bus services and normal bus services is assumed to be same. Similarly, dedicated bus monthly pass rates were estimated by equating the intended average profit per bus per day with the profit equation of the dedicated bus service.

To illustrate this, consider the figure below (Figure 3), representing an origin and destination route where these services are being planned. Assume BMTC could either run a normal bus service or a chartered/dedicated bus service between these points.

The following parameters are considered in the equations below:

f - Average fare per passenger-km (INR/pass-km)

l - Route Length (comprising initial dead kilometres) (km)

C_b - Capacity of the bus (pass/bus)

LF - Load Factor

CS - Cost charged to the clients (INR/km)

OC - Operating Cost per km (INR/km)

D_{op}- Number of days operated in a month

x – Break-even dead kilometres charged per day (km)

MP - Monthly Pass Rate (INR)

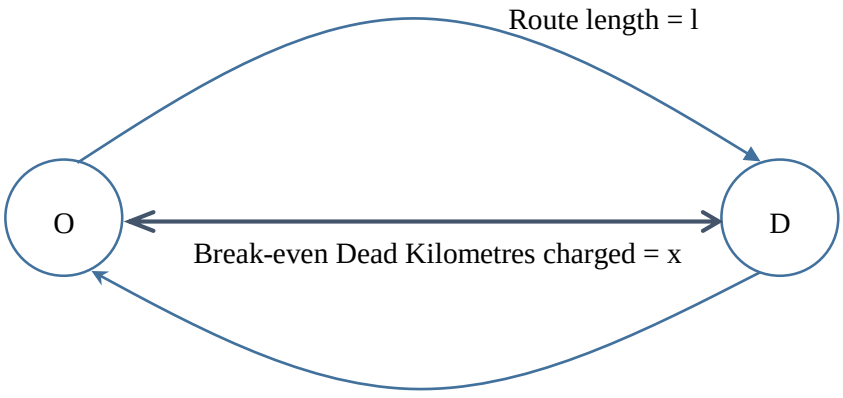

Figure 3: Origin and destination route

The profit generated by running a normal bus service between O and D for one bus per day for two trips, π_{norm} , is calculated as:

$$\pi_{norm} = 2 * f * l * C_b * LF - 2 * OC * l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The profit generated by running a chartered bus service between O and D for one bus per day for two trips, π_{chart}, is calculated as:

$$\pi_{chart} = CS * (2l + x) - 2 * OC * l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

The break-even point for dead kilometres can be computed by equating the two equations.

$$\pi_{norm} = \pi_{chart}$$

$$\pi_{norm} = CS * (2l + x) - 2 * OC * l \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Therefore, break-even dead kilometres, x, is given below:

$$x = \frac{\pi_{norm} + 2*OC*l - 2*CS*l}{CS} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Similarly, monthly pass rates for the dedicated bus services can be calculated by using the equation given below:

$$\pi_{norm} * D_{op} = MP * C_b - D_{op} * OC * 2l \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

$$MP = \frac{\pi_{norm}*D_{op} + D_{op}*OC*2l}{C_b} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

Using these models, the number of dead kilometres to be charged was computed for chartered bus services. Similarly the monthly pass rate for the dedicated bus services was computed, and is discussed in the next section. Using the same formula, slab rates were proposed for the chartered/dedicated bus services.

6. Data Collection and Analysis

6.1. Data Analysis

Using data (BMTC 2018) of the existing and potential clients, average profit margin per bus per day was computed based on the existing dead kilometre model and the proposed revised model by BMTC. This profit margin was used in this analysis to create different scenarios and thereby determine the slab rates based on route lengths by varying the intended average profit per bus per day. This also helped to determine the additional bus demand required to break-even in profit. Using these average profit margins, equivalent load factor required in normal bus services to generate these profit margins was calculated.

The data used in this analysis is provided in the Table 1 below. Average fare per passenger-km for both ordinary[6] and AC buses was calculated using the existing route data during peak hours that was provided by BMTC. This study assumed that the charged cost/km was equal to the operating cost/km, thereby ensuring that any dead km charged would result in profit.

The days of operation for the calculation of monthly pass rates was assumed to be 22 days. A sensitivity analysis was carried in this study to estimate the dead kilometres, by varying the operational cost. In this analysis the charged cost was considered to be constant. At the first level the operating cost was increased by INR 3/km whereas in the second level, the operating cost was increased by INR 8/km. The calculations of this table are provided in the Annexure I.

Table 1: Input data used in analysis

Variables	Ordinary Buses		AC Buses	
	42 Seats	50 Seats	35 Seats	42 Seats
Average Fare per Passenger-km (INR/pass-km)	0.87	0.87	1.7	1.7
Operating Cost (INR/km)	48	52	76	80
Charge Cost (INR/km)	48	52	76	80
Days of Operation in a Month	22	22	22	22
Sensitivity Analysis Operating Cost (INR/km)[7]	51 and 56	55 and 60	79 and 84	83 and 88

The existing dead kilometre charging model of BMTC and also the proposed revised charging model of BMTC were considered to compute the maximum and minimum average profit per bus per day. Currently, BMTC charges the client certain dead kilometres in order to make profit for the chartered services, whereas monthly pass rates are fixed based on the route lengths. In the revised model by BMTC, to generate profit, a certain margin is fixed over cost per kilometre (CPKM) which varies with route length[8]. This formed the basis for our average profit margin for different scenarios.

Table 2 shows the average profit margin per bus per day (for both Ordinary and AC services), both from the existing BMTC model and from the revised proposed model by BMTC. The calculations are provided in the Annexure II.

[6] In this report, the terms ordinary and non AC bus are used interchangeably.
[7] Explained in the Sensitivity Analysis section
[8] Refer to Annexure II

Table 2: Average profit margins per bus per day

Models	Average Profit Margin - Ordinary Buses (INR/day)		Average Profit Margin - AC Buses (INR/day)[9]
	Dedicated	Chartered	
Existing model (BAU)	1,305 (~ 1,500)	1,130 (~1,500[10])	1,717 (~1,750)
Revised model by BMTC	471 (~500)	471 (~500)	724 (~750)

The average approximated profit margin from the existing model comes out to be INR 1,500 per bus per day. This profit margin might be on the higher side (resulting in higher prices than private bus operators), thereby restricting the likelihood of attracting potential clients for these services. On the other hand, the revised model by BMTC generates an average profit margin of INR 500 per bus per day. The price changes brought about by this model are likely to expand the customer base; however, the additional bus demand requirement at these profit margins might exceed the available fleet for chartered/dedicated services (approximately 800 buses). Therefore, there is a need to analyse feasible profit margins within this range (INR 500-1500). Using the average profit margins given in the table above, different scenarios have been formulated as shown in Table 3.

Table 3: Scenarios based on average profit margin per bus per day

Scenarios	Average Profit Margin- Ordinary Buses (INR/day)	Average Profit Margin- AC Buses (INR/day)
Scenario 1	500	750
Scenario 2	750	1,000
Scenario 3	1,000	1,250
Scenario 4	1,250	1,500

To gauge these average profit margins from the normal services perspective, the average load factors were calculated using Equation (1). The respective load factors were calculated for all the scenarios, and are shown in Table 4.

[9] Disaggregated data on dedicated and chartered AC services was not available.
[10] Considered high profit margin of INR 1,500 in line with the dedicated bus services.

Table 4: Load factors for different scenarios

Scenarios	Load Factors - Ordinary Buses		Load Factors - AC buses	
	42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	1.58	1.42	1.52	1.33
Scenario 2	1.71	1.53	1.61	1.4
Scenario 3	1.85	1.64	1.69	1.46
Scenario 4	1.98	1.75	1.77	1.53

The table above highlights the load factors required throughout the route length to maintain the average profit margin per bus per day for the different scenarios. Maintaining these high load factors for profitability might not be realistic for a majority of the normal bus routes. From the data provided by BMTC[11], schedule C buses[12] constitute around 78% of the total fleet. This provides an opportunity to convert a few of these buses into chartered/dedicated bus services during the peak hour, to generate higher profit. A pre-determined slab rate for each scenario provides higher flexibility to BMTC when negotiating contracts for chartered services with potential clients. The calculations for these load factors are given in Annexure III.

Consequently, for each scenario, the average profit margin per bus per day was fixed to determine:

- Minimum dead kilometres to be charged for chartered services
- Monthly pass rate for dedicated bus services, based on different route length intervals[13]

For each scenario, the two-way route lengths are divided into four intervals: '< 25 km', '25-50 km', '50-75 km', and '75-100 km'. Slab rates, corresponding to each interval in terms of dead kilometres to be charged, were calculated using Equation (4) for chartered bus services, and using Equation (6) for monthly pass for dedicated bus services.

Tables 5 and 6 show the slab rates for chartered and dedicated bus services respectively, by equating π_{norm} to the average profit levels in the formulated scenarios. Here, profit from normal bus service for the equivalent load factor will be different for the route length slab. The average across all the route length intervals will be equal to intended average profit per bus per day in the respective scenario. For the chartered bus services, the dead kilometres value was computed to generate the intended average profit per bus per day.

[11] Internal notes from BMTC
[12] Schedule C buses – Buses for which the cost per kilometre (CPKM) is greater than earning per kilometre (EPKM)
[13] Route lengths were one of the criteria considered for determining the slab rates in the revised BMTC model.

In Table 5, two different seating capacities have been considered for both ordinary (42 and 50 seats) and AC buses (35 and 42 seats). The route lengths form the basis of the differential charging of dead kilometres. The dead kilometres value was rounded off to an appropriate value to have consistency in the rate chart. There is no significant difference in the charged dead kilometres for different capacities as the difference in the number of seats is not that high.

The dead kilometres to be charged increases with increase in the route length, thus ensuring that the average profit margin per bus per day is maintained. For example, in Scenario 2 for ordinary buses, the intended average profit is around INR 750 per bus per day; the dead kilometre charged for a 25-50 km route length to generate this profit for a 50 seat bus is 12 km. With increase in the intended profit margin in the scenarios, the charged dead kilometres increase. For the case mentioned above, the dead kilometres to be charged in Scenario 3 increases to 15 km. These proposed slab rates give BMTC a flexible platform to negotiate on the rates with the clients. Sample calculations are provided in Annexure IV.

Table 5: Proposed slab rates for chartered bus services

Scenarios	Route Length Two-way (km)	Dead Km Charged Per Day (km) - Ordinary Buses		Dead Km Charged Per Day (km) - AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	5.00	5.00	5.00	5.00
	25-50	10.00	10.00	10.00	10.00
	50-75	15.00	13.00	13.00	13.00
	75-100	20.00	18.00	18.00	18.00
Scenario 2	< 25	7.00	7.00	5.00	5.00
	25-50	13.00	12.00	10.00	10.00
	50-75	20.00	20.00	18.00	17.00
	75-100	28.00	25.00	25.00	23.00
Scenario 3	< 25	10.00	8.00	7.00	7.00
	25-50	18.00	15.00	15.00	13.00
	50-75	28.00	25.00	22.00	20.00
	75-100	38.00	35.00	30.00	28.00
Scenario 4	< 25	10.00	10.00	8.00	8.00
	25-50	20.00	20.00	15.00	15.00
	50-75	33.00	30.00	25.00	25.00
	75-100	45.00	42.00	35.00	35.00

Similarly, for dedicated bus services two different capacities were considered for both the ordinary (42 and 50 seats) and AC bus (35 and 42 seats) services, as shown in Table 6. The pass rates were determined on the basis of the two way route length. It was observed that the pass rates were higher for smaller capacity buses for the same route length, and increases with

route length. As the intended average profit per bus per day increases, the pass rate increases. For example in Scenario 2 for ordinary buses, the intended average profit to make is around INR 750 per bus per day; the monthly pass rate for this comes out to be INR 1,150. The current monthly pass rates by BMTC are calculated by dividing the route lengths into different intervals, which includes the dead kilometres.

This proposed model uses only the operational route length to determine the monthly pass rate, which considers the intended average profit per bus per day. Also, there are only two length slabs[14] for AC buses in the current BMTC charge sheet. This is likely to deter passengers traveling shorter routes from choosing these services, thereby reducing the demand. This model proposes rates for dedicated AC bus services under four route lengths. CSTEP proposes that the monthly pass rates be charged as per the route length intervals, which may encourage additional demand for these services.

Table 6: Proposed slab rates for dedicated bus services[15]

Scenarios	Route Length Two- way (km)	Monthly Pass (INR) - Ordinary Buses		Monthly Pass (INR) - AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	1,050	1,050	2,250	2,250
	25-50	1,200	1,050	2,250	2,250
	50-75	1,950	1,750	3,600	3,150
	75-100	2,600	2,350	4,900	4,300
Scenario 2	< 25	1,050	1,050	2,250	2,250
	25-50	1,250	1,150	2,300	2,250
	50-75	2,100	1,900	3,800	3,300
	75-100	2,900	2,550	5,200	4,500
Scenario 3	< 25	1,050	1,050	2,250	2,250
	25-50	1,350	1,200	2,450	2,250
	50-75	2,250	2,000	4,000	3,450
	75-100	3,100	2,750	5,450	4,700
Scenario 4	< 25	1,050	1,050	2,250	2,250
	25-50	1,450	1,300	2,550	2,250
	50-75	2,400	2,150	4,200	3,650
	75-100	3,250	2,900	5,700	4,950

[14] Two length slabs (AC buses) – Route length up to 120 km and route length from 120 to 160 km

[15] Monthly pass rate from the proposed CSTEP model for several scenarios comes out to be lesser than the monthly pass rate charged by BMTC. Therefore minimum monthly pass rate is kept as INR 1,050 for ordinary and INR 2,250 for AC services as per BMTC monthly pass rates (https://www.mybmtc.com/en/monthly_pass). Same is reflected in Table 6, 8 and 10.

6.2. Sensitivity Analysis

With increasing fuel prices [16] (Good Returns 2018) and staff wages, the operating cost is likely to go higher in the near future. This section indicates changes in slab rates by taking into account increased operating costs. The CPKM data for previous years (2012-13 to 2017-18) was considered in order to estimate the average annual increase in operating cost. From this data, for the operational cost, a minimum increase of INR 3/km and a maximum increase of INR 8/km was considered (BMTC 2017). In this analysis, only operational cost is varied and charged cost is considered constant. For instance, for an ordinary 50-seat bus the charged cost considered is INR 52/km and the operating cost considered is INR 55/km and INR 60/km. The differential in operating and charged cost needs to be accounted in the dead kilometres charged in order to maintain the same level of intended average profit per bus per day.

Tables 7 and 8 show the slab rates for chartered and dedicated bus services respectively, for operational cost increases of INR 3/km and INR 8/km. Under Scenario 2 for an ordinary bus (50 seats & route length 25-50 km), the dead kilometres to be charged is 12 km (Table 5) for an operational cost of INR 52/km, and 15km (Table 7) for an operational cost of INR 55/km.

Table 7: Proposed slab rates for chartered bus services (OC increase - INR 3/km)

Scenarios	Route Length Two-way (km)	Dead km Charged Per Day (km) - Ordinary Buses		Dead km Charged Per Day (km) - AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	7.00	5.00	5.00	5.00
	25-50	12.00	10.00	10.00	10.00
	50-75	18.00	17.00	15.00	15.00
	75-100	25.00	23.00	22.00	20.00
Scenario 2	< 25	10.00	8.00	7.00	7.00
	25-50	15.00	15.00	13.00	12.00
	50-75	25.00	23.00	20.00	20.00
	75-100	35.00	32.00	28.00	28.00
Scenario 3	< 25	10.00	10.00	8.00	8.00
	25-50	20.00	18.00	15.00	15.00
	50-75	30.00	30.00	25.00	23.00
	75-100	43.00	40.00	33.00	32.00
Scenario 4	< 25	12.00	10.00	10.00	10.00
	25-50	23.00	22.00	18.00	17.00
	50-75	38.00	35.00	28.00	28.00
	75-100	52.00	48.00	40.00	38.00

[16] Diesel price in Bengaluru: June 2017 – INR ~57.50/litre and June 2018 – INR ~68.90/litre

Similarly, for dedicated bus services the revised rates have been calculated and shown in Table 8 below. With the increase in operating cost, the monthly pass rate increases as well. Under Scenario 2, the monthly pass rate for an ordinary bus (42 seats & route length 25-50km) is INR 1,250 for an operational cost of INR 52/km (Table 6) and INR 1,350 for an operational cost of INR 55/km (Table 9).

This analysis provides these services with the flexibility to modify their rates in the event of increased operational costs.

Table 8: Proposed slab rates for dedicated bus services (OC increase - INR 3/Km)

Scenarios	Route Length Two-way (Km)	Monthly Pass (INR)- Ordinary Buses		Monthly Pass (INR)- AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	1,050	1,050	2,250	2,250
	25-50	1,250	1,100	2,250	2,250
	50-75	2,050	1,800	3,700	3,250
	75-100	2,800	2,450	5,050	4,400
Scenario 2	< 25	1,050	1,050	2,250	2,250
	25-50	1,350	1,200	2,400	2,250
	50-75	2,250	1,950	3,950	3,450
	75-100	3,000	2,650	5,350	4,700
Scenario 3	< 25	1,050	1,050	2,250	2,250
	25-50	1,450	1,250	2,500	2,250
	50-75	2,350	2,100	4,100	3,600
	75-100	3,200	2,850	5,600	4,850
Scenario 4	< 25	1,050	1,050	2,250	2,250
	25-50	1,500	1,350	2,600	2,300
	50-75	2,500	2,250	4,300	3,750
	75-100	3,400	3,050	5,850	5,150

Tables 9 and 10 show the proposed slab rates for chartered and dedicated bus services respectively, for the second level of increase in operating cost (i.e. an increase of INR 8/km). Trends similar to the previous example are observed in this instance as well.

Table 9: Proposed slab rates for chartered bus services (OC increase - INR 8/Km)

Scenarios	Route Length Two-way (km)	Dead km Charged Per Day (km) - Ordinary Buses		Dead km Charged Per Day (km) - AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	10.00	10.00	8.00	7.00
	25-50	15.00	15.00	13.00	12.00
	50-75	25.00	25.00	20.00	20.00
	75-100	35.00	32.00	28.00	28.00
Scenario 2	< 25	10.00	10.00	10.00	8.00
	25-50	20.00	18.00	15.00	15.00
	50-75	30.00	30.00	25.00	25.00
	75-100	43.00	40.00	33.00	32.00
Scenario 3	< 25	13.00	12.00	10.00	10.00
	25-50	23.00	22.00	18.00	18.00
	50-75	40.00	35.00	28.00	28.00
	75-100	52.00	48.00	40.00	38.00
Scenario 4	< 25	15.00	15.00	10.00	10.00
	25-50	27.00	25.00	20.00	20.00
	50-75	45.00	40.00	32.00	30.00
	75-100	60.00	55.00	45.00	42.00

Table 10: Proposed slab rates for dedicated bus services (OC increase - INR 8/Km)

Scenarios	Route Length Two-way (km)	Monthly Pass (INR) - Ordinary Buses		Monthly Pass (INR) - AC Buses	
		42 Seats	50 Seats	35 Seats	42 Seats
Scenario 1	< 25	1,050	1,050	2,250	2,250
	25-50	1,350	1,200	2,400	2,250
	50-75	2,200	1,950	3,950	3,400
	75-100	2,950	2,650	5,350	4,650
Scenario 2	< 25	1,050	1,050	2,250	2,250
	25-50	1,450	1,250	2,500	2,250
	50-75	2,350	2,100	4,100	3,600
	75-100	3,200	2,850	5,600	4,850
Scenario 3	< 25	1,050	1,050	2,250	2,250
	25-50	1,550	1,350	2,600	2,250
	50-75	2,500	2,250	4,300	3,700
	75-100	3,400	3,000	5,850	5,050
Scenario 4	< 25	1,050	1,050	2,250	2,250
	25-50	1,600	1,450	2,750	2,350
	50-75	2,700	2,350	4,500	3,900
	75-100	3,650	3,200	6,100	5,300

6.3. Additional Bus Demand Required

With the aim of attracting new potential clients and generate demand for these services, BMTC has proposed a revised model. According to this revised model, the average profit of INR 1,500

per bus per day from the current dead kilometre model is reduced to INR 500. With the reduction in the profit margin per bus per day, in order to maintain the same profit as in the existing dead kilometre model, BMTC will need to generate additional demand for these services at those revised pricing. Tables 11 and 12 provides the net profit per day per bus in each scenario for different percentages of spare bus fleet utilisation.

According to data provided by BMTC, 800 buses are currently in use for the chartered and dedicated bus services, out of which 600 are ordinary and 200 are AC buses. BMTC has approximately 800 buses to spare for these services[17]. The estimation of the additional bus fleet demand took into account 600 buses for ordinary and 200 buses for AC services. The difference between the intended average profits per bus per day in the new scenario and the existing scenario was used to compute the net profit in the respective scenarios. The calculation is shown in Annexure V.

Table 11: Net profit per day for additional bus demand of ordinary services

Scenarios	Net Profit Per Day (INR) – Ordinary Bus				
	Average Profit Per Bus Per Day	Percentage of Spare Bus Fleet Used			
		100	75	50	25
Scenario 1	INR 500	(-) 3,00,000	(-) 3,75000	(-) 4,50,000	(-) 5,25,000
Scenario 2	INR 750	0	(-) 1,12,500	(-) 2,25,000	(-) 3,37,500
Scenario 3	INR 1,000	3,00,000	1,50,000	0	(-) 1,50,000
Scenario 4	INR 1,250	6,00,000	4,12,500	2,25,000	37,500

Table 11 shows the net profit per day for additional ordinary bus demand. For example, in Scenario 3, if 100% of the spare bus fleet were used (i.e. 600 ordinary buses) the daily net profit for the ordinary services would be INR 3,00,000. On the other hand, these services would financially break even if 50% of the spare bus fleet were used in the same scenario.

Similarly for AC bus services, it was observed that for Scenario 2, the break-even profit point occurred when 75% of the spare bus fleet was used. For Scenario 4, even if 25% of the spare bus fleet were used, the daily net profit for the ordinary services would be INR 37,500.

[17] Internal notes by BMTC

Table 12: Net profit per day for additional demand of AC services

Scenarios	Net Profit per Day – AC Services				
	Average Profit Per Bus Per Day	Percentage of Spare Bus Fleet Used			
		100	75	50	25
Scenario 1	INR 750	(-) 50,000	(-) 87,500	(-) 1,25,000	(-) 1,62,500
Scenario 2	INR 1,000	50,000	0	(-) 50000	(-) 100,000
Scenario 3	INR 1,250	1,50,000	87,500	25,000	(-) 37,500
Scenario 4	INR 1,500	2,50,000	1,75,000	1,00,000	25,000

This analysis will help BMTC negotiate pricing with their clients keeping the additional demand in perspective. BMTC could negotiate for a certain level of commitment in terms of buses to be deployed with a particular client at the proposed rates.

7. Findings and Discussion

A few key findings from the study are detailed below:

- The average approximated profit margin from the existing model comes out to be INR 1,500 per day per bus. This profit margin might be on the higher side, thereby restricting the likelihood of attracting potential clients for these services.
- The revised model by BMTC generates average profit margin of INR 500 per day per bus. This model will likely enhance customer base but the additional bus demand requirement at these profit margins might exceed the available fleet.
- It was observed in the additional bus demand section, for Scenario 1 (both ordinary and AC bus services), even at 100% of spare fleet utilisation, the net profit turns out to be negative. This indicates that at low profit margin (INR 500), the additional spare fleet is not sufficient to achieve profit compared to the existing scenario.
- Having a good spectrum of route length intervals ensures that the passengers travelling on shorter route lengths do not pay high prices. Hence, it can be a way to tap into the latent demand that may exist for shorter corridors.
- These proposed slab rates for various scenarios can provide BMTC a platform to negotiate on the pricing of the services and even have an additional demand perspective for the proposed prices.

However interviews have also revealed that there are multiple issues which need to be addressed by BMTC. These include:

- The need for a customer-centric approach
- The need for providing competitive rates on a per/km or pass cost, which BMTC is currently unable to do
- The need for providing new buses, which do not have frequent break-downs and are well maintained
- The need for contract negotiations including providing insurance/indemnity to corporate employees travelling on BMTC buses (this is provided by private transport operators)

8. Conclusion and Recommendations

The current financial model for chartered/dedicated bus services that focuses on making profits through dead kilometres has restricted the number of corporate customers. The revised BMTC model that focusses on generating minimum profit margin needs additional services to be operated, to generate a profit margin equivalent to the existing dead kilometre model. Both the models are not viable in the long run, with the increasing operating cost per km. In the context of varying operating cost, CSTEP proposed a model based on route length to estimate the dead kilometres to be charged and monthly pass for chartered services and dedicated bus services. If BMTC wishes to increase the customer base, it needs to adopt an alternative model which would reduce the number of dead kilometres and move towards a multi-slab fare model.

CSTEP's analysis shows that such a model would allow for customers travelling varying distances to be charged differentially. This could potentially increase the number of customers. Such a model also offers BMTC different profit slabs per bus per trip ensuring that these operations remain profitable. Finally, it offers BMTC and existing/potential customers an opportunity to negotiate the fare per km/monthly pass rate, and for the corresponding number of buses to be deployed.

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Annexure I

Calculation for Average Fare per Passenger-km

Ordinary Bus Services

Example:

Route No 258 CC[18] - (Nelamangala to Kempegowda bus station); Route length = 23 km

Peak time revenue (INR) = 24,034

Peak time ridership = 1,493

Average fare per passenger-km = Revenue/ridership/route length

= 24,034/1,493/23

=0.69 ~ 0.7 INR/ passenger-km

AC Bus Services

Example:

Route V-500CA[19] - (Banashankari to ITPL); Route length - 26 km

Total revenue (INR) per day- 8,58,789

Total ridership per day – 20,318

Average fare per passenger-km = Revenue/ridership/route length

= 8,58,789/20,318/26

= 1.62 ~ 1.7 INR/passenger-km

[18] Based on ETM data shared by BMTC for route no. 258CC (May 2017)
[19] Based on ETM data shared by BMTC for route no. V-500CA (Jan 2017)

Annexure II

Calculation for Average Profit Margins: Ordinary Services

Existing Model

Based on Data from Potential Client:

Total operating km (point to point- two side) – 2,633 km

Charged km (including dead km) – 4,950 km

Percentage of operating km - 53% ~ 50%

Based on Data from Existing Client:

Total km operated - 2,259

Total km charged per day - 4,519 km

Total number of bus operated - 56

Revenue per day (R) - INR 1,93,309

Profit per day (INR) = (R- OC*Dop) = 75,815

Profit per day per bus (INR) = 75,815/56 = 1,353 ~ INR 1,500

Based on Overall Dedicated Bus Service Data from BMTC:

Km charged per day - 14,900 km

Km operated per day - 7,450 km

Revenue per day - INR 5,81,908.50

Profit per day - INR 1,94,508.50

Profit per day per bus - INR 1,305 ~ 1,500

Based on Overall Chartered Bus Service Data from BMTC:

Km charged per day - 23,989.5 km

Km operated per day - 11,994.75 km

Revenue per day - INR 9,16,357.35

Profit per day - INR 2,92,630.35

Profit per day per bus - INR 1,129 ~ 1,500

Revised Model by BMTC

Route Length (km)	Peak-time Revenue	Profit (INR/day)
30	1.25*CPKM	390 (1.25 *CPKM - CPKM)
31-40	1.22*CPKM	400.4 (1.22 *CPKM - CPKM)
41-50	1.20*CPKM	468 (1.20 *CPKM - CPKM)
51-60	1.18*CPKM	514.8 (1.18 *CPKM - CPKM)
>61	1.16*CPKM	582.4 (1.16 *CPKM - CPKM)
Average		471.12 ~ 500

Calculation for Average Profit Margins: AC Services

Existing Model

Assumption**:** Percentage km operated per day is taken as 50% (same as ordinary services)

Based on Overall Dedicated Service Data from BMTC

Km charged per day - 26,280 km

Km operated per day - 13,140 km

Revenue per day - INR 14,27,234

Profit per day - INR 3,76,034

Profit per day per bus - INR 1,717 ~ 1,750

Revised Model by BMTC

Route Length (km)	Peak-time Revenue	Profit (INR/day)
30	1.25*CPKM	600 (1.25 *CPKM - CPKM)
31-40	1.22*CPKM	616 (1.22 *CPKM - CPKM)
41-50	1.20*CPKM	720 (1.20 *CPKM - CPKM)
51-60	1.18*CPKM	792 (1.18 *CPKM - CPKM)
>61	1.16*CPKM	896 (1.16 *CPKM - CPKM)
Average		724.8 ~ 750

Annexure III

Load Factor Calculation:

The load factors are calculated from Equation (1):

$$\pi_{norm} = 2 * f * l * C_b * LF - 2 * OC * l$$

For an average profit of INR 500:

$$\text{LF} = \frac{\pi_{norm} + 2 * OC * l}{2 * f * l * C_b}$$

π_{norm} - INR 500

OC - INR 48

l - Average route length (25 km)

f - 0.87

C_b - 42

$$\text{LF} = \frac{500 + 2 * 48 * 25}{2 * 0.87 * 25 * 42}$$

$$= 1.58$$

Annexure IV

Slab Rates for Chartered Services

Dead kilometres calculated using Equation (4):

$$x = \frac{\pi_{norm} + 2 * OC * l - 2 * CS * l}{CS}$$

For a route length range of 25- 50 km:

Average profit = INR 375.25

OC = INR 48

CS = INR 48

$$x = \frac{375.25 + 2 * 48 * 38 - 2 * 48 * 38}{48}$$

= 7.72 ~ 10 km

Slab rates for Dedicated Services

Monthly pass calculated using Equation (6):

$$MP = \frac{\pi_{norm} * D_{op} + D_{op} * OC * 2l}{C_b}$$

For a route length range of 25- 50 km:

Average profit = INR 375.25

OC = INR 48

C_b = 42

Dop = 22

$$MP = \frac{375.25 * 22 + 22 * 48 * 38}{42}$$

= INR 1,153 ~ 1,200

Annexure V

Calculation for Additional Demand

Maximum profit/bus/day = INR 1,500

Existing number of bus = 600

Profit/day = INR 9, 00,000

Additional buses available = 600 (ordinary)

For INR 500 profit: 100% utilisation of additional buses

Net profit per day (INR) = (600+600)*500 - 9, 00,000= -3,00,000 (which indicates a loss of INR 3,00,000)

Initiative 5: Exploring Potential of BMTC Land Resources

Initiative 5: Exploring Potential of BMTC Land Resources

Abbreviations and Acronyms

Abbreviations	Full Form
BDA	Bengaluru Development Authority
BIAAPA	Bengaluru International Airport Area Planning Authority
BMICAPA	Bangalore Mysore Infrastructure Corridor Area Planning Authority
BMTC	Bangalore Metropolitan Transport Corporation
CSTEP	Center for Study of Science, Technology and Policy
GoK	Government of Karnataka
KEA	Karnataka Evaluation Authority
Km	Kilometre(s)
RCUDA	Ramnagara Channapatna Urban Development Authority
TTMC	Traffic and Transit Management Centre

Executive Summary

BMTC is the sole bus service provider for Bengaluru. It was the only profit-making state transport undertaking in the country in the past few years. BMTC generates revenue from both traffic and non-traffic sources. The traffic revenue includes revenue from the sale of tickets and monthly passes, whereas non-traffic revenue includes revenue from advertisements as well as commercial activities at traffic and transit management centres (TTMC) and bus stations.

The gross revenue for BMTC in 2016-17 was INR 2,106 crores, of which traffic revenue contributed to INR 1,770 crore (approximately 84%), while non-traffic contributed to INR 336 crore (16%). During the period 2015-2017, BMTC witnessed a 6% reduction in traffic revenue. During the same period, non-traffic revenue increased by 13%. An additional way for BMTC to increase this non-traffic revenue would be to explore the monetisation potential of its land resources.

This study focused on revenue generation activities for BMTC land parcels. The existing land parcels were categorised as developed, partially developed and undeveloped. Because master plans were not available, the study considered undeveloped land parcels only within the Bengaluru Development Authority (BDA) jurisdiction, and not those in other areas, for economic activity analysis. The potential undeveloped land parcels were identified based on their existing land-use, proposed land-use and approach roads. For these select land parcels, suitable economic activities were proposed.

The proposed activities for undeveloped land parcels were based on Zonal Regulations and Proposed Land-Use, BDA Revised Master Plan, 2031. For public and semi-public land-use, BMTC can consider developing educational and medical institutions. Similarly, for land parcels proposed for residential use, BMTC can consider joint development (with other entities) for residential projects. For other undeveloped land parcels with areas greater than 10 acres, BMTC can consider renewable energy generation under the open access model[1].

[1] https://amplussolar.com/blogs/what-is-open-access-in-power-sector

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1. Introduction

BMTC generates revenue from traffic and non-traffic sources. The traffic revenue includes revenue from sale of tickets and monthly pass. The non-traffic revenue includes revenue from advertisements as well as commercial activities at traffic and transit management centres and bus stations.

The gross revenue for BMTC in 2016-17 was INR 2,106 crore, of which traffic revenue contributed to INR 1,770 crore (~84%), while non-traffic contributed to INR 336 crore (16%). During the period 2015-2017, BMTC witnessed a reduction of 6% in traffic revenue. During the same period, non-traffic revenue increased by 13%. To increase the non-traffic revenue, BMTC established Traffic Transit Management Centres (TTMC). These centres function as BMTC bus stands/interchange stations and also provide space on lease for commercial activities.

In addition to TTMCs, depots and workshop land parcels, BMTC has other land parcels in and around Bengaluru. A significant fraction of these parcels lie vacant. Given the potential for non-traffic revenue generation from commercial activities, BMTC needs to explore ways to monetise its land parcels. This additional revenue can help strengthen the financial health of BMTC. This study suggests ways by which BMTC can monetise its land resources.

2. Log Frame/Theory of Change/Programme Theory

BMTC has more than 200 land parcels in and around Bengaluru. The study suggests ways for monetising these land resources to supplement BMTC's overall revenue.

	Intervention Logic	Verifiable Indicators of Achievement	Sources and Means of Verification	Assumptions
Overall Objectives	*What are the overall broader objectives to which the activity will contribute?* • Generation of non-traffic revenue from BMTC's land resources	*What are the key indicators related to the overall objectives?* • List of developable land parcels • Potential economic activities at these land parcels	*What are the sources of information for these indicators?* • List of existing land parcels from BMTC • Existing land-use map (BDA, Revised Master Plan, 2015) • Proposed land-use plan (BDA, Revised Master Plan, 2031) • Zonal regulations, (BDA, Revised Master Plan, 2031)	*Availability of appropriate data sets related to BMTC land resources*
Specific Objectives	*What specific objectives is the activity intended to achieve to contribute to the overall objectives?* • To explore potential of BMTC land parcels for revenue generation • To suggest suitable economic activities for select land parcels	*Which indicators clearly show that the objective of the activity has been achieved?* • List of developable land parcels • List of existing economic activities around the land parcel • List of permissible activities as per zonal regulations • List of potential economic activities at these land parcels	*What are the sources of information that exist or can be collected? What are the methods required to get this information?* • Existing land-use map (BDA, Revised Master Plan, 2015) • Proposed land-use plan (BDA, Revised Master Plan, 2031) • Zonal regulations (BDA, Revised Master Plan, 2031) • Site visits	*Which factors and conditions outside the PI's responsibility are necessary to achieve that objective? (external conditions)* *Which risks should be taken into consideration?* • Data availability of BMTC land parcels • Exact location and plot boundary of the BMTC land parcels

Expected Results	*The results are the outputs envisaged to achieve the specific objective.* *What are the expected results? (enumerate them)* • Potential economic activities for select land parcels	*What are the indicators to measure whether and to what extent the activity achieves the expected results?* • The feasibility of the land parcel to host suggested economic activities	*What are the sources of information for these indicators?* • Economic potential for the suggested activity • Predominant activities in the surrounding areas	*What external conditions must be met to obtain the expected results on schedule?* • Timely availability of information on existing and proposed activities for the select land parcel from BMTC
Activities	*What are the key activities to be carried out and in what sequence in order to produce the expected results?* *(group the activities by result)* 1. Collection of data on existing land parcels from BMTC 2. Land parcel analysis (existing and proposed land-use analysis) 3. Identification of potential land parcels based on data availability 4. Suggest suitable economic activities in select land parcels	***Means:*** *What are the means required to implement these activities, e. g. personnel, training, studies, etc.* • Existing land-use map (BDA, Revised Master Plan, 2015) • Proposed land-use plan (BDA, Revised Master Plan, 2031) • Zonal regulations (BDA, Revised Master Plan, 2031) • Site visits	*What are the sources of information about action progress?* • List of developable land parcels • List of suggested activities for select land parcels	*What pre-conditions are required before the action starts?* • Timely availability of existing and proposed activities for the select land parcels from BMTC

3. Problem Statement

To increase BMTC's non-traffic revenue by monetising the existing BMTC land resources

BMTC's non-traffic revenue is currently less than 20% of its total revenue, which can be increased significantly by utilising its land resources. BMTC has 237 land parcels in and around Bengaluru. Of these parcels, BMTC has developed 86 land parcels for various purposes such as TTMCs, bus stands and depots with additional activities (workshops, quarters, etc.). However, there are many land parcels whose potential for economic activities are yet to be determined. Appropriate utilisation of these land parcels can increase the share of non-traffic revenue to supplement BMTC's operational revenue.

4. Objectives and Issues for Evaluation

Objectives:

- To explore potential of BMTC land parcels for revenue generation
- To suggest suitable economic activities for select land parcels

Scope:

- Geographical Coverage: Existing BMTC land parcels for which the necessary land-use data (existing and proposed) is available

5. Evaluation Design

5.1. Information Sources

Primary Source: The primary source comprised site visits (field survey) to select land parcels, based on secondary data analysis. This survey helped validate the land parcel details as well as the neighbouring land-use pattern and activity centres. It also helped shortlist potential economic activities for that land parcel.

Secondary Sources:

- BMTC land parcel data: Location, survey number, area of land and current status of development
- Existing land-use map of Bengaluru: BDA, Revised Master Plan, 2015
- Proposed land-use plan of Bengaluru: BDA, Revised Master Plan, 2031
- Approach roads: BDA, Revised Master Plan, 2031

6. Evaluation Methodology

The work process has been detailed below:

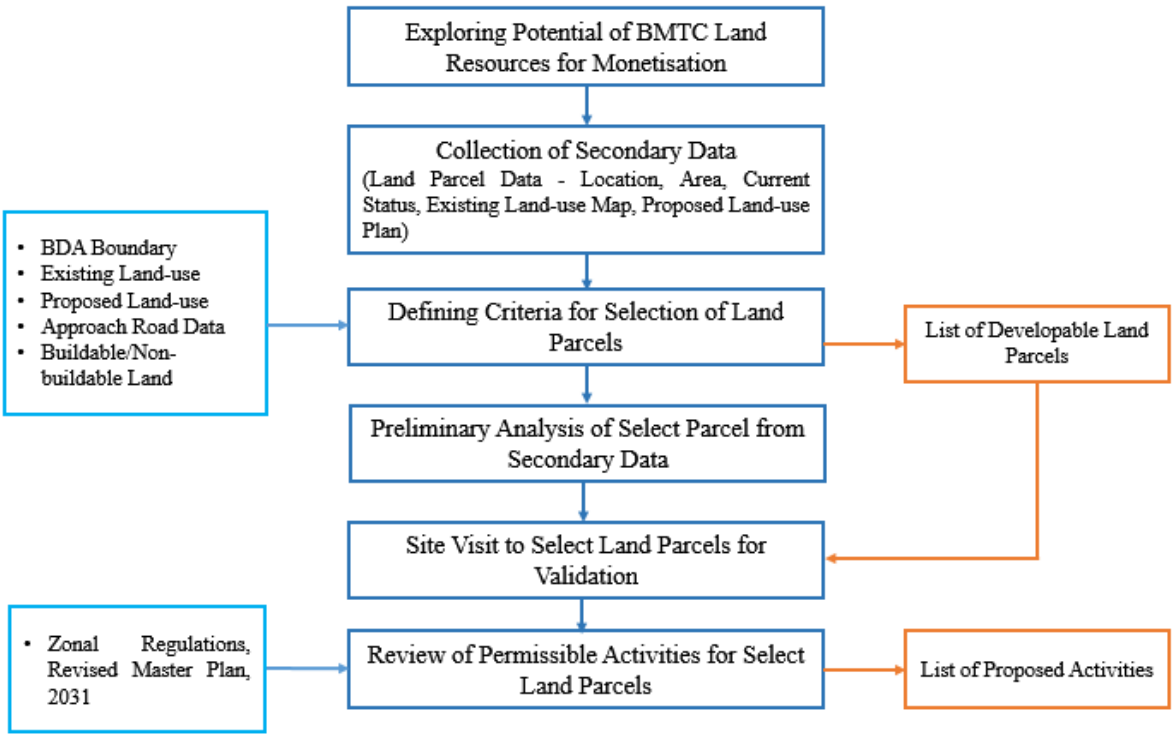

Figure 1: Methodology for identifying potential land parcels and economic activities

7. Data Collection and Analysis

The list of existing land parcels was collected from BMTC. The data includes location of the land parcel (village/hobli/taluk), survey number, area in acres and guntas[2], and current status of development. The complete land parcel data list is given in Annexure 1.

BMTC has approximately 1,052 acres of land in and around Bengaluru. For the study, these land parcels were divided into three categories:

- Developed – TTMCs, bus stands and depots with additional activities (workshops, quarters, etc.)
- Partially developed – Depots with no other activity
- Undeveloped – Vacant land parcels with no activities

[2] 1 Acre = 40 Guntas

Details of land parcels under each of these categories is given in Table 1.

Table 1: Details of land parcels with BMTC

Sl. No.	Land Parcel Category	No. of Land Parcels	Area (Acre)
1	Developed	86	216
2	Partially Developed	37	179
3	Undeveloped	114	657
	Total	237	1,052

BMTC has 63% of the land in the undeveloped category, 17% in the partially developed category and 20% of the land in the developed land parcel category. This study identifies the potential for economic activities that can be carried out in the undeveloped land parcels. Out of these undeveloped land parcels, a few are outside the Bangalore Development Authority (BDA) boundary. The local planning authorities outside BDA are:

1. Bengaluru International Airport Area Planning Authority (BIAAPA)
2. Hosakote Planning Authority
3. Nelamangala Planning Authority
4. Anekal Planning Authority
5. Ramnagara Channapatna Urban Development Authority (RCUDA)
6. Kanakpura Planning Authority
7. Magadi Planning Authority

As the master plans of these areas were not available in the appropriate format, land parcels only within the BDA jurisdiction were considered for further study. The criteria considered for selecting the land parcels are given in the next section.

7.1. Criteria for Selection of Land Parcels

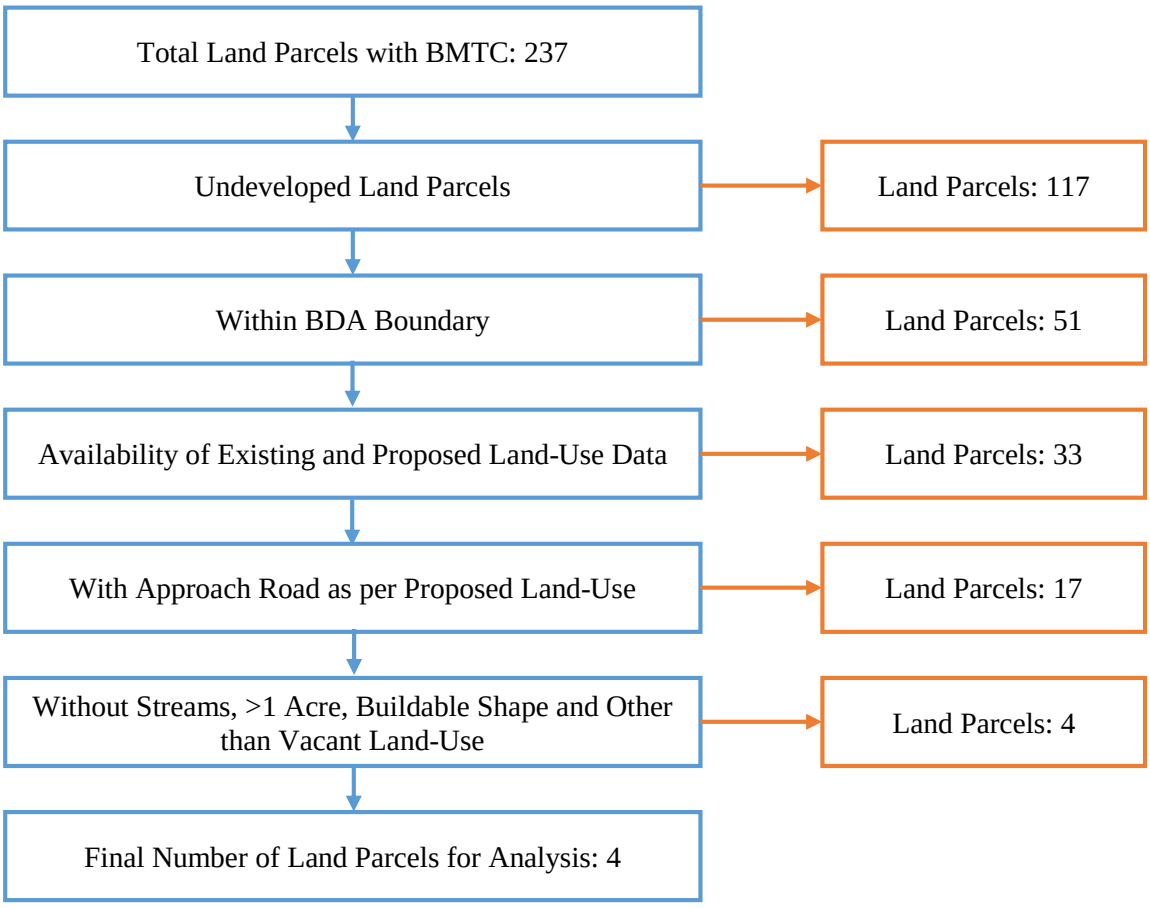

Figure 2: Methodology for selection of land parcel

Figure 2 presents the process used for selecting the appropriate land parcels for the study. The broad criteria include selection of undeveloped land parcels within the BDA jurisdiction with existing and proposed land-use data. Further, the undeveloped land parcels that have their proposed land-use as 'vacant' could not be considered. Also, undeveloped land parcels that have no approach road could not be considered for further analysis. Thus, a final list of developable land parcels was arrived at (as shown in Table 2):

Table 2: Final list of land parcels

Location/Village	Area (Acre-Gunta)	Existing Land-Use	Proposed Land-Use	Approach Road
Gunjurpalya, Varthur	20-0	Vacant	Public Semi Public (P/SP)+ recreation	Approach roads (30 m wide, 15 m wide, 12 m wide)
		Vacant	Transportation + (P/SP)	Approach roads (45 m wide, 12 m wide)
Nimbekaipura, Bidarahalli	3-0	Agriculture	Residential	12 m wide approach road
Kaji Sonnenahalli, Bidarahalli	2-0	Agriculture	Public Utility	18 m wide road (going through adjoining survey number)
Doddabanahalli, Bidarahalli	2-0	Agriculture+ residential+ recreational	Residential	24 m wide approach road, 18 m road on one side and 12 m road through the survey number

7.2. Economic Activity Analysis

For the economic analysis of the potential land parcels, the following steps were carried out:

- Identifying of existing activities surrounding the land parcel, based on satellite imagery (Google Earth)
- Reviewing the proposed economic activities as per proposed land-use and zonal regulations (BDA 2007, 2017b)
- Conducting site visit to validate the secondary analysis
- Proposing potential economic activities based on secondary research and primary site visits

7.3. Land Parcel and Economic Activity Analysis - Gunjurpalya, Varthur Hobli

7.3.1. Land Parcel Details

- Survey no. 53 & 109
- Area – 20 Acres
- Existing land-use – Vacant
- Proposed land-use – Public/Semi-Public and Transportation

7.3.2. Existing Land-Use

As per the BDA Revised Master Plan, 2015, the existing land-use of the BMTC land parcel is 'vacant'. The surrounding land-use within a radius of 1 km is also predominantly vacant. A few residential developments, agricultural land and educational institutions lie close to the site. There is an industrial corridor (Information Technology companies) at a distance of approximately 3 km to the west (Figure 3).

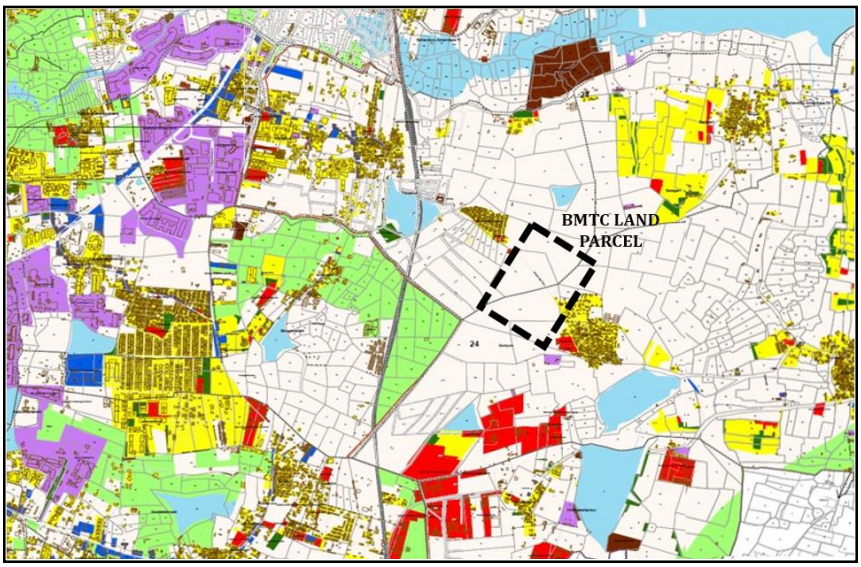

Figure 3: Existing land-use, Gunjurpalya

7.3.3. Proposed Land-Use

As per the BDA Revised Master Plan, 2031, the proposed land-use of the BMTC land parcel is public/semi-public (~13 acres) and transportation (~7 acres). The surrounding land-use is predominantly residential. This land parcel falls in the public/semi-public belt as per the proposed land-use plan (Figure 4).

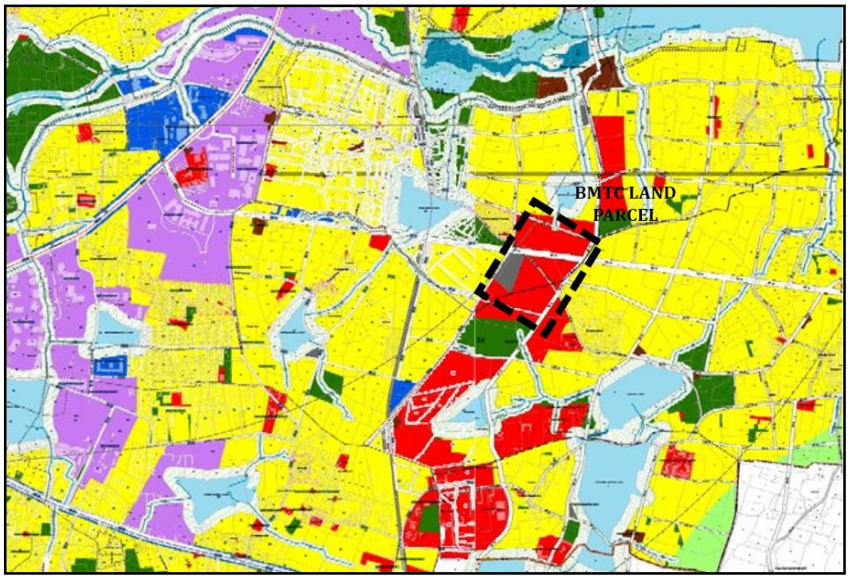

Figure 4: Proposed land-use, Gunjurpalya

7.3.4. Existing Activities

There are approximately 3 community halls, 16 schools and 12 hospitals within a radius of 5 km from the land parcel. The majority of these public and semi-public establishments are located on the west side of the land parcel (Figure 5). Very less development is seen towards the east of this land parcel.

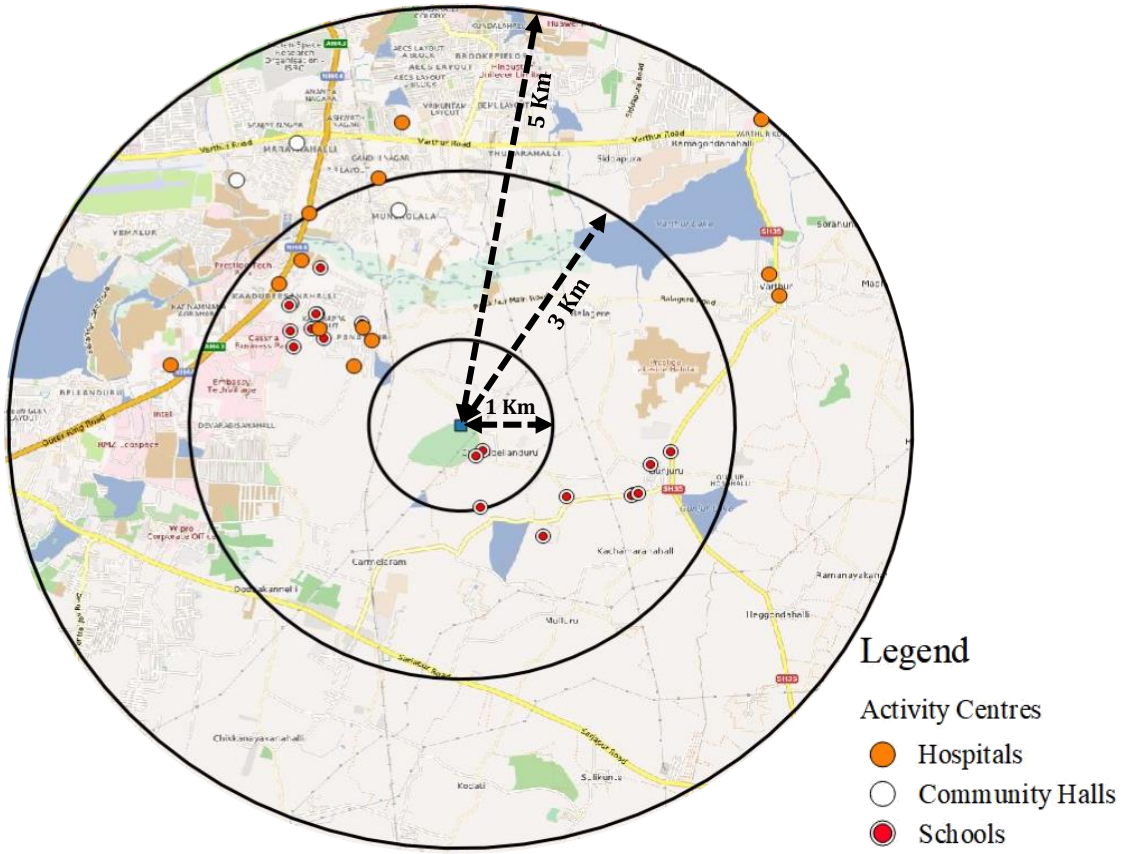

Figure 5: Existing economic activities, Gunjurpalya

7.3.5. Permissible Activities

For the select land parcels, a list of permissible activities was prepared based on the Zonal Regulations, BDA Revised Master Plan, 2031(BDA 2017a). This list of activities is represented in Table 3.

Table 3: Permissible activities as per Zonal Regulations

Traffic and Transportation	Public & Semi-Public
• Retail shops • Restaurants and hotels • Showrooms • Offices • Boarding and lodging houses • Banking counters • Indoor recreational uses • Multiplexes • Clubs	• Government administrative centres, district offices, law courts, jails, police stations • Institutional offices • Health facilities (including health tourism) • Educational, cultural and religious institutions • Community halls, working hostel facilities • Convention centres of non-commercial nature • Sub-offices of utilities • All uses permissible in parks and open spaces

7.3.6. Proposed Economic Activities

The study analysed existing and permissible activities to propose a set of economic functions to help BMTC monetise this land parcel.

- **Hospital:** Although there are a number of hospitals to the west of this land parcel, it was observed that there is an upcoming residential development to the east of this land. This would need to be served by a world-class hospital, which could be developed on the public/semi-public portion of the Gunjurpalya land parcel.
- **College:** The analysis also revealed that there is currently just one reputed college in a 5 km vicinity of the site. Given that upcoming residential areas surrounding the

BMTC land parcel would require quality higher educational institutions, such institutions could be established on this land parcel.

- **Hotel:** As this land parcel is near the IT corridor, there is a need for high-quality hotels catering to the people visiting these IT companies. Currently there are few quality luxury hotels along this corridor. Thus, the land parcel designated for 'transportation' land-use could be used to set up a luxury hotel.

7.4. Land Parcel and Economic Activity Analysis – Nimbekaipura, Bidarhalli Hobli

7.4.1. Land Parcel Details

- Survey no. 52
- Area – 3 Acres
- Existing land-use – Agriculture
- Proposed land-use – Residential

7.4.2. Existing Land-Use

As per the BDA Revised Master Plan, 2015, the existing land-use for this BMTC land parcel is agriculture. This parcel is situated near the Old Madras Road. The surrounding land-use is predominantly agriculture, followed by vacant and industrial (Figure 6).

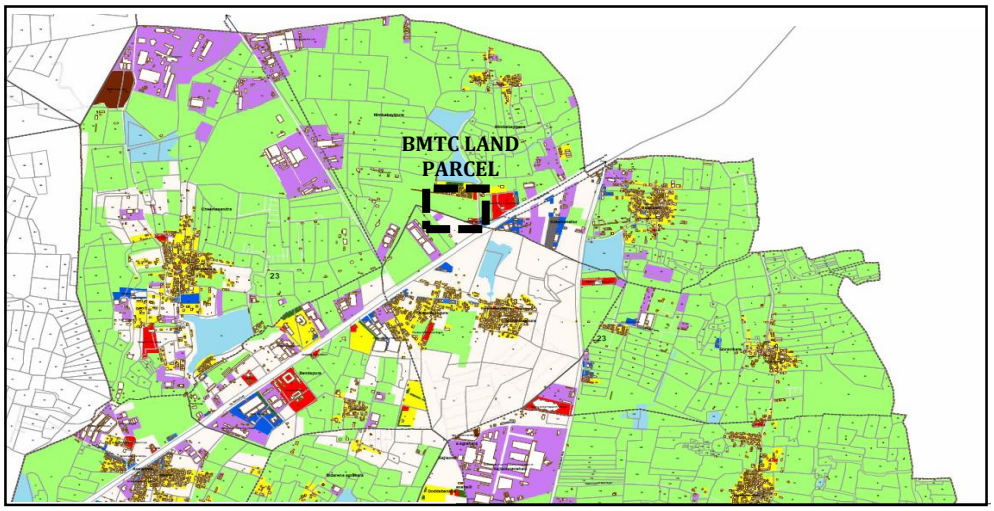

Figure 6: Existing land-use, Nimbekaipura

7.4.3. Proposed Land-Use

As per the BDA Revised Master Plan, 2031 (BDA 2017a), the proposed land-use for this BMTC land parcel is residential. The adjoining land parcels are proposed for transportation, commercial, industrial and public/semi-public use (Figure 7).

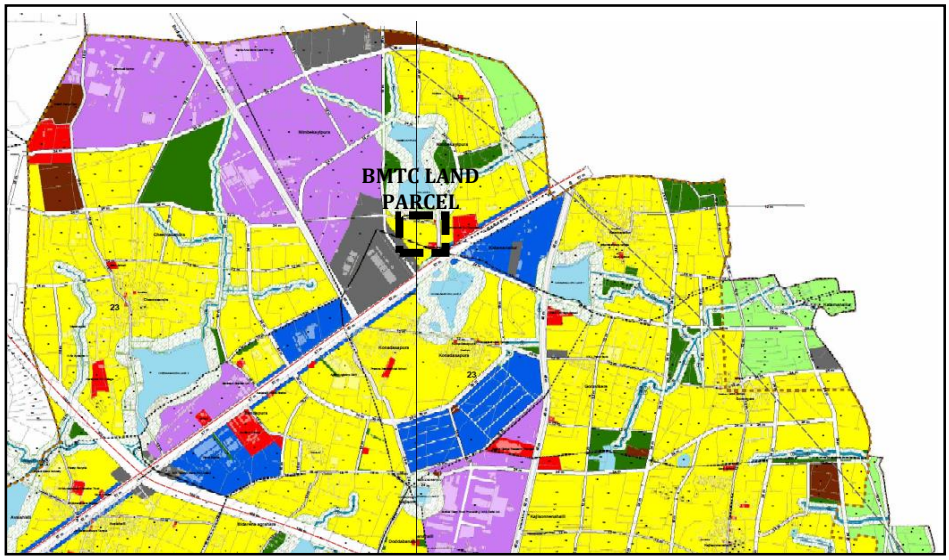

Figure 7: Proposed land-use, Nimbekaipura

7.4.4. Existing Activities

This land parcel has about 10 residential apartments, 9 schools and 1 hospital within a radius of 3 km from the land parcel. A few plotted developments were seen in the surroundings (Figure 8).

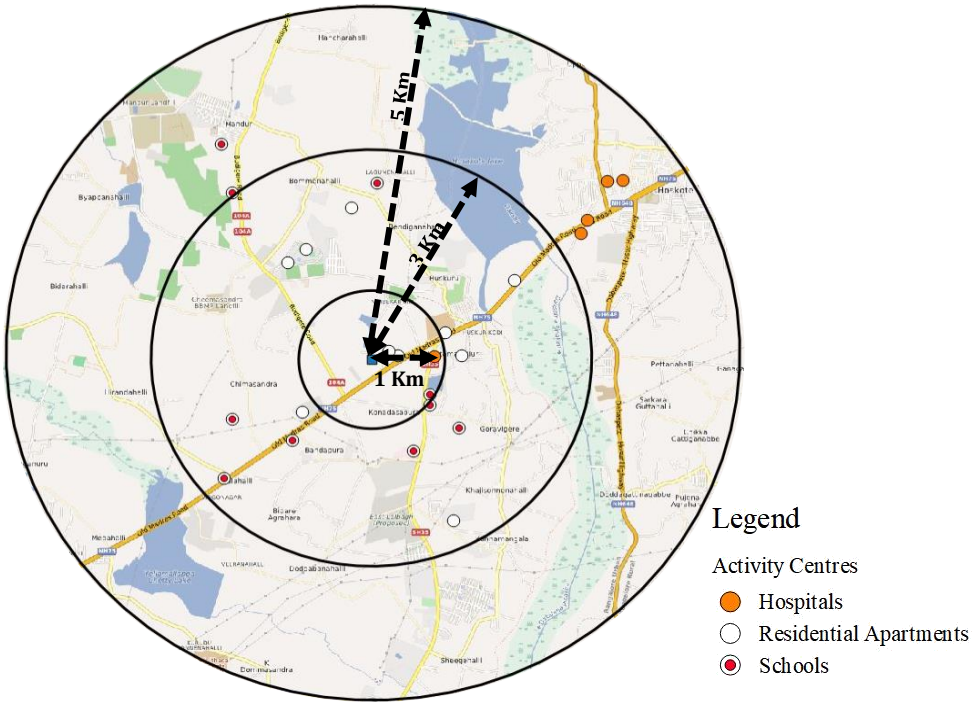

Figure 8: Existing economic activities, Nimbekaipura

7.4.5. Permissible Activities

Based on the Zonal Regulations, BDA Revised Master Plan, 2031 (BDA 2017b), the permissible activities for residential land-use are:

- Plotted Residential Development
- Villas, Semi-detached Houses
- Apartments, Hostels, Dharmashala
- Multi Dwelling Housing, Service Apartment
- Group Housing

7.4.6. Proposed Economic Activities

The study analysed existing and permissible activities to propose a set of economic functions that could be implemented to help BMTC monetise this land parcel. For this land parcel, the following activity has been proposed:

- **Residential Apartments:** This land parcel is adjoining a national highway (Old Madras Road), connects to a proposed employment hub (industrial corridor) and is in close proximity to the Bengaluru International Airport. This, along with the permissible zonal regulations, makes it an ideal choice for multi-storied apartments.

7.5. Land Parcel and Economic Activity Analysis – Kaji Sonnenahalli, Bidarhalli Hobli

7.5.1. Land Parcel Details

- Survey no. 22
- Area – 2 Acres
- Existing land-use – Agriculture
- Proposed land-use – Public Utility

7.5.2. Existing Land-Use

As per the BDA Revised Master Plan, 2015, the existing land-use for BMTC land parcel is agriculture. The predominant surrounding land-use for this land parcel is also agriculture (Figure 9).

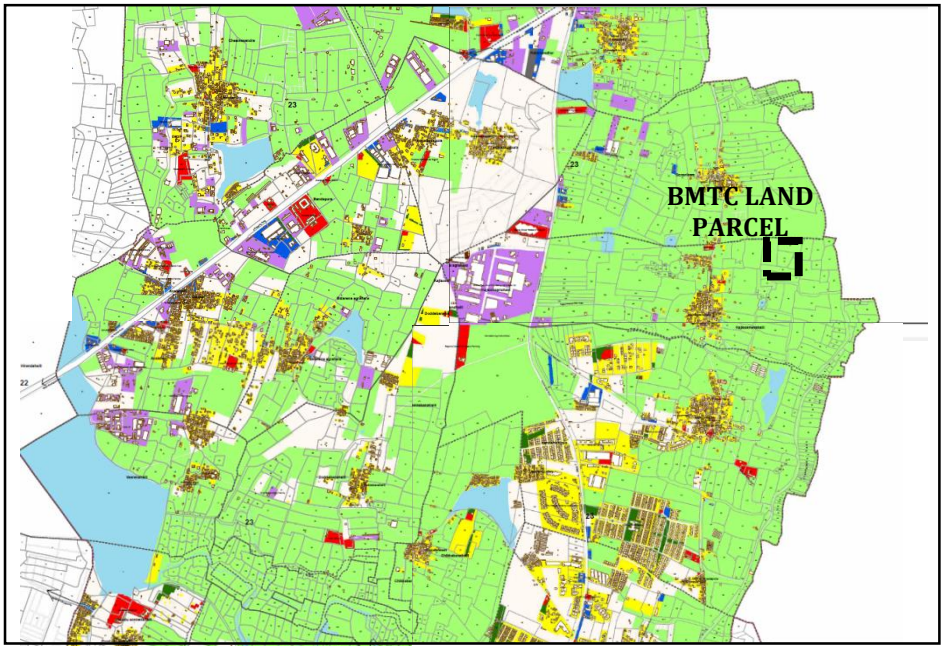

Figure 9: Existing land-use, Kaji Sonnenahalli

7.5.3. Proposed Land-Use

As per the BDA Revised Master Plan, 2031 (BDA 2017a), the proposed land-use for the BMTC land parcel is public utility. The proposed land-use for the surrounding area is predominantly residential (Figure 10).

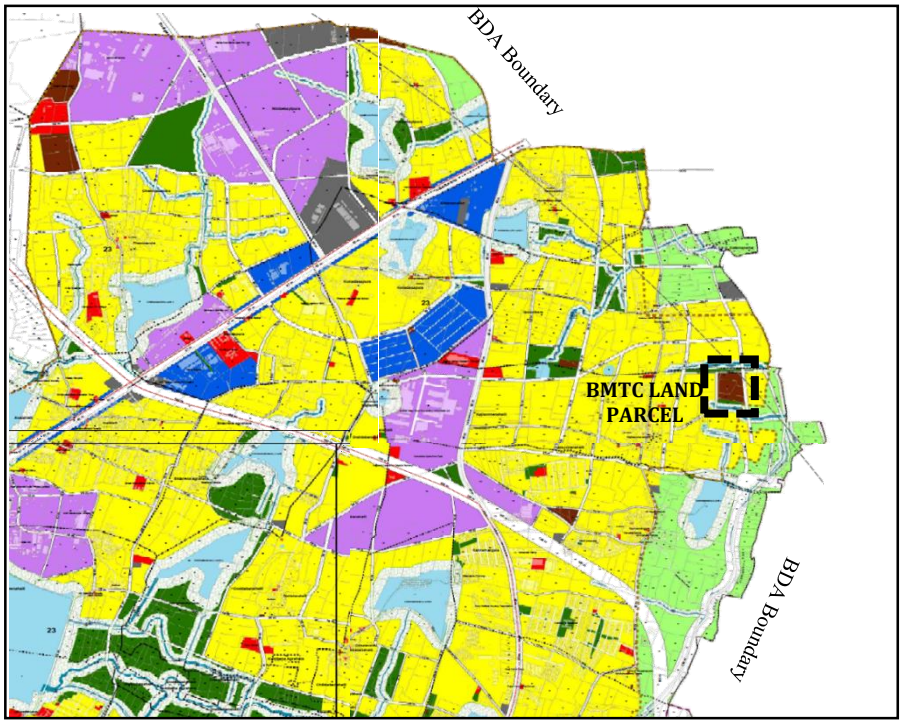

Figure 10: Proposed land-use, Kaji Sonnenahalli

7.5.4. Existing Activities

There are a few residential apartments, 12 schools and 2 hospitals within a radius of 5 km from this land parcel. Development is seen to the west of the land parcel (3 km) and rural habitations are seen to the east (Figure 11).

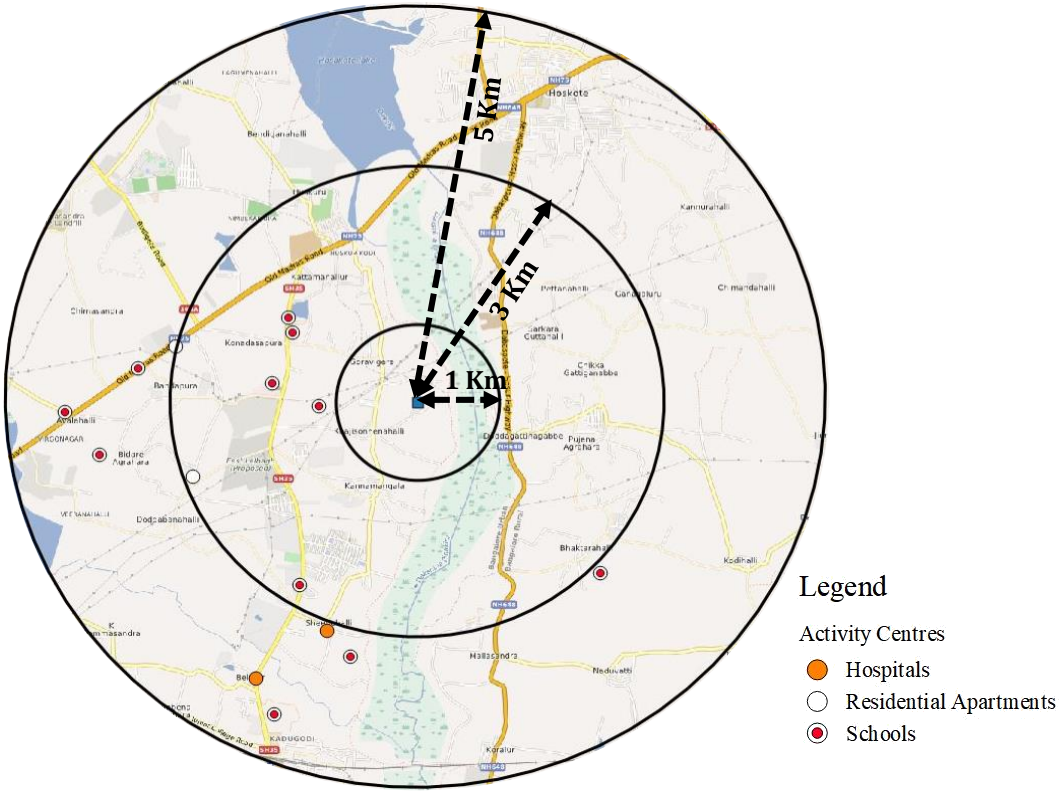

Figure 11: Existing economic activities, Kaji Sonnenahalli

7.5.5. Permissible Activities

Based on the Zonal Regulations, BDA Revised Master Plan, 2031 (BDA 2017a), the permissible activities for public utility are listed below.

- Solid Waste Landfills
- Water Treatment Plants
- Power Plants
- Fuel Stations
- Transformers and Microwave Towers

7.5.6. Proposed Economic Activities

The study analysed existing and permissible activities, and the following activity was proposed for this land parcel:

- **Fuel Stations:** In the proposed land-use, the area surrounding this land parcel is predominantly residential. This area is likely to witness high private vehicle ownership, which would generate demand for setting up a petrol pump.

7.6. Analysis of Land Parcels above 5 Acres

After consultations with the stakeholder (BMTC), the land parcel analysis has been revised to exclude land parcels under litigation and include land parcels with area greater than or equal to 5 acres. Based on the land area criteria, 29 land parcels which fall within and outside the BDA boundary are shortlisted for exploring the development potential.

Out of these land parcels, 13 land parcels have an area between 5 and 10 acres and 16 land parcels have an area above 10 acres. Of the 16 land parcels greater than 10 acres, 6 land parcels are within the BDA boundary and the remaining fall under different planning authorities (BMICAPA[3], Anekal, Magadi, Hoskote, Nelamangala and BIAAPA[4]).

7.6.1. Land Parcel Analysis: Area above 10 Acres

The following table shows the details for land parcels with an area above 10 acres.

Table 4: Land parcels with area more than 10 acres

Location	Area (Acre)	LPA	Proposed (RMP 2021/2031)	Approach Road
Bagalur	13	BDA	Open space/Parks/ Recreation	No proposed approach road
Bukkasagara	10	Anekal	Transportation	Road proposed for widening passing through the property to ~~18M~~18m
Byalakere	30	BDA	Agriculture	24m, 15m and 12m wide road through the survey number
Chagalahatti	10	BDA	Agriculture	Kuccha approach road
Chunchanaguppe	10	Magadi	Residential	40-m road proposed
Kadagrahara	18	BDA	Agriculture	No approach road, one kuccha road along the survey number
Kadaranahalli	21	BDA	Agriculture	Kuccha road
Madhugirihalli	15	BDA	Agriculture	Kuccha road

[3] BMICAPA – Bangalore Mysore Infrastructure Corridor Area Planning Authority
[4] BIAAPA – Bengaluru International Airport Area Planning Authority

Mattahalli	16	Nelamangala	Reservoir catchment area, no development proposed	Roads are proposed
Sadenahalli	10	BIAAPA	Special Agriculture Zone	Road inventory unknown
Sulivara	10	Magadi	Forest/Hillock	Road inventory unknown
Thotagere	13	Nelamangala	Reservoir catchment area, no development proposed	Roads exists, condition and width not known

The above table shows that, there are three land parcels with potential for development based on proposed land use. The Bagalur land parcel has been proposed for open space and parks but has no approach road, Bukkasagara has been proposed for transportation use and also has a proposed 18 m wide approach road. The third potential land parcel is Chunchanaguppe which is proposed for residential development and has a 40m wide proposed road nearby.

Three other land parcels – Mattahalli, Sulivara and Thotagere fall either in a forest/hillock region and reservoir catchment area. Hence these are not suitable for development.

Remaining land parcels have proposed land use as agriculture and hence feasibility for solar parks can be checked out for these land parcels.

7.6.1.1. Land Parcels Feasible for Solar Parks

Land parcels which are above 10 acres also offer the possibility of setting up solar parks whose energy generation and feeding back to the grid could benefit BMTC directly or indirectly. A preliminary topographical analysis of the 10 acre land parcels indicate that there are 8 land parcels which have the potential for establishing solar parks. The analysis further maps these land parcels to the nearest sub-stations. Table 5 gives details of the same.

Table 5: Feasible parcels for solar park

Sl. No.	Location	Nearby Substation Name
1	Bukkasagara	Jigani 66/11 kV
2	Byalakere	Yelahanka 66/11 kV
3	Chunchanakuppe	Soladevanahalli 66/11 kV
4	Jadigenahalli	Jadigenahalli 66/11 kV
5	Kadaranahalli	Peenya 220/66/11 kV

6	Madhugirihalli	KIADB Doddaballapura 220/66/11 kV
7	Mathhalli	Nelamangala 66/11 kV
8	Sadenahalli	Rajanukunte 66/11 kV

The following figure shows location of the land parcels feasible for solar parks and the nearest substation. Most of these land parcels are located in the North-East of Bengaluru. Out of eight feasible land parcels, 3 fall within the BDA boundary.

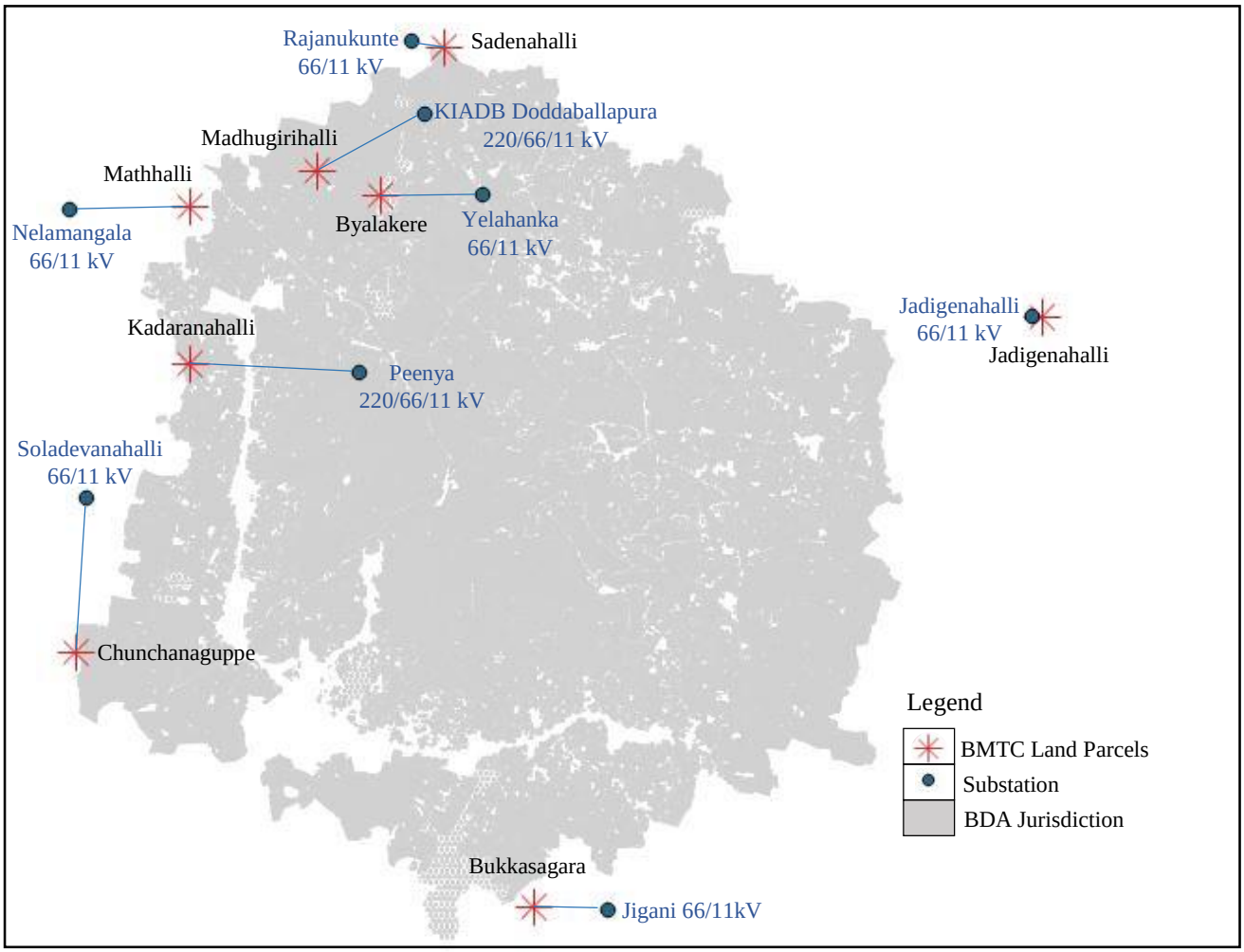

Figure 12: Land parcels feasible for solar parks

7.6.2. Land Parcel Analysis: Area between 5 and 10 Acres

Table 6 shows the land parcels with area 5-10 acres. Of the 12 land parcels, no development has been proposed for 5 land parcels as per the proposed master plan. These land parcels majorly fall in the reservoir catchment area or within 2km from river. Hence these parcels are not suitable for development.

Four other land parcels have been proposed for developable land use. Kalanayakanahalli land parcel has been proposed for transportation land use, but the surroundings are still undeveloped.

Arebinnamangala which falls within BIAAPA boundary, has been proposed for industrial development. Kannur falls along the proposed commercial corridor with commercial as well as residential land use proposed. This land parcel has a 36m wide road (commercial corridor) and other 12m approach road running through the survey number. This parcel has good scope for development. The Somanahalli land parcel has been proposed for public /semi-public and residential use and has 18m and 12m wide approach roads.

Other two land parcels are proposed for agriculture and one of them at Shivakote has 12m wide proposed approach road. This parcel can be considered for activities permissible in agriculture land use.

Table 6: Land parcels with area 5-10 acres

Location	Area (Acre)	LPA	Proposed Land use (RMP 2021/2031)	Approach Road	Remarks
Arebinna mangala	7	BIAAPA	Industrial	No approach road seen	
Bettahalli	6	Nelamangala	2 km from the river Arkavathi river, no development proposed	No development proposed	Plain agriculture land seen from google earth image, approach road nearby.
Bommashettihalli	5	Nelamangala	Reservoir catchment area, no development proposed	60 m wide road proposed through the site, 8m and 7m internal roads proposed	Plantation and agriculture land seen from satellite image, with approach roads nearby.
Gollarapalya	5	Nelamangala	Reservoir catchment area, no development proposed		Agriculture land with no approach roads.
Kalanayakanahalli	5	Anekal	Transportation	Village road	Tree plantation and residential construction seen from google earth image.

Kannur	5	BDA	Residential+ commercial	36m wide/12m wide	12m wide road goes through the survey number, commercial corridor along 36m wide road. Good scope of development if site is along 36m road or in the north part of the survey number
Kengeri Additional land Kengeri	7	BMICAPA		45m wide roads (Bangalore-Mysore highway and nice ring road) crossing nearby. Approach road - Bangalore Mysore highway	Vacant land with plantation
Sadenahalli	5	BIAAPA	Special Agriculture Zone		
Shivakote	6	BDA	Agriculture	12m road proposed	Vacant land with plantation satellite image.
Somanahalli	5	Kanakpura	Public Utility (majority of the survey no.) and partly residential	18m and 12m village roads through the survey no	Based on the survey no. and the lat/long, the land parcel comes under forest/hillock area. Survey no 60 is a huge land parcel
Venkatapura	8	Nelamangala	Reservoir catchment area, no development proposed.	Roads exists, condition and width not known Planned tree plantation seen	Agriculture land with kuccha roads
Venkatapura	6	Nelamangala	Reservoir catchment area, no development proposed.	Roads exists, condition and width not known	

8. Findings and Discussions

The scope for developing BMTC's land parcels depends on their location, approach roads as well as permissible and existing activities.

Incomplete information regarding the land parcel boundary, appropriate demarcation of land through signage, location details and litigation is the major constraint for data analysis.

The nature of ownership of BMTC land parcels and the terms associated with BMTC leasing land parcels to third parties for development require a detailed analysis. The conditions under which BMTC can develop its land parcels also require further investigation. This is especially true because these land parcels have been purchased from the Government of Karnataka and the terms and conditions applicable for their development are not currently known to CSTEP.

9. Conclusion and Recommendations

In this study, BMTC land parcels were analysed to suggest suitable economic activities for generating additional non-traffic revenue. As the revenue from traffic has been decreasing for the last few years, monetisation of BMTC's land resources can supplement its overall revenue.

The proposed activities for undeveloped land parcels were based on Zonal Regulations and Proposed Land-Use, BDA Revised Master Plan, 2031. For public and semi-public land-use, BMTC can consider developing educational institutions and medical establishments. Similarly, for land parcels with proposed land-use as residential, BMTC can consider joint development for residential projects.

For other undeveloped land parcels with areas greater than 10 acres, BMTC can consider renewable energy generation under the open access model. BMTC pays a commercial rate of electricity to BESCOM (Bangalore Mirror 2017), so exploring the open access model can help BMTC cut down on power charges.

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Annexure I

List of BMTC Land Parcels

Sl.No	Location Details - Locality/Village	Hobli	Taluk	Survey No./Site No.	Extent of land (Acre-Gunta)		Latest status
1	Aduru	Bidarahalli	East	74	21	0	Vacant
2	Agara	Kengeri	South	73	1	20	Vacant
3	Anjanapura 10th Block	Uttarahalli	South	CA-14	1	36	Depot-44
4	Anjanapura 5th Block	Uttarahalli	South	CA-13	0	23	Vacant (compound)
5	Arebinnamangala	Jala	North(add)	23	7	0	Vacant
6	Arehalli	Uttarahalli	South	28	10	0	Vacant (compound)
7	Austin Town		North	CA-12	0	14	Bus stand
8	Bagalur	Jala	North(add)	271	13	0	Vacant (Fenced)
9	Baiyappanahalli	Bidarahalli	East	44	3	10	Vacant
10	Banashankari	Uttarahalli	South	7	2	15	TTMC
11	Banashankari (Karisandra)	Uttarahalli	South	CA-4A	3	31	Depot-20
12	Banashankari 3rd Stage 2nd Phase	Uttarahalli	South	CA	0	21	Bus stand
13	Bandebommasandra	Bidarahalli	East	38	3	20	Vacant
14	Bannerghatta	Jigani	Anekal	20	2	0	TTMC
15	Basaveshwaranagara	Yashavanthapura	North	CA	1	12	Bus stand
16	Bendiganahalli	Bidarahalli	East	50	1	10	Vacant
17	Bettadasanapura	Beguru	South	20	5	0	Vacant
18	Bettahalli	Dasanapura	North	30	6	0	Vacant (compound)
19	Bettahalli	Dasanapura	North	38	3	0	Vacant (compound)
20	Bharathnagar (Magadi road)	Yashavanthapura	North		0	28	Vacant (Fenced)
21	Bhutanahalli	Jigani	Anekal	114/1	3	30	Vacant
22	BIAL	Yalahanka	Devanahalli	2	1	14	Vacant
23	Bidadi	Bidadi	Bidadi	28B	5	0	Depot-36
24	Bidadi	Bidadi	Bidadi	16,17	2	26	Vacant
25	Bidadi	Bidadi	Bidadi	42/3	0	33	Bus stand
26	Bidadi	Bidadi	Bidadi	18	3	33	Depot under construction
27	Bidaraguppe	Attibele	Anekal	366	2	0	Vacant
28	Bidaraguppe	Attibele	Anekal	331	1	4	Vacant
29	Bidaraguppe	Attibele	Anekal	437	0	32	Vacant (compound)
30	Bommashettihalli	Dasanapura	North	61	5	15	Vacant (compound)
31	Bommenahalli	Bidarahalli	East	96	2	2	Vacant
32	BTM Layout	Beguru	South	CA	0	15	Bus stand under construction
	BTM Layout	Beguru	South	CAI	1	21	
	BTM Layout	Begurt	South		0	19	
33	BTM Layout Quarters	Beguru	South	12 Nos.			Quarters
34	Bukkasagara	Jigani	Anekal	97	10	0	Vacant (compound)
35	Byalakere	Hesaraghatta	North(add)	130	30	0	Vacant
36	Bylakonenahalli	Dasanapura	North	21	1	4	Vacant(compound)
37	Byrathi	Bidarahalli	East	28	7	0	Depot-48
38	Chagalahatti	Jala	North(add)	102	10	0	Vacant

Sl.No	Location Details - Locality/Village	Hobli	Taluk	Survey No./Site No.	Extent of land (Acre-Gunta)		Latest status
39	Challagatta	Kengeri	South	13	5	0	Workshop construction
40	Chandra Layout		North	CA-345	2	10	Depot-17
41	Channamanakere	Uttarahalli	South	CA	0	18	Bus stand
42	Chikkabettahalli	Yalahanka	North(add)	14	10	24	Depot-47
43	Chikkamaranahalli		North	CA-20	0	32	Bus stand
44	Chikkanagamangala	Sarjapura	Anekal	189	1	12	Quarters
45	Chikkanagamangala	Sarjapura	Anekal	29	10	0	Depot-38 & RTO Track
46	Chikkelur	Tavarekere	South	35/3	0	31	Vacant
47	Chimasandra	Bidarahalli	East	83	3	25	Vacant
48	Chinthalamadivala	Sarjapura	Anekal	17	2	0	Vacant
49	Chokkanahalli	Hesaraghatta	North(add)	6	10	0	Vacant(compound) & RTO Track construction
50	Chunchanaguppe	Tavarekere	South	43	10	0	Vacant
51	Dasanapura	Dasanapura	North	106	13	4	Depot-40 & Workshop under construction.
52	Deepanjalinagara	Kengeri	South	KIMCO	3	0	Depot-16
53	Devanahalli	Kasaba	Devanahalli	3,04,305	2	23	Depot under construction
54	Doddabanahalli	Bidarahalli	East	3	2	0	Vacant
55	Doddajala	Jala	North(add)	46	2	0	Vacant
56	Dodderi	Tavarekere	South	77	10	0	Vacant
57	Dombarahalli	Dasanapura	North	18	5	27	Vacant
58	Domlur		North	CA	0	15	TTMC
	Domlur		North	CA	0	39	TTMC
59	Electronic City	Beguru	South	36 (p)	2	10	Depot-19
60	Gattihalli	Sarjapura	Anekal	175	1	39	Vacant(compound)
-61	Gattihalli	Sarjapura	Anekal	216	1	18	Vacant
62	Gollarapalya	Dasanapura	North	28	5	0	Vacant
63	Gowdahalli	Dasanapura	North	20	4	9	Vacant
64	Gundur	Bidarahalli	East	66	1	5	Vacant
65	Gunjur	Varthur	East	285	6	0	Depot-41 & Quarters
66	Gunjurpalya	Varthur	East	109,53	20	0	Vacant
67	Hadosiddapura	Varthur	East	62	1	27	Vacant(Fenced)
68	Hancharahalli	Bidarahalli	East	52	13	30	Vacant
69	Hancharahalli	Bidarahalli	East	51	1	0	Vacant
70	Hebbal	Kasaba	North	82/1,84/4	7	34	Depot-28
71	Hennur	Yashavanthapura		CA Site 04	3	28	Depot-10
72	Hesaragatta	Hesaraghatta	North(add)	32:3A	0	23	Bus stand
73	Hirandahalli	Bidarahalli	East	39P/1	13	39	Vacant(Fenced)
74	Hirandahalli	Bidarahalli	East	82	0	19	Vacant
75	Honnasandra	Dasanapura	North	26	11	28	Vacant
76	Honnasandra	Dasanapura	North	13	7	29	Vacant
77	Hosakote	Kasaba	Hoskote	300	3	14	Depot-39
78	Hosakote (PWD)	Kasaba	Hoskote	314	1	30	Bus stand under construction

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79	HRBR 1st Block(Kalyan nagar)		East	CA-11	1	21	Depot-23
80	HRBR 1st Block Banaswadi		East	CA.Sy no.211	3	10	Vacant
81	HSR Layout	Beguru	South	CA-38	4	21	Depot-25
82	Hucchanapalya	Dasanapura	North	8	16	21	Vacant
83	Huttanahalli	Jala	North(add)	148	7	22	Vacant
84	Huttanahalli	Jala	North(add)	72	3	0	Depot under construction
85	Indiranagara		North	48	3	5	Depot-6 & Quarters
86	ISRO Layout	Uttarahalli	South	CA	1	5	Bus stand
87	ITI	K.R Puram	East	68,62	14	0	D-24,29,Workshop-2
88	Jadigenahalli	Jadigenahalli	Hoskote	233	10	0	Vacant
89	Jayanagara		South	CITB	4	15	Depot-4
90	Jayanagara 4th Block		South	CITB	0	34	TTMC
91	Jayanagara pump house				0	9	Pump house
92	Jayanagara Quarters		South			37 Nos.	Quarters
93	Jeevanbhimanagara			CA	0	31	Bus stand
94	Jigani	Jigani	Anekal	38,39,40	6	0	Depot27 and quarters
95	Jigani bus stand	Jigani	Anekal		0	3	Bus stand
96	K R Puram Bus Stand	K.R Puram	East	915	0	22	Bus stand
97	Kadagrahara	Bidarahalli	East	34	18	4	Vacant(Fenced)
98	Kadaranahalli	Dasanapura	North	42	21	10	Vacant(Fenced)
99	Kadugodi	Bidarahalli	East	259	0	32	Bus stand
100	Kalanayakanahalli	Kasaba	Anekal	24 /1,2,3	5	30	Vacant
101	Kalasipalya		North		4	13	Bus stand under construction
102	Kammasandra	Bidarahalli	East	34	1	32	Vacant
103	Kanminke	Kengeri	South	41	25	0	Vacant
104	Kannalli	Yashavanthapura	North	96	3	24	D-35 & Quarters
105	Kannur	Bidarahalli	East	16	5	0	Vacant
106	Kathriguppe	Uttarahalli	South	48,49,50 ,	5	10	D-13&Samudhaya Bhavana
107	Kathriguppe, Bhavani Housing Society	Uttarahalli	South	CA-7	0	20	Vacant
108	Kavalbyrasandra	Kasaba	North	31	0	15	Bus stand
109	Kavalhosahalli	Kasaba	Anekal	9/1,2	4	37	Depot under construction
110	Kenchanapura	Kengeri	South	8	0	14	Vacant
111	Kengeri	Kengeri	South	111/112 /	6	0	D-12
112	Kengeri	Kengeri	South	33/27/5 0	0	6	Vacant (Shops)
113	Kengeri	Kengeri	South	37/1,	4	20	TTMC&D-37
114	Kengeri - opp. To Shirke Aprt.	Kengeri	South	CA	0	12	Vacant
115	Kengeri Approach Road Kengeri		South	125/2	0	8	Road

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116	Kengeri Additional land Kengeri		South	126, 127, 128	7	15	Vacant
117	Kengeri St. Town	Kengeri	South	CA	0	38	Bus stand under construction
118	Khazisonnenahalli	Bidarahalli	East	22	2	0	Vacant
119	Kittaganur	Bidarahalli	East	21	1	25	Vacant
120	Kittanahalli	Dasanapura	North	47	6	32	Vacant
121	Kodalipura	Attibele	Anekal	97	1	27	Vacant
122	Kodati	Varthur	East	76	8	0	D-42 & Quarters
123	Kodati	Varthur	East	41	1	18	Vacant (Fenced)
124	Kodigehalli	Bidarahalli	East	1	1	21	Vacant
125	Kommaghatta	Kengeri	South	162	2	7	Vacant (Compound)
126	Koramangala	Beguru	South	36	5	0	D-15& TTMC
127	Koramangala Sports Complex Qtrs	Beguru	South			2 Nos	Quarters
128	Kothanur Dinne	Uttarahalli	South	80/2A	3	31	D-34
129	Kuduregere	Dasanapura	North	7	2	10	Vacant
150	Kumaraswamy Layout	Uttarahalli	South	CA	0	12	Bus stand
151	Kurubarahalli	Tavarekere	South	116	5	0	Vacant
152	Laggere	Yashavanthapura	North	92	0	36	Bus stand
153	Lakshmidevinagara	Yashavanthapura	North	1,112	0	8	Bus stand
134	Lingadiranahalli	Yashavanthapura	North	25	0	19	Bus stand
135	Madappanahalli	Hesaraghatta	North(add)	58	18	0	Vacant
136	Madappanahalli	Hesaraghatta	North(add)	59	18	16	Vacant (Compound)
137	Madhugirihalli	Hesaraghatta	North(add)	25	15	0	Vacant
138	Mahanthalingapura	Jigani	Anekal	4,748	40	0	Vacant
139	Mallapura	Kasaba	Nelamangala	5/1, 5/2	0	20	Vacant (Fenced)
140	Mallasandra	Yashavanthapura	North	77	2	0	Bus stan under construction
141	Malleshwaram 18th cross	Yashavanthapura	North		0	13	Bus stand
142	Mandur	Bidarahalli	East	116	4	12	Vacant
143	Mandur	Bidarahalli	East	64,155	32	24	Sy.No.155(Compound) Depot-47
144	Mandur	Bidarahalli	East	128	3	0	Vacant
145	Marathalli	Varthur	East	98	0	28	Bus stand
146	Mattahalli	Dasanapura	North	41/B/1, 2	16	0	Vacant
147	Menasiganahalli	Kasaba	Anekal	30	0	34	Vacant
148	Mulluru	Varthur	East	23	2	0	Vacant
149	Muneshwara Block	Uttarahalli	South	CA	0	32	Bus stand
150	Munnekolalu	Varthur	East	99	2	0	Vacant
151	Nagadasanahalli	yalahank	North(add)	11	2	35	Depot under construction
152	Naganayakanahalli	Uttarahalli	South	48	2	30	Vacant
153	Nagarabhavi 2nd stage 10th Block	Yashavanthapura	North	CA 6/12	2	23	Depot under construction
154	Nagarabhavi 2nd stage 10th Block	Yashavanthapura	North	CA 6/11	0	25	Depot under construction
155	Nagarabhavi 2nd stage 9th Block	Yashavanthapura	North	36/2	0	27	Bus stand

Sl.No	Location Details - Locality/Village	Hobli	Taluk	Survey No./Site No.	Extent of land (Acre-Gunta)		Latest status
156	Nagasandra	Dasanapura	North	21	2	1	Vacant
157	Nagondanahalli	K.R Puram	East	120	2	0	Vacant
158	Nallurahalli	K.R Puram	East	5	2	38	Vacant
159	Nandini Layout		North	CA	0	39	Bus Stand
160	Nandini Layout Quarters (LF-33)		North	1 to 12 of LF		12 Nos	Quarters
161	Nanjamba Agrahara			CA	0	10	Vacant
162	Nimbekaipura	Bidarahalli	East	52	3	0	Vacant
163	N.R.Colony				0	7	Bus Stand
164	Pattanagere Gollahalli	Kasaba	Anekal	18P/4	1	25	Vacant
165	Peenya 1st stage	Yashavanthapura	North	20A-1	1	16	RTO Track
161	Peenya 4th phase	Yashavanthapura	North	481, 482, 483	7	27	Depot-9&22
167	Peenya Quarters	Yashavanthapura	North			20 Nos	Quarters
168	Pillaganahalli	Uttarahalli	south	1	7	18	Depot under construction
169	Pillannagarden	Yashavanthapura	North	CA Site	0	25	Vacant (compound)
170	Poornapragna Layout	Uttarahalli	South	CA	2	34	Depot-33
171	Puradapalya	Tavarekere	South	37	0	27	Vacant
172	Puttenahalli	Yelahanka	North(add)	CA Site 1	1	20	Vacant (fenced)
173	R T Nagara (Ganaenahalli)	Yashavanthapura	North	CA-2	1	14	Depot-14
174	R.P.C Layout (Hampinagara)		North	CA-29P	0	31	Bus Stand
175	Ragihalli	Uttarahalli	Anekal	3	0	34	Vacant
176	Rajarajeshwarinagara	Kengeri	South	CA-10	0	37	Bus Stand
177	Rajarajeshwarinagara	Kengeri	South	CA-11	2	16	D-21
178	Ravugodlu	Uttarahalli	South	6	10	0	Vacant
179	Sadaramangala	K.R Puram	East	60	2	25	Depot under construction
180	Sadenahalli	Hesaraghatta	North(add)	24	10	0	Vacant
181	Sadenahalli	Hesaraghatta	North(add)	20	5	0	Vacant
182	Sadenahalli	Hesaraghatta	North(add)	30	6	0	Depot-46
183	Sathanoor	Jala	North(add)	54	3	0	Vacant
184	Shanthinagara	Beguru	South	443/1/2 3	7	12	TTMC
185	Shanthinagara	Beguru	South	33	3	3	Depot-2
186	Shanthinagara	Beguru	South	33	3	18	Depot-3
187	Shanthinagara (open land infront of South Division)	Beguru	South	33	1	38	Parking
188	Shanthinagara (Security Gate)	Beguru	South	33	0	4	security Gate
189	Shanthinagara (Cycle stand)	Beguru	South	33	0	6	Cycle stand
190	Shanthinagara (Hospital)	Beguru	South	33	0	12	hospital
191	Shanthinagara (Corpporate office)	Beguru	South	33	2	5	Corporate Office
192	Shanthinagara (RWB)	Beguru	South	33	17	3	RWB

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193	Shanthinagara (CTM (O) Office)	Beguru	South	33	1	12	CTM (O) OFFICES
194	Shanthinagara (infront of TTMC)	Beguru	South	33	0	34	Parking
193	Shanthinagara PWD and SIHS Qtrs	Beguru	South			130 Nos	Quarters
196	Shivajinagar		North	43/2-1, 4112-1	1	17	Bus stand
197	Shivajinagar Additional land		North		0	12	Bus stand
198	Shivajinagar (Petrol bunk Additional land)		North		0	6	Bus stand
199	Shivakote	Hesaraghatta	North(add)	24	6	0	Vacant (fenced)
200	Shivanahalli	Jigani	Anekal	43	3	29	Vacant
201	Shivanahalli	Jigani	Anekal	13	4	36	Vacant
202	Shivanahalli	Jigani	Anekal	58	3	14	Vacant
203	Shivanapura	Dasanapura	North	116	5	0	Depot-43 & Quarters
204	Singapura	Yelahanka	North(add)	109	0	24	Bus stand
205	Siddapura	Varthur	East	6	1	0	Vacant
206	Siddapura	Varthur	East	3/1A-P-1	2	21	Vacant
207	Somanahalli	Uttarahalli	South	242	5	0	Vacant
208	Srigandadakaval (Summanahalli)	Yeshavanthapura	North	6,068	4	0	Depot-31
209	St.Johns Prestige Woods Apartments (Tavarekere)	Beguru	South	47Nos.			Apartments
210	Subhash Nagara		North	91	7	4	Depot-7 &KBS Bus stand
211	Subhash Additional Land	Nagara	North	92	1	22	Depot-7
212	Sulivara	Tavarekere	South	60	10	0	Vacant
213	Surya City	Chandapura	Anekal	CA	5	0	D-32
214	Tavarekere (Magadi Road)	Tavarekere	South	61&62	0	20	Vacant
215	Thammanayakanahalli Kasaba		Anekal	23	4	0	Vacant
216	Thotagere	Dasanapura	North	26	13	15	Vacant
217	Uttari	Uttarahalli	South	165	2	2	Vacant (compound)
218	Uttari	Uttarahalli	South	70	1	13	Vacant (compound)
219	Vaddarahal 1 i	Dasanapura	North	27 & 28	23	28	Training institute
220	Vartur	Varthur	East	123	2	20	Vacant
221	Vartur	Varthur	East	118/5	1	36	Vacant
222	Venkatapura	Dasanapura	North	14	8	0	Vacant (compound)
223	Venkatapura	Dasanapura	North	12	6	0	Vacant
224	Vidyaranyapura	Yelahanka	North(add)	CA	0	32	Bus stand
225	Vijaynagara	Kasaba	North	132,33	3	37	TTMC
226	Vijaynagara Multi Purpose Land		North	541C	0	1	Multipurpose building
227	Vishweshawaraiah Layout	Kengeri	South	CA-16	0	22	Vacant (compound)

Sl.No	Location Details - Locality/Village	Hobli	Taluk	Survey No./Site No.	Extent of land (Acre-Gunta)		Latest status
228	Visweshvariaha layout			CA No.	2	29	Vacant
229	Viveknagara		North	CA	0	8	Bus stand
230	Whitefield ITPL	K.R Puram	East	120A	3	0	Depot-18 & TTMC
231	Yelachaguppe Rampura	Tavarekere	South	4	1	18	Vacant
232	Yelahanka	Yelahanka	North(add)	69	13	20	Depot-11 & 30
233	Yelahanka 5th phase	Yelahanka	North(add) CA		1	2	Bus stand
234	Yelahanka Satt. Town	Yelahanka	North(add) CA		0	25	Bus stand
235	Yelahanka school land	Yelahanka	North(add)		0	32	Bus stand
236	Yeshwanthapura	Yeshwanthapura	North	38, 37, 41	9	18	Depot-8&26, TTMC
237	Yeshwanthapura (Gopal Theatre)	Yeshwanthapura	North		0	4	Road Purpose

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